SERVICE MANUAL

INDUSTRIAL ENGINE

TN

4TN107HT

4TN107TT

4TN107FHT

4TN107FTT

YANMAR

California
Proposition 65 Warning

Diesel engine exhaust and some of its constituents are known to the state of California to cause cancer, birth defects, and other reproductive harm.

Foreword:

This Service Manual has been developed for the exclusive use of service and repair professionals such as YANMAR authorized distributors and YANMAR authorized dealers. It is written with these professionals in mind and may not contain the necessary detail or safety statements that may be required for a non-professional to perform the service or repair properly and/or safely. Please contact an authorized YANMAR repair or service professional before working on your YANMAR product.

Disclaimers:

All information, illustrations and specifications in this manual are based on the latest information available at the time of publishing. The illustrations used in this manual are intended as representative reference views only. Moreover, because of our continuous product improvement policy, we may modify information, illustrations and/or specifications to explain and/or exemplify a product, service or maintenance improvement. We reserve the right to make any change at any time without notice. YANMAR is a registered trademark of YANMAR POWER TECHNOLOGY CO., LTD. in Japan, the United States and/or other countries.

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Please be sure to follow the necessary procedure.

SERVICE MANUAL	MODEL	4TN107HT, 4TN107TT, 4TN107FHT, 4TN107FTT
	CODE	0BTN4-EN0700

Contents

This service manual is divided into eight sections from 0000 to 7000 as shown below, and each section explains about the specified items. With these four digits, engine parts, equipment, and functions are described. The first section, "0000 Engine information" gives you general engine information related to the warranty, safety, specifications, outline, and periodic maintenance.

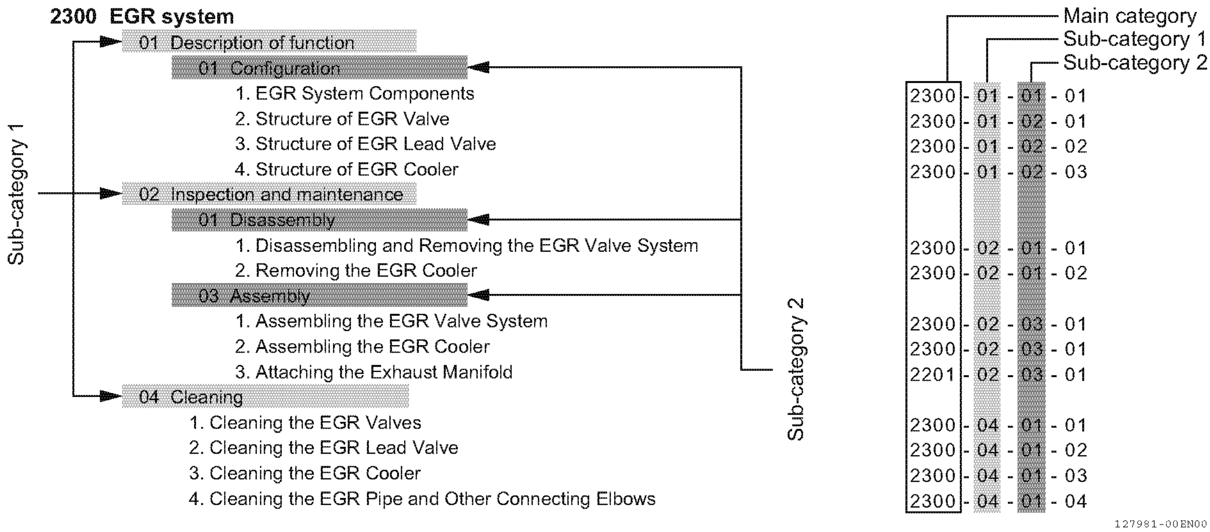
0000	**Engine information**			
0∗00	**Main engine component**	∗ :	1 Engine 2 Cylinder block	3 F/W housing and oil pan 4 Timing gear
1∗00	**Maine engine moving parts**	∗ :	1 Camshaft 2 Piston, Connecting rod	3 Crankshaft 4 Cylinder head assembly
2∗00	**Intake/exhaust system**	∗ :	1 Intake system 2 Exhaust system 3 EGR system	4 Turbocharger 5 After-treatment system
3000	**Lubrication system**			
4000	**Cooling system**			
5000	**Fuel system**			
7∗00	**Electrical/control system**	∗ :	1 Electrical equipment 2 Wire harness	3 Sensors 4 Electronic control system

In the main category, the additional two digits are applied to further divide into sub-category 1 and sub-category 2 to describe more specific information.

Sub-category 1		Sub-category 2	
01	Description of function	01	Components
02	Inspection and maintenance	01	Disassembly
		02	Inspection
		03	Assembly
		04	Maintenance
03	Adjustment		
04	Cleaning		

In the table of contents, specific information is given in accordance with the categories with ten numerals. The first four digits indicate the category, the next two digits indicate sub-category 1, and the following two digits indicate sub-category 2, in a sequence. The last two digits next to the sub-category 2 identify the contents of the sub-category 2. Therefore, depending on the description of functions or parts, sub-category 1 or sub-category 2 may be omitted, or the order may be reversed.

Here is the example for "2300 EGR system".



For the EGR system cooler installation, you can refer to 2300-02-03-01, that is composed of "2300 (part) - 02 (Inspection and maintenance) - 03 (Assembly) - 01 (Assembling the EGR cooler)". On each page, this ten digit reference number is indicated at the upper right.

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1400 Cylinder head assembly

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* Applicable only to EU Stage V certified models

Introduction

This service manual describes the maintenance procedure for the 4TN107 engine (direct injection type with high-pressure common rail system (EU Stage V certified model has DPF + SCR after-treatment device)). The engines in this series are industrially certified by EPA in the United States, ARB in state of California, EU Stage IIIA or EU Stage V in Europe, or equivalent.

Please use this manual for accurate, quick and safe servicing of the engine. The engine described in this manual has standard specifications, and the specifications and components may differ from the engine customized for each customer. Refer to the documentation supplied by the optional equipment manufacturer for specific service instructions.

In addition, SMARTASSIST-DIRECT (SA-D), which is YANMAR's failure diagnosis tool, is required for some parts replacement and troubleshooting of the 4TN107 engine. Please read both Troubleshooting Manual and SMARTASSIST-DIRECT Operation Manual.

YANMAR products are continuously undergoing improvement. This Service Manual might not address possible field modifications to the equipment.

1. YANMAR Limited Warranty

■ What is covered by this warranty?

YANMAR warrants to the original retail purchaser that a new 4TN107 industrial engine will be free from defects in material and/or workmanship for the duration of the warranty period.

- YANMAR engines may be equipped with external components including, but not limited to: wiring harnesses, electrical devices, control panels, radiators, air filters, fuel filters, and/or exhaust systems that are supplied and/or installed by manufacturers other than YANMAR. For warranty information on such external components, please contact the machine or component manufacturer directly.

This warranty is provided in lieu of all other warranties, express or implied. YANMAR specifically disclaims any implied warranties of merchantability or fitness for a particular purpose, except where such disclaimer is prohibited by law. If such disclaimer is prohibited by law, then implied warranties shall be limited in duration to the life of the express warranty.

■ How long is the warranty period?

The YANMAR standard limited warranty period runs for a period of twenty-four (24) months or twothousand (2000) engine operation hours, whichever occurs first. An extended limited warranty of thirtysix (36) months or three thousand (3000) engine operating hours, whichever occurs first, is provided for these specific parts only: the cylinder block, cylinder head, crankshaft forging, connecting rods, flywheel, flywheel housing, camshaft, timing gear, and gear case. The warranty period for both the standard limited warranty and the extended limited warranty (by duration or operation hours) begins on the date of delivery to the original retail purchaser and is valid only until the applicable warranted duration has passed or the operation hours are exceeded, whichever comes first.

■ What the engine owner must do:

If you believe your YANMAR engine has experienced a failure due to a defect in material and/or workmanship, you must contact an authorized YANMAR industrial engine dealer or distributor within thirty (30) days of discovering the failure. You must provide proof of ownership of the engine, proof of the date of the engine purchase and delivery, and documentation of the engine operation hours. Acceptable forms of proof of delivery date include, but are not limited to: the original warranty registration or sales receipts or other documents maintained in the ordinary course of business by YANMAR dealers and/or distributors, indicating the date of delivery of the YANMAR products to the original retail purchaser. This information is necessary to establish whether the YANMAR product is still within the warranty period. Thus, YANMAR strongly recommends you register your engine as soon as possible after purchase in order to facilitate any future warranty matters.

You are responsible for the transportation of the engine to and from the repair location as designated by YANMAR.

■ To locate an authorized YANMAR industrial engine dealer or distributor:

You can locate your nearest authorized YANMAR industrial engine dealer or distributor by visiting the YANMAR website at:

https://www.yanmar.com

- Click on “Dealer Locater” in the website heading to view the “Dealer Locater” menu.
- Choose the Product Category from the pull down menu.
- Choose the country from the pull down menu.
- Click on “Search” to browse YANMAR dealer or distributor.

■ What YANMAR will do:

YANMAR warrants to the original retail purchaser of a new YANMAR engine that YANMAR will make such repairs and/or replacements at YANMAR’s option, of any part(s) of the YANMAR product covered by this warranty found to be defective in material and/or workmanship. Such repairs and/or replacements will be made at a location designated by YANMAR at no cost to the purchaser for parts or labor.

■ What is not covered by this warranty?

This warranty does not cover parts affected by or damaged by any reason other than defective materials or workmanship including, but not limited to, accident, misuse, abuse, natural disaster, neglect, improper installation, improper maintenance, improper storage, the use of unsuitable attachments or parts, the use of contaminated fuels, the use of fuels, oils, lubricating oils, or fluids other than those recommended in your YANMAR Operation Manual, unauthorized alterations or modifications, ordinary wear and tear, and rust of 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, injectors, lubricating oils, and cleaning fluids. Use genuine YANMAR parts for the air cleaner element, lubricating oil filter, and fuel filter. The warranty does not cover failures or malfunctions caused by the use of non-genuine parts.
This warranty does not cover the cost of shipping the products to or from the warranty repair facility.

■ 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 limitation 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.

■ 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.

1. Safety Statements

YANMAR is concerned for your safety and your machine's condition. Safety statements are one of the primary ways to call your attention to the potential hazards associated with YANMAR engine operation. Follow the precautions listed throughout the manual before operation, during operation, and during periodic maintenance procedures for your safety, the safety of others and to protect the performance of your engine.

Keep the labels from becoming dirty or torn and replace them if they are lost or damaged.Keep the labels from becoming dirty or torn and replace them if they are lost or damaged. Also, if you need to replace a part that has a label attached to it, make sure you order the new part and label at the same time.

This safety symbol is used with most safety precautions.
It is a precaution and a warning. It tells you: Be careful! This is about your safety!
Carefully read and obey the instruction that comes with this symbol.

DANGER — DANGER indicates a hazardous situation which, if not avoided, will result in death or serious injury.

WARNING — WARNING indicates a hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION — CAUTION indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

NOTICE — NOTICE indicates a situation which can cause damage to the machine, personal property and / or the environment or cause the equipment to operate improperly.

A-00000-00005-A-01_EN

Fig. 00-1 Signal words

2. Basic Precautions

2.1 Danger

⚠ DANGER

High Pressure Hazard!

- This engine uses a high-pressure common rail system. For disassembly of the high-pressure parts (e.g. the high-pressure pipe) in particular, be sure to wait for approximately 10 to 15 minutes before performing disassembly.
- Do not loosen the high-pressure fuel injection lines while the engine is running, even in low idle. This is dangerous because fuel under high pressure will blow out.
- Failure to comply will result in death or serious injury.

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.

Explosion Hazard!

- Keep the area around the battery well-ventilated. While the engine is running or the battery is charging, hydrogen gas is produced which can be easily ignited.
- Keep sparks, open flame and any other form of ignition away while the engine is running or battery is charging.
- Never check the remaining battery charge by shorting out the terminals. This will result in a spark and may cause an explosion or fire. Use a hydrometer to check the remaining battery charge.
- If the electrolyte is frozen, slowly warm the battery before you recharge it.
- Failure to comply will result in death or serious injury.

Precautions against unintentional starting of the engine

- Never jump-start the engine by shorting the starter terminal and battery terminal. If the gears engage while the safety circuit of the driven machine is turned off, the driven machine can unexpectedly move.
- Failure to comply will result in death or serious injury.

DANGER

Fire and Explosion Hazard!

- Diesel fuel is extremely flammable and explosive under certain conditions.
- When you remove any fuel system component to perform maintenance (such as changing the fuel filter) place an approved container under the opening to catch the fuel.
- Never use a shop rag to catch the fuel. Vapors from the rag are flammable and explosive.
- Wipe up any spills immediately.
- Wear eye protection. The fuel system is under pressure and fuel could spray out when you remove any fuel system component.
- Only use the key switch to start the engine.
- Never jump-start the engine by shorting the starter terminal and battery terminal. This will result in a spark and may cause a fire or explosion.
- Only fill the fuel tank with diesel fuel. Filling the fuel tank with gasoline may result in a fire and will damage the engine.
- Never refuel with the engine running.
- Keep sparks, open flames or any other form of ignition (match, cigarette, static electric source) well away when refueling.
- Never overfill the fuel tank.
- Fill the fuel tank. Store any containers containing fuel in a well-ventilated area, away from any combustibles or sources of ignition.
- Be sure to place the diesel fuel container on the ground when transferring the diesel fuel from the pump to the container. Hold the hose nozzle firmly against the side of the container while filling it. This prevents static electricity build up which could cause sparks and ignite fuel vapors.
- Never place diesel fuel or other flammable material such as oil, hay or dried grass close to the engine during engine operation or shortly after shutdown.
- Before you operate the engine, check for fuel leaks. Replace rubberized fuel hoses every two years or every 2000 hours of engine operation, whichever comes first, even if the engine has been out of service. Rubberized fuel lines tend to dry out and become brittle after two years or 2000 hours of engine operation, whichever comes first.
- Never remove the fuel cap with the engine running.
- Never use diesel fuel as a cleaning agent.
- Failure to comply will result in death or serious injury.

Crush Hazard!

- When you need to transport an engine for repair, have a helper assist you to attach it to a hoist and load it on a truck.
- Never stand under a hoisted engine. If the hoist mechanism fails, the engine will fall on you, causing death or serious injury.
- Failure to comply will result in death or serious injury.

2.2 Warning

⚠ 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 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 running.
- 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.

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 running 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.

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.

Hazardous Substance Hazard!

- Always read and follow safety related precautions found on containers of hazardous substances like parts cleaners, primers, sealants and sealant removers.
- When removing the soot filter from the DPF for cleaning purposes, soot ash in the filter may scatter. Wear gloves, anti-dust mask, eye protection and other protective equipment.
- When transporting a DPF unit with a soot filter for maintenance or cleaning, fix it firmly in the package to prevent soot ash scattering during transport.
- Soot Ash removed from the soot filter may be considered as industrial waste. Adequate provision must be assured for the containment of the material once it is removed. Disposal should be performed in accordance with local laws and regulations.
- Failure to comply could result in death or serious injury.

⚠ 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! (1)

- If you must drain the engine lubricating oil while it is still hot, stay clear of the hot engine lubricating 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 and engine block during operation and shortly after you shut the engine down. These surfaces are extremely hot while the engine is running and could seriously burn you.
- Failure to comply could result in death or serious injury.

Burn Hazard! (2)

- 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!

- While the engine is running or right after the engine has stopped, there is still high pressure fuel left in the fuel piping system. When you need to disassemble the fuel system, wait for 10 to 15 minutes after stopping the engine.
- If fuel is spraying out or leaking from broken fuel system such as high-pressure fuel injection lines, it may be in high pressure. Avoid skin contact. 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.
- Disassembling or repairing the fuel system shall be done by professionals such as the authorized YANMAR distributor or dealer.
- Failure to comply could result in death or serious injury.

Shock Hazard!

- Turn off the battery switch (if equipped) or disconnect the negative battery cable before servicing the electrical system.
- Check the electrical harnesses for cracks, abrasions, and damaged or corroded connectors. Always keep the connectors and terminals clean.
- Failure to comply could result in death or serious injury.

⚠ WARNING

Entanglement Hazard!

- Stop the engine before you begin to service it.
- Never leave the key in the key switch when you are servicing the engine. Someone may accidentally start the engine and not realize you are servicing it. This could result in a serious injury.
- If you must service the engine while it is running, 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.

Sudden Movement Hazard!

- Engaging the transmission or PTO at an elevated engine speed could result in unexpected movement of the equipment.
- Failure to comply could result in death or serious injury.

Caution Relating to ECU (Engine Controller) and DCU (Dosing Control Unit (Applicable only to EU Stage V certified models))

- Using non-designated ECU/DCU, writing non-designated data to the ECU/DCU, leaving it broken, or removing sensors and actuators. Doing so could result in the violation of emission control regulations and will void the product warranty.
- Be sure to use th ECU and DCU with the specified engine type. Also use the ECU in conjunction with the engines with specified serial number. Using ECU and DCU with other engine combinations that are not specified will void the engine warranty.
- When replacing the fuel injector, you need to rewrite the fuel injection quantity adjustment data in the ECU. You will need YANMAR's genuine SMARTASSIST-DIRECT (SA-D) for rewriting the data. Always contact your authorized YANMAR dealer who can handle SMARTASSIST-DIRECT (SA-D).
  ECU that does not have the proper fuel injection quantity adjustment data written will void the engine warranty.
- When replacing sensors related to SCR catalysts, or replacing DM (Dosing Module), DCU data needs to be re-written. You will need YANMAR's genuine SMARTASSIST-DIRECT (SA-D) for re-writing. Always contact your authorized YANMAR dealer who can handle SMARTASSIST-DIRECT (SA-D).
- When replacing the ECU or DCU, you will need SMARTASSIST-DIRECT (SA-D) for transferring data from the old ECU or DCU to the new ECU or DCU. Contact your authorized YANMAR dealer who can handle SMARTASSIST-DIRECT (SA-D).
  If the data is not correctly transferred to the new ECU, the engine performance cannot be ensured.
- Improper use or misuse of the ECU may result in death or serious injury due to an abrupt and unexpected increase in engine speed.

Caution when the Stationary Regeneration Request Lamp of the Diesel Particulate Filter (DPF) Comes On (Applicable only to EU Stage V certified models)

- A DPF collects particulate matter (PM) with a soot filter (SF). Since the PM collected in the SF will cause clogging if left as it is, the accumulated PM needs to be burned (regenerated) by self-regeneration, assisted regeneration, or reset regeneration. There are cases in which PM cannot be burned (the DPF cannot be regenerated) if operating conditions such as idling with no load or low-speed, low-load operation are repeated frequently. If the ECU determines that the stationary regeneration is required to burn the accumulated PM, the DPF regeneration request lamp attached to the controller of the driven machine comes on.
- If the DPF regeneration request lamp comes on, immediately perform the stationary regeneration. If the engine is continuously operated with the DPF regeneration request lamp left on, PM will accumulate excessively, which may cause it to burn abnormally. This may lead to breakage of the DPF, or fire.

2.3 Caution

⚠ CAUTION

DPF Regeneration (Applicable only to EU Stage V certified models)

- During reset regeneration, post-injection is used and fuel is burned directly inside the DPF (burned by chemical reaction inside the DOC). Through this heat, regeneration occurs inside the SF, but the combustion increases the temperature of the exhaust gas to close to 600 °C (1112 °F).
  Stay away from the exhaust gas. Extremely hot exhaust gas may burn you. Be careful that neither people nor flammable materials are near the exhaust gas outlet. Never operate the engine in an enclosed area without proper ventilation.
- Observe the following conditions when performing stationary regeneration.
  - Never operate the engine in an enclosed area. Accumulation of gas may cause carbon monoxide poisoning.
  - Regeneration causes the exhaust gas temperature to increase. To prevent fire, make sure that there are no flammable materials around the exhaust gas outlet.
  - Never tough the exhaust pipe. The temperature of the exhaust gas can be extremely high. Never stand near or around the exhaust gas outlet.

Coolant Hazard!

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

Flying Object Hazard!

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

2.4 Notice

NOTICE

Diesel Fuel

- Poor quality fuel can reduce engine performance and cause damage. Only use diesel fuels recommended by YANMAR for the best engine performance. The recommended fuel complies with the U.S. EPA and ARB protection guidelines.
- The common rail system installed as this engine's fuel injection device is very high in pressure and sprays fuel into the cylinder. If any impurities or water mixes into the fuel, the sliding parts of the fuel system causes friction and may degrade the engine's exhaust gas property durability. Only use clan diesel fuel.
- Keep the fuel tank and fuel-handling equipment clean at all times. Be careful not to let any contaminants or even dust from the outside into the filler port when supplying fuel.
- Never remove the primary strainer (if equipped) from the fuel tank filler port. If removed, dirt and debris could get into the fuel system causing it to clog.
- Be sure to use YANMAR genuine filter for replacing the fuel filter or the water separator.

Engine Lubricating Oil

- Only use the engine lubricating oil specified. Other engine lubricating oils may affect warranty coverage, cause internal engine components to seize and/or shorten engine life.
- Prevent dirt and debris from contaminating the engine lubricating oil. Carefully clean the oil cap/dipstick and the surrounding area before you remove the cap.
- Never mix different types of engine lubricating oil. This may adversely affect the properties of the engine lubricating oil.
- Always keep the oil level between the upper and lower lines on the oil dipstick.
- Never overfill the engine lubricating oil. Overfilling may result in white exhaust smoke, engine overspeed or internal damage.
- Be sure to use YANMAR genuine filter for replacing the engine lubricating oil filter.

Engine Coolant

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

Urea Water (Applicable only to EU Stage V certified models)

- Only use the urea water specified. Other urea water may affect warranty coverage.
  The quality and composition of the urea water are very important. Using low-quality urea water can degrade the NOx purification rate, and cause system failure.
- Urea water can freeze and expand its volume very easily. Be careful not to break the device when handling at low temperature.
- When storing the urea water, its expiry period depends on the storage temperature.
  Refer to the manual provided by the manufacturer of the urea water for details.
- When handling the urea water, do not use items like gloves or the like. Fibers may get into the urea water. It may clog the urea water filter, or cause urea deposit at the Dosing Module (DM) exhaust nozzle.
- When filling diesel fuel, do not fill the urea water tank with the diesel fuel. Also, do not fill the fuel tank with the urea water.

NOTICE

Inspecting and Starting

- If any problem is noted during the visual check, the necessary corrective action should be taken before you operate the engine.
- This is an electric feed pump. When you prime the fuel system, turn the key switch to the ON position for 10 to 15 seconds. Air inside the fuel will bleed automatically.

- If any indicator fails to illuminate when the key switch is in the ON position, see your authorized YANMAR industrial engine dealer or distributor for service before operating the engine.

- Never hold the key in the START position for longer than 15 seconds. Take a pause at least 30 seconds until the restart. The starter motor may overheat and cause damage.

- If the engine fails to start, wait until the engine comes to a complete stop before you attempt to start it again. Engaging the starter while the engine is still rotating will result in damage to the starter and flywheel.

- Never use an engine starting aid such as ether. Engine damage will result.

- Never move the key to the START position while the engine is running. This may damage the starter motor pinion and/or ring gear.

Engine Break-in Period

- New engine break-in:
  - On the initial engine start-up, allow the engine to idle for approximately 15 minutes while you check for proper engine lubricating oil pressure, diesel fuel leaks, engine lubricating oil leaks, coolant leaks, and for proper operation of the indicators and/or gauges.
  - During the first hour of operation, vary the engine speed and the load on the engine.
    Short periods of maximum engine speed and load are desirable. Avoid prolonged operation at minimum or maximum engine speeds and loads for the next four to five hours.
  - During the break-in period, carefully observe the engine lubricating oil pressure and engine temperature.
  - During the break-in period, check the engine lubricating oil and engine coolant levels frequently.

- Make sure the engine is installed on a level surface. If the engine is continuously operated at an angle greater than 30° in any direction, or the engine is operated for a short period of time (less than three minutes) at an angle greater than 35°, the engine lubricating oil may enter the combustion chamber, causing excessive engine speed or white exhaust smoke. This may cause serious engine damage.

NOTICE

Alarm System

- If there is a problem with the engine and/or its control components, the engine failure lamp comes on and indicates the status. If the engine failure lamp comes on during engine operation, stop the engine immediately. Do not keep running the engine while th engine failure lamp is on. It will not only void the engine warranty, but could result in a serious malfunction or damage to the engine. Determine the cause and repair the problem before you continue to operate the engine.

- The illustrations and descriptions of optional equipment in this manual, such as the operator's console, are for a typical engine installation. Refer to the documentation supplied by the optional equipment manufacturer for specific operation and maintenance instructions.

Environment Conditions for Operation

- Observe the following environmental operating conditions to maintain engine performance, and avoid premature engine wear:
  - Avoid operating in extremely dusty conditions.
  - Avoid operating in the presence of chemical gases or fumes.
  - Avoid operating in a corrosive atmosphere such as salt water spray.
  - Never expose the engine to the rain.
  - If the ambient temperature exceeds +40 °C, or falls below -20 °C, there are possibilities of:
    - If the ambient temperature exceeds +40 °C: overheating, degradation of lubricating oil, or electrical equipment failure.
    - If the ambient temperature falls below -20 °C: damages due to the hardening of the rubber parts, and engine start failure.
    - Contact your authorized YANMAR dealer or distributor when using the engine in such temperature range.
- Further, for engines with turbochargers, be aware that leaving them idling or working in low-load in an environment with ambient temperature below -15 °C (+5 °F) may freeze the intake pipe. If this continues, operate the engine with proper load every three hours to prevent the engine from freezing.
- Contact your authorized YANMAR industrial dealer or distributor if it is required to operate the engine at high altitude. Operating the engine at high altitude reduces the engine power, de-stabilizes the operation, and generates exhaust gas that exceeds the design specifications.

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

- The maximum air intake restriction, in terms of differential pressure measurement, must not exceed 6.23 kPa. Clean or replace the air cleaner element if the air intake restriction exceeds the above mentioned value.

Engine Stop

- For maximum engine life, YANMAR recommends that when shutting the engine down, you allow the engine to idle, without load, for five minutes. This will allow the engine components that operate at high temperature, such as the turbocharger (if equipped) and exhaust system, to cool slightly before the engine itself is shut down.

NOTICE

Battery and Electrical Equipment

- Always keep the battery in a best charged state. Electronic controlled engines may not be able to start.

- Use a specialized battery charger to recharge a battery with a voltage of 8 V or less. Booster charging a battery with a voltage of 8 V or less will generate an abnormally high voltage and damage electrical equipment. If using a rapid charger to recharge the battery is unavoidable, do not insert and turn the starter key to the ON position while the battery is being charged. Avoid using a charger equipped with a boost function (cell start assist) to start the engine. Excessive voltage will be applied and will damage the ECU.

- If the battery cables are connected reversely on the engine or battery, the current limiter's SCR diode may be damaged. If the SCR diode is damaged, the charging system will not operate properly, resulting in damage to the electrical wiring.

- Do not remove the positive (+) battery cable from the alternator terminal B while the engine is running. This will result in damage to the alternator.

- Do not turn the battery switch (if equipped) OFF while the engine is running. This will result in damage to the alternator.

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

- Make sure that the combined total resistance of the battery cable in both directions between the starter motor and the battery is within the value indicated in the battery cable resistance in the electric wiring section. The starter motor will malfunction or break down if the resistance is higher than the specified value.

- When the battery indicator goes out, it should not come on again. The battery indicator only comes on during operation if the alternator fails or if the V-belt breaks. However, if an LED is used in the battery indicator, the LED may faintly be lit during normal operation.

- If you use a non-specified V-belt, it will cause inadequate charging and shorten the belt life. Use the specified belt.

- Do not connect the alternator terminals IG and L in the charging system. This will result in damage to the alternator.

- Do not connect a load between the alternator terminals L and E. This will result in damage to the alternator.

- Do not operate the engine if the alternator is producing unusual sounds. This will result in damage to the alternator.

- Agricultural or other chemicals, especially those with a high sulfur content, can adhere to the IC regulator. This will corrode the conductor, and result in battery over-charging (boiling) and charging malfunctions. Consult YANMAR before using the equipment in such an environment. Otherwise, the warranty is voided.

NOTICE

ECU (Engine Controller) and DCU (Dosing Control Unit (Applicable only to EU Stage V certified models))

- Do not insert or remove the ECU for a period of at least 60 seconds after power supply to the unit has been turned ON or OFF.
- Do not insert or remove the connector when the DCU power supply is ON. Moreover, when the key switch is turned OFF, and you have confirmed that the after-run has finished (by checking from the operation noise of the SM, or defining the time required to shut down the DCU after turning OFF the key (approx. 10 minutes)), remove the connector.
- Do not touch the connector pins of the ECU and DCU directly with your hands. Doing so may result in corrosion of the connector pins and/or damage to the internal circuits of the ECU and DCU due to static electricity.
- Do not forcefully insert a tester's measuring probe into the connector's female coupler. Doing so may cause malfunction due to defective contact of the connector pins.
- Be careful not to let water get into the coupler when removing/inserting a connector. It may cause malfunction due to corrosion of the connector pins.
- Do not remove/insert the connectors more than 10 times. Doing so may cause malfunction due to defective contact of the connector pins.
- Do not use a ECU or DCU that has been dropped or has fallen.
- Do not disassemble the ECU and DCU terminals.

Urea SCR System (Applicable only to EU Stage V certified models)

- When the engine key is turned off, if any urea water remains in the urea water passage, it will freeze and expand, or dry-up leaving deposits. As a result, it will damage the devices. In order to prevent damage, the SM sucks back to the tank any urea water remaining in the passage (after-run). After the engine key is turned off and a waiting time of a few minutes has passed, the urea water is sucked back. The operation is complete in a maximum of about 10 minutes. Do not shut down the power (for example by removing the wiring from the battery) until the suction is complete and the DCU power turns off.
- When storing the machine for a long period of time, if the SM membrane dries, the sealing property deteriorates, and the SM cannot suck urea water. As a result, it may not be possible to start the engine. In this case, fill urea water from the SM inlet, then the engine may be started.
- Since the DM becomes hot due to valve operation, it is cooled using the engine coolant. Only use the specified engine coolant (see 0000-10-03-01 "Engine Coolant"). If you need to conduct inspection or repair work, do not touch it until the temperature decreases.
- A heater is built into the NOx sensor (sensor part), and performs self-heating. While measuring NOx concentration, the temperature of the sensor will increase to approximately 150 °C. If you need to conduct inspection or repair work, do not touch it until the temperature decreases.
- Do not insert or remove a connector of the controller when the power supply is ON.
- Do not use a NOx sensor that has been dropped or has fallen.
- Do not touch or disassemble the NOx sensor with your hands.

NOTICE

High-pressure Cleaning

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

- Never use high-pressure water or compressed air at greater than 193 kPa, or a wire brush to clean the radiator fins. Radiator fins will become damaged easily.

- Do not directly clean the alternator using high-pressure water. This will damage the alternator, resulting in inadequate charging.
- The starter motor is water-proofed according to JIS D 0203, R2 to protect the starter motor from rain or while cleaning. Do not use high-pressure water or submerse the starter motor in water when cleaning it.
- Avoid using high-pressure water for cleaning the electronic or electric devices installed on the engine, including the ECU, DCU (applicable only to EU Stage V certified models), relays, or harness couplers.
- Otherwise, water may intrude to such devices, and cause malfunction.

Periodic Maintenance

- Establish a periodic maintenance plan according to the engine application, and make sure you perform the required periodic maintenance at intervals. Failure to follow these guidelines will impair the engine's safety and performance characteristics, shorten the engine's life, and may affect the warranty coverage on your engine.
- Periodic maintenance prevents unexpected downtime, reduces the number of accidents due to poor machine performance and helps extend the life of the engine.

- The tightening torque in the Standard Torque Chart (see General Service Information section) should be applied only to the bolts with a "7" head. (JIS strength classification: 7T)
- For 4T bolts and locknuts, apply 60 % of the torque listed in the table (0000-07-03-01).
- If aluminum alloy is contained in the parts to be tightened, apply 80 % of the torque listed in the table (0000-07-03-01).

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

- 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.

- 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.

- Remove or install the high-pressure fuel injection lines as an assembly whenever possible. If you remove the retainer from the high-pressure fuel injection lines, or bend the lines, it will make it difficult to re-install the lines.

- After marking the position of the supply pump drive gear, do not rotate the engine crankshaft. If you rotate the crankshaft, the injection timing of the supply pump will change.

NOTICE

- Avoid damage to the turbocharger or the engine. Do not spray cleaning fluid or water too strongly. Use short strokes from a spray bottle to inject cleaning fluid or water into the turbocharger.
  If you spray too much cleaning fluid or water, or spray it too strongly, it will damage the turbocharger.

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

- If the waste valve does not meet specifications, replace the turbocharger or have it repaired by a qualified repair facility.

- Never use a steel wire brush to clean fuel injectors. It may damage the nozzles and other components.

- When disassembling the parts, arrange all parts so that they can be re-assembled to the correct location. It is important that all parts are returned to the same position during the reassembly process.

- Keep the piston pins, piston assemblies, and connecting rod assemblies together in one place, so that they can be returned to the same position during the reassembly process. Use labels to identify the parts and installation positions.

- Do not allow the honing tool to continually operate in the same position for any length of time.
  The cylinder wall will be damaged. Use the tool in constant up-and-down motion.

- Any part which is found defective as a result of inspection or any part whose measured value does not satisfy the standard must be replaced.

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

Disposal of Hazardous Materials

- Always be environmentally responsible. Follow the guidelines of the EPA or other governmental agencies for the proper disposal of hazardous material. Failure to follow these procedures may seriously harm the environment.
- Please consult your local government or your local recovery facility for proper treatment of hazardous substances such as engine lubricating oil, diesel fuel, antifreeze and soot filter soot (applicable only to EU Stage V certified models).
- When disposing of urea water, if there is a local nitrogen regulations, dispose of it as industrial waste (applicable only to EU Stage V certified models).
- Never dispose of hazardous materials by dumping them into a sewer, on the ground, or into ground water or waterways.

NOTICE

Engine Modification

- Never attempt to modify the engine's design or safety features such as defeating the engine speed limit control.
- Modifications may impair the engine's safety and performance characteristics, and shorten the engine's life. Any alterations to this engine may void its warranty.
- Never customize the engine design or any safety function such as releasing the engine speed limit or the diesel fuel injection amount limit.
- Modifications may impair the engine's safety and performance characteristics, and shorten the engine's life. Any alterations to this engine may void its warranty.
  Be sure to use YANMAR genuine replacement parts.

Operating the Engine or the Driven Machine

- Never permit anyone to operate the engine or driven machine without proper training.
- Read and understand this Service Manual before you operate or service the driven 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.
- Contact your authorized YANMAR industrial engine dealer for more information about other training available to you.

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1. Engine Names (Codes)

The code of each engine is configured by the following rules.

4 TN 107 F ○○ – ○ ○ ○○○

Customer code

Rated revolution

Classification based on voltage/output setting

1: 12 V Standard
2: 24 V Standard
3: 12 V Derate spec.
4: 24 V Derate spec.
5: 12 V Non-standard
6: 24 V Non-standard

Classification with aspiration

HT: Exhaust gas turbocharger with charge air cooler
TT: 2-stage exhaust gas turbocharger with charge air cooler

Classification based on fuel injection system and exhaust gas after-treatment

F: Common rail + EGR + DPF + SCR (applicable only to EU Stage V certified models)
None: Common rail + EGR

Cylinder bore (mm)

Series name

No. of cylinders

2. Engine General Specifications

Type	Vertical in-line, water cooled, 4-cycle diesel engine
Combustion system	Direct injection
Aspiration	Exhaust gas turbocharger with charge air cooler
Fuel injection system	Common rail
Starting system	Electric starting
Cooling system	Radiator
Lubricating system	Forced lubrication with trochoid pump
PTO position	Flywheel side
Direction of rotation	Counterclockwise (viewed from flywheel side)

Note: The information described in Principal Engine Specifications is for a standard engine. To obtain the information for the engine installed in your driven machine, please refer to the manual provided by the driven machine manufacturer. Engine rating conditions are as follows (SAE J1349, ISO 3046/1):

- *Atmospheric condition: Room temperature 25 °C, atmospheric pressure 100 kPA (750 mmHg), relative humidity 30 %*
- *Fuel temperature at fuel injection pump inlet: 40 ± 3 °C*
- *Fuel feeding pressure: 20 ± 10 kPa*
- *After the engine break-in period with YANMAR standard cooling fan, air cleaner, and muffler equipped.*
- *1 PS = 0.7355 kW*

3. Principal Engine Specifications

■ 4TN107HT

Engine model		4TN107HT	
Version		VM	
Type		Vertical in-line, water cooled, 4-cycle diesel engine	
Combustion system		Direct injection	
Aspiration		Exhaust gas turbocharger with charge air cooler	
Fuel injection system		Common rail	
No. of cylinders		4	
Bore × stroke		Europe and US: ø107.0 × 127.1 mm Japan: ø107.0 × 127.0 mm	
Displacement		Europe and US: 4.571 L Japan: 4.567 L	
At rated output (Limited output)	Engine speed	2000 min^{-1}	2200 min^{-1}
	Gross output	100 kW	110 kW
Top clearance		0.919 ± 0.073 mm (Considering the oil clearance)	
Engine mass (excluding dryer and after-treatment device)		$545\ ^{+10}_{-5}$ 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	
Starting system		Electric starting (Starter motor: DC 24 V / 12 V)	
Dimensions	Overall length	972 mm	
	Overall width	639 mm	
	Overall height	939 mm	
Engine lubricating oil pan capacity	Capacity	20.2 L (deep type)	
	Effective capacity	6.5 L (deep type)	
Engine coolant capacity (total)		8.9 L (engine only)	
Cooling fan type × diameter		Resin suction - ø600 × 7	
Crank V-pulley dia. / Fan V-pulley dia.		ø150 mm / ø150 mm	
Balancer		None	

Engine specifications

■ 4TN107TT

<table>
<tr><td colspan="2">Engine model</td><td colspan="2">4TN107TT</td></tr>
<tr><td colspan="2">Version</td><td colspan="2">VM</td></tr>
<tr><td colspan="2">Type</td><td colspan="2">Vertical in-line, water cooled, 4-cycle diesel engine</td></tr>
<tr><td colspan="2">Combustion system</td><td colspan="2">Direct injection</td></tr>
<tr><td colspan="2">Aspiration</td><td colspan="2">2-stage exhaust gas turbocharger with charge air cooler</td></tr>
<tr><td colspan="2">Fuel injection system</td><td colspan="2">Common rail</td></tr>
<tr><td colspan="2">No. of cylinders</td><td colspan="2">4</td></tr>
<tr><td colspan="2">Bore × stroke</td><td colspan="2">Europe and US: ø107.0 × 127.1 mm
Japan: ø107.0 × 127.0 mm</td></tr>
<tr><td colspan="2">Displacement</td><td colspan="2">Europe and US: 4.571 L
Japan: 4.567 L</td></tr>
<tr><td rowspan="2">At rated output
(Limited output)</td><td>Engine speed</td><td>2000 min^{-1}</td><td>2200 min^{-1}</td></tr>
<tr><td>Gross output</td><td>141 kW</td><td>155 kW</td></tr>
<tr><td colspan="2">Top clearance</td><td colspan="2">0.919 ± 0.073 mm (Considering the oil clearance)</td></tr>
<tr><td colspan="2">Engine mass (excluding dryer and after-treatment device)</td><td colspan="2">560^{+10}_{-5} kg</td></tr>
<tr><td colspan="2">PTO position</td><td colspan="2">Flywheel side</td></tr>
<tr><td colspan="2">Direction of rotation</td><td colspan="2">Counterclockwise (viewed from flywheel side)</td></tr>
<tr><td colspan="2">Cooling system</td><td colspan="2">Liquid-cooled with radiator</td></tr>
<tr><td colspan="2">Lubricating system</td><td colspan="2">Forced lubrication with trochoid pump</td></tr>
<tr><td colspan="2">Starting system</td><td colspan="2">Electric starting (Starter motor: DC 24 V / 12 V)</td></tr>
<tr><td rowspan="3">Dimensions</td><td>Overall length</td><td colspan="2">977 mm</td></tr>
<tr><td>Overall width</td><td colspan="2">743 mm</td></tr>
<tr><td>Overall height</td><td colspan="2">939 mm</td></tr>
<tr><td rowspan="2">Engine lubricating
oil pan capacity</td><td>Capacity</td><td colspan="2">20.2 L (deep type)</td></tr>
<tr><td>Effective capacity</td><td colspan="2">6.5 L (deep type)</td></tr>
<tr><td colspan="2">Engine coolant capacity (total)</td><td colspan="2">9.0 L (engine only)</td></tr>
<tr><td colspan="2">Cooling fan type × diameter</td><td colspan="2">Resin suction - ø650 × 7</td></tr>
<tr><td colspan="2">Crank V-pulley dia. / Fan V-pulley dia.</td><td colspan="2">ø150 mm / ø150 mm</td></tr>
<tr><td colspan="2">Balancer</td><td colspan="2">None</td></tr>
</table>

■ **4TN107FHT**

Engine model		4TN107FHT	
Version		VM	
Type		Vertical in-line, water cooled, 4-cycle diesel engine	
Combustion system		Direct injection	
Aspiration		Exhaust gas turbocharger with charge air cooler	
Fuel injection system		Common rail	
No. of cylinders		4	
Bore × stroke		Europe and US: ø107.0 × 127.1 mm Japan: ø107.0 × 127.0 mm	
Displacement		Europe and US: 4.571 L Japan: 4.567 L	
At rated output (Limited output)	Engine speed	2000 min^{-1}	2200 min^{-1}
	Gross output	100 kW	110 kW
Top clearance		0.919 ± 0.073 mm (Considering the oil clearance)	
Engine mass (excluding dryer and after-treatment device)		545^{+10}_{-5} 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	
Starting system		Electric starting (Starter motor: DC 24 V / 12 V)	
Dimensions	Overall length	972 mm	
	Overall width	639 mm	
	Overall height	939 mm	
Engine lubricating oil pan capacity	Capacity	20.2 L (deep type)	
	Effective capacity	6.5 L (deep type)	
Engine coolant capacity (total)		8.9 L (engine only)	
Cooling fan type × diameter		Resin suction - ø600 × 7	
Crank V-pulley dia. / Fan V-pulley dia.		ø150 mm / ø150 mm	
Balancer		None	

■ 4TN107FTT

Engine model		4TN107FTT	
Version		VM	
Type		Vertical in-line, water cooled, 4-cycle diesel engine	
Combustion system		Direct injection	
Aspiration		2-stage exhaust gas turbocharger with charge air cooler	
Fuel injection system		Common rail	
No. of cylinders		4	
Bore × stroke		Europe and US: ø107.0 × 127.1 mm Japan: ø107.0 × 127.0 mm	
Displacement		Europe and US: 4.571 L Japan: 4.567 L	
At rated output (Limited output)	Engine speed	2000 min^{-1}	2200 min^{-1}
	Gross output	141 kW	155 kW
Top clearance		0.919 ± 0.073 mm (Considering the oil clearance)	
Engine mass (excluding dryer and after-treatment device)		560^{+10}_{-5} 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	
Starting system		Electric starting (Starter motor: DC 24 V / 12 V)	
Dimensions	Overall length	977 mm	
	Overall width	743 mm	
	Overall height	939 mm	
Engine lubricating oil pan capacity	Capacity	20.2 L (deep type)	
	Effective capacity	6.5 L (deep type)	
Engine coolant capacity (total)		9.0 L (engine only)	
Cooling fan type × diameter		Resin suction - ø650 × 7	
Crank V-pulley dia. / Fan V-pulley dia.		ø150 mm / ø150 mm	
Balancer		None	

1. External Appearance and Component Identification

Fig.00-2 shows where the major engine components for 4TN107FTT engine (2-stage turbocharger) are located. Single-stage turbocharger is installed in the 4TN107(F)HT engines.

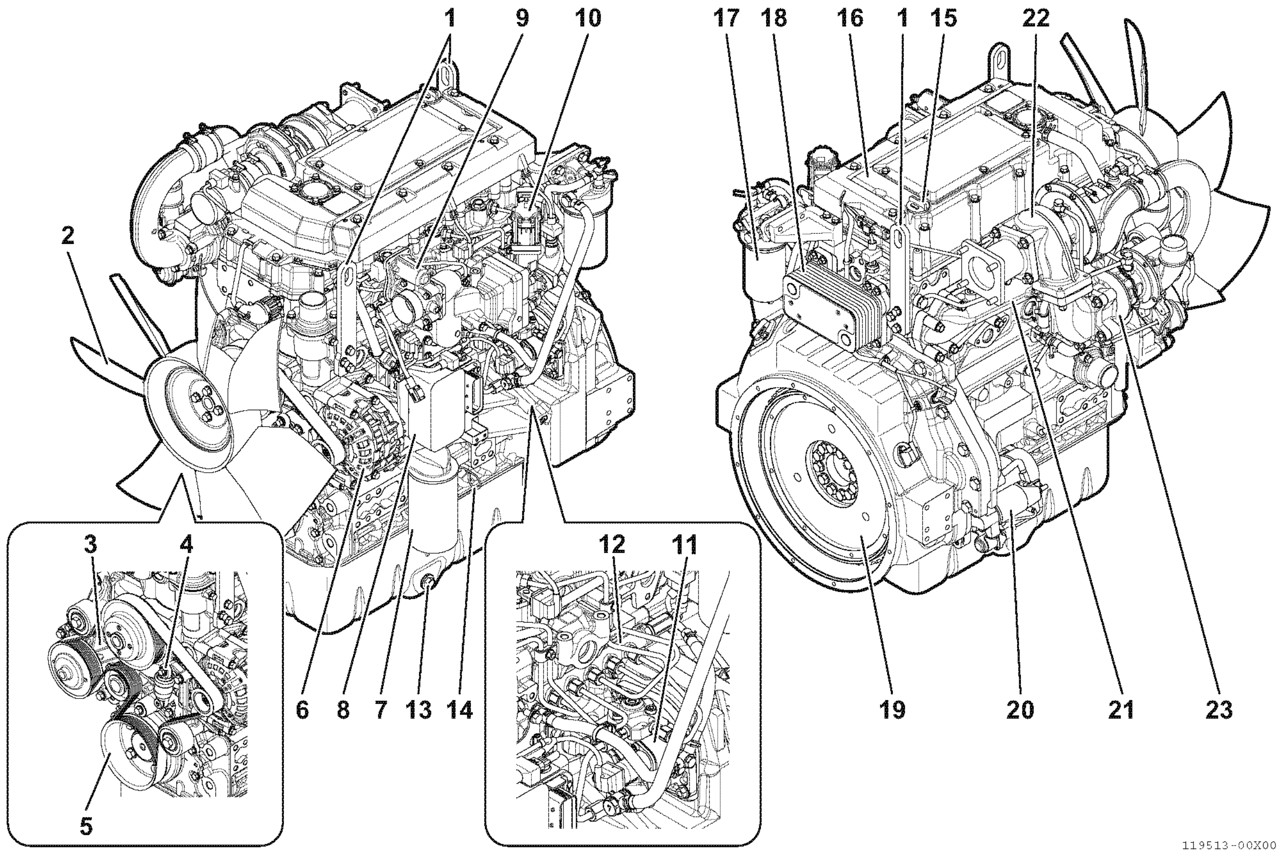


Fig. 00-2

1- Lifting eye (fan side, flywheel side)	12- Common rail
2- Engine cooling fan	13- Engine lubricating oil drain plug*1
3- Engine coolant pump	14- Engine lubricating oil dipstick
4- Belt auto tensioner	15- Filler port for engine lubricating oil
5- Crankshaft V-pulley	16- Bonnet
6- Alternator	17- Fuel filter
7- Engine lubricating oil filter	18- EGR cooler
8- Lubricating oil cooler	19- Flywheel
9- Intake throttle valve (Not applicable to EU Stage III A equivalent certified model (4TN107HT, 4TN107TT))	20- Starter motor
	21- Exhaust manifold
10- EGR valve	22- Low-pressure stage turbocharger
11- Supply pump	23- High-pressure stage turbocharger

**1. The engine lubricating oil drain plug location may vary depending on the oil pan options.*

The after-treatment device (ATD unit: DPF + Urea water SCR) for 4TN107FHT, 4TN107FTT (EU Stage V certified models) is normally installed separately from the engine.

2. Location of Engine Name Plate and Emission Labels

Fig.00-3 shows the location of engine name plate and emission labels on 4TN107 engine.

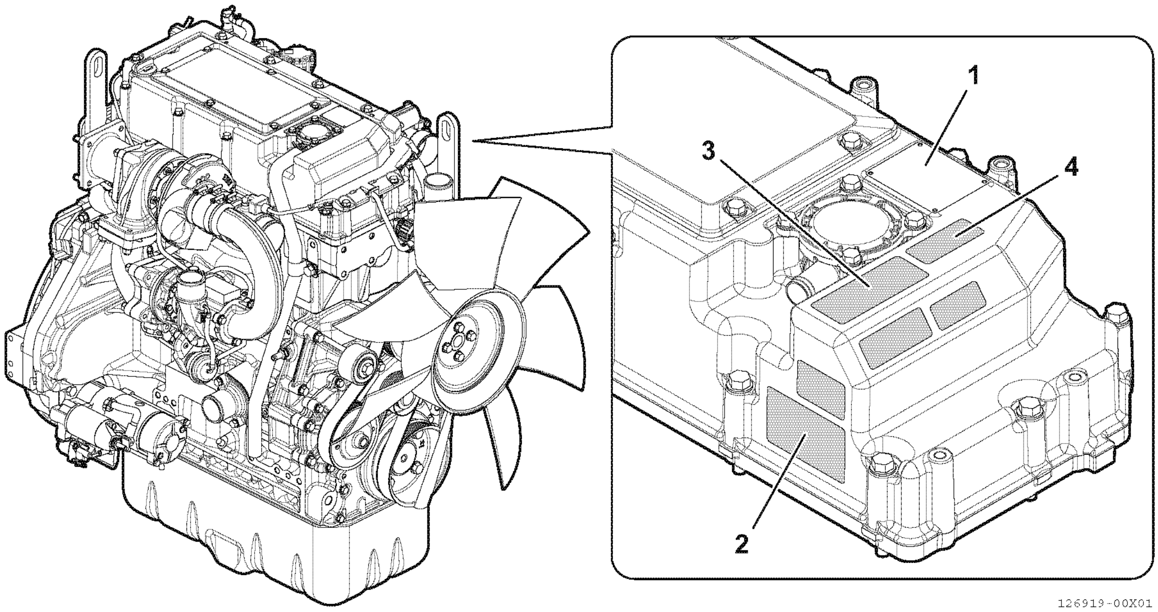


Fig. 00-3

Engine	Engine nameplate	EPA/ARB label	EU label	Non-road vehicle label
4TN107	On the top of the bonnet (Cooling fan or intake side) (1, Fig.00-3)	Side face of the bonnet (Cooling fan or exhaust side) (2, Fig.00-3)	On the top of the bonnet (Cooling fan or exhaust side) (3, Fig.00-3)	On the top of the bonnet (Cooling fan side or center) (4, Fig.00-3)

3. Engine Nameplate and Emission Labels

3.1 Engine nameplate (standard)

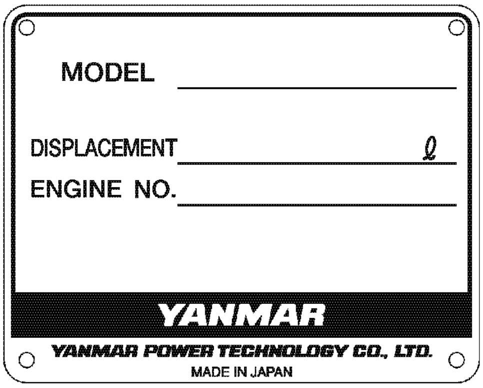


Fig. 00-4

3.2 Emission labels

Since emission control regulations are being issued on a global basis, it is necessary to identify which regulations a particular engine complies with. We have listed several different types of labels you might find on your engine.

■ EPA/ARB labels (typical)

Fig.00-5 shows the EPA labels while Fig.00-6 shows EPA and ARB label.

Fig. 00-5

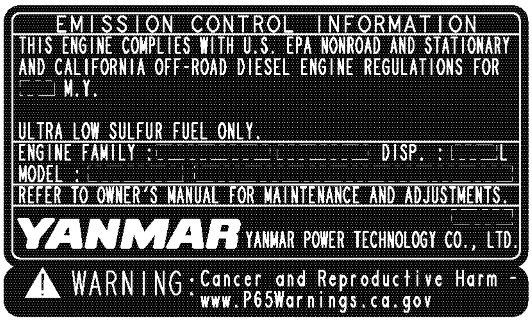


Fig. 00-6

■ EU label

Fig.00-7 shows the EU Stage V emission label.

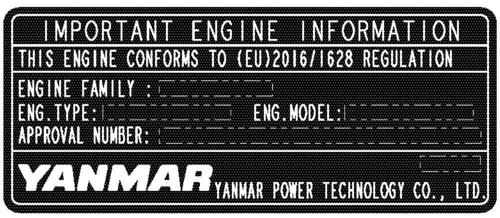


Fig. 00-7

4. Function of Major Engine Components

4.1 Intake/exhaust system

Fig.00-8 shows a reference of the intake/exhaust system of the 2-stage turbocharged engine.

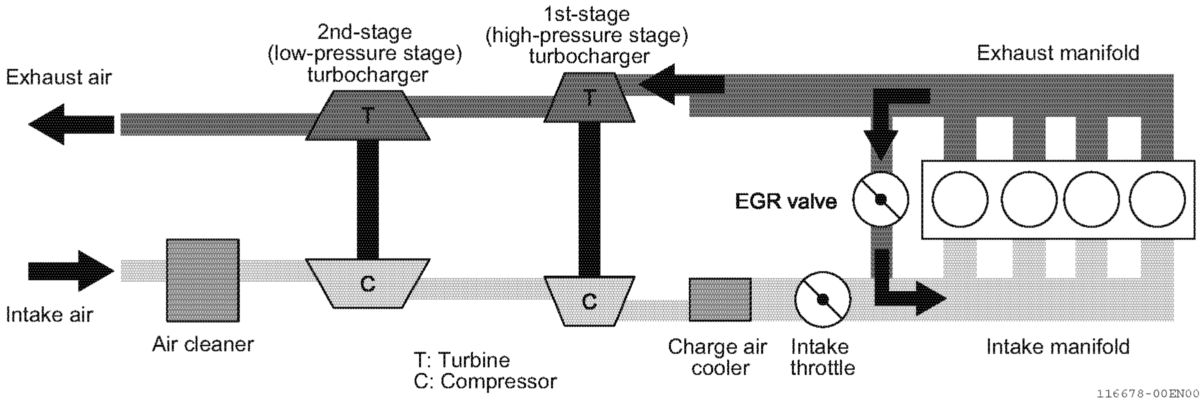


Fig. 00-8

Part name	Description
Air cleaner	The air cleaner prevents airborne contaminants from entering the engine by its internal filter element. Air cleaner filter element needs periodic maintenance and replacement. See 0000-08-03-03 “Every 250 hours of operation: Clean air cleaner” and 0000-08-03-04 “Every 500 hours of operation: Replace air cleaner element”.
Charge air cooler	Charge air cooler is a heat exchanging device that cools down intake air that is compressed in the turbocharger. The charge air cooler cools air and air density increases, which optimizes the combustion and improves output power.
Intake throttle (applicable only to EU Stage V certified models)	Intake throttle is a device that controls the amount of air in the engine, the intake throttle is used to burn accumulated soot inside the DPF. Depending on the engine speed and load, the engine controller indicates the best throttle opening, and as a result, the engine takes in the minimum air capacity required, which rises the exhaust temperature, and the soot accumulated in the DPF is burned.
EGR valve	EGR lowers the combustion temperature by introducing a part of exhaust gas into the intake air and reduces NOx which is a composition subject to emission control regulations. Depending on the engine speed and load, the engine controller indicates the best valve opening to control the EGR amount. EGR requires periodic inspection and cleaning. See 0000-08-03-08 “Every 4500 hours of operation”.
Turbocharger	A turbocharger improves the output performance of the engine by turning the turbine using exhaust gas and compressing the intake air with a compressor. Turbocharger requires periodic inspection. See 0000-08-03-08 “Every 4500 hours of operation”.

4.2 Lubricating oil system

The lubricating oil system force-feeds engine lubricating oil to the crankshaft main bearings, large and small connecting rod bearings, camshaft bearings, valve train, and moving portions of other parts, such as the turbocharger, to lubricate and cool down each part.

The overview of 4TN107 series engine lubricating oil system is shown in Fig.00-9. In this system, the lubricating oil pump pumps engine lubricating oil from the oil pan through the lubricating oil suction pipe to the lubricating oil cooler and the lubricating oil filter. Engine lubricating oil circulates through the main gallery of the cylinder block to the crank chamber and other lubricating oil system parts.

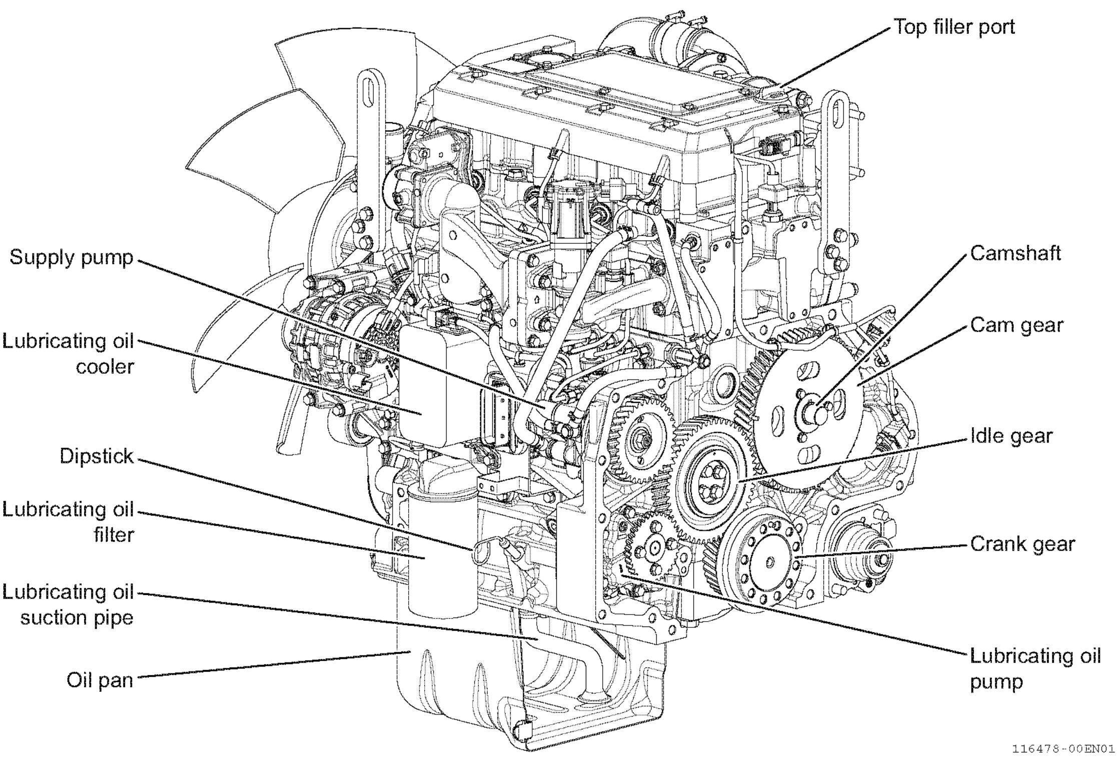


Fig. 00-9

Part name	Description
Engine lubricating oil filter	This eliminates impurities in the lubricating oil such as soot generated by combustion of fuel, oxides, and worn metal particles, and cleans the engine lubricating oil to prevent degradation. Engine lubricating oil filter requires periodical replacement. Be sure to do so at regular intervals, based on the maintenance schedule. See 0000-08-03-04 “Every 500 hours of operation”.
Engine lubricating oil cooler	The engine coolant cools the engine lubricating oil to prevent the engine lubricating oil from heating up. The lubricating oil cooler is positioned upstream of the lubricating oil filter. Coolant from the cylinder block flows and cools the lubricating oil that passes through the inside of the cooler, and returns to the intake port of the coolant pump.
Top filler port	You can fill oil to the crankcase from the top filler port of the bonnet.
Dipstick	The dipstick is on the engine intake side, and is used to check the amount of lubricating oil from the oil surface level of the engine lubricating oil in the engine crankcase.

4.3 Cooling system

An overview of the cooling system for the 4TN107 engine is shown in Fig.00-10.

The main components include a coolant pump (for flowing the coolant), and a fan and a radiator for releasing heat which the coolant absorbed from the cylinder block. Accessories that comes with the cooling system includes a lubricating oil cooler (for cooling lubricating oil) and an EGR cooler (for cooling EGR gas).

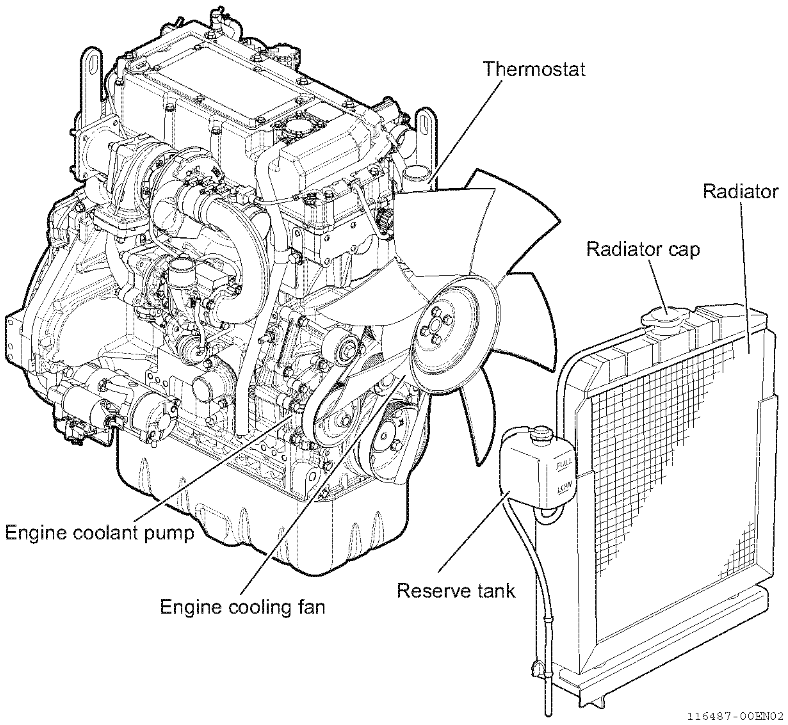


Fig. 00-10

Part name	Description
Engine coolant pump	The coolant pump circulates the engine coolant through the cylinder block and the cylinder head. The coolant returns to the radiator.
Engine cooling fan	Power taken out from the crankshaft V-pulley drives the fan with the V-ribbed belt. The engine cooling fan circulates air through the radiator.
Radiator	The radiator acts as a heat exchanger. As the engine coolant circulates through the cylinder block, it absorbs heat, and the heat is released inside the radiator. As the engine cooling fan circulates air through the radiator, the heat is transferred to the air.
Radiator cap	The radiator cap adjusts the cooling system pressure. As the engine coolant temperature rises, the system pressure and the coolant volume increases. When the pressure reaches a preset value, the release valve in the radiator cap opens and the excess engine coolant flows into the reserve tank. As the engine coolant temperature drop, the system pressure and the coolant volume decrease. As the pressure drop, the suction valve in the radiator cap opens, allowing the engine coolant to flow from the sub tank to the radiator.
Reserve tank	The reserve tank contains the overflow of engine coolant from the radiator. If you need to add engine coolant to the system, add it to the reserve tank; not the radiator.
Thermostat	A thermostat is placed in the cooling system to prevent the engine coolant from circulating into the radiator until the engine coolant temperature reaches a preset temperature. When the engine is cold, no engine coolant flows through the radiator. Once the engine reaches its operating temperature, the thermostat opens and allows the engine coolant to flow through the radiator.

4.4 Fuel system

The 4TN107 engine applies a common rail system, which adds pressure to the fuel with a supply pump, and after the fuel is pumped to the rail, it injects the fuel into the cylinder from the injector with the best amount and timing.

The part that sends fuel oil from the fuel tank to the supply pump is the fuel system. The components of the fuel system are shown in Fig.00-11.

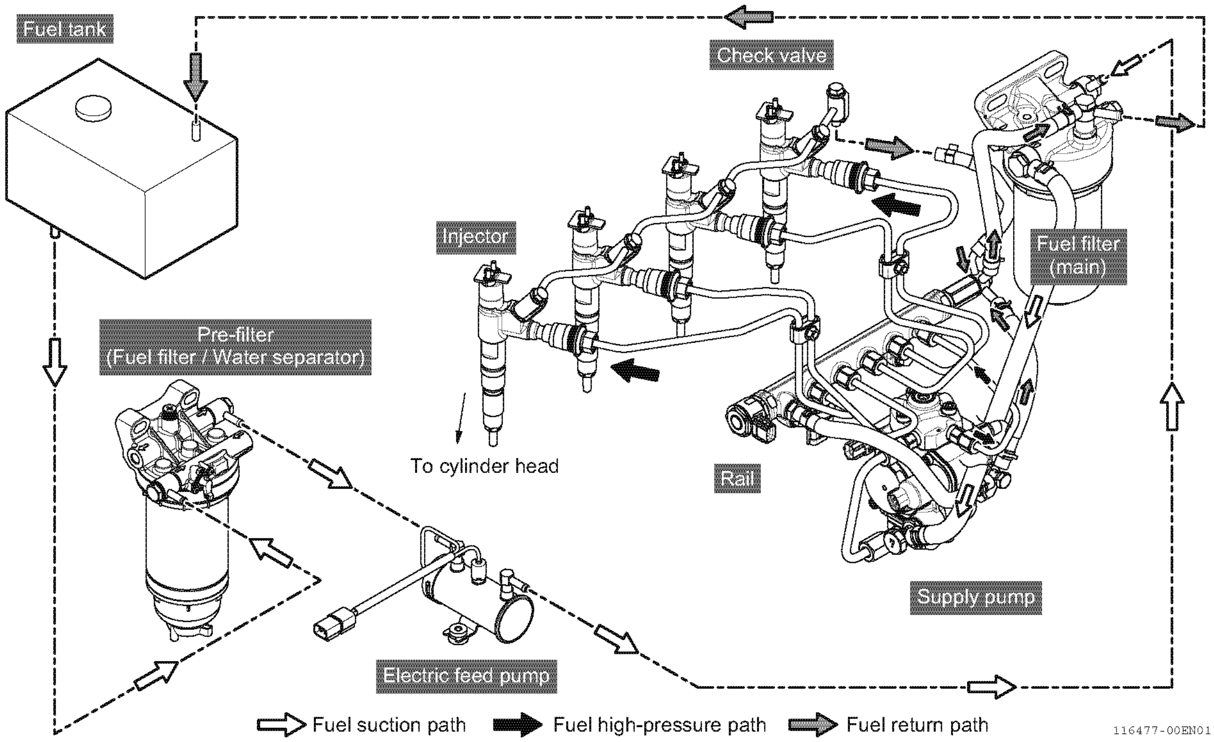


Fig. 00-11

Part name	Description
Fuel tank	The fuel tank is a reservoir that holds diesel fuel. Fuel from the fuel tank enters the supply pump via the pre-filter (oil-water separator), solenoid-type fuel feed pump, and the main filter to be pressurized and sent to the rail. Excess fuel returns back into the fuel tank.
Pre-filter (water separator)	A pre-filter (water separator) has a function that separates water in the fuel with the internal filter element, and removes water from the fuel that enters the supply pump. The pre-filter is attached between the fuel tank and the fuel filter (main). It is required to periodically replace the internal filter element and drain water. See 0000-08-03-04 “Every 500 hours of operation”
Electric feed pump	Sends fuel to the supply pump from the fuel tank. DI engines use electromagnetic feed pumps. When you prime the fuel system, turn the key switch to the ON position for 10 to 15 seconds. Air inside the fuel will bleed automatically.
Fuel filter (main)	The fuel filter removes contaminants and sediments from the diesel fuel. The fuel filter requires periodical replacement. See 0000-08-03-04 “Every 500 hours of operation”

4.5 Electrical equipment

Part name	Description
Battery	The battery supplies electric power to the starter while the engine is being cranked. Along with the alternator, power is provided to electrical equipment such as the electronic control system and the control panel lamp.
Alternator	The alternator is driven by a V-belt. The V-belt is powered by the crankshaft V-pulley. The alternator supplies electricity to the engine systems and charges the battery while the engine is running.
Starter motor	The starter motor is powered by the battery. When you turn the key switch in the operator’s console to the START position, the starter motor engages with the ring gear installed on the flywheel and starts the flywheel in motion.

5. Electronic Control System

5.1 System overview

In order to comply with emission control regulations including EU Stage V and EPA Final 4, the 4TN107 engine applies an EGR system as an emission device EGR, a DPF system and a urea SCR system as after-treatment devices, and a common rail system as an engine fuel injection device. These systems are electronically controlled by DCU and ECU controllers. Fig.00-12 shows the overview of the electronic control system. The electronic control system of the 4TN107 engine other than the EU Stage V certified model does not include the DPF system of the after-treatment device, the urea water SCR system, and the DCU that controls it.

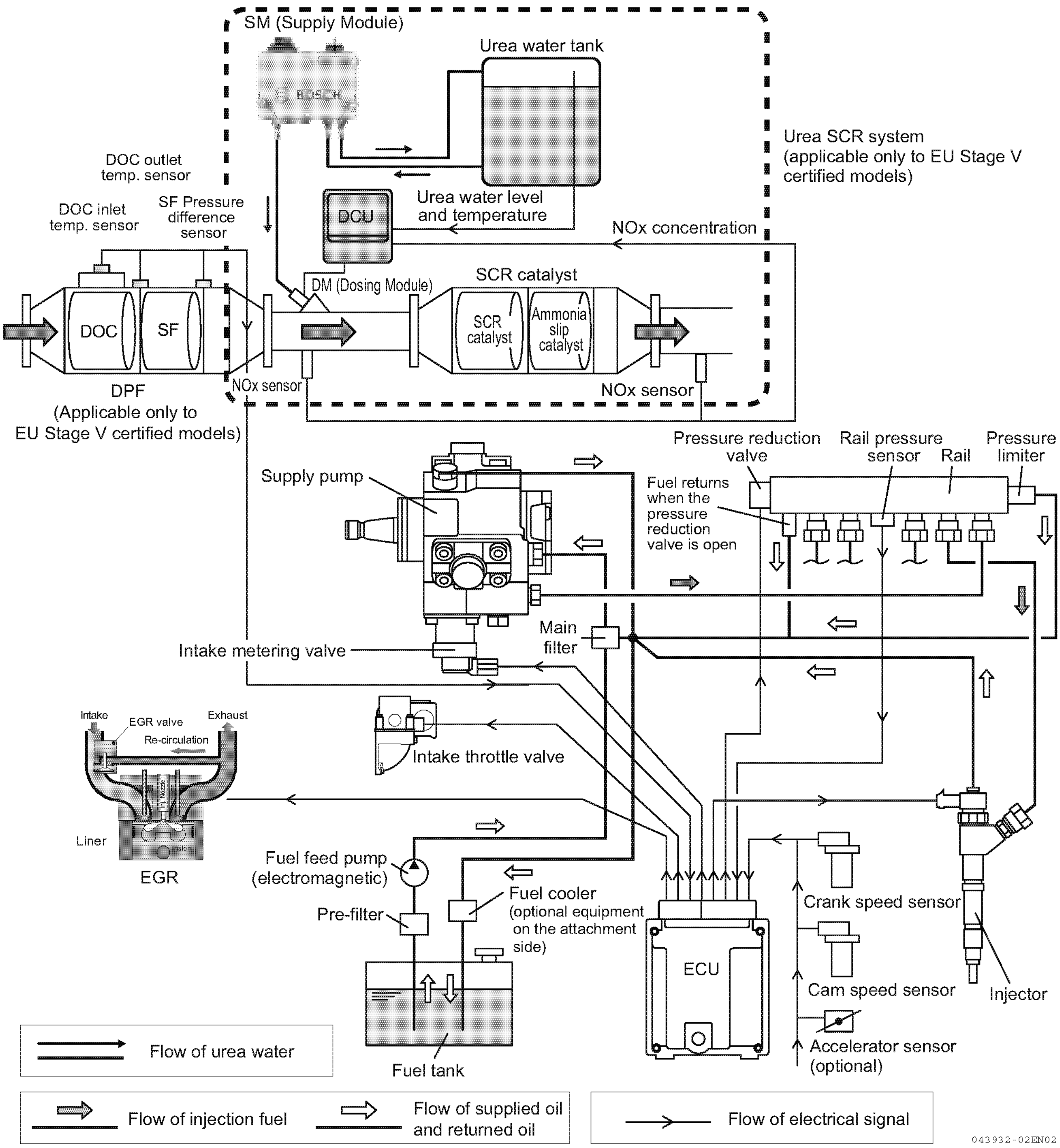


Fig. 00-12

5.2 Main electronic control-related components and features

Electronic control-related components and features that are related to the engine combustion system are shown below. For parts related to after-treatment device, see 0000-05-06-01 “After-treatment Device (ATD Unit)” in the next page.

System/Parts name		Description
Engine controller (ECU)		To be precise, E-ECU is an abbreviation for Engine Electronic Control Unit. By controlling the fuel injection timing, injection volume, injection pressure, and number of injection in accordance with the target speed indication entered from the accelerator sensor, the controller adjusts the engine speed and power. Depending on the above-mentioned speed and power, the controller controls the EGR opening. Also, the controller acts as the key station of the application function.
Fuel pump (supply pump)		The fuel pump supplies fuel to the common rail.
Common rail		The common rail stores the compressed high-pressure fuel from the supply pump and distributes fuel to the injector in each cylinder.
Fuel injector		The fuel injectors inject the high-pressure fuel from the rail to the engine combustion room after receiving a signal from the ECU in the most appropriate injection timing, injection volume, injection ratio, number of injection and spray condition.
EGR valve		The EGR valve controls the exhaust gas recirculation flow rate depending on the engine speed/load signals from the ECU. It is installed on the top of the exhaust manifold.
Intake throttle valve (applicable only to EU Stage V certified models)		The intake throttle adjusts the amount of intake air in the engine and controls the exhaust temperature to assist the DPF regeneration.
Accelerator sensor (machine setting)		Unlike mechanical governors, the electronically controlled common rail system has no governor lever. In stead, the accelerator sensor is required to set the engine target speed. The ECU determines the target speed by catching the size of voltage from the accelerator sensor. The accelerator sensor is located in the machine operator part. Specification only for constant speed engines such as those for electric generator do not require accelerator sensors because the engine speed can be shifted via a panel switch.
	Option	With CAN communication, the target engine speed can be determined by the ECU equipped on the driven machine.
Engine failure lamp		The failure lamp is installed on the operator’s console and ECU displays the occurrence of failures to inform the operator of the initial diagnosis of failures when an error is detected in the ECU or the electronic control system.
	Option	The display pattern varies depending on the machine.
SMARTASSIST-DIRECT (SA-D)		SMARTASSIST-DIRECT allows the operator to troubleshoot the cause of a problem based on detailed information regarding the defects occurring in the ECU internal control information.
	Option for service	The SMARTASSIST-DIRECT can also be used for data maintenance tasks including ECU internal programming, mapping and adjustment values.
Engine coolant temperature sensor		The engine coolant temperature sensor is used as a starting aid, and controls EGR when starting the engine in cold conditions. Use YANMAR genuine parts. Other devices cannot be used together with this sensor.
On-glow control		At cold start, when the key switch is set to the ON position, the system automatically energizes the glow plug relay and keeps it energized for particular amount of time depending on the engine coolant temperature. (Maximum 15 seconds) The preheat indicator lights up while the relay is being energized. When the indicator goes out, turn the key switch to the “START” position to start the engine.

6. After-treatment Device (ATD Unit) (Applicable only to EU Stage V certified models)

6.1 System overview

The after-treatment device (ATD unit) comprises the diesel particulate filter (DPF) and urea SCR filter (SCR). As shown in Fig.00-13 the ATD unit is composed of the DPF and SCR, and they are connected with the SCR pipe. The ATD unit is normally installed separately from the engine. The SCR system includes a urea water tank for storing urea water, the DM (Dosing Module) for injecting urea water as a high pressure mist, the SM (Supply Module) for pumping urea water to the DM, and the DCU for controlling the injection volume of urea water. For details of the structure and components of the DPF and SCR, see 2502-01-01-01 “DPF System” and 2503-01-01-01 “Urea SCR System”.

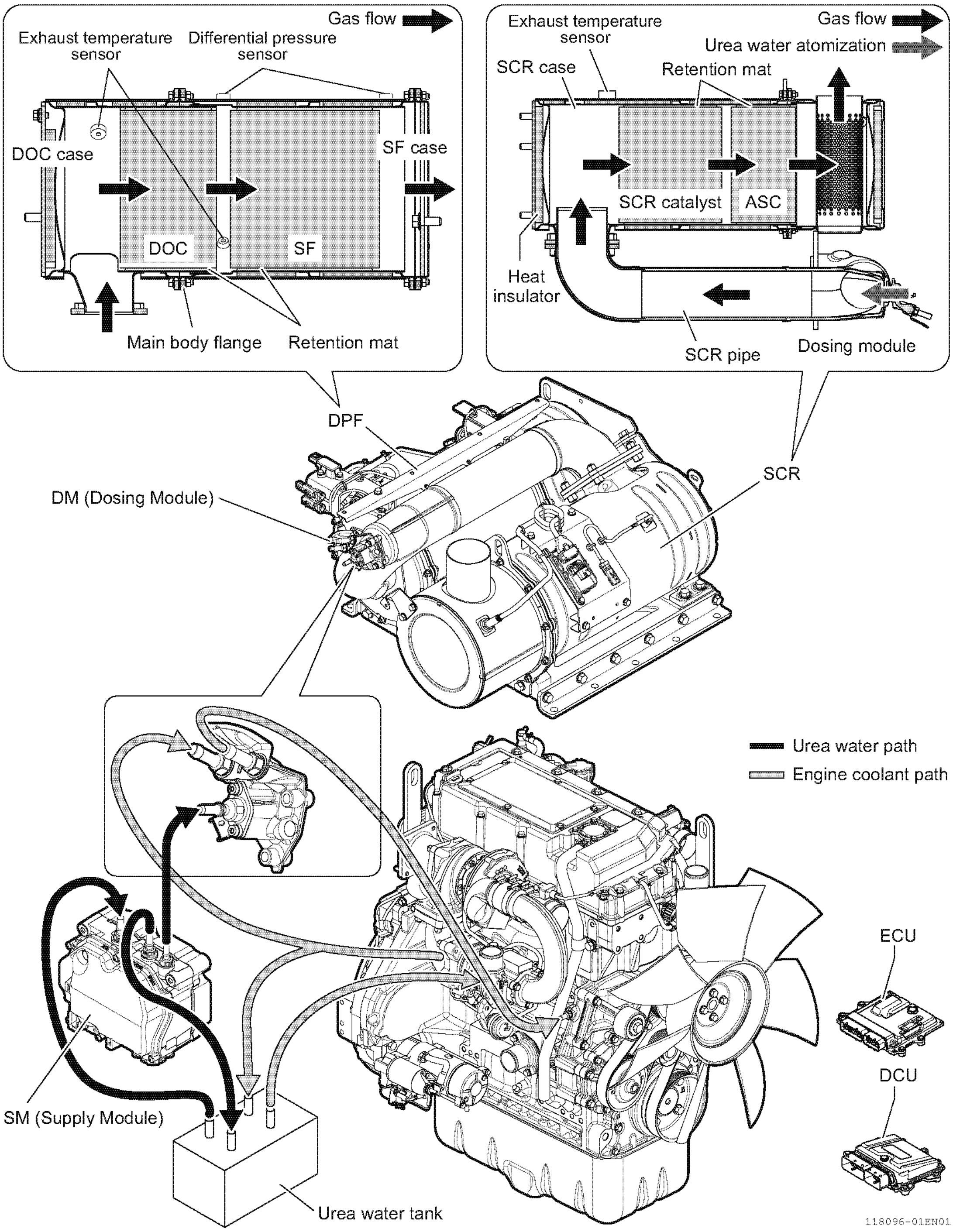


Fig. 00-13

6.2 Electronic control components and features related to after-treatment

System/Parts name	Description
Diesel Particulate Filter (DPF)	The Diesel Particulate Filter (DPF) consists of the diesel oxidation catalyst (DOC) and the soot filter (SF). It is a device to prevent the discharge of particulate matter (PM) by oxidizing the hazardous constituent with the DOC and collecting the PM in the exhaust gas with the SF.
Urea SCR system (SCR)	Urea SCR system is a technology for cleaning nitrogen oxide (NOx) included in exhaust gas. By spraying urea water into exhaust gas, it breaks down the NOx inside the exhaust gas into non-toxic N_2 (Nitrogen) and H_2O (Water). SCR stands for Selective Catalytic Reduction.
Dosing module (DM)	Dosing Module (DM) is a device for spraying the urea water mist into exhaust gas. Spraying is performed by the Dosing Control Unit (DCU) calculating the number of injection per unit time based on the NOx concentration, and the injection signal is sent to DM to activate the injection valve.
Supply module (SM)	Supply Module (SM) is a device for pumping urea water to the Dosing Module. There is a built-in heater for melting the urea water when it is frozen. If the urea water remains in the urea water path, the system may be damaged due to expansion. Therefore, when the engine key is off, the system sucks out the urea water and pump it back to the tank.
Dosing control unit (DCU)	Based on the information from the NOx sensor and the exhaust temperature sensor, DCU controls injecting the urea water into the exhaust gas and the melting of urea water.

1. Abbreviations and Symbols

■ Abbreviations

A	amperage
AC	alternating current
ACEA	Association des Constructeurs Europens d'Automobilies
Ah	amperage-hour
approx.	approximately
API	American Petroleum Institute
ARB	Air Resources Board
ATDC	after top dead center
BTDC	before top dead center
°C	degree Celsius
CARB	California Air Resources Board
CCA	cold cranking amp
cm	centimeter
cm^3	cubic centimeter
cm^3/min	cubic centimeter per minute
cu in	cubic inch
DC	direct current
DI	direct injection
DVA	direct volt adapter
EPA	Environmental Protection Agency
ESG	electronic speed governor
°F	degree Fahrenheit
fl oz	fluid ounce (U.S.)
fl oz/min	fluid ounce (U.S.) per minute
ft	foot
ft·lb	foot pound
ft·lbf/min	foot pound force per minute
g	gram
gal/hr	gallon (U.S.) per hour
gal	gallon (U.S.)
GL	gear lubricant
hp	horsepower (U.S.)
hrs	hours
I.D.	inner diameter
IDI	indirect injection
in	inch
in·lb	inch pound
JASO	Japanese Automobile Standards Organization
kg	kilogram
kgf/cm^2	kilogram-force per square centimeter
kgf·m	kilogram-force meter
km	kilometers
kPa	kilopascal
kW	kilowatt
L	liter
L/hr	liter per hour
lb	pound
lbf	pound force
mL	milliliter
mm	millimeter
MPa	megapascal
mV	millivolt
N	newton
N·m	newton meter
No.	number
O.D.	outer diameter
oz	ounce
PS	horsepower (metric)
psi	pound per square inch
qt	quart (U.S.)
min^{-1} (rpm)	revolutions per minute
SAE	Society of Automotive Engineers
sec.	second
t	short ton (2000 lb)
TBN	Total Base Number
TDC	top dead center
V	Bolt
VAC	volt alternating current
VDC	volt direct current
W	watt

■ Symbols

°	degree (Angle / temperature)
+	plus
-	minus
±	plus or minus
Ω	ohm
m	micro
%	percent
- (to)	value range

2. 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
lbf	×	4.4480	= 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

■ 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

°F = (1.8 × °C) + 32
°C = 0.556 × (°F - 32)

1. Cylinder Head Specifications

■ Cylinder head

Inspection item			Standard	Limit	Refer to
Valve clearance			0.0099 to 0.0138 in. (0.25 to 0.35 mm)	–	0000-08-03-05
Combustion surface distortion (flatness)			0.0020 in. (0.05 mm) or less	–	1401-02-02-02
Valve recession		Intake	0.0150 to 0.0229 in. (0.38 to 0.58 mm)	–	1403-02-02-02
		Exhaust	0.0165 to 0.0244 in. (0.42 to 0.62 mm)	–	
Valve seat	Seat angle	Intake	120°	–	1403-03-01-01
		Exhaust	90°	–	
	Seat correction angle		40°, 150°	–	

■ Intake/exhaust valve and guide

Inspection item		Standard	Limit	Refer to
Intake	Guide inner diameter	0.3155 to 0.3160 in. (8.008 to 8.020 mm)	–	1403-02-02-01/ 1403-02-02-02
	Valve stem outer diameter	0.3136 to 0.3142 in. (7.960 to 7.975 mm)	–	
	Valve stem bend	0.0013 to 0.0024 in. (0.033 to 0.060 mm)	–	
Exhaust	Guide inner diameter	0.3155 to 0.3160 in. (8.008 to 8.020 mm)	–	
	Valve stem outer diameter	0.3134 to 0.3140 in. (7.955 to 7.970 mm)	–	
	Valve stem bend	0.0015 to 0.0026 in. (0.038 to 0.065 mm)	–	
Valve guide protection form cylinder head		0.5398 to 0.5516 in. (13.7 to 14.0 mm)	–	
Valve stem seal protection form cylinder head		0.6698 to 0.6816 in. (17.0 to 17.3 mm)	–	

■ Push rod

Inspection item	Standard	Limit	Refer to
Push rod bend	0.0012 in. (0.03 mm) or less	–	1402-02-02-03

Engine standard value

■ Rocker arm and shaft

Inspection item	Standard	Limit	Refer to
Arm shaft hole diameter	0.8674 to 0.8680 in. (22.015 to 22.03 mm)	–	1402-02-02-01/ 1403-02-02-02
Arm shaft outer diameter	0.8656 to 0.8664 in. (21.97 to 21.99 mm)	–	
Oil clearance	0.0008 to 0.0024 in. (0.020 to 0.060 mm)	–	

■ Valve spring

Inspection item	Standard	Limit	Refer to
Free length	2.4372 in. (61.86 mm)	–	1402-02-02-03
Squareness	–	–	

2. Camshaft and Timing Gear Train Specifications

■ Camshaft

Inspection item		Standard	Limit	Refer to
End play		0.0020 to 0.0079 in. (0.05 to 0.20 mm)	–	1101-02-02-01
Bend (1/2 the dial gauge reading)		0 to 0.0079 in. (0 to 0.20 mm)	–	1101-02-02-02
Cam lobe height		2.1292 to 2.1339 in. (54.04 to 54.16 mm)	–	
Shaft outer diameter/ Bushing inner diameter (#1 - #5)	Bushing inner diameter	2.6004 to 2.6039 in. (66.00 to 66.09 mm)	–	1101-02-02-02
	Camshaft outer diameter	2.5970 to 2.5980 in. (65.91 to 65.94 mm)	–	
	Oil clearance	0.0024 to 0.0071 in. (0.060 to 0.180 mm)	–	

■ Tappet

Inspection item	Standard	Limit	Refer to
Tappet bore (block) diameter	0.6304 to 0.6311 in. (16.000 to 16.018 mm)	–	0200-02-02-01, 1102-02-02-01
Tappet stem outer diameter	0.6294 to 0.6300 in. (15.975 to 15.990 mm)	–	
Oil clearance	0.0004 to 0.0017 in. (0.010 to 0.043 mm)	–	

■ Idle gear shaft and bushing

Inspection item	Standard	Limit	Refer to
Shaft outer diameter	2.7556 to 2.7568 in. (69.94 to 69.97 mm)	–	0400-02-02-02
Bushing inner diameter	2.7580 to 2.7592 in. (70.00 to 70.03 mm)	–	
Oil clearance	0.0012 to 0.0035 in. (0.030 to 0.090 mm	–	

■ Timing gear backlash

Inspection item	Standard	Limit	Refer to
Crank gear, cam gear, idle gear, supply pump gear, and lubricating oil pump gear	0.0032 to 0.0055 in. (0.08 to 0.14 mm)	0.0063 in. (0.16 mm)	0400-02-02-01

3. Crankshaft and Piston Specifications

■ Crankshaft

Inspection item		Standard	Limit	Refer to
Bend (1/2 the dial gauge reading)		–	0.0008 in. (0.02 mm)	1302-02-02-01, 1301-02-02-02
Crank pin	Journal outer diameter	2.8152 to 2.8156 in. (71.452 to 71.462 mm)	–	
	Bearing insert thick-ness	0.0781 to 0.0785 in. (1.982 to 1.992 mm)	–	
	Oil clearance	0.0021 to 0.0041 in. (0.054 to 0.103 mm)	–	
Crank journal	Journal outer diameter	3.465 to 3.4657 in. (87.952 to 87.962 mm)	–	
	Bearing insert thick-ness	0.0980 to 0.0987 in. (2.487 to 2.505 mm)	–	
	Oil clearance	0.0020 to 0.0033 in. (0.051 to 0.085 mm)	–	

■ Thrust bearing

Inspection item	Standard	Limit	Refer to
Crankshaft end play	0.0032 to 0.0083 in. (0.08 to 0.21 mm)	0.0110 in. (0.28 mm)	1301-02-02-01

■ Piston

Inspection item		Standard	Limit	Refer to
Piston outer diameter (Measure at 90° to the piston pin)		4.2132 to 4.2145 in. (106.934 to 106.966 mm)	–	1202-02-02-02
Piston outer diameter measurement location (Upward from the bottom of the piston)		0.9259 in. (23.5 mm)	–	
Piston pin	Hole diameter	1.6565 to 1.6568 in. (42.042 to 42.052 mm)	–	
	Pin outer diameter	1.6546 to 1.6548 in. (41.994 to 42.000 mm)	–	
	Oil clearance	0.0017 to 0.0023 in. (0.042 to 0.058 mm)	–	

■ Piston ring

Inspection item		Standard	Limit	Refer to
Top ring	Ring groove width	0.0985 to 0.0997 in. (2.50 to 2.53 mm)	–	1202-02-02-02
	Ring width	0.0973 to 0.0981 in. (2.47 to 2.49 mm)	–	
	Side clearance	0.0004 to 0.0024 in. (0.01 to 0.06 mm)	–	
	End gap	0.0099 to 0.0138 in. (0.25 to 0.35 mm)	–	
Second ring	Ring groove width	0.0818 to 0.0823 in. (2.075 to 2.090 mm)	–	
	Ring width	0.0776 to 0.0784 in. (1.97 to 1.99 mm)	–	
	Side clearance	0.0033 to 0.0047 in. (0.085 to 0.120 mm)	–	
	End gap	0.0138 to 0.0197 in. (0.35 to 0.50 mm)	–	
Oil ring	Ring groove width	0.1200 to 0.1206 in. (3.045 to 3.060 mm)	–	
	Ring width	0.1170 to 0.1178 in. (2.97 to 2.99 mm)	–	
	Side clearance	0.0022 to 0.0035 in. (0.055 to 0.090 mm)	–	
	End gap	0.0079 to 0.0158 in. (0.20 to 0.40 mm)	–	

■ Connecting rod

Inspection item		Standard	Limit	Refer to
Connecting rod small end	Piston pin bearing inner diameter	1.6568 to 1.6573 in. (42.051 to 42.064 mm)	–	1201-02-02-03
	Piston pin outer diameter	1.6546 to 1.6548 in. (41.994 to 42.000 mm)	–	
	Oil clearance	0.0020 to 0.0028 in. (0.051 to 0.070 mm)	–	
Connecting rod large end	Side clearance	0.0079 to 0.0158 in. (0.20 to 0.40 mm)	–	1201-02-02-01

4. Cylinder Block Specifications

■ Cylinder block

Inspection item	Standard	Limit	Refer to
Cylinder inner diameter	4.21582 to 4.2170 in. (107.00 to 107.03 mm)	4.2209 in. (107.13 mm)	0200-02-02-01

5. Engine Service Standards

Inspection item		Standard	Limit	Remarks
Intake/exhaust valve clearance		0.0099 to 0.0138 in. (0.25 to 0.35 mm)	–	
Compression pressure at 250 min^{-1}		478.5 psi (3.3 MPa, 33.6 kgf/cm^2)	–	
Thermostat		Valve opening temperature	Full opening lift temperature	
	Standard	156 to 163 °F (69 to 73 °C)	0.39 in. (10 mm) or above 185 °F (85 °C)	
	Option	176 to 183 °F (80 to 84 °C)	0.39 in. (10 mm) or above 203 °F (95 °C)	
Working temperature range for engine coolant temperature sensor		-22 to 248 °F (-30 to 120 °C)	–	
Engine coolant capacity		7.5 L	–	(Engine only)
Injection valve opening pressure for adjusting engine lubricating oil	Rated	58.0 to 72.5 psi (0.40 to 0.50 MPa, 4.1 to 5.1 kgf/cm^2)	–	Oil temperature 203 °F (95 °C) (At main gallery)
	Low idle	8.7 psi (0.06 MPa, 0.6 kgf/cm^2) or above	–	Oil temperature 176 °F (80 °C) (At main gallery)
Engine lubricating oil capacity (standard)		20.2 L	–	
Flywheel rotation sensor Mounting face to pulser protrusion		1.4283 to 1.4480 in. (36.25 to 36.75 mm)	–	Rotation sensor to pulser clearance 0.028 to 0.067 in. (0.7 to 1.7 mm)
Gear speed sensor Mounting face to pulser protrusion		1.1722 to 1.1919 in. (29.75 to 30.25 mm)	–	Rotation sensor to pulser clearance 0.020 to 0.059 in. (0.5 to 1.5 mm)

6. Standard Torque

Always tighten the bolts and nuts to the specified torque. Applying excessive torque may damage the fastener or component and not enough torque may cause a leak or component failure.

NOTICE

The tightening torque in the Standard Torque Chart (see General Service Information section) should be applied only to the bolts with a “7” head. (JIS strength classification: 7T)

- Apply 60 % torque to bolts that are not listed.
- If the aluminum alloy is contained in the material of the tightening parts, apply 80 % torque of the tightening torque listed in the table.

Item	Nominal thread diameter × pitch	Tightening torque	Remarks
Hexagon bolt (7T) and nut	M6 × 1.0 mm	8.0 ± 0.7 ft·lb (95.6 ± 8.9 in.·lb, 10.8 ± 1.0 N·m, 1.1 ± 0.1 kgf·m)	• Use 80 % of the torque to the left when the tightening aluminum parts. • Use 60 % of the torque to the left for 4T bolts and lock nuts.
	M8 × 1.25 mm	18.8 ± 2.1 ft·lb (225.7 ± 25.67 in.·lb, 25.5 ± 2.9 N·m, 2.6 ± 0.3 kgf·m)	
	M10 × 1.5 mm	36.1 ± 3.6 ft·lb (433.7 ± 43.4 in.·lb, 49.0 ± 4.9 N·m, 5.0 ± 0.5 kgf·m)	
	M12 × 1.75 mm	65.1 ± 7.2 ft·lb (780.6 ± 86.7 in.·lb, 88.2 ± 9.8 N·m, 9.0 ± 1.0 kgf·m)	
	M14 × 2.0 mm	97.7 ± 11.1 ft·lb (1172.7 ± 132.8 in.·lb, 132.5 ± 15.0 N·m, 13.5 ± 1.5 kgf·m)	
	M18 × 2.5 mm	191.4 ± 18.1 ft·lb (2296.8 ± 216.8 in.·lb, 259.5 ± 24.5 N·m, 26.5 ± 2.5 kgf·m)	
Rc plug (Conventional PT plug)	1/8	7.2 ft·lb (86.7 in.·lb, 9.8 N·m, 1.0 kgf·m)	–
	1/4	14.5 ft·lb (173.5 in.·lb, 19.6 N·m, 2.0 kgf·m)	
	3/8	21.7 ft·lb (260.2 in.·lb, 29.4 N·m, 3.0 kgf·m)	
	1/2	43.4 ft·lb (520.4 in.·lb, 58.8 N·m, 6.0 kgf·m)	
Pipe joint bolt	M6	6.5 ± 0.7 ft·lb (77.9 ± 8.9 in.·lb, 8.8 ± 1.0 N·m, 0.9 ± 0.1 kgf·m)	–
	M8	10.8 ± 1.5 ft·lb (130.1 ± 17.7 in.·lb, 14.7 ± 2.0 N·m, 1.5 ± 0.2 kgf·m)	
	M10	16.6 ± 2.1 ft·lb (119.1 ± 25.7 in.·lb, 22.5 ± 2.9 N·m, 2.3 ± 0.3 kgf·m)	
	M12	21.7 ± 3.6 ft·lb (260.2 ± 43.4 in.·lb, 29.4 ± 4.9 N·m, 3.0 ± 0.5 kgf·m)	
	M14	32.5 ± 3.6 ft·lb (390.3 ± 43.4 in.·lb, 44.1 ± 4.9 N·m, 4.5 ± 0.5 kgf·m)	
	M16	39.8 ± 3.6 ft·lb (477.1 ± 43.4 in.·lb, 53.9 ± 4.9 N·m, 5.5 ± 0.5 kgf·m)	

Note: Torque values shown in this manual are for clean, non-lubricated fasteners unless otherwise specified.

7. Torque for Major Bolts and Nuts

N·m (kgf·m)

No.	Part	Thread diameter × pitch	Lubricating oil application		Tightening torque
			Seat	Thread	
1	Cylinder head bolt	M15 × 1.5 mm	Lubricating oil	Lubricating oil	See 1401-02-03-01 "Attaching the Cylinder Head Assembly" for details
2	Connecting rod bolt	M10 × 1.0 mm	Lubricating oil	Lubricating oil	See 1202-02-03-02 "Attaching the Piston and Connecting Rod" for details
3	Flywheel bolt	M12 × 1.25 mm	Lubricating oil	Lubricating oil	150 ± 5 (15.3 ± 0.5)
4	Main bearing cap bolt	M16 × 1.5 mm	Lubricating oil + extreme pressure agent (5 %)	Lubricating oil + extreme pressure agent (5 %)	See 1301-02-03-01 "Attaching the Crank-shaft" for details
5	Crank pulley bolt	M12 × 1.25 mm	No lubrication	No lubrication	88.2 ± 9.8 (9.0 ± 1.0)
6	Fuel injector bolt	M8 × 1.25 mm	No lubrication	No lubrication	25.5 ± 2.9 (2.6 ± 0.3)
7	Supply pump gear nut	M14 × 1.5 mm	No lubrication	No lubrication	64 ± 4 (6.5 ± 0.4)
8	Fuel injection line nut	M12 × 1.5 mm	No lubrication	No lubrication	35 ± 5 (3.6 ± 0.5)
9	Furl return pipe joint bolt	M8 × 1.25 mm	Fuel	No fuel	14.7 ± 2.0 (1.5 ± 0.2)
10	Injector terminal nut	M4 × 0.7 mm	No lubrication	No lubrication	2.0 ± 0.1 (0.2 ± 0.01)
11	Pipe joint bolt for fuel inlet of supply pump	M14 × 1.5 mm	No lubrication	No lubrication	20.1 ± 2.4 (2.1 ± 0.2)
12	Pipe joint bolt for fuel outlet of supply pump	M10 × 1.0 mm	No lubrication	No lubrication	10.3 ± 2.4 (1.1 ± 0.2)
13	Pipe joint bolt for rail overflow	M10 × 1.0 mm	No lubrication	No lubrication	20.1 ± 2.4 (2.1 ± 0.2)
14	Flywheel speed sensor bolt	M6 × 1.0 mm	No lubrication	No lubrication	6.5 ± 1.5 (0.7 ± 0.2)
15	Camshaft speed sensor bolt	M6 × 1.0 mm	No lubrication	No lubrication	10.0 ± 2.0 (1.0 ± 0.2)
16	Intake pressure sensor bolt	M6 × 1.0 mm	No lubrication	No lubrication	7.0 ± 1.4 (0.7 ± 0.1)
17	Water temperature sensor	M12 × 1.5 mm	No lubrication (Copper PK)	No lubrication	22 ± 2 (2.2 ± 0.2)
18	Glow plug	M10 × 1.25 mm	No lubrication	No lubrication	17.5 ± 2.5 (1.8 ± 0.3)
19	Glow plug terminal nut	M4 × 0.7 mm	No lubrication	No lubrication	1.25 ± 0.25 (0.1 ± 0.03)

Engine standard value

<Torque for major bolts and nuts>

N·m (kgf·m)

No.	Part	Thread diameter × pitch	Lubricating oil application		Tightening torque
			Seat	Thread	
20	Exhaust manifold bolts	M10 × 1.5 mm	No lubrication	No lubrication	49.0 ± 4.9 (5.0 ± 0.5)
21	EGR cooler bolt	M8 × 1.25 mm	No lubrication	No lubrication	25.5 ± 2.9 (2.6 ± 0.3)
22	Ambient temperature sensor breather joint (aluminum)	M6 × 1.0 mm	No lubrication	No lubrication	7.0 ± 1.4 (0.7 ± 0.1)
23	EGR, Intake manifold temperature sensor	M14 × 1.5 mm	No lubrication	No lubrication	14.0 ± 3.0 (1.4 ± 0.3)
24	Exhaust temperature sensor	M12 × 1.25 mm	No lubrication	No lubrication	32.5 ± 7.5 (3.3 ± 0.8)
25	Exhaust pressure sensor	1/2 · 20 SAE J514	No lubrication	No lubrication	20.0 ± 2.0 (2.0 ± 0.2)
26	Lubricating oil filter	1-12UNF	Lubrication on O-ring	No lubrication	21.0 to 25.0 (2.1 to 2.6)
27	Exhaust manifold pressure steel pipe	M12 × 1.25 mm	No lubrication	No lubrication	29.4 ± 4.9 (3.0 ± 0.5)
28	EGR cooler	M8 × 1.25 mm	No lubrication	No lubrication	25.5 ± 2.9 (2.6 ± 0.3)
29	High-pressure line retainer bolt	M6 × 1.0 mm	No lubrication	No lubrication	1.5 to 2.0 (0.15 to 0.2)
30	Engine lubricating oil pressure sensor	3/8 UNF	No lubrication	No lubrication	9.8 ± 1.0 (1.0 ± 0.1)
31	Fuel filter CMP bolt	M10 × 1.5 mm	No lubrication	No lubrication	30 ± 3 (3.1 ± 0.3)
32	Breather valve bolt	M6 × 1.0 mm	No lubrication	No lubrication	6 ± 1 (0.6 ± 0.1)
33	Bonnet bolt	M6 × 1.0 mm	No lubrication	No lubrication	8.6 ± 0.8 (1.0 ± 0.1)
34	Breather hose clamp (single-stage turbo-charger type only)	M12 × 1.75 mm (S45C)	No lubrication	No lubrication	25.9 ± 2.9 (2.6 ± 0.3)
35	Tensioner	M12 × 1.5 mm (SCM)	No lubrication	No lubrication	125 ± 10 (12.8 ± 1.0)

8. Special Service Tools

■ Valve guide tool (For removing the valve guide)

Locally manufactured

L1	L2	d1	d2
0.787 in. (20 mm)	2.953 in. (75 mm)	0.256 in. (6.5 mm)	0.394 in. (10 mm)

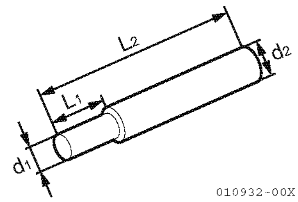


Fig. 00-14

■ Valve guide tool (For installing the valve guide)

Locally manufactured

L1	L2	d1	d2
0.394 in. (10 mm)	2.362 in. (60 mm)	0.512 in. (13 mm)	0.630 in. (16 mm)

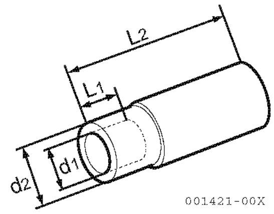


Fig. 00-15

■ Connecting rod bushing replacement tool (For removing/installing the connecting rod bushing)

Locally manufactured

L1	L2	d1	d2
0.787 in. (20 mm)	3.937 in. (100 mm)	1.339 in. (34 mm)	1.457 in. (37 mm)

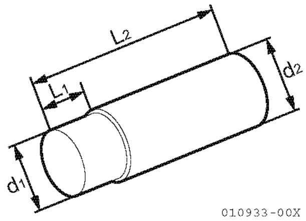


Fig. 00-16

■ Valve spring compressor (For removing/installing the valve spring)

YANMAR Part No.: 129100-92630

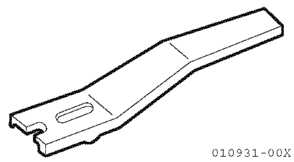


Fig. 00-17

■ Valve stem seal insertion tool (For inserting the valve stem seal)

Locally manufactured

d1	d2	d3	L1	L2	L3
0.670 in. (17 mm)	0.985 in. (25 mm)	0.512 in. (13 mm)	0.690 in. (17.5 mm)	2.758 in. (70 mm)	0.197 in. (5 mm)

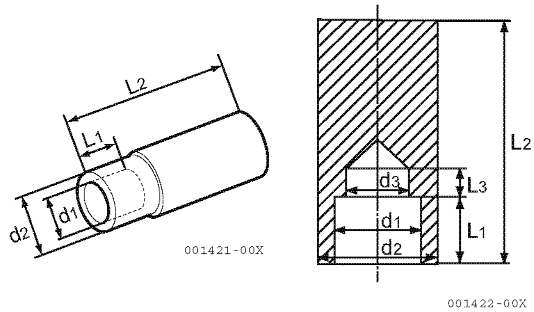


Fig. 00-18

■ Lubricating oil filter wrench (For removing/installing the engine lubricating oil filter)

Commercially available

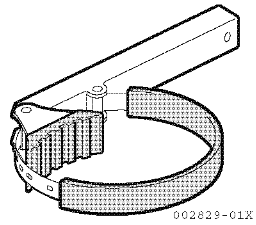


Fig. 00-19

■ Fuel filter wrench (For removing fuel main filter and water separator)

- For main filter
  YANMAR Part No.: 129G01-92700
- For water separator
  YANMAR Part No.: 129G01-92710
- For water collection cup of water separator
  YANMAR Part No.: 129G01-92720

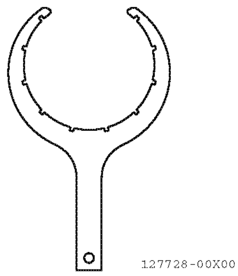


Fig. 00-20

■ Flex-Hone (For re-honing the cylinder liner)

YANMAR Part No.: 129400-92450
Cylinder bore: 3.740 - 4.255 in. (95 - 108 mm)
or
YANMAR Part No.: 129400-92460
Cylinder bore: 3.979 - 4.492 in. (101 - 114 mm)

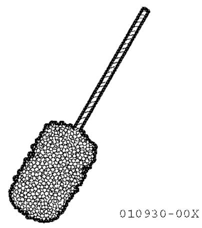


Fig. 00-21

■ Piston insertion tool (For installing the piston)

Commercially available

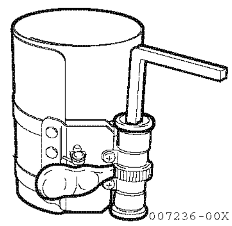


Fig. 00-22

■ Piston ring expander (For removing/installing the piston ring)

Commercially available

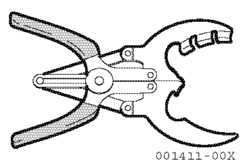


Fig. 00-23

■ Positioning pin for servicing DPF (For installing DOC and SF)

YANMAR Part No.: 129G01-17950

Engine standard value

<Special service tools>

■ Urea tank header attaching/detaching tool (Applicable only to EU Stage V certified models)

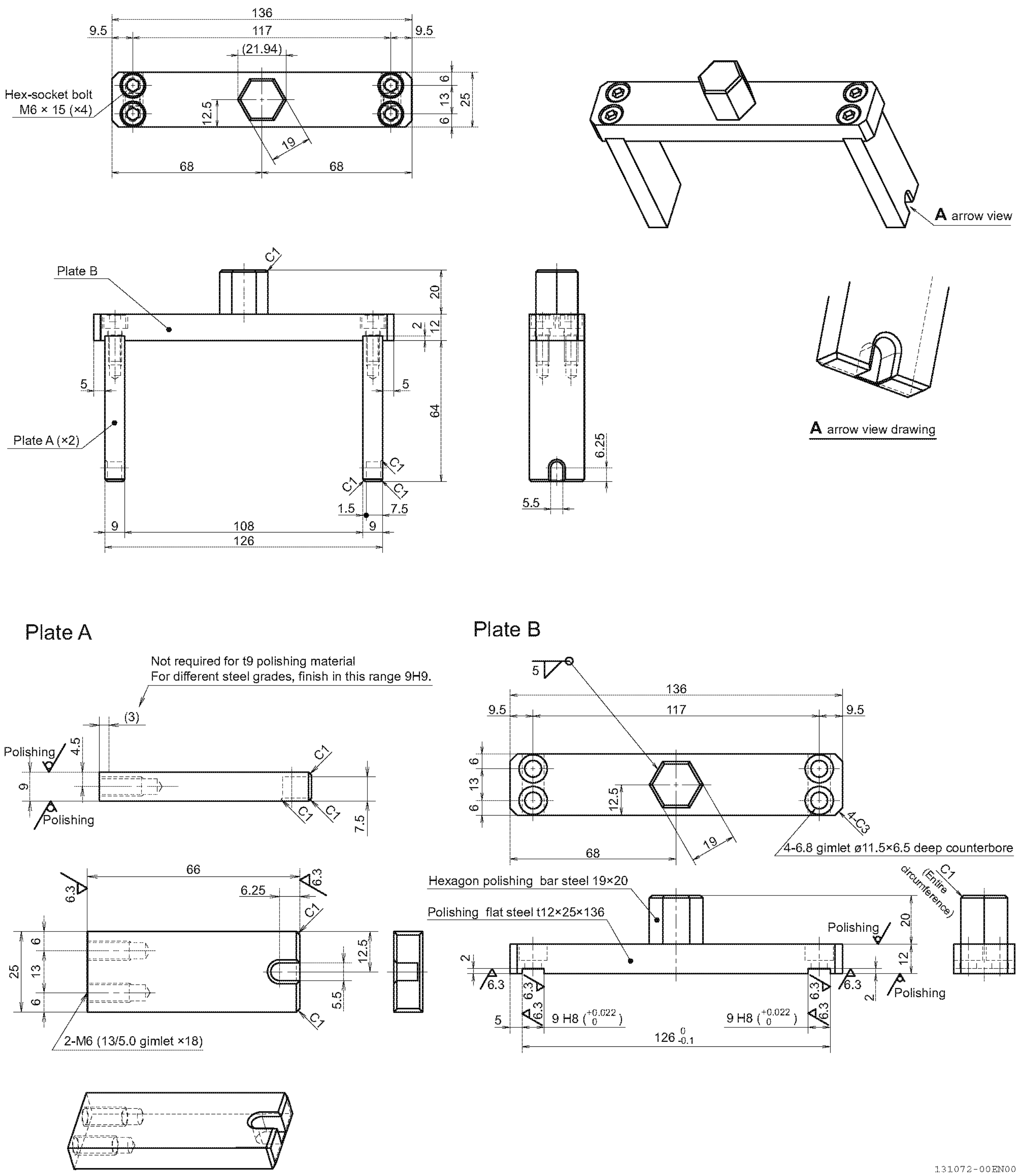


Fig. 00-24

■ Compression gauge adapter (for measuring the compression pressure)

1- Injector adapter

YANMAR Part No.: 129G01-92950

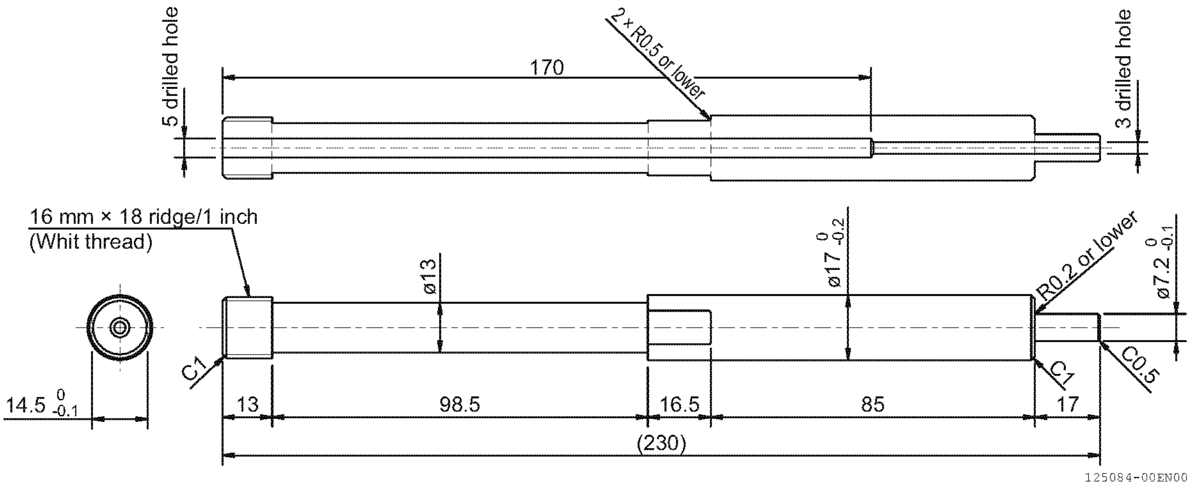


Fig. 00-25

2- Glow plug adapter

YANMAR Part No.: 129G01-92960

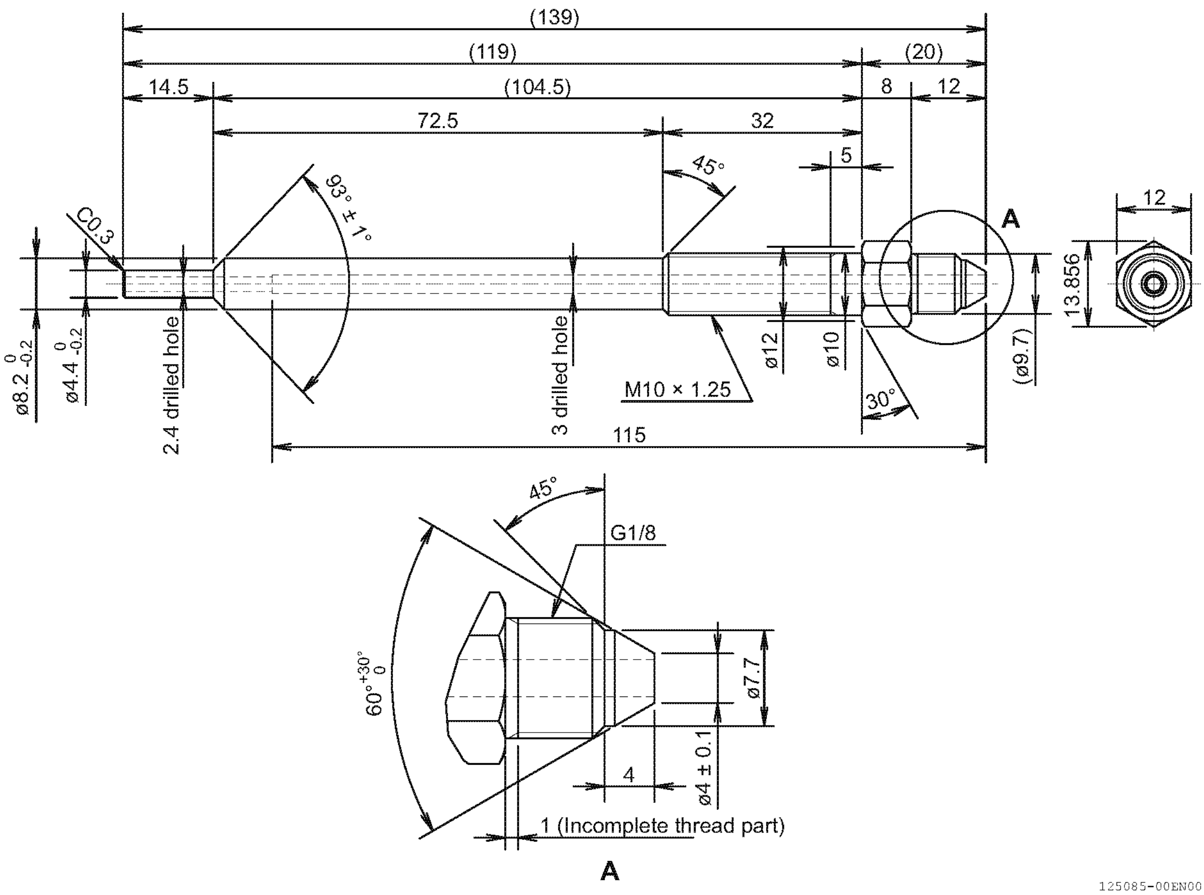


Fig. 00-26

9. Measurement Instruments

■ Dial indicator (commercially available)

For measuring the shaft bend and end play.

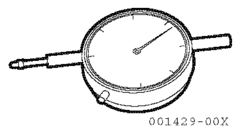


Fig. 00-27

■ Test indicator (commercially available)

For measuring narrow or deep portions that cannot be measured by using a dial gauge.

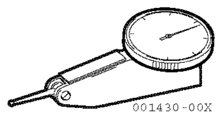


Fig. 00-28

■ Magnetic shift (commercially available)

For holding the dial gauge during the measurement. The angle of the stand is adjustable.

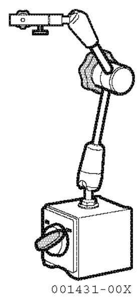


Fig. 00-29

■ Micrometer (commercially available)

For measuring the outer diameters of the crankshaft, pistons, piston pins, etc.

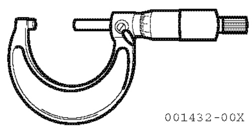


Fig. 00-30

■ Cylinder bore gauge (commercially available)

For measuring the inner diameters of the cylinder lines, connecting rod bearings, etc.

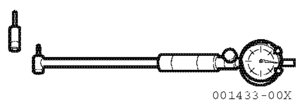


Fig. 00-31

■ Caliper (commercially available)

For measuring the outer diameters, depth, thickness, and width.

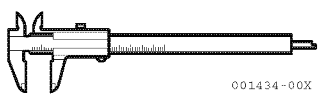


Fig. 00-32

■ Depth micrometer (commercially available)

For measuring the valve recession.

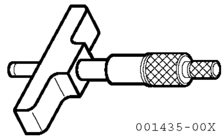


Fig. 00-33

■ Square (commercially available)

For measuring valve spring inclination and straightness of parts.

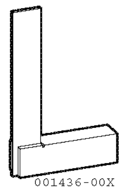


Fig. 00-34

■ V-block (commercially available)

For measuring the shaft bend.

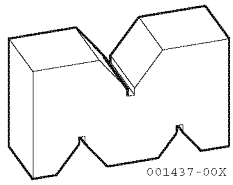


Fig. 00-35

■ Torque wrench (commercially available)

For tightening nuts and bolts to the specified torque.

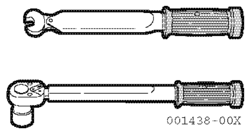


Fig. 00-36

■ Feeler gauge (commercially available)

For measuring the gear backlash, piston and valve clearance.

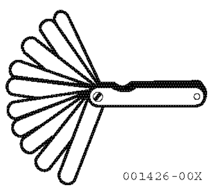


Fig. 00-37

■ Compression gauge (commercially available)

Measure the compression pressure.
Use a gauge for diesel (Max. 5 MPa F/S or over).

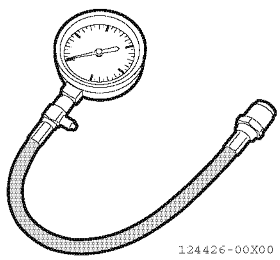


Fig. 00-38

1. Introduction

This section of the Service Manual describes the procedures for proper care and maintenance of the engine.

1.1 The importance of periodic maintenance

Engine deterioration and wear occurs in proportion to length of time the engine has been in service and the conditions the engine is subject to during operation. Periodic maintenance prevents unexpected downtime, reduces the number of accidents due to poor machine performance and helps extend the life of the engine.

1.2 Performing periodic maintenance

⚠ 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.**

Perform periodic maintenance procedures in an open, level area free from traffic. If possible, perform the procedures indoors to prevent environmental conditions, such as rain, wind, or snow, from damaging the machine.

1.3 YANMAR replacement parts

Always use YANMAR genuine parts when replacement parts are needed. Genuine replacement parts help ensure long engine life.

1.4 Allowable exhaust gas back pressure and intake air negative pressure

■ Allowable exhaust gas back pressure (upper limit during usage)

- 55 kPa (5606 mmAq) or less

■ Allowable intake air negative pressure (upper limit)

- 6.23 kPa (635 mmAq) or less

If the above intake negative pressure value is exceeded, clean the air cleaner or replace the air cleaner element.

2. Periodic Maintenance Schedule

Daily and periodic maintenance is important to keep the engine in good operating condition. The following is a summary of maintenance items by periodic maintenance intervals. Periodic maintenance intervals vary depending on engine application, loads, diesel fuel and engine lubricating oil used and are hard to establish definitively. The following should be treated only as a general guideline.

NOTICE

Establish a periodic maintenance plan according to the engine application, and make sure you perform the required periodic maintenance at intervals. Failure to follow these guidelines will impair the engine's safety and performance characteristics, shorten the engine's life and may affect the warranty coverage on your engine.

This engine may inject fuel after general combustion for the purpose of self-regeneration of the DPF.
This fuel may enter the oil pan through the cylinder and dilute the engine lubricating oil. Check the oil level daily. If it is above the upper limit of the dipstick, replace the oil regardless of the replacement intervals.

See 0000-02-01-01 “YANMAR Limited Warranty”.

For the items marked with ●, the specialized knowledge and skill are particularly required.
Have your authorized YANMAR dealer or distributor perform maintenance according to this manual.

○: Check ◇: Replace ●: Have your authorized YANMAR dealer or distributor perform checking and cleaning

System category	Check item	Daily check	Periodic maintenance interval								
			Every 50 hours	Every 250 hours	Every 500 hours	Every 1500 hours	Every 2000 hours	Every 3000 hours	Every 4500 hours	Every 6000 hours	Every 9000 hours
Cooling system	Check and refill engine coolant	○									
	Check and clean radiator fins and charge air cooler fins			○							
	Replace cooling fan V-belt							◇*1			
	Replace engine coolant						◇*2 or every 2 years				
Cylinder head	Check and adjust intake/ exhaust valve clearance					●					
Electrical equipment	Check indicators	○									
	Check ECU and related sensors and actuators								●		
	Check battery		○								
Engine lubricating oil	Check engine lubricating oil level, and refill oil if necessary.	○									
	Drain and fill engine lubricating oil				◇*2 or every 1 year						
	Replace engine lubricating oil filter										

Periodic maintenance

○: Check ◇: Replace ●: Have your authorized YANMAR dealer or distributor perform checking and cleaning

System category	Check item	Daily check	Periodic maintenance interval								
			Every 50 hours	Every 250 hours	Every 500 hours	Every 1500 hours	Every 2000 hours	Every 3000 hours	Every 4500 hours	Every 6000 hours	Every 9000 hours
Intake and exhaust system	Clean air cleaner			○							
	Replace air cleaner element				◇						
	Check turbocharger								●		
	Check crankcase breather, and replace filter element								◇		
	Check and clean EGR and EGR cooler								●		
After-treatment device *3	Check DPF and related components (including the cleaning of soot filter)									●*4	
	Replace DPF										◇
	Check DOC/SCR catalyst and related sensors								●		
	Replace SCR										◇
	Check and replace SM (Supply Module) main filter								◇*2 or every 3 years		
Fuel system	Check fuel oil level, and refill oil if necessary	○									
	Check fuel filter and water separator	○									
	Drain fuel tank			○							
	Drain water separator		○								
	Replace fuel filter and water separator				◇						
	Check and clean injector								●		
Urea water *3	Check urea water level, and refill if necessary	○									
Rubber hose	Check and replace of rubber hoses such as fuel hose, engine coolant hose, lubricating oil hose, and turbocharger hose						◇*2 or every 2 years				

*1. *Replace the belt a with new one every 3000 hours of operation time or when the tensioner position at stationary reaches the "replacement interval" position.*
*2. *Whichever comes first.*
*3. Applicable only to EU Stage V certified models.
*4. If your engine is equipped with DPF cleaning alarm, check and clean the soot filter when the alarm lamp comes on.
If your engine is not equipped with DPF cleaning alarm, clean the soot filter every 6000 hours of operation.

3. Periodic Maintenance Procedures

3.1 Daily checks

Before you begin any jobs, make sure the engine is in good operating condition. Before you start work, make sure you check the following items as a daily check, and finish taking any necessary action.

⚠ WARNING

High-Pressure Hazard!

- **If fuel is spraying out or leaking from broken fuel system such as high-pressure fuel injection lines, it may be in high-pressure. Avoid skin contact. 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.**
- **Disassembling or repairing the fuel system shall be done by professionals such as the authorized YANMAR distributor or dealer.**
- **Failure to comply could result in death or serious injury.**

1- Visual checks

1. Check for engine lubricating oil leaks.
2. Check for fuel leaks.
3. Check for engine coolant leaks.
4. Check for urea water leaks.
5. Check for damaged or missing parts.
6. Check for loose, missing or damaged fasteners.
7. Check the electrical harnesses for cracks, abrasions, and damaged or corroded connectors.
8. Check the hoses for cracks, abrasions, and damaged, loose, or corroded clamps.
9. Check the radiator fins and clean them as necessary. For details, see 0000-08-03-03 “Check and clean radiator fins”.
10. Check the water separator for the presence of water and contaminants. If you find any water or contaminants, drain the fuel filter/water separator. For details, see 0000-08-03-02 “Drain water separator”. If you have to drain the water separator frequently, drain the fuel tank and check for the presence of water in your fuel supply. For details, see 0000-08-03-03 “Drain fuel tank”.

NOTICE

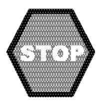
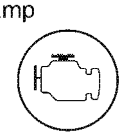
- If any problems are found during the visual check, the necessary corrective action should be taken before you operate the engine.
- Check the water in the water separator every day. The fuel system in the common rail system is under extremely high pressure. If water is mixed with the fuel in the supply pump, it may result in seizure of the supply pump and injector.

2- Checking the diesel fuel, engine lubricating oil, engine coolant, and urea water (applicable only to EU Stage V certified models) levels

For checking these levels and refilling, see 0000-10-01-03 “Filling the fuel tank”, 0000-10-02-01 “Checking and servicing engine lubricating oil”, 0000-10-03-01 “Checking and servicing engine coolant”, and 0000-10-04-01 “Refilling urea water”.

3- Checking the operator’s console

Before you operate the engine, check the operator’s console and make sure that all of the warning indicators are functioning properly. Turning the key switch to the ON position will make the indicators light up for two seconds, then go out. Refer to Fig.00-39 for the function of each warning indicator.

<table>
<tr><th>Alarm lamp</th><th>Turns the key switch OFF and ON</th><th>After engine start-up</th><th colspan="2">Failure alarm</th></tr>
<tr><td>Preheat indicator</td><td>Goes out after 1 to 15 seconds, depending on the coolant temperature.</td><td>Goes out</td><td colspan="2">–</td></tr>
<tr><td>Lubricating oil pressure indicator (Engine oil alarm)</td><td>Lit</td><td>Goes out when the engine oil pressure becomes within the normal range.</td><td colspan="2">Comes on if the lubricating system fails.</td></tr>
<tr><td>Coolant temperature indicator (Coolant temperature alarm)</td><td>Comes on momentarily, then goes out.</td><td>–</td><td colspan="2">Comes on if the engine coolant overheats.</td></tr>
<tr><td>Battery charge indicator</td><td>Lit</td><td>Goes out when the alternator starts charging power to the battery.</td><td colspan="2">Comes on if the charging system fails.</td></tr>
<tr><td>DPF regeneration request lamp *1</td><td>Comes on for 2 seconds, and then goes out.</td><td>–</td><td colspan="2">• Comes on if stationary regeneration is required.
• Goes out when stationary regeneration starts after pushing the DPF regeneration request switch.</td></tr>
<tr><td>Exhaust temperature alarm lamp *1</td><td>Comes on for 2 seconds, and then goes out.</td><td>–</td><td colspan="2">Comes on during reset regeneration and stationary regeneration. Goes out when those regenerations are complete.</td></tr>
<tr><td>DPF regeneration approval lamp *1</td><td>Comes on for 2 seconds, and then goes out.</td><td>–</td><td colspan="2">• Flashes during stand-by before stationary regeneration.
• Comes on when stationary regeneration starts. Goes out when regeneration is complete.</td></tr>
<tr><td>DPF regeneration inhibit lamp *1</td><td>Comes on for 2 seconds, and then goes out.</td><td>–</td><td colspan="2">Comes on when the DPF regeneration inhibit switch is turned to “Regeneration Inhibited”.</td></tr>
<tr><td rowspan="3">Engine failure lamp</td><td rowspan="3">Comes on for 2 seconds, and then goes out.</td><td>–</td><td>Amber warning lamp
</td><td>1. Comes on when engine faults are detected.
2. Flashes when stationary regeneration or ash cleaning (Level 1) is required. *1</td></tr>
<tr><td>–</td><td>Engine stop lamp
</td><td>1. Comes on when severe engine failures are detected.
2. Flashes when ash cleaning (Level 2) is required. *1</td></tr>
<tr><td>–</td><td>Fault indicator lamp
</td><td>1. Comes on when engine faults are detected.
2. Comes on when stationary regeneration or ash cleaning is required. *1</td></tr>
<tr><td>Urea water level warning lamp *1</td><td>Comes on for 2 seconds, and then goes out.</td><td>–</td><td colspan="2">When the remaining urea water inside the tank is low, the indicator turns on or flashes.</td></tr>
<tr><td>Urea water injection warning lamp *1</td><td>Comes on for 2 seconds, and then goes out.</td><td>–</td><td colspan="2">When the control for SCR system or EGR system does not work properly, the indicator turns on or flashes</td></tr>
</table>

**1: Applicable only to EU Stage V certified models*

122737-00EN00

Fig. 00-39 Function list for indicators

3.2 Every 50 hours of operation

Perform the following maintenance every 50 hours after the initial operation.

- Check battery
- Drain water separator

1- Checking battery

DANGER

Explosion Hazard!

- **Never check the remaining battery charge by shorting out the terminals. This will result in a spark and may cause an explosion or fire. Use a hydrometer to check the remaining battery charge.**
- **If the electrolyte is frozen, slowly warm the battery before you recharge it.**
- **Failure to comply will 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.**

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 lubricating oil, diesel fuel and engine coolant.
  Consult the local authorities or reclamation facility.
- Never dispose of hazardous materials 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.

1. When the amount of fluid nears the lower limit (3, Fig.00-40), fill with distilled water (commercially available, 2, Fig.00-40) so it is at the upper limit (1, Fig.00-40). 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.

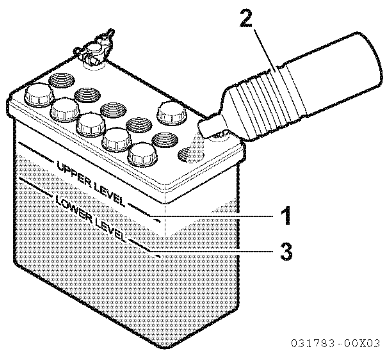


Fig. 00-40

2. If the engine cranking speed is so slow that the engine does not start, recharge the battery.
   Use a specialized battery charger to recharge a battery with a voltage of 8 V or less.
   Booster charging a battery with a voltage of 8 V or less will generate an abnormally high voltage and damage electrical equipment.

   If unavoidably using a rapid charger to recharge the battery, do not insert and turn the starter key to ON position while the battery is being charged. Avoid using a charger equipped with a boost function (cell start assist) to start the engine. Excessive voltage will be applied and will damage the ECU.
3. If the engine still does not start even after charging, have your battery and engine start system checked, and replace the battery if necessary.
4. If operating the machine where the ambient temperature could drop to -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.

2- Draining water separator

⚠ DANGER

Fire and Explosion Hazard!

- **Diesel fuel is extremely flammable and explosive under certain conditions.**
- **When you remove any fuel system component to perform maintenance (such as changing the fuel filter) place an approved container under the opening to catch the fuel.**
- **Never use a shop rag to catch the fuel.**
  Vapors from the rag are flammable and explosive.
- **Wipe up any spills immediately.**
- **Wear eye protection. The fuel system is under pressure and fuel could spray out when you remove any fuel system component.**
- **Failure to comply will result in death or serious injury.**

NOTICE

- Be sure to perform periodic maintenance in a clean environment free from dust.
- Always be environmentally responsible.
- Follow the guidelines of the EPA or other governmental agencies for the proper disposal of hazardous materials such as engine lubricating oil, diesel fuel and engine coolant.
  Consult the local authorities or reclamation facility.
- Never dispose of hazardous materials 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.

NOTICE

Be sure to check water in the water separator daily. The fuel system in the common rail system is extremely high-pressured. If water is mixed to the supplied fuel in the supply pump, seizure to the supply pump and the injector may result.

- Drain the water separator whenever there are contaminants, such as water, collected in the bottom of the cup. Do not wait for the scheduled maintenance intervals if contaminants have collected.
- The cup of the separator is made from semi-transparent material. In the cup, there is a red-colored float ring. When water collects inside the cup, the float ring will rise. Also, some optional water separators are equipped with a sensor to detect the amount of contaminants. This sensor sends a signal to an indicator to alert the operator.

Drain the fuel water separator as follows:

1. Position an approved container under the water separator to collect water and contaminants drained from the water separator.
2. Turn the fuel valve (1, Fig.00-41) to the position (2, Fig.00-41) to close it.
3. Loosen the drain plug (3, Fig.00-41) at the bottom of the water separator by hand, and drain water. If no water comes out, turn the air vent screw (4, Fig.00-41) at the top of the water separator counterclockwise 2 to 3 turns to loosen it.
4. If still no water comes out, open the fuel valve.
5. After draining the water separator, hand-tighten the drain valve.

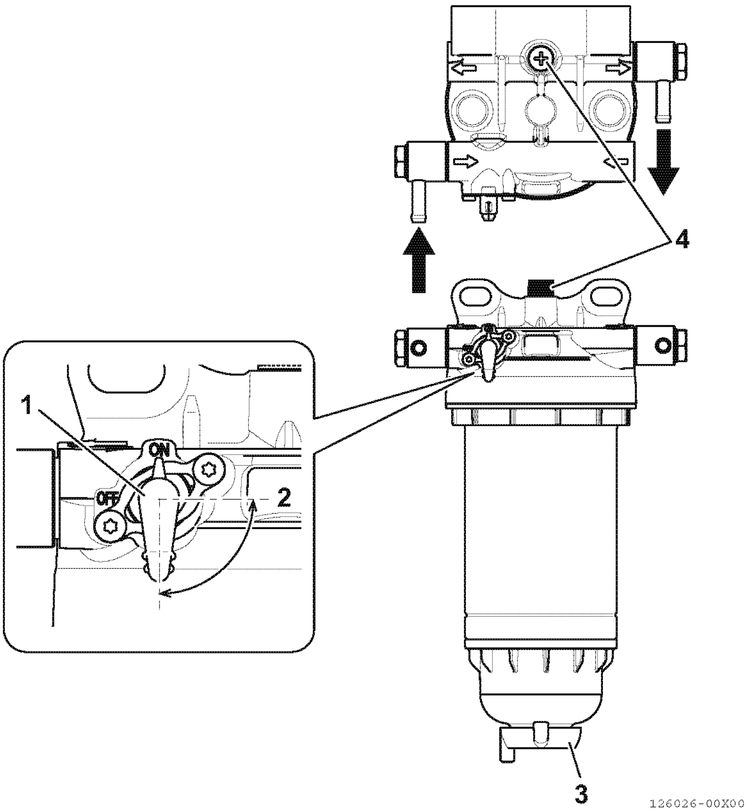


Fig. 00-41

6. If the air vent screw has been loosened, be sure to tighten it.
7. Open the fuel valve, and prime the fuel system. See 0000-10-01-04 “Priming the fuel system”.
8. Check for fuel leaks.

3.3 Every 250 hours of operation

Perform the following maintenance every 250 hours of operation.

- Check and clean radiator fins and charge air cooler fins
- Clean air cleaner
- Drain fuel tank

1- Checking and cleaning radiator fins and charge air cooler fins

CAUTION

Flying Object Hazard!

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

Dirt and dust adhering to the radiator fins reduce the cooling performance, causing overheating. Contaminants and dusts on the charge air cooler can cause low performance and exhaust gas. Make it a rule to check the radiator fins daily and clean as needed.

Note that a typical radiator is shown in Fig.00-42 for illustrative purposes only.
Charge air cooler is usually installed either on the front or back of the radiator.

- Blow off dirt and dust from fins and radiator with 28 psi (0.19 MPa; 2 kgf/cm^2) or less of compressed air (1, Fig.00-42). Be careful not to damage the fins with the compressed air.
- If there is a large amount of contamination on the fins, apply detergent, thoroughly clean and rinse with tap water.

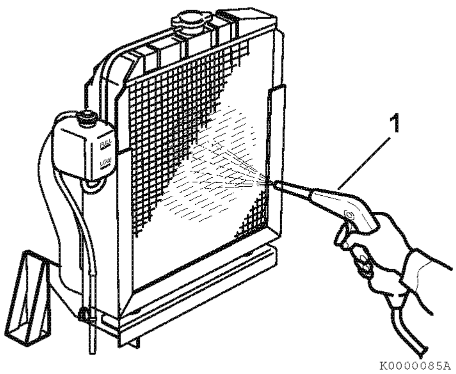


Fig. 00-42

NOTICE

Never use high-pressure water or compressed air at greater than 193 kPa (19,686 mmAq) or a wire brush to clean the radiator fins. Radiator fins become damaged easily.

2- Cleaning air cleaner

⚠ CAUTION

Flying Object Hazard!

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

Note that a typical air cleaner is shown in Fig.00-43 and Fig.00-44 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 (1, Fig.00-43).
2. Remove the element (2, Fig.00-43). If the cleaner is equipped with double elements, then remove the outer element only.
3. Blow air (3, Fig.00-43) through the element from the inside out using 42 to 71 psi (0.29 to 0.49 MPa; 3.0 to 5.0 kgf/cm^2) compressed air to remove the particulates. Use the minimum necessary air pressure to remove the dust without damaging the element.

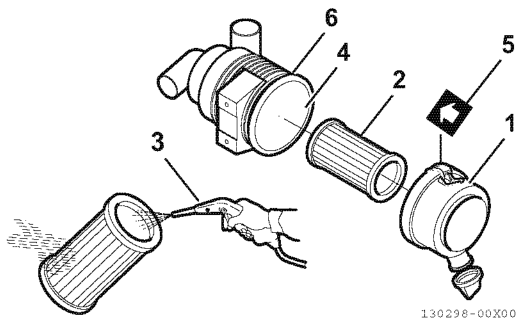


Fig. 00-43

4. If the air cleaner is equipped with double elements, only remove and replace the inner element (1. Fig.00-44) if the engine lacks power or the dust indicator actuates (if equipped).

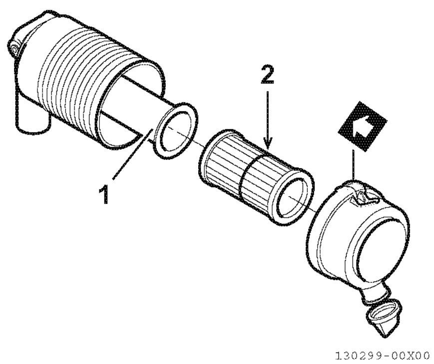


Fig. 00-44

5. The inner element should not be removed when cleaning or replacing the outer element. The inner element is used to prevent dust from entering the engine while servicing the outer element.
6. Replace the element with t new one if the element is damaged, or excessively dirty or oily.
7. Clean inside of the air cleaner cover.
8. Install the element into the air cleaner case (4, Fig.00-44).
9. If there is a red line (2, Fig.00-44) in the outer element, reinsert the element until the red line aligns with the end face of the air cleaner case.
10. Align the match mark (arrow, 5, Fig.00-43) of the cover and the match mark (arrow, 6, Fig.00-43) of the case, and then install the air cleaner cover.
11. Firmly tighten the air cleaner cover.

NOTICE

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

3- Draining fuel tank

⚠ DANGER

Fire and Explosion Hazard!

- **Diesel fuel is extremely flammable and explosive under certain conditions.**
- **When you remove any fuel system component to perform maintenance (such as changing the fuel filter) place an approved container under the opening to catch the fuel.**
- **Never use a shop rag to catch the fuel. Vapors from the rag are flammable and explosive.**
- **Wipe up any spills immediately.**
- **Wear eye protection. The fuel system is under pressure and fuel could spray out when you remove any fuel system component.**
- **Failure to comply could result in death or serious injury.**

NOTICE

- Always be environmentally responsible. Follow the guidelines for the proper disposal of hazardous material. Failure to follow these procedures may seriously harm the environment.
- Follow the guidelines of the EPA or other governmental agencies for the proper disposal of hazardous materials such as engine lubricating 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.

Note that a typical fuel tank is illustrated.

1. Place an approved container under the diesel fuel tank (1, Fig.00-45) to collect the contaminates.
2. Remove the fuel cap (3, Fig.00-45).
3. Remove the drain plug (2, Fig.00-45) of the fuel tank to drain the contaminates (water, dirt, etc.) from the bottom of the tank.
4. Drain the tank until clean diesel fuel with no water and dirt flows out. Reinstall the drain plug, and firmly tighten it.
5. Reinstall the fuel cap.
6. Check for fuel leaks.

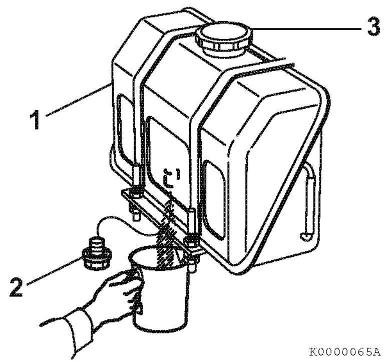


Fig. 00-45

NOTICE

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

3.4 Every 500 hours of operation

Perform the following maintenance every 500 hours of operation.

- Replace fuel filter element
- Replace water separator element
- Replace air cleaner element
- Replace engine lubricating oil and lubricating oil filter

1- Replacing fuel filter element

⚠ DANGER

Fire and Explosion Hazard!

- **Diesel fuel is extremely flammable and explosive under certain conditions.**
- **When you remove any fuel system component to perform maintenance (such as changing the fuel filter) place an approved container under the opening to catch the fuel.**
- **Never use a shop rag to catch the fuel. Vapors from the rag are flammable and explosive.**
- **Wipe up any spills immediately.**
- **Wear eye protection. The fuel system is under pressure and fuel could spray out when you remove any fuel system component.**
- **Failure to comply could result in death or serious injury.**

NOTICE

- Always be environmentally responsible. Follow the guidelines of the EPA or other governmental agencies for the proper disposal of hazardous material. Failure to follow these procedures may seriously harm the environment.
- Follow the guidelines of the EPA or other governmental agencies for the proper disposal of hazardous materials such as engine lubricating 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.

NOTICE

For maximum engine life, YANMAR recommends that when shutting the engine down, you allow the engine to idle, without load, for five minutes. This will allow the engine components that operate at high temperature, such as the turbocharger (if equipped) and exhaust system, to cool slightly before the engine itself is shut down.

Replace the fuel filter every 500 hours of operation to prevent contaminants from adversely affecting the diesel fuel flow.

1. Stop the engine, and allow it to cool.
2. Close the fuel valve of the water separator.
3. Turn and remove the fuel filter counterclockwise (1, Fig.00-46) by hand or filter wrench.
   When using a filter wrench for removal, use a YANMAR genuine or a plier type to the plastic part of the filter (2, Fig.00-46). Refer to 0000-07-05-01 "Special Service Tools" for YANMAR genuine filter wrench. When removing the fuel filter, hold the fuel filter carefully not to spill fuel.
   Wipe spilled fuel.

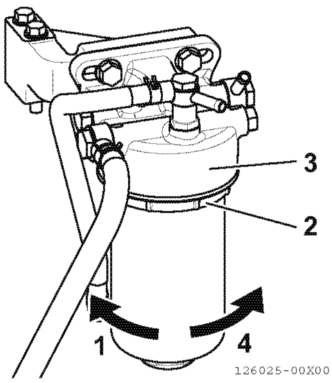


Fig. 00-46

4. Clean the filter mounting surface, and apply a small amount of diesel fuel to the gasket of the new fuel filter.
5. Attach a new fuel filter to the head (3, Fig.00-46). Turn the filter clockwise (4, Fig.00-46) by hand, and tighten until it hits the head. The target torque is 30 ± 5 N·m, but do not use any tools.

Applicable fuel filter Part No.
129G01-55800

6. Open the fuel valve of the water separator.
7. Prime the fuel system. See 0000-10-01-04 "Priming the fuel system".
8. Check for fuel leaks.

NOTICE

- Be sure to use YANMAR genuine filter for replacing the fuel filter.
- Be sure to prime the fuel system before starting the engine. If air is mixed to the fuel, seizure to the supply pump and the injector may result.

2- Replacing water separator element

⚠ DANGER

Fire and Explosion Hazard!

- **Diesel fuel is extremely flammable and explosive under certain conditions.**
- **When you remove any fuel system component to perform maintenance (such as changing the fuel filter) place an approved container under the opening to catch the fuel.**
- **Never use a shop rag to catch the fuel. Vapors from the rag are flammable and explosive.**
- **Wipe up any spills immediately.**
- **Wear eye protection. The fuel system is under pressure and fuel could spray out when you remove any fuel system component.**
- **Failure to comply could result in death or serious injury.**

NOTICE

- Always be environmentally responsible. Follow the guidelines of the EPA or other governmental agencies for the proper disposal of hazardous material. Failure to follow these procedures may seriously harm the environment.
- Follow the guidelines of the EPA or other governmental agencies for the proper disposal of hazardous materials such as engine lubricating 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.

NOTICE

For maximum engine life, YANMAR recommends that when shutting the engine down, you allow the engine to idle, without load, for five minutes. This will allow the engine components that operate at high temperature, such as the turbocharger (if equipped) and exhaust system, to cool slightly before the engine itself is shut down.

Replace the water separator element every 500 hours of operation.

1. Place an approved container under the water separator to collect drained water and contaminants.
2. Turn the fuel valve (1, Fig.00-47) to the position (2, Fig.00-47) to close it.
3. Loosen the drain valve (3, Fig.00-47) to drain fuel and contaminants.
   See 0000-08-03-02 “Drain water separator”.
4. Use your hand or filter wrench to turn the water-collecting cup (4, Fig.00-47) counterclockwise, and remove from the filter element (6, Fig.00-47). When using a filter wrench, use YANMAR genuine or plier type. For YANMAR genuine filter wrench, refer to 0000-07-05-01 “Special service tools”.
   If a drain sensor is equipped, disconnect the sensor wire from the cup before removing the cup.
   When removing the water collecting cup, be careful not to spill fuel. Wipe immediately if fuel spills.
5. Remove the float (7, Fig.00-47) from the water collecting cup. Pour the contaminants into the container and dispose properly.
6. Use your hand or filter wrench to turn the filter element (8, Fig.00-47) counterclockwise, and remove from the bracket (9, Fig.00-47). When using a filter wrench, use YANMAR genuine or plier type, and remove by attaching to the resin part of the filter element. For YANMAR genuine filter wrench, refer to 0000-07-05-01 “Special service tools”.
7. Clean inside the water collecting cup using new fuel oil.
8. Replace the O-ring of the water collecting cup with a new one (12, Fig.00-47).
9. Clean the filter element mounting surface of the bracket, and apply a thin layer of fuel to the gasket surface of the new filter element.

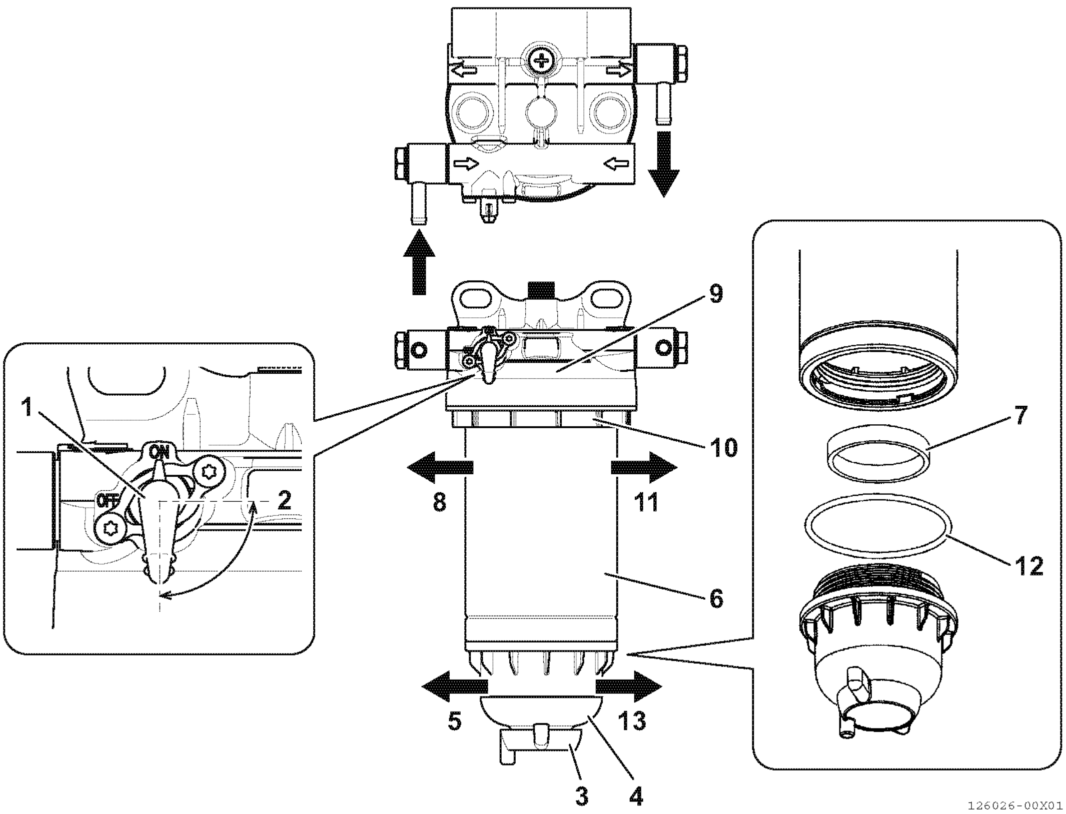


Fig. 00-47

10. Install a new filter element to the bracket, and tighten it clockwise (11, Fig.00-47).
    Be sure to tighten it by hand. Do not use any tools.
11. Install a new O-Ring (12, Fig.00-47) to the water collecting cup, attach to the filter element with the float, and tighten it clockwise (13, Fig.00-47). Be sure to tighten it by hand. Do not use any tools.

Part name	Part No.
Element	129G01-55740
O-Ring	129G01-55920

NOTICE

When replacing the filter element of the water separator, make sure to use a YANMAR genuine filter element.

12. Close the drain valve by hand. If a drain sensor is equipped, reconnect the sensor wire.
13. Open the fuel valve.
14. Prime the fuel system. See 0000-10-01-04 “Priming the fuel system”.

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 fuel leaks.

3- Replacing air cleaner element

NOTICE

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

Replace the air cleaner element (2, Fig.00-48) every 500 hours of operation even if it is not damaged. When replacing the element, clean inside the air cleaner case (4, Fig.00-48).

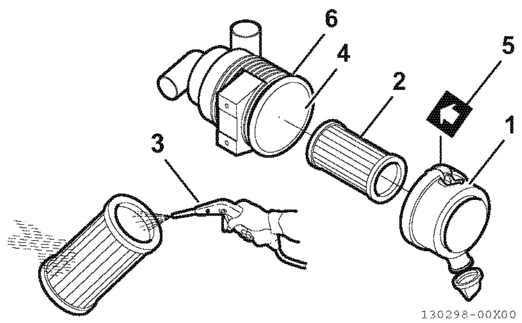


Fig. 00-48

If the air cleaner is equipped with a double element, only remove and replace the inner element (1, Fig.00-49) if the engine lacks power or the dust indicator actuates (if equipped). The inner element is used as a back-up for the outer element.

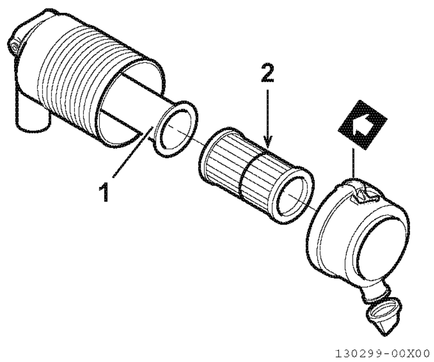


Fig. 00-49

4- Replacing engine lubricating oil and lubricating oil filter

⚠ WARNING

Burn Hazard!

- **If you must drain the engine lubricating oil while it is still hot, stay clear of the hot engine lubricating oil to avoid being burned.**
- **Always wear eye protection.**
- **Failure to comply could result in death or serious injury.**

NOTICE

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

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 lubricating 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.

Change the engine lubricating oil and replace the lubricating oil filter every 500 hours or one year whichever comes first. Refer to the procedures below for each replacement.

1	Draining the engine lubricating oil	See 3000-02-04-01 “Draining the Engine Lubricating Oil”.
2	Removing the lubricating oil filter	See 3200-02-01-01 “Removing the Lubricating Oil Filter”.
3	Reassembling the lubricating oil filter	See 3200-02-03-01 “Installing the Lubricating Oil Filter”.
4	Filling engine lubricating oil	See 3000-02-04-02 “Filling Engine Lubricating Oil”.

Applicable engine lubricating oil filter Part No. (standard)
127695-35150

3.5 Every 1500 hours of operation

Perform the following maintenance every 1500 hours of operation.

- Check and adjust intake/exhaust valve clearance

1- Checking and adjusting intake/exhaust valve clearance

For the check method of intake/exhaust valve clearance, see 1403-03-02-01 “Measuring and Adjusting Valve Clearance”. For the standard values for clearance, see 0000-07-01-01 “Cylinder Head Specifications”.

To maintain the correct timing for opening and closing the intake/exhaust valves, it is necessary to adjust the intake/exhaust valve clearance in proper procedure. Improper adjustment increases the engine noise, and causes poor performance and engine damage. See 0000-07-01-01 “Intake/exhaust valve and guide”.

3.6 Every 2000 hours of operation

Perform the following maintenance every 2000 hours of operation.

- Replace engine coolant
- Checking and replacing of rubber hoses such as fuel pipe, engine coolant pipe, lubricating oil pipe, and turbocharger pipe

1- Replacing engine coolant

⚠ DANGER

Scald Hazard!

- **Do not open the radiator cap during 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 could result in death or serious injury.**

⚠ WARNING

Burn Hazard!

- **Wait until the engine cools before you drain the engine coolant. Hot engine coolant may splash and burn you.**
- **Failure to comply could result in death or serious injury.**

⚠ CAUTION

Coolant Hazard!

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

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 lubricating 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.

Change the engine coolant every 2000 hours or two years, whichever comes first. Drain the engine coolant, and refill the cooling system with new engine coolant (antifreeze).

1	Draining engine coolant	See 4000-02-04-01 “Draining Engine Coolant”.
2	Filling engine coolant	See 4000-02-04-02 “Filling Radiator with Engine Coolant”.

2- Checking and replacing of rubber hoses such as fuel pipe, engine coolant pipe, lubricating oil pipe, and turbocharger pipe

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 lubricating 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.

Regularly check the rubber hoses used for the fuel system, engine coolant system, turbocharger lubricating oil return line, and the turbocharger intake line. If the rubber hoses are cracked or degraded, replace them. Replace the rubber hoses every 2000 hours or two years, whichever comes first.

3.7 Every 3000 hours of operation

Perform the following maintenance every 3000 hours of operation.

- Replace cooling fan V-belt

1- Replacing cooling fan V-belt

A V-ribbed belt is used for the cooling fan V-belt, and the belt tension is automatically adjusted by the hydraulic auto tensioner. The belt needs to be replaced every 3000 hours of operation, or when the stationary tensioner position reaches the replacement interval position, whichever comes first.

■ Check tensioner position

Fig.00-50 (left) shows the layout of the cooling fan V-belt and the auto tensioner while Fig.00-50 (right) shows the detailed view of the tensioner. When operating the engine for the first time, and while the belt is stationary, the protrusion of the tensioner arm is positioned in the tensioner bracket groove (1). Once the belt the becomes elongated as the engine is operated, the piston (indicated by the large arrow) of the hydraulic unit is expanded, and the protrusion moves to the groove (2) indicated by the small arrow. When the protrusion reaches the groove (2), then it is time to replace the belt.

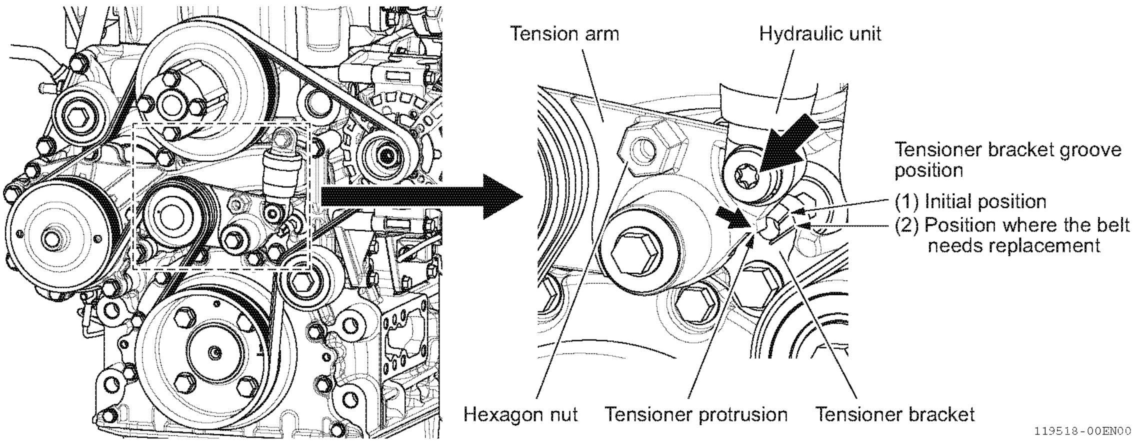


Fig. 00-50

■ Replacement procedure of cooling fan V-belt

Operate the hydraulic unit to loosen the belt tension to remove/install the belt. Turn the hexagon nut (Fig.00-50) of the tensioner arm counterclockwise (2, Fig.00-51) by using a tool such as a ratchet wrench or the like (1, Fig.00-51), and move the tensioner arm downward until the hole for inserting a fixing tool (1, Fig.00-52) at the back of the tensioner arm (3, Fig.00-51) can be seen. Insert a cross slot screw driver into the hole, and fix the tensioner arm in place. With the arm fixed in place, remove/install the belt. Since the hydraulic unit may break if the hydraulic pressure rises suddenly, take three seconds or more to move the arm slowly from (Fig.00-51) to (Fig.00-52) when removing/ installing the belt.

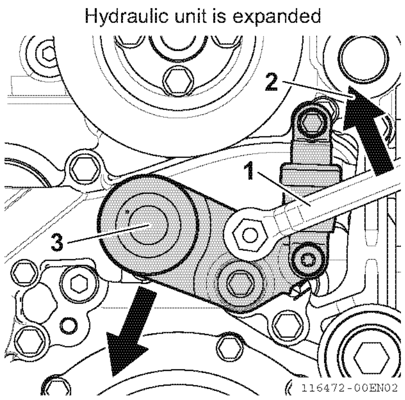


Fig. 00-51

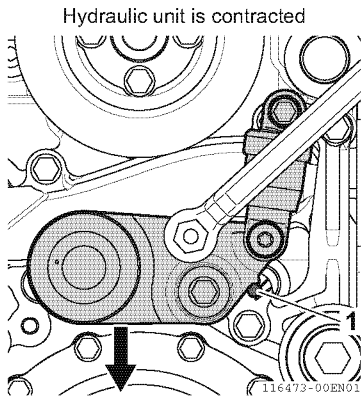


Fig. 00-52

3.8 Every 4500 hours of operation

Perform the following maintenance every 4500 hours of operation.

- Check ECU and related sensors and actuators
- Check turbocharger
- Check crankcase breather, and replace filter element
- Check and clean EGR and EGR cooler
- Check DOC/SCR catalyst and related sensors (applicable only to EU Stage V certified models)
- Check and clean injector
- Check and replace SM (Supply module) main filter (applicable only to EU Stage V certified models)

1- Checking ECU and related sensors and actuators

Check the appearance and wiring of the ECU and related sensors and actuators, and check the occurrence status and error history of the engine failure lamp and warning lamps on the control panel every 4500 hours of operation. If necessary, use the failure diagnosis tool SMARTASSIST-DIRECT (SA-D) for more detailed checks. Contact your authorized YANMAR dealer who can handle SMARTASSIST-DIRECT (SA-D).

2- Checking turbocharger

The turbocharger is operated in high temperature gas, rotating at a rate as high as approximately 150,000 min^{-1}. To maintain the unit with excellent performance for continuous use for a long time, check the turbocharger every 4500 hours of operation. Inspection and services of the turbocharger must be done by the authorized YANMAR distributor or dealer. If you notice that the engine seems sluggish or the exhaust color is abnormal never wait until the next periodic interval. For cleaning and inspection of the turbocharger, see 2400-02-02-01 “Inspecting the Turbocharger”, 2400-02-02-02 “Inspecting the Waste Gate Valve”, 2400-04-01-01 “Turbocharger Cleaning Procedure”.

3- Checking crankcase breather, and replacing filter element

The blow-by gas in the crank case is exhausted through the blow-by gas filter equipped inside the bonnet. Replace the filter element every 4500 hours of operation.

■ Replacement procedure of the filter element

For replacing the filter element, see 1404-02-04-01 “Replacing the breather filter element”.

■ Inspecting the breather system

For inspecting the breather system, see 1404-02-02-01 “Inspecting the Breather System”.

4- Checking and cleaning EGR and EGR cooler

The EGR system is composed of the EGR cooler, EGR valve, and EGR lead valve, etc. When the EGR system is used as an exhaust gas passage for a long time, carbon accumulates and scale forms inside the passage. This hinders exhaust gas circulation, resulting in deterioration of EGR efficiency and exhaust emissions. Clean the EGR and EGR cooler every 4500 hours of operation.
For cleaning the EGR system, see 2300-04-01-01 “Cleaning the EGR Valves”.

5- Checking DOC/SCR catalyst and related sensors (applicable only to EU Stage V certified models)

Check the appearance and wiring of the DOC/SCR catalyst, and related sensors, and check the occurrence status and error history of the DOC in the DPF and/or SCR, and related parts in accordance with the engine failure lamp and warning lamps on the control panel of the driven machine. If necessary, use a failure diagnosis tool, SMARTASSIST-DIRECT (SA-D) for more detailed checks. Contact your authorized YANMAR dealer who can handle SMARTASSIST-DIRECT (SA-D).

6- Checking and cleaning injector

Check the injector tip every 4500 hours of operation to ensure the optimum fuel injection and engine performance. Clean the injector tip with a soft brush if necessary.

7- Checking and replacing SM (Supply Module) main filter (applicable only to EU Stage V certified models)

NOTICE

- For the maintenance of the main filter, wait for 10 minutes after turning off the engine key (after complete shutoff).
- Before replacing, make sure that all parts are sufficiently cooled. Do not work in high temperature or high pressure environment.
- Replacement should be done when the remaining urea water is low after finishing the after-run. Be careful of the urea water flowing out when removing the filter cover.
- Do not replace when the urea water is frozen.
- When replacing, because there may be pressure remaining in the system, wear appropriate protection gears.
- When replacing, do not apply excessive pressure to the parts, or break by stepping on them.
- When replacing, do not wear gloves that can create contamination such as fiber dust.

NOTICE

Make sure you do not damage the thread part of the O-ring of the filter element, and thread and seal part of the filter element while replacing. If you try to attach the filter when the urea water is crystallized, the O-ring may be damaged. Rinse the crystal with water.

NOTICE

- Do not install when the filter paper of the filter element is wet. Deformation of the filter makes it difficult to insert.
- Do not reuse the filter element. Deformation of the filter makes it difficult to insert.
- When replacing the main filter element, make sure to replace the equalizing element with the new one included in the kit.
- When tightening the filter cover, use a specified tool (27 mm wrench: DIN 3124/ISO 2725-1).
- When installing, make sure that there are no contaminants such as foreign matter and dust. When replacing, do not wear gloves that can create contamination such as fiber dust.

The SM (Supply Module) applies a pressure of 9 bars to the urea water sucked out from the urea water tank, and pumps it to the DM (Dosing Module). The main filter equipped inside the SM needs to be replaced every 4500 hours or three years, whichever comes first. When replacing the main filter, replace the equalizing element inserted inside the main filter at the same time. Do not reuse the main filter after cleaning.

1	Replacing the SM main filter	See 2503-02-02-01 “Replacement procedure of the SM main filter”.

3.9 Every 6000 hours of operation (applicable only to EU Stage V certified models)

Perform the following maintenance every 6000 hours of operation.

- Check DPF and related components (including the cleaning of soot filter)

1- Check DPF and related components (including the cleaning of soot filter)

⚠ WARNING

- **When removing the soot filter from the DPF for cleaning purposes, soot ash in the filter may scatter. Wear gloves, anti-dust mask, eye protection and other protective equipment.**
- **When transporting a DPF unit with a soot filter for maintenance or cleaning, fix it firmly in the package to prevent soot ash scattering during transport.**
- **Soot Ash removed from the soot filter may be considered as industrial waste. Adequate provision must be assured for the containment of the material once it is removed. Disposal should be performed in accordance with local laws and regulations.**

■ Check DPF DOC

Check the appearance of the sensors such as the DPF exhaust temperature sensor and the differential pressure sensor. In addition, check the error occurrence status on the after-treatment related devices or parts and error history by observing the failure lamps and warning lamps on the control panel. Perform these checks every 6000 hours. If necessary, use a failure diagnosis tool, SMARTASSIST-DIRECT (SA-D) for more detailed checks. Contact your authorized YANMAR dealer who can handle SMARTASSIST-DIRECT (SA-D).

■ Clean soot filter

- If your engine is equipped with DPF cleaning alarm, check and clean the soot filter when the alarm lamp comes on. If your engine is not equipped with DPF cleaning alarm, clean the soot filter every 6000 hours of operation.
- The SF is cleaned at a YANMAR service center equipped with a cleaning facility.
  The SF is built into the SF case. Therefore, send the SF without removing it from the case.
- For removing the SF, see 2502-02-01-02 “Removing the SF”.

3.10 Every 9000 hours of operation (applicable only to EU Stage V certified models)

Replace the following parts every 9000 hours of operation.

- DPF
- SCR

Before replacing those parts, contact your authorized YANMAR dealer or distributor.

See the following sections for the replacement procedure.

1	Replacing and removing the ATD unit	2501-02-01-01 “Replacing (Removing) the ATD Unit” 2501-02-03-01 “Replacing (Assembling) the ATD Unit”
2	Removing, replacing, and assembling the DPF	2502-02-01-01 “Replacing (Removing) the DPF” 2502-02-03-01 “Replacing (Assembling) the DPF”
3	Removing, replacing, and assembling the SCR	2503-02-01-01 “Replacing (Removing) the SCR” 2503-02-03-01 “Replacing (Assembling) the SCR”

1. Troubleshooting by Measuring Compression Pressure

Low compression pressure is a major cause for blow-by gas to increase (cause of dirty lubricating oil and excess lubricating oil consumption) and starting failure. The compression pressure is affected by the following factors:

- Size of the clearance between the piston ring and cylinder
- Size of the clearance of intake/exhaust valve seat
- Gas leak from nozzle gasket or cylinder head gasket

Pressure drop is caused by increase of parts wearing, and pressure drop causes the drop of engine durability. Pressure drop can also be caused by cylinders and pistons being scratched by small dusts that result from dirty air cleaner element or damaged piston ring. Measure the compression pressure to determine the condition of the engine.

1.1 Compression pressure measurement method (1)

The basic way to measure the compression pressure is to remove the injector and attach the compression gauge adapter. For compression gauge adapters for injectors, refer to 0000-07-05-01 “Special Service Tools”.

1- Removing the injectors

1. In order to remove the injectors, you will need to remove the bonnet and the harness cover that is attached to the bonnet.
   For removal of the bonnet (1, Fig.00-53), see 1404-02-01-01 “Removing the bonnet”. For removal of the harness cover (2, Fig.00-53), see 7200-02-01-01 “Removing the Wire Harness Assembly”.

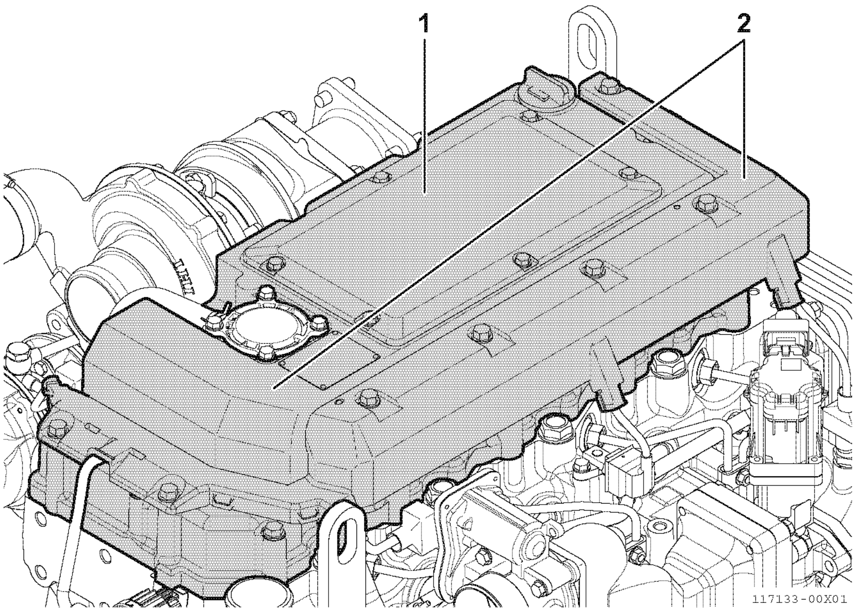


Fig. 00-53

2. Next, remove the high-pressure line assembly between the injector and the rail (1, Fig.00-54), the injector wire harness assembly (2, Fig.00-54), the oil leakage line assembly (3, Fig.00-54), and all of the injectors from the cylinders. How to remove the above items are explained in 5300-02-01-01 “Removing the Injectors”

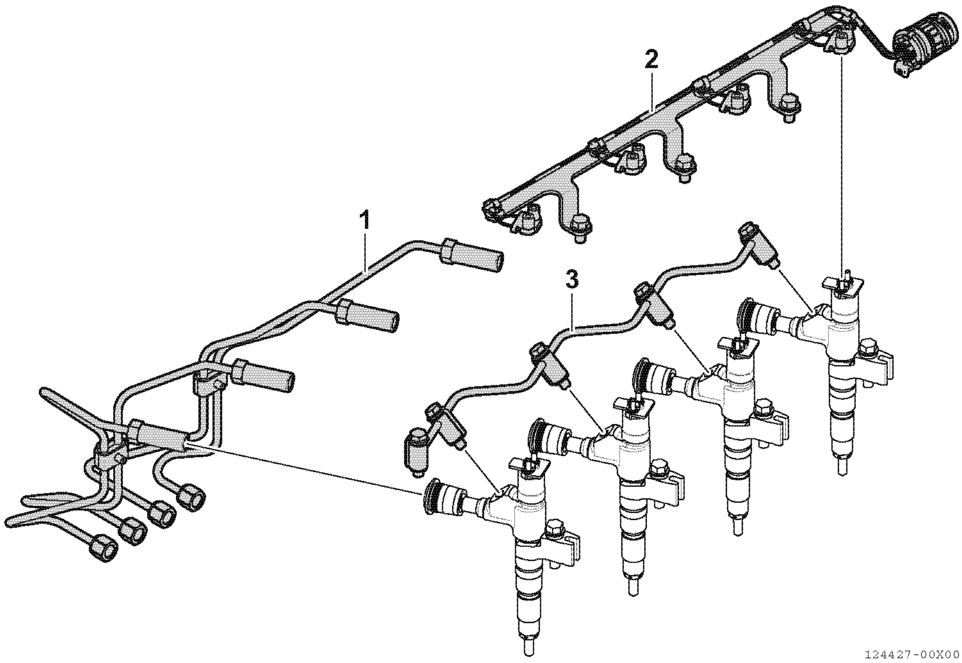


Fig. 00-54

2- Measuring the compression pressure

1. Close the valves of the fuel systems such as the water separator.
2. Next, use the SMARTASSIST-DIRECT (SA-D) and reassemble the removed injectors, high-pressure line, and injector wire harness assembly. Here, remove the retainer of the high-pressure line, and connect the rail and injector accordingly for each cylinder. Each injector should be set so that fuel does not contact the operator.
3. Insert a compression gauge adapter along with a gasket (129978-11871) into the cylinder to be measured, and fix with a retainer. Attach a compression gauge to the adapter. See 0000-07-05-02 “Measurement Instruments” for compression gauge.
4. Connect SA-D, and cut the fuel injection of all cylinders using "Active Control" function.
   For details, refer to the SMARTASSIST-DIRECT operation manual.
5. Crank the engine until the compression gauge reading is stabilized, and measure the compression pressure.

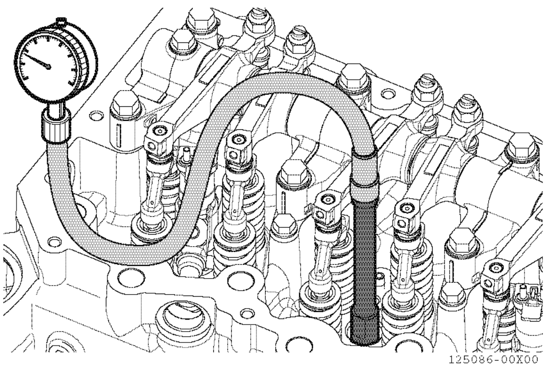


Fig. 00-55

6. After measuring the compression pressure of all cylinders, turn off the SA-D active control, communication, and engine key switch.
7. Remove the compression gauge and gauge adapter. Remove the injector gasket.

3- Attaching the Injector

1. Remove the injector and the high-pressure line set besides the engine. Insert each injector of the cylinders to its correct cylinder. Temporarily fix the injector with a retainer. Replace the O-ring and gasket of the injector to a new one.
2. Insert a pipe seal to each cylinder, and attach the high-pressure fuel injection lines between the rail and injectors. Replace the high-pressure pipe assembly to a new one. Tighten the mounting bolts of the injector holding retainer to the specified torque, and then tighten the cap nuts of the high pressure pipe to the specified torque.
3. Attach the fuel leakage line assembly, and the injector wire harness assembly.
   Refer to 5300-02-03-01 "Attaching the Injector” for further instruction.
4. Attach the bonnet and harness cover. For installation of the bonnet, see 1404-02-03-02 “Installing the bonnet”. For installation of the harness cover, see 7200-02-03-01 “Installing the Wire Harness Assembly”.
5. Open valves of fuel system.
6. Start the engine and check for fuel leaks.

1.2 Compression pressure measurement method (2)

Compression pressure can be measured by removing the glow plug and attaching the compression gauge adapter to the glow plug hole. For compression gauge adapters for glow plugs, refer to 0000-07-05-01 “Special Service Tools”.

1- Removing the glow plug

For removing the glow plug, see 7103-02-01-01 “Removing the Glow Plug”.

2- Measuring the compression pressure

1. Close the valves of the fuel systems such as the water separator.
2. Attach a compression gauge adapter (for glow plugs) to the cylinder which its compression pressure is to be measured. The adapter is attached to the cylinder block with bolt threads. For details on tightening torques, see 7103-02-03-01 “Installing the Glow Plug”. Attach a compression gauge to the adapter. See 0000-07-05-02 “Measurement Instruments” for compression gauge.
3. Connect SA-D, and cut the fuel injection of all cylinders using "Active Control" function. For details, refer to the SMARTASSIST DIRECT operation manual.
4. Crank the engine until the compression gauge reading is stabilized, and measure the compression pressure.
5. After measuring the compression pressure of all cylinders, turn off the SA-D active control, communication, and engine key switch.
6. Remove the compression gauge and gauge adapter.

3- Installing the glow plug

Install the removed glow plug. For details on installing, refer to 7103-02-03-01 “Installing the Glow Plug”.

1.3 Standard value of compression pressure (reference value)

The graph of standard value (reference value) of compression pressure of 4TN107 engine is shown in Fig.00-56. Engine rotation speed 250 min^{-1} is about 3.3 MPa.

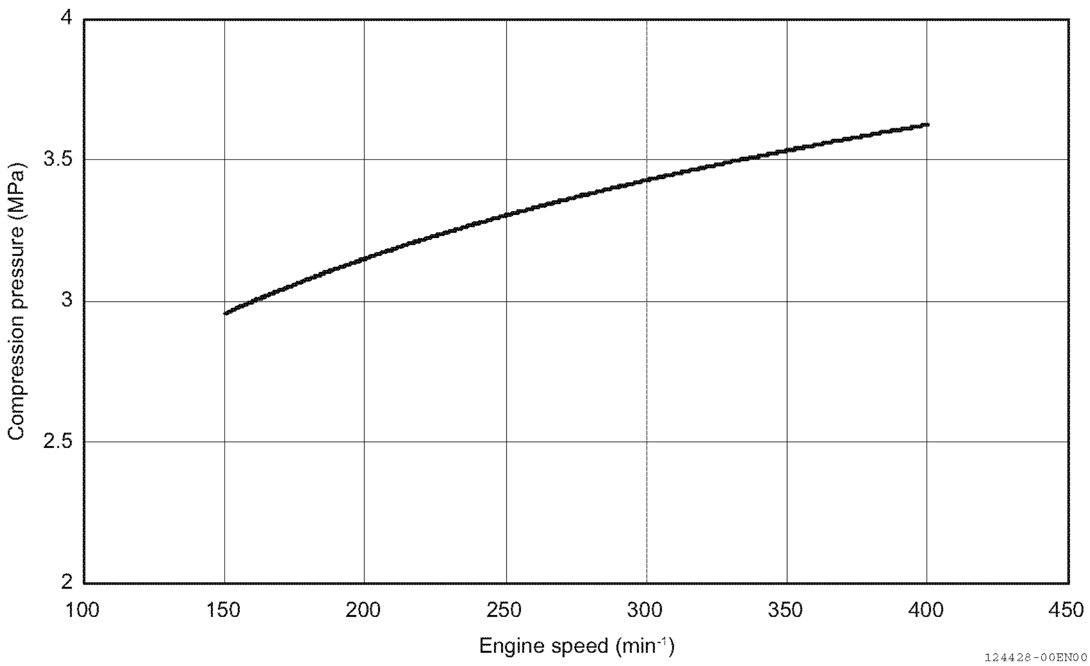


Fig. 00-56

1.4 Compression pressure and troubleshooting

When the measured compression pressure is below the reference value, inspect each part by referring to the table below.

No.	Item	Cause	Corrective action
1	Air cleaner element	Element is clogged	Clean the element
		Element is broken	Replace the element
		Element seal failure	
2	Valve clearance	Valve clearance is too big or no clearance	Adjusting the valve clearance
3	Valve timing	Incorrect valve clearance	Adjusting the valve clearance
4	Cylinder head gasket	Gas leak from gasket	Replace the gasket
			Retighten the cylinder head bolts to the specified torque.
5	Intake/exhaust valve	Sticking valve	Replace the intake/exhaust valve.
	Valve seat	Gas leak due to worn valve seat or foreign matter trapped in valve	Lap the valve seat
6	Piston	Gas leak from scratches or wearing	Perform honing and use an oversized part.
	Piston ring		
	Cylinder		

2. Quick Reference Table for Troubleshooting

The following table summarizes the general trouble symptoms and their causes. If any trouble symptom occurs, take corrective action before it becomes a serious problem so as not to shorten the engine service life.

2.1 Starting failure

■ Starter motor does not rotate

Trouble symptoms	Cause	Corrective action	Refer to
Failure indicator does not turn on after turning the key	Fusing, open circuit of fuse	• Inspect and replace fuse • Repair or replace harness	
	Open circuit of wiring	Repair or replace the harness open circuit	
	Short circuit of wiring (coating failure), excess electric load to additional equipment	• Inspect, repair, or replace harnesses • Reconsider additional equipment	
	Failure or open circuit of key switch	• Repair or replace harness • Replace key switch	
	Failure of main relay (Trouble besides contact sticking that cannot be detected by ECU)	• Repair or replace harness • Replace main relay	
	ECU failure (that ECU cannot self-control)	Replace ECU	
ECU failure indicator turns on after turning the key (2 seconds)	Fusing, open circuit of fuse	• Inspect and replace fuse • Repair or replace harness	
	Starter failure	Repair or replace starter	7101-02-04-01 “Causes and Preventive Measures of Starter Failure”
	Open circuit of wiring	Repair or replace the harness open circuit	
	Battery voltage drop	Inspect and charge the battery	0000-08-03-02 “Check battery”
	Failure, open circuit, or short-circuit of starter relay	• Repair or replace harness • Replace starter relay	
	Failure of actuator relay (Contact failure that cannot be detected by ECU)	Replace actuator relay	
	ECU failure (that ECU cannot self-control)	Replace ECU	
	ECU control function is working	• Not a failure • Use in an authorized way	Check the engine stopping factor or starter holding factor by SA-D (SMARTASSIST-DIRECT)
	Failure from ECU self diagnosis	Replace ECU	

Cause and corrective action of failure

<Quick reference table for troubleshooting>

■ Starter rotates

Trouble symptoms	Cause	Corrective action	Refer to
Engine does not start (Not even the first explosion (ignition))	Improper intake/exhaust valve clearance	Adjusting the valve clearance	1403-03-02-01 “Measuring and Adjusting Valve Clearance”
	Compression leakage from valve seat	Lap the valve seat	1403-03-01-01 “Grinding and Lapping the Valve Seats”
	Intake/exhaust valve seizure	Correct or replace intake/ exhaust valve	1403-02-01-01 “Removing the Intake and Exhaust Valves”
	Seized or broken piston ring	Replace the piston ring	1202-02-03-01 “Reassembling the Pistons”
	Worn piston ring, piston or cylinder	Perform honing and use an oversized part	0200-02-04-01 “Cylinder Block Honing and Boring”
	Seizure of crank pin bearing or bearing part	Repair or replace	1301-02-02-02 “Inspecting the Crankshaft (After Disassembly)”
	Foreign matter trapped in combustion chamber	Disassemble and repair	0100-02-01-01 “Disassembling the Engine”
	Governor adjustment failure	Make adjustment	
	Improper open/close timing of intake/exhaust valves	Adjusting the valve clearance	1403-03-02-01 “Measuring and Adjusting Valve Clearance”
	Incorrect engine lubricating oil	Use correct engine lubricating oil	0000-10-02-01 “Engine lubricating oil specifications”
	Water in fuel system	Drain the fuel filter	0000-08-03-02 “Drain water separator”
	Clogged fuel filter	Clean or replace	0000-08-03-04 “Replace water separator element”
	Air in fuel system	Remove air	0000-10-01-04 “Priming the fuel system”
	Clogged or cracked fuel line	Clean or replace	
	Insufficient fuel supply to fuel supply pump	Check the fuel tank cock, fuel filter, fuel line, and fuel feed pump	
	Priming failure	Disassemble the priming pump and clean the foreign matter trapped in the valve	5000-01-01-02 “Fuel System Components”
	Starter failure	Repair or replace starter	7101-02-04-01 “Causes and Preventive Measures of Starter Failure”
	Alternator failure	Repair or replace	7102-02-01-01 “Removing the Alternator”
	Open circuit of wiring	Repair or replace the harness open circuit	
	Battery voltage drop	Inspect and charge the battery	0000-08-03-02 “Check battery”.
	Failure of actuator relay (Contact failure that cannot be detected by ECU)	Replace actuator relay	
	Failure of starting aid relay (Contact failure that cannot be detected by ECU)	Replace starting aid relay	
	Signal failure of water temperature sensor (Failure that cannot be detected by ECU)	Replace water temperature sensor	Monitor the cooling water temperature by SA-D (SMARTASSIST-DIRECT)
	Open circuit or short circuit of starting aid relay	• Repair or replace harness • Replace relay	

Cause and corrective action of failure

Trouble symptoms	Cause	Corrective action	Refer to
Engine does not start (Stops immediately after continuous explosion)	Water in fuel system	Drain the fuel filter	0000-08-03-02 “Drain water separator”.
	Air in fuel system	Remove air	0000-10-01-04 “Priming the fuel system”.
	Insufficient fuel supply to fuel supply pump	Check the fuel tank cock, fuel filter, fuel line, and fuel feed pump	
	Key switch outage	Replace key switch	
	Signal failure of rotation sensor (Causes of noise that cannot be detected by ECU)	• Clean or replace rotation sensor • Repair or replace fuel injection pump	Monitor engine speed by SA-D (SMARTASSIST-DIRECT)
	Signal failure of rotation sensor	• Repair or replace harness • Repair or replace fuel injection pump	
Engine starts slower than before	Clogged fuel filter	Clean or replace	0000-08-03-04 “Replace water separator element”
	Strainer at feed pump inlet is clogged	Clean the strainer	
	Failure of starting aid relay (Contact failure that cannot be detected by ECU)	Replace starting aid relay	
	Signal failure of water temperature sensor (Failure that cannot be detected by ECU)	Replace water temperature sensor	Monitor the cooling water temperature by SA-D (SMARTASSIST-DIRECT)
	Signal failure of rotation sensor (Causes of noise that cannot be detected by ECU)	• Clean or replace rotation sensor • Repair or replace fuel injection pump	Monitor engine speed by SA-D (SMARTASSIST-DIRECT)
	Open circuit or short circuit of starting aid relay	• Repair or replace harness • Replace relay	

2.2 Engine stops after starting

Trouble symptoms	Cause	Corrective action	Refer to
No exhaust smoke	Improper intake/exhaust valve clearance	Adjusting the valve clearance	1403-03-02-01 “Measuring and Adjusting Valve Clearance”
	Seizure of crank pin bearing or bearing part	Repair or replace	1301-02-02-02 “Inspecting the Crankshaft (After Disassembly)”
	Position failure of piston ring end gap	Correct the ring joint positions	1202-02-03-01 “Reassembling the Pistons”
	Governor adjustment failure	Make adjustment	
	Incorrect engine lubricating oil	Use correct engine lubricating oil	0000-10-02-01 “Engine lubricating oil specifications”
	Insufficient engine lubricating oil Level	Add correct engine lubricating oil	3000-02-04-02 “Filling Engine Lubricating Oil”
	Clogged fuel filter	Clean or replace	0000-08-03-04 “Replace water separator element”
	Air in fuel system	Remove air	0000-10-01-04 “Priming the fuel system”.
	Clogged or cracked fuel line	Clean or replace	
	Insufficient fuel supply to fuel supply pump	Check the fuel tank cock, fuel filter, fuel line, and fuel feed pump	
	Fusing, open circuit of fuse	• Inspect and replace fuse • Repair or replace harness	
	Open circuit of wiring	Repair or replace the harness open circuit	
	Failure or open circuit of key switch	• Repair or replace harness • Replace key switch	
	Key switch outage	Replace key switch	
	Failure of actuator relay (Contact failure that cannot be detected by ECU)	Replace actuator relay	
	Signal failure of rotation sensor (Causes of noise that cannot be detected by ECU)	• Clean or replace rotation sensor • Repair or replace fuel injection pump	Monitor engine speed by SA-D (SMARTASSIST-DIRECT)
	Signal failure of rack position sensor (Cannot be detected by ECU)	Repair or replace fuel injection pump	Monitor the rack position sensor signal by SA-D (SMARTASSIST-DIRECT)
	Failure of rack actuator (cannot detect by ECU)	Repair or replace fuel injection pump	Check the rack actuator by SA-D (SMARTASSIST-DIRECT)
	Signal failure of rotation sensor	• Repair or replace harness • Repair or replace fuel injection pump	
	Engine overspeeds.	• Check the drag turning from attached parts • Check the speed sensor signal	
Small exhaust smoke	Clogged exhaust pipe	Clean exhaust pipe	

Trouble symptoms	Cause	Corrective action	Refer to
Large exhaust smoke	Intake/exhaust valve seizure	Correct or replace intake/ exhaust valve	1403-02-01-01 “Removing the Intake and Exhaust Valves”
	Seized or broken piston ring	Replace the piston ring	1202-02-03-01 “Reassembling the Pistons”
	Worn piston ring, piston or cylinder	Perform honing and use an oversized part	0200-02-04-01 “Cylinder Block Honing and Boring”
	Water in fuel system	Drain the fuel filter	0000-08-03-02 “Drain water separator”.
	Clogged air filter	Clean the air filter	0000-08-03-03 “Clean air cleaner”

2.3 Speed control failure

Trouble symptoms	Cause	Corrective action	Refer to
Cannot change speed with accelerator (Constant speed)	ECU control function is working	• Not a failure • Use in an authorized way	Check the engine stopping factor or starter holding factor by SA-D (SMARTASSIST-DIRECT)
	Open circuit or short circuit of accelerator sensor	• Repair or replace harness • Replace accelerator sensor	
	CAN communication error	• Repair or replace harness • Replace ECU	

■ No load

Trouble symptoms	Cause	Corrective action	Refer to
Cannot set to certain speed	Signal failure of accelerator sensor (Failure that cannot be detected by ECU)	Repair or replace accelerator sensor	Monitor the accelerator sensor by SA-D (SMARTASSIST-DIRECT)
	ECU failure (that ECU cannot self-control)	Replace ECU	
	ECU control function is working	• Not a failure • Use in an authorized way	Check the engine stopping factor or starter holding factor by SA-D (SMARTASSIST-DIRECT)
	Open circuit or short circuit of water temperature sensor	• Repair or replace harness • Replace water temperature sensor	
	Open circuit or short circuit of EGR valve motor	• Repair or replace harness • Replace EGR valve	
Does not accelerate well	Clogged fuel filter	Clean or replace	0000-08-03-04 “Replace water separator element”
	Insufficient fuel supply to fuel supply pump	Check the fuel tank cock, fuel filter, fuel line, and fuel feed pump	
	Strainer at feed pump inlet is clogged	Clean the strainer	
	Clogged air filter	Clean the air filter	0000-08-03-03 “Clean air cleaner”
	Clogged exhaust pipe	Clean exhaust pipe	

Trouble symptoms	Cause	Corrective action	Refer to
Engine hunting	Seized or broken piston ring	Replace the piston ring	1202-02-03-01 “Reassembling the Pistons”
	Seizure of crank pin bearing or bearing part	Repair or replace	1301-02-02-02 “Inspecting the Crankshaft (After Disassembly)”
	Crank pin bearing and journal bearing are worn out	Measure and replace	1301-02-02-02 “Inspecting the Crankshaft (After Disassembly)”
	Loosening or wearing of the engine’s vibration isolation support	Repair or replace the defective part	
	Water in fuel system	Drain the fuel filter	0000-08-03-02 “Drain water separator”.
	Air in fuel system	Remove air	0000-10-01-04 “Priming the fuel system”.
	Signal failure of accelerator sensor (Failure that cannot be detected by ECU)	Repair or replace accelerator sensor	Monitor the accelerator sensor by SA-D (SMARTASSIST-DIRECT)
	Signal failure of water temperature sensor (Failure that cannot be detected by ECU)	Replace water temperature sensor	Monitor the cooling water temperature by SA-D (SMARTASSIST-DIRECT)
	Signal failure of rotation sensor (Causes of noise that cannot be detected by ECU)	• Clean or replace rotation sensor • Repair or replace fuel injection pump	Monitor engine speed by SA-D (SMARTASSIST-DIRECT)
	Signal failure of rack position sensor (Cannot be detected by ECU)	Repair or replace fuel injection pump	Monitor the rack position sensor signal by SA-D (SMARTASSIST-DIRECT)
	Failure of rack actuator (cannot detect by ECU)	Repair or replace fuel injection pump	Check the rack actuator by SA-D (SMARTASSIST-DIRECT)

■ During work operation

Trouble symptoms	Cause	Corrective action	Refer to
Engine hunting	Intake/exhaust valve seizure	Correct or replace intake/ exhaust valve	1403-02-01-01 “Removing the Intake and Exhaust Valves”
	Seizure of crank pin bearing or bearing part	Repair or replace	1301-02-02-02 “Inspecting the Crankshaft (After Disassembly)”
	Crank pin bearing and journal bearing are worn out	Measure and replace	1301-02-02-02 “Inspecting the Crankshaft (After Disassembly)”
	Loosening or wearing of the engine’s vibration isolation support	Repair or replace the defective part	
	Water in fuel system	Drain the fuel filter	0000-08-03-02 “Drain water separator”.
	Air in fuel system	Remove air	0000-10-01-04 “Priming the fuel system”.
	Signal failure of accelerator sensor (Failure that cannot be detected by ECU)	Repair or replace accelerator sensor	Monitor the accelerator sensor by SA-D (SMARTASSIST-DIRECT)
	Signal failure of water temperature sensor (Failure that cannot be detected by ECU)	Replace water temperature sensor	Monitor the cooling water temperature by SA-D (SMARTASSIST-DIRECT)
	Signal failure of rotation sensor (Causes of noise that cannot be detected by ECU)	• Clean or replace rotation sensor • Repair or replace fuel injection pump	Monitor engine speed by SA-D (SMARTASSIST-DIRECT)

2.4 Lack of engine output

Trouble symptoms	Cause	Corrective action	Refer to
Exhaust color is normal	Improper intake/exhaust valve clearance	Adjusting the valve clearance	1403-03-02-01 “Measuring and Adjusting Valve Clearance”
	Compression leakage from valve seat	Lap the valve seat	1403-03-01-01 “Grinding and Lapping the Valve Seats”
	Intake/exhaust valve seizure	Correct or replace intake/ exhaust valve	1403-02-01-01 “Removing the Intake and Exhaust Valves”
	Cylinder head gasket blow-by	Replace the gasket	1401-02-01-01 “Removing the Cylinder Head Assembly”
	Crank pin bearing and journal bearing are worn out	Measure and replace	1301-02-02-02 “Inspecting the Crankshaft (After Disassembly)”
	Incorrect engine lubricating oil	Use correct engine lubricating oil	0000-10-02-01 “Engine lubricating oil specifications”
	Incorrect diesel fuel	Use correct fuel oil	0000-10-01-01 “Diesel fuel specifications”
	Clogged fuel filter	Clean or replace	0000-08-03-04 “Replace water separator element”
	Air in fuel system	Remove air	0000-10-01-04 “Priming the fuel system”.
	Clogged or cracked fuel line	Clean or replace	
	Insufficient fuel supply to fuel supply pump	Check the fuel tank cock, fuel filter, fuel line, and fuel feed pump	
	Strainer at feed pump inlet is clogged	Clean the strainer	
	ECU control function is working	• Not a failure • Use in an authorized way	Check the engine stopping factor or starter holding factor by SA-D (SMARTASSIST-DIRECT)
	Open circuit or short circuit of water temperature sensor	• Repair or replace harness • Replace water temperature sensor	
	Open circuit or short circuit of EGR valve motor	• Repair or replace harness • Replace EGR valve	
Exhaust color is white	Seized or broken piston ring	Replace the piston ring	1202-02-03-01 “Reassembling the Pistons”
	Worn piston ring, piston or cylinder	Perform honing and use an oversized part	0200-02-04-01 “Cylinder Block Honing and Boring”
	Position failure of piston ring end gap	Correct the ring joint positions	1202-02-03-01 “Reassembling the Pistons”
	Reverse assembly of piston rings	Reassemble correctly	1202-02-03-01 “Reassembling the Pistons”
	Worn intake/exhaust valve guide	Measure and replace	1403-02-02-01 “Inspecting the Valve Guides”
	Improper open/close timing of intake/exhaust valves	Adjusting the valve clearance	1403-03-02-01 “Measuring and Adjusting Valve Clearance”
	Radial bearing is worn	Disassemble and inspect	2400-01-02-01 “Bearings”
	Incorrect diesel fuel	Use correct fuel oil	0000-10-01-01 “Diesel fuel specifications”
	Water in fuel system	Drain the fuel filter	0000-08-03-02 “Drain water separator”.

Trouble symptoms	Cause	Corrective action	Refer to
Exhaust color is black	Compression leakage from valve seat	Lap the valve seat	1403-03-01-01 “Grinding and Lapping the Valve Seats”
	Intake/exhaust valve seizure	Correct or replace intake/ exhaust valve	1403-02-01-01 “Removing the Intake and Exhaust Valves”
	Blower is dirty	Clean the blower	2400-04-01-01 “Turbocharger Cleaning Procedure”
	Waste gate activation failure	Disassemble and inspect	2400-02-02-02 “Inspecting the Waste Gate Valve”
	Insufficient radiator cooling	Replace the thermostat or inspect the fan belt looseness	4000-02-01-01 “Removing the engine coolant pump” or 4000-02-04-04 “Replacing the Cooling Fan Belt”
	Insufficient engine coolant level	Check for water leakage from engine coolant system	4000-02-02-01 “Inspecting the Cooling System (Before Disassembly)”
	Stretched fan belt	Adjust the belt tension	4000-02-04-04 “Replacing the Cooling Fan Belt”
	Thermostat failure	Check or replace	4000-02-01-01 “Removing the engine coolant pump”
	Incorrect diesel fuel	Use correct fuel oil	0000-10-01-01 “Diesel fuel specifications”
	Clogged air filter	Clean the air filter	0000-08-03-03 “Clean air cleaner”
	Engine used at high temperatures or at high altitude	Study output drop and load matching	
	Clogged exhaust pipe	Clean exhaust pipe	

2.5 Sound and vibration

Trouble symptoms	Cause	Corrective action	Refer to
High knocking sound during combustion	Failure of starting aid relay (Contact failure that cannot be detected by ECU)	Replace starting aid relay	
	Signal failure of water temperature sensor (Failure that cannot be detected by ECU)	Replace water temperature sensor	Monitor the cooling water temperature by SA-D (SMARTASSIST-DIRECT)
Uneven combustion sound	Incorrect diesel fuel	Use correct fuel oil	0000-10-01-01 "Diesel fuel specifications"
	Water in fuel system	Drain the fuel filter	0000-08-03-02 "Drain water separator".
	Clogged air filter	Clean the air filter	0000-08-03-03 "Clean air cleaner"
	Clogged exhaust pipe	Clean exhaust pipe	
	Signal failure of accelerator sensor (Failure that cannot be detected by ECU)	Repair or replace accelerator sensor	Monitor the accelerator sensor by SA-D (SMARTASSIST-DIRECT)
	Signal failure of rotation sensor (Causes of noise that cannot be detected by ECU)	• Clean or replace rotation sensor • Repair or replace fuel injection pump	Monitor engine speed by SA-D (SMARTASSIST-DIRECT)
Noise other than combustion sound occurring from engine	Improper intake/exhaust valve clearance	Adjusting the valve clearance	1403-03-02-01 "Measuring and Adjusting Valve Clearance"
	Compression leakage from valve seat	Lap the valve seat	1403-03-01-01 "Grinding and Lapping the Valve Seats"
	Intake/exhaust valve seizure	Correct or replace intake/exhaust valve	1403-02-01-01 "Removing the Intake and Exhaust Valves"
	Seized or broken piston ring	Replace the piston ring	1202-02-03-01 "Reassembling the Pistons"
	Seizure of crank pin bearing or bearing part	Repair or replace	1301-02-02-02 "Inspecting the Crankshaft (After Disassembly)"
	Crank pin bearing and journal bearing are worn out	Measure and replace	1301-02-02-02 "Inspecting the Crankshaft (After Disassembly)"
	Connecting rod bolt is loose	Tighten with specified torque	0000-07-04-01 "Torque for Major Bolts and Nuts"
	Foreign matter trapped in combustion chamber	Disassemble and repair	0100-02-01-01 "Disassembling the Engine"
	Excessive gear backlash	Adjust gear mesh	0400-02-02-01 "Measuring Timing Gear Backlash"
	Improper open/close timing of intake/exhaust valves	Adjusting the valve clearance	1403-03-02-01 "Measuring and Adjusting Valve Clearance"
	Loosening or wearing of the engine's vibration isolation support	Repair or replace the defective part	
Engine vibration is big	Intake/exhaust valve seizure	Correct or replace intake/exhaust valve	1403-02-01-01 "Removing the Intake and Exhaust Valves"
	Seized or broken piston ring	Replace the piston ring	1202-02-03-01 "Reassembling the Pistons"
	Seizure of crank pin bearing or bearing part	Repair or replace	1301-02-02-02 "Inspecting the Crankshaft (After Disassembly)"
	Crank pin bearing and journal bearing are worn out	Measure and replace	1301-02-02-02 "Inspecting the Crankshaft (After Disassembly)"
	Connecting rod bolt is loose	Tighten with specified torque	0000-07-04-01 "Torque for Major Bolts and Nuts"
	Loosening or wearing of the engine's vibration isolation support	Repair or replace the defective part	

2.6 Engine lubricating oil

Trouble symptoms	Cause	Corrective action	Refer to
Excessive engine lubricating oil consumption	Seized or broken piston ring	Replace the piston ring	1202-02-03-01 “Reassembling the Pistons”
	Worn piston ring, piston or cylinder	Perform honing and use an oversized part.	0200-02-04-01 “Cylinder Block Honing and Boring”
	Position failure of piston ring end gap	Correct the ring joint positions	1202-02-03-01 “Reassembling the Pistons”
	Reverse assembly of piston rings	Reassemble correctly	1202-02-03-01 “Reassembling the Pistons”
	Foreign matter trapped in combustion chamber	Disassemble and repair	0100-02-01-01 “Disassembling the Engine”
	Worn intake/exhaust valve guide	Measure and replace	1403-02-02-01 “Inspecting the Valve Guides”
	Radial bearing is worn	Disassemble and inspect	2400-01-02-01 “Bearings”
	Incorrect engine lubricating oil	Use correct engine lubricating oil	0000-10-02-01 “Engine lubricating oil specifications”
	Lubrication system leakage	Repair	3100-02-01-01 “Removing the Lubricating Oil Pump”
	Excess oil supply to crankcase	Check the engine lubricating oil	3000-02-04-03 “Checking the Engine Lubricating Oil”
	Clogged air filter	Clean the air filter	0000-08-03-03 “Clean air cleaner”
Dilution by diesel fuel	Intake/exhaust valve seizure	Correct or replace intake/exhaust valve	1403-02-01-01 “Removing the Intake and Exhaust Valves”
	Seized or broken piston ring	Replace the piston ring	1202-02-03-01 “Reassembling the Pistons”
	Worn piston ring, piston or cylinder	Perform honing and use an oversized part.	0200-02-04-01 “Cylinder Block Honing and Boring”
Engine lubricating oil with water	Cylinder head gasket blow-by	Replace the gasket	1401-02-01-01 “Removing the Cylinder Head Assembly”
	Water jacket is cracked	Repair or replace	4000-02-01-01 “Removing the engine coolant pump”
Low lubricating oil pressure (Lubricating oil pressure indicator is on)	Crank pin bearing and journal bearing are worn out	Measure and replace	1301-02-02-02 “Inspecting the Crankshaft (After Disassembly)”
	Connecting rod bolt is loose	Tighten with specified torque	0000-07-04-01 “Torque for Major Bolts and Nuts”
	Water jacket is cracked	Repair or replace	4000-02-01-01 “Removing the engine coolant pump”
	Incorrect engine lubricating oil	Use correct engine lubricating oil	0000-10-02-01 “Engine lubricating oil specifications”
	Lubrication system leakage	Repair	3100-02-01-01 “Removing the Lubricating Oil Pump”
	Insufficient delivery capacity of trochoid pump	Check and repair	3100-02-01-01 “Removing the Lubricating Oil Pump”
	Clogged engine lubricating oil Filter	Clean or replace	0000-08-03-04 “Replace engine lubricating oil and lubricating oil filter”
	Pressure regulating valve failure	Clean, adjust or replace	3100-02-01-01 “Removing the Lubricating Oil Pump”
	Insufficient engine lubricating oil level	Add correct engine lubricating oil	3000-02-04-02 “Filling Engine Lubricating Oil”
	Excess oil supply to crankcase	Check the engine lubricating oil	3000-02-04-03 “Checking the Engine Lubricating Oil”

2.7 Engine coolant

Trouble symptoms	Cause	Corrective action	Refer to
Overheat (Water temperature indicator is on)	Cylinder head gasket blow-by	Replace the gasket	1401-02-01-01 “Removing the Cylinder Head Assembly”
	Seized or broken piston ring	Replace the piston ring	1202-02-03-01 “Reassembling the Pistons”
	Insufficient radiator cooling	Replace the thermostat or inspect the fan belt looseness	4000-02-01-01 “Removing the engine coolant pump” or 4000-02-04-04 “Replacing the Cooling Fan Belt”
	Insufficient engine coolant level	Check for water leakage from engine coolant system	4000-02-02-01 “Inspecting the Cooling System (Before Disassembly)”
	Water jacket is cracked	Repair or replace	4000-02-01-01 “Removing the engine coolant pump”
	Stretched fan belt	Adjust the belt tension	4000-02-04-04 “Replacing the Cooling Fan Belt”
	Thermostat failure	Check or replace	4000-02-01-01 “Removing the engine coolant pump”
	Engine used at high temperatures or at high altitude	Study output drop and load matching	
Low water temperature	Excessive radiator cooling	Replace the thermostat	4000-02-01-01 “Removing the engine coolant pump”
	Thermostat failure	Check or replace	4000-02-01-01 “Removing the engine coolant pump”

2.8 Intake

Trouble symptoms	Cause	Corrective action	Refer to
Pressure drop (Air cleaner indicator is on)	Improper exhaust valve clearance	Adjusting the valve clearance	1403-03-02-01 “Measuring and Adjusting Valve Clearance”
	Compression leakage from valve seat	Lap the valve seat	1403-03-01-01 “Grinding and Lapping the Valve Seats”
	Intake/exhaust valve seizure	Correct or replace intake/exhaust valve	1403-02-01-01 “Removing the Intake and Exhaust Valves”
	Clogged air filter	Clean the air filter	0000-08-03-03 “Clean air cleaner”
	Engine used at high temperatures or at high altitude	Study output drop and load matching	

2.9 Exhaust

■ During work operation

Trouble symptoms	Cause	Corrective action	Refer to
Exhaust color is white	Seized or broken piston ring	Replace the piston ring	1202-02-03-01 “Reassembling the Pistons”
	Worn piston ring, piston or cylinder	Perform honing and use an oversized part	0200-02-04-01 “Cylinder Block Honing and Boring”
	Reverse assembly of piston rings	Reassemble correctly	1202-02-03-01 “Reassembling the Pistons”
	Improper open/close timing of intake/exhaust valves	Adjusting the valve clearance	1403-03-02-01 “Measuring and Adjusting Valve Clearance”
	Radial bearing is worn	Disassemble and inspect	2400-01-02-01 “Bearings”
	Excessive radiator cooling	Replace the thermostat	4000-02-01-01 “Removing the engine coolant pump”
	Thermostat failure	Check or replace	4000-02-01-01 “Removing the engine coolant pump”
	Excess oil supply to crankcase	Check the engine lubricating oil	3000-02-04-03 “Checking the Engine Lubricating Oil”
	Incorrect diesel fuel	Use correct fuel oil	0000-10-01-01 “Diesel fuel specifications”
	Water in fuel system	Drain the fuel filter	0000-08-03-02 “Drain water separator”.
	Failure of starting aid relay (Contact failure that cannot be detected by ECU)	Replace starting aid relay	
	Open circuit or short circuit of starting aid relay	• Repair or replace harness • Replace relay	
Exhaust color is black	Compression leakage from valve seat	Lap the valve seat	1403-03-01-01 “Grinding and Lapping the Valve Seats”
	Intake/exhaust valve seizure	Correct or replace intake/exhaust valve	1403-02-01-01 “Removing the Intake and Exhaust Valves”
	Improper open/close timing of intake/exhaust valves	Adjusting the valve clearance	1403-03-02-01 “Measuring and Adjusting Valve Clearance”
	Blower is dirty	Clean the blower	2400-04-01-01 “Turbocharger Cleaning Procedure”
	Waste gate activation failure	Disassemble and inspect	2400-02-02-02 “Inspecting the Waste Gate Valve”
	Incorrect diesel fuel	Use correct fuel oil	0000-10-01-01 “Diesel fuel specifications”
	Clogged air filter	Clean the air filter	0000-08-03-03 “Clean air cleaner”
	Engine used at high temperatures or at high altitude	Study output drop and load matching	
	Clogged exhaust pipe	Clean exhaust pipe	

Trouble symptoms	Cause	Corrective action	Refer to
Excessive blow-by gas	Compression leakage from valve seat	Lap the valve seat	1403-03-01-01 “Grinding and Lapping the Valve Seats”
	Intake/exhaust valve seizure	Correct or replace intake/ exhaust valve	1403-02-01-01 “Removing the Intake and Exhaust Valves”
	Seized or broken piston ring	Replace the piston ring	1202-02-03-01 “Reassembling the Pistons”
	Worn piston ring, piston or cylinder	Perform honing and use an oversized part	0200-02-04-01 “Cylinder Block Honing and Boring”
	Seizure of crank pin bearing or bearing part	Repair or replace	1301-02-02-02 “Inspecting the Crankshaft (After Disassembly)”
	Position failure of piston ring end gap	Correct the ring joint positions	1202-02-03-01 “Reassembling the Pistons”
	Reverse assembly of piston rings	Reassemble correctly	1202-02-03-01 “Reassembling the Pistons”
	Foreign matter trapped in combustion chamber	Disassemble and repair	0100-02-01-01 “Disassembling the Engine”
	Worn intake/exhaust valve guide	Measure and replace	1403-02-02-01 “Inspecting the Valve Guides”
	Incorrect engine lubricating oil	Use correct engine lubricating oil	0000-10-02-01 “Engine lubricating oil specifications”
	Clogged engine lubricating oil Filter	Clean or replace	0000-08-03-04 “Replace engine lubricating oil and lubricating oil filter”
Exhaust temperature rise	Improper intake/exhaust valve clearance	Adjusting the valve clearance	1403-03-02-01 “Measuring and Adjusting Valve Clearance”
	Compression leakage from valve seat	Lap the valve seat	1403-03-01-01 “Grinding and Lapping the Valve Seats”
	Seized or broken piston ring	Replace the piston ring	1202-02-03-01 “Reassembling the Pistons”
	Blower is dirty	Clean the blower	2400-04-01-01 “Turbocharger Cleaning Procedure”
	Waste gate activation failure	Disassemble and inspect	2400-02-02-02 “Inspecting the Waste Gate Valve”
	Insufficient radiator cooling	Replace the thermostat or inspect the fan belt looseness	4000-02-01-01 “Removing the engine coolant pump” or 4000-02-04-04 “Replacing the Cooling Fan Belt”
	Insufficient engine coolant level	Check for water leakage from engine coolant system	4000-02-02-01 “Inspecting the Cooling System (Before Disassembly)”
	Stretched fan belt	Adjust the belt tension	4000-02-04-04 “Replacing the Cooling Fan Belt”
	Clogged air filter	Clean the air filter	0000-08-03-03 “Clean air cleaner”
	Clogged exhaust pipe	Clean exhaust pipe	

2.10 Fuel

Trouble symptoms	Cause	Corrective action	Refer to
Excessive fuel consumption	Compression leakage from valve seat	Lap the valve seat	1403-03-01-01 “Grinding and Lapping the Valve Seats”
	Excessive radiator cooling	Replace the thermostat	4000-02-01-01 “Removing the engine coolant pump”
	Engine used at high temperatures or at high altitude	Study output drop and load matching	
Water is mixed in fuel (Water separator indicator is on)	Incorrect diesel fuel	Use correct fuel oil	0000-10-01-01 “Diesel fuel specifications”
	Water in fuel system	Drain the fuel filter	0000-08-03-02 “Drain water separator”.
	Insufficient sealing property of fuel tank	Inspect the fuel tank and cap, attach genuine product	
Fuel filter becomes dirty often	Incorrect diesel fuel	Use correct fuel oil	0000-10-01-01 “Diesel fuel specifications”
	Insufficient sealing property of fuel tank	Inspect the fuel tank and cap, attach genuine product	

2.11 Electrical

Trouble symptoms	Cause	Corrective action	Refer to
Battery charging failure (Battery charge indicator is on)	Alternator failure	Repair or replace	7102-02-01-01 “Removing the Alternator”
	Open circuit of wiring	Repair or replace the harness open circuit	
	Battery voltage drop	Inspect and charge the battery	0000-08-03-02 “Check battery”.
	Cannot turn off main relay	Replace relay	
ECU failure indicator flashes	Open circuit of wiring	Repair or replace the harness open circuit	
	Open circuit or short circuit of water temperature sensor	• Repair or replace harness • Replace water temperature sensor	
	Open circuit or short circuit of accelerator sensor	• Repair or replace harness • Replace accelerator sensor	
	Signal failure of rotation sensor	• Repair or replace harness • Repair or replace fuel injection pump	
	Engine overspeeds	• Check the drag turning from attached parts • Check the speed sensor signal	
	CAN communication error	• Repair or replace harness • Replace ECU	
	Open circuit or short circuit of EGR valve motor	• Repair or replace harness • Replace EGR valve	
	Open circuit or short circuit of starting aid relay	• Repair or replace harness • Replace relay	
	Cannot turn off main relay	Replace relay	
	Failure from ECU self diagnosis	Replace ECU	
ECU failure indicator does not turn on after turning the key (2 seconds)	Fusing, open circuit of fuse	• Inspect and replace fuse • Repair or replace harness	
	Open circuit of wiring	Repair or replace the harness open circuit	
	Failure or open circuit of key switch	• Repair or replace harness • Replace key switch	
	Failure of main relay (Trouble besides contact sticking that cannot be detected by ECU)	• Repair or replace harness • Replace main relay	
	Open circuit of ECU failure indicator	• Replace the indicator • Repair or replace harness	
	ECU failure (that ECU cannot self-control)	Replace ECU	
Certain ECU control function does not work	Open circuit of wiring	Repair or replace the harness open circuit	
	ECU failure (that ECU cannot self-control)	Replace ECU	
	CAN communication error	• Repair or replace harness • Replace ECU	
Fusing, cut (repeatedly)	Fusing, open circuit of fuse	• Inspect and replace fuse • Repair or replace harness	
	Short circuit of wiring (coating failure), excess electric load to additional equipment	• Inspect, repair, or replace harnesses • Reconsider additional equipment	

1. Diesel Fuel

1.1 Diesel fuel specifications

Diesel fuel should comply with the following specifications. The table lists several worldwide specifications for diesel fuels.

Diesel fuel specifications	Location
JIS K2204 Grade 2	Japan
ASTM D975 No. 1D S15 No. 2D S15	USA
EN590	European Union
ISO 8217 DMX	International
BS 2869-A1 or A2	United Kingdom
KSM-2610	Korea
GB252	China

■ Additional technical fuel requirements

- When operating the engine in cold districts or high altitudes, the fuel cetane number should be equal to 45 or higher.
- The sulfur content must not exceed 15 ppm by mass.
  A higher sulfur content fuel may cause sulfuric acid corrosion in the cylinders of the engines.
  Especially in USA and Canada, Ultra Low Sulfur fuel must be used.
- Use the fuel that can be used where the temperature is 12 °C (53.6 °F) lower than the expected lowest temperature to prevent the fuel from freezing.
- Bio-diesel fuels
  See 0000-09-01-02 “Bio-diesel fuels”.
- Water or sediment in the fuel must not exceed 0.05 % by volume.
- The ash content must not exceed 0.01 % by mass.
- The carbon residue content must not exceed 0.35 % by mass. Less than 0.1 % is preferred.
- The total aromatic content must not exceed 35 % by volume. Less than 30 % is preferred.
- PAH (Polycyclic Aromatic Hydrocarbons) must not exceed 10 % by volume.
- The metal content (magnesium, silicon, and aluminum) must not exceed 1 ppm by mass.
  (Test analysis method JPI-5S-44-95)
- The diesel fuel must be free from zinc and sodium.
- Lubricity: Wear mark of WS1.4 should be maximum of 460 µm at HFRR test.

■ Prohibition

- Never use kerosene.
- Never mix kerosene or used lubricating oil with the diesel fuel.
- Never use residual fuels that cause diesel fuel filter clogging and carbon deposits on the nozzles.
- Never use diesel fuel that has been stored for a long period of time in a drum or the like.
- Never use diesel fuel purchased from unauthorized dealers.
- Fuel additives are not recommended. Some fuel additives may cause poor engine performance.
  Consult your YANMAR representative for more information.

1.2 Bio-diesel fuels

1- General description of bio-diesel fuel

Bio-diesel fuel is a mixture of diesel fuel and fatty acid methyl ester (FAME) from which glycerin, catalyst and methanol have been removed by transesterification using vegetable oil such as soybeans, rapeseed and palm oil, and animal-derived fat. Bio-diesel fuel that is not mixed with diesel fuel is called “B100”, which means that it consists of 100 % (pure) bio-diesel fuel. However, in general, bio-diesel fuels are a blend fuel that contains diesel fuel, and the blend ratio can be identified from the name. For example, “B7” contains 7 % bio-diesel fuel and 93 % diesel fuel, and “B20” contains 20 % bio-diesel fuel and 80 % diesel fuel. However, untreated vegetable oil is not regarded as bio-diesel fuel, and cannot be used at any concentration. In response to the increasing interest in reduction of the use of fossil fuel in regard to global warning, governments and regulatory bodies are encouraging the use of bio-diesel fuels.

2- Characteristics of bio-diesel fuel

- The higher the blend level of bio-diesel fuel, the lower the PM (Particulate Matter), CO (Carbone Monoxide), and HC (Hydrocarbon). However, the amount of NOx (Nitrogen Oxides) increases.
  In addition, unburned fuel, aldehyde, and benzene in the PM also increase.
- Bio-diesel fuel has a high flash point as high as 120 °C while the flash point of diesel fuel is 50 °C, so it is safer than normal diesel fuel. (JIS K 2204, DIN EN 14214)
- Bio-diesel fuel accelerates oxidation and corrosion of aluminum, brass, bronze, copper, and zinc.
- Bio-diesel fuel damages parts, causing problems such as swelling or solidification of rubber and resin used in seals, gaskets, hoses, adhesives, or paints.
- Bio-diesel fuel reacts with the oxygen in the air, and produces sediment in the engine. Therefore, it is required to use the bio-diesel fuel within the specified period.
- Since bio-diesel fuel accelerates oxidation when using fuel which contains a high ratio of bio-diesel, it requires more frequent replacement of the lubricating oil.
- The engine output and specific fuel consumption of bio-diesel fuel is reduced. In the case of B20, it reduces approximately by 2 % for the output, and 3 % for the fuel consumption.

Note: Bio-diesel fuels with a concentration of 7 % or more (B7 or above) may have an adverse effect on the engine’s performance and durability. The higher the blend level of bio-diesel fuel, the higher the risk of engine trouble.

3- Engines that you can use bio-diesel fuel with

The following YANMAR engines can be operated with bio-diesel fuel. Special preparation such as parts replacement or shortened maintenance intervals may be required depending on the concentration of the bio-diesel fuel. Required preparation and operating conditions vary depending on the following engine groups. For details, see the following sections, 5 and 6.

■ Engine group A

- 3TNM68, 3TNM72, 2TNV70, 3TNV70 and 3TNV76
- 3TNV82A, 3TNV84, 3TNV84T, 3TNV88, 4TNV84, 4TNV84T, 4TNV88, 4TNV94L, 4TNV98 and 4TNV98T
- 4TNV106 and 4TNV106T
- 4TNE92, 4TNE94L and 4TNE98 for forklift application
- 3TNM74F, 3TNV74F, 3TNV80F, 3TNV80FT
- 3TNV88F

■ Engine group B

- 3TNV88C, 3TNV86CT, 3TNV86CHT, 4TNV88C, 4TNV86CT, 4TNV86CHT, 4TNV98C and 4TNV98CT
- 4TNV94HT, 4TNV94CHT, 4TNV94FHT
- 4TN107HT, 4TN107TT, 4TN107FHT, 4TN107FTT

4- Recommended fuel

If you use bio-diesel fuel (up to concentration B20), please use one that complies with the standards given below.

European Norm EN14214 or American Standard ASTM D-6751
JIS K 2390 U (if in Japan)

In particular, in North America, you must purchase the fuel from a BQ-9000-certified manufacturer or BQ-9000-certified distributor. (Reference: In Japan, the maximum concentration legally allowed for on-road use is B5 as of August 2018.)

5- Conditions for the operation with bio-diesel fuel

When operating the YANMAR engines listed in section 3, follow the proper operating conditions, parts replacement, service and maintenance depending on the concentration of the bio-diesel fuel.

a) Bio-diesel fuels up to concentration B7 (7 %)

No special preparation (parts replacement) is required for all engines listed in section 3.
The operating conditions and maintenance intervals provided in the Operation Manual will apply. However, you must follow the standard operating conditions given in the Operation Manual.

b) Bio-diesel fuels up to concentration B8 (8 %) to B10 (10 %)

Required preparation (parts replacement) and operating conditions are shown in the below table.

Engine group A and B*1

Parts replacement	Parts replacement is not required.
Maintenance interval	1. Half of the standard interval*2 is applied to the following maintenance. • Replacement interval of the fuel filter • Cleaning interval of the water separator • Draining interval of the diesel tank 2. Inspect, clean, and adjust the fuel injectors every 1000 hours of operation.

*1. See section 3 for the engines that you can use bio-diesel fuel with.
*2. The standard interval is referred to as the maintenance interval applicable when the engine is operated using diesel fuel (B0). This is also described in the Operation Manual and Service Manual.

c) Bio-diesel fuels up to concentration B11 (11 %)

Required preparation (parts replacement) and operating conditions are shown in the below table.

Engine group A*1

Parts replacement	Replace the following parts. 1. Fuel hose (The material inside the hose should be fluororubber or fluorocarbon resin) 2. Diaphragm fuel feed pump (Replace the pump with the electric feed pump.) 3. Water separator (If not equipped, it is required to install it.) 4. Fuel filter O-ring 5. Water separator O-ring
Maintenance interval	1. Half of the standard interval*2 is applied to the following maintenance. • Replacement interval of the fuel filter • Cleaning interval of the water separator • Draining interval of the diesel tank 2. Inspect, clean, and adjust the fuel injectors every 1000 hours of operation.

Engine group B*1

Parts replacement	Replace the following parts. 1. Water separator O-ring (If the O-ring material is fluorocarbon resin, then it is not required to replace the O-ring.)
Maintenance interval	1. Half of the standard interval*2 is applied to the following maintenance. • Replacement interval of the fuel filter • Cleaning interval of the water separator • Draining interval of the diesel tank 2. Inspect, clean, and adjust the fuel injectors every 1000 hours of operation.

*1. See section 3 for the engines that you can use bio-diesel fuel with.
*2. The standard interval is referred to as the maintenance interval applicable when the engine is operated using diesel fuel (B0). This is also described in the Operation Manual and Service Manual.

For replacing the parts (parts replacement described in this manual applies to those engines in the engine group B), see Fig.00-57.

6- Precautions

If you operate the engine by using the bio-diesel fuel, follow the operating conditions given below. These conditions apply to all engines listed in the section 3.

a) Only use the bio-diesel fuel suitable for the engine operating conditions. Since the bio-diesel fuel solidifies at low temperature, check the working temperature of the diesel fuel to be used.

b) The following daily checks are very important.

- Check the lubricating oil level. If the lubricating oil level exceeds the lubricating oil level of the previous day, replace the engine lubricating oil.
- Perform a daily check of the water separator's water level. Drain the water separator to prevent the water level from exceeding the "Maximum" on the indicator.

c) Bio-diesel fuel of any concentration can be used only within the limited period of three months from the date of manufacture. Therefore, use bio-diesel fuel within two months from supplying it to the tank, or within three months from its manufactured date, whichever comes first.

d) When storing the engine for a long time without operating the engine, you will need to take the bio-diesel fuel out completely and operate the engine for at least 30 minutes with diesel fuel.
Then, perform the operations in accordance with the procedure given in the operation manual.

e) Be sure to replace diesel fuel hoses every two years or 2000 hours, the same as when using diesel fuel.

7- Kit components for B20 (TNV Tier4 CR)

■ Water separator (Replace the O-ring only)

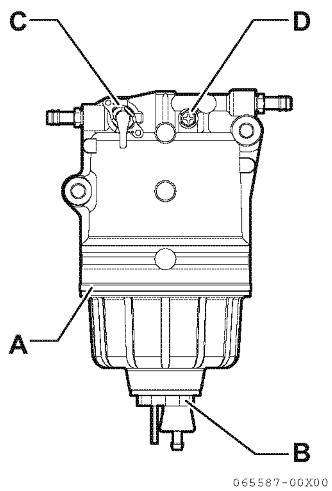


Fig. 00-57

A	24326-001000 (G100)
B	24316-000070 (P7)
C	24316-000110 (P11) Valve lever
D	24316-000060 (P6) Air plug

1.3 Filling the fuel tank

⚠ DANGER

Fire and Explosion Hazard!

- **Diesel fuel is extremely flammable and explosive under certain conditions.**
- **Only fill the fuel tank with diesel fuel. Filling the fuel tank with gasoline may result in a fire and will damage the engine.**
- **Never refuel with the engine running.**
- **Wipe up any spills immediately.**
- **Keep sparks, open flames or any other form of ignition (match, cigarette, static electric source) well away when refueling.**
- **Never overfill the fuel tank.**
- **Fill the fuel tank. Store any containers containing fuel in a well-ventilated area, away from any combustibles or sources of ignition.**
- **Be sure to place the diesel fuel container on the ground when transferring the diesel fuel from the pump to the container. Hold the hose nozzle firmly against the side of the container while filling it. This prevents static electricity build up which could cause sparks and ignite fuel vapors.**
- **Never place diesel fuel or other flammable material such as oil, hay or dried grass close to the engine during engine operation or shortly after shutdown.**
- **Before you operate the engine, check for fuel leaks. Replace rubberized fuel hoses every two years or every 2000 hours of operation, whichever comes first, even if the engine has been out of service. Rubberized fuel lines tend to dry out and become brittle after two years or 2000 hours of operation, whichever comes first.**
- **Failure to comply will result in death or serious injury.**

NOTICE

- Poor quality fuel can reduce engine performance and cause damage. Only use diesel fuels recommended by YANMAR for the best engine performance. The recommended fuel complies with the U.S. EPA and ARB protection guidelines.
- The common rail system installed as this engine's fuel injection device is very high in pressure and sprays fuel into the cylinder. If any impurities or water mixes into the fuel, the sliding parts of the fuel system causes friction and may degrade the engine's exhaust gas property durability. Only use clan diesel fuel.
- Keep the fuel tank and fuel-handling equipment clean at all times. Be careful not to let any contaminants or even dust from the outside into the filler port when supplying fuel.
- Never remove the primary strainer (if equipped) from the fuel tank filler port. If removed, dirt and debris could get into the fuel system causing it to clog.

Note that a typical fuel tank is shown. The fuel tank on your engine may be different.

1. Clean the area around the fuel cap (1, Fig.00-58).
2. Remove the fuel cap (1, Fig.00-58) of the fuel tank (2, Fig.00-58).
3. Fully fill the tank with the fuel while observing the fuel level sight gauge (3, Fig.00-58). Never overfill the fuel tank.
4. Reattach the fuel cap (1, Fig.00-58), and hand-tighten it. If you over-tighten it, the fuel cap will be damaged.

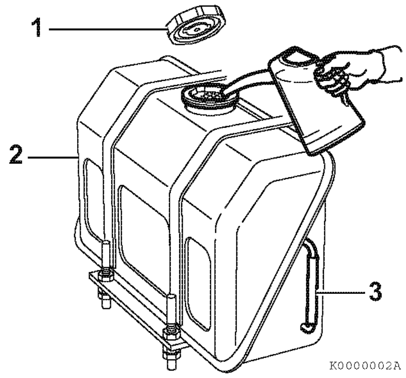


Fig. 00-58

NOTICE

Be sure to check the remaining fuel level by using the fuel level sight gauge to avoid the engine from running out of fuel. The supply pump may get seized.

1.4 Priming the fuel system

⚠ DANGER

Fire and Explosion Hazard!

- **Diesel fuel is extremely flammable and explosive under certain conditions.**
- **If the unit has an electric fuel pump, when you prime the fuel system, turn the key switch to the ON position for 10 to 15 seconds to allow the electric fuel pump to prime the system.**
- **Never open the air vent valve while the fuel system is being primed. The fuel filter has an internal air vent screw.**
- **Failure to comply will result in death or serious injury.**

The fuel system needs to be primed under certain conditions:

- Before starting the engine for the first time.
- After refilling the fuel to the fuel tank due to running out of fuel.
- After fuel system maintenance such as replacing the fuel filter and fuel system components, or draining the water separator.

Follow the procedure below to prime the fuel system.

1. Turn the key switch to the ON position, and keep it in that position for 10 to 15 seconds.
   This will allow the electric fuel pump to prime the fuel system.
2. Never use the starter motor to start the engine in order to prime the fuel system.
   This may cause the starter motor to overheat, and damage the coils, pinion and/or ring gear.

   NOTICE

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

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2. Engine Lubricating Oil

NOTICE

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

2.1 Engine lubricating oil specifications

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

■ Service classification

- API service categories: CJ-4, CK-4
- ACEA service categories: E-6, E-9
- JASO service category: DH-2

■ Definitions

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

NOTICE

- Make sure that the engine lubricating oil, engine oil storage containers, and engine oil filling equipment are free of sediment and water.
- Replace the engine lubricating oil every 500 hours of operation. However, the different interval applies depending on the driven machine types or the lubricating oil capacity.
  Refer to the operation manual provided by the driven machine manufacturer for details.
- Select an appropriate lubricating oil viscosity depending on the ambient temperature where the engine will be operated.
  See **Fig.00-59** for the SAE service grade viscosity chart.
- YANMAR does not recommend the use of engine lubricating additives.
- Never mix the different types (brands) of engine lubricating oil.

■ Additional technical engine lubricating oil requirements

The engine lubricating oil must be replaced when the Total Base Number (TBN) has been reduced to 1.0 mgKOH/g. TBN (mgKOH/g) test method is described in JIS K-2501-5.2-2 (HCl) and ASTM D4739 (HCl).

2.2 Engine lubricating oil viscosity

Select an appropriate lubricating oil viscosity depending on the ambient temperature where the engine will be operated. See Fig.00-59 for the SAE service grade viscosity chart.

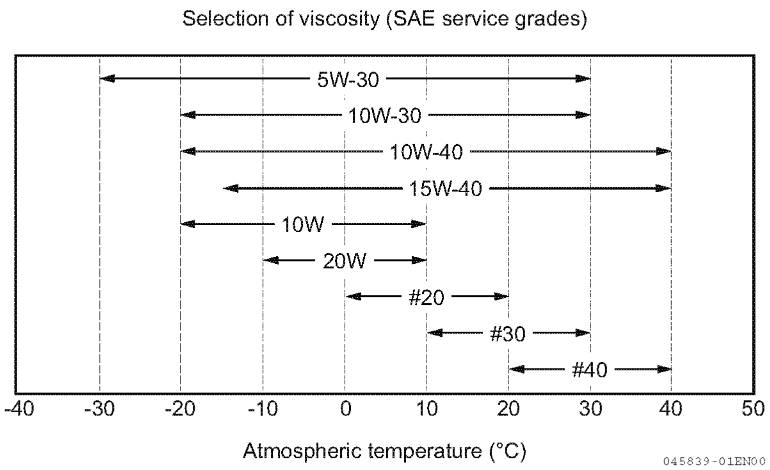


Fig. 00-59

Use multi grade oil in 4TN107 engines. 10W-40 and 15W-40 (summer grade) are recommended for this type of engine.

2.3 Checking and servicing engine lubricating oil

See the following sections for checking and servicing the engine lubricating oil.

1	Draining the engine lubricating oil	See 3000-02-04-01 “Draining the Engine Lubricating Oil”.
2	Filling engine lubricating oil	See 3000-02-04-02 “Filling Engine Lubricating Oil”.
3	Engine lubricating oil capacity	See 3000-02-04-02 “Engine lubricating oil capacity (Deep type)”.
4	Checking the engine lubricating oil	See 3000-02-04-03 “Checking the Engine Lubricating Oil”.

3. Engine Coolant

DANGER

Scald Hazard!

- **Never remove the radiator cap if the engine is hot. Steam and hot engine coolant will spurt out and seriously burn you. Allow the engine to cool down before you attempt to remove the radiator cap.**
- **Tighten the radiator cap securely after you check the radiator. Steam can spurt out during engine operation if the cap is loose.**
- **Always check the level of the engine coolant by observing the reserve tank.**
- **Failure to comply will result in death or serious injury.**

WARNING

Burn Hazard!

- **If you must drain the engine lubricating oil while it is still hot, stay clear of the hot engine lubricating oil to avoid being burned. Always wear eye protection.**
- **Failure to comply could result in death or serious injury.**

CAUTION

Coolant Hazard!

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

NOTICE

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

3.1 Engine coolant specifications

Use a Long Life Coolant (LLC) or an Extended Life Coolant (ELC) that meets or exceeds the following guidelines and specifications:

- ASTM D6210, D4985 (US)
- JIS K-2234 (Japan)
- SAE J814C, J1941, J1034 or J2036 (International)

■ Alternative engine coolant

If an Extended or Long Life Coolant is not available, alternatively, you may use an ethylene glycol or propylene glycol based conventional engine coolant (green).

NOTICE

- Always use a mix of engine coolant and water. Never use water only.
- Mix the engine coolant and water per the instructions on the engine coolant container.
- Water quality is important to engine coolant performance. YANMAR recommends that soft, distilled, or demineralized water be used to mix with engine coolants.
- Never mix extended or long life engine coolants and conventional (green) engine coolants.
- Never mix different types and/or colors of engine coolants.
- Replace the engine coolant every 2000 hours of operation or once every two years.

3.2 Checking and servicing engine coolant

See the following sections for checking and servicing the engine coolant.

1	Draining engine coolant	See 4000-02-04-01 “Draining Engine Coolant”.
2	Filling engine coolant	See 4000-02-04-02 “Filling Radiator with Engine Coolant”.
3	Engine coolant capacity	See 4000-02-04-02 “Engine coolant capacity (Standard)”.
4	Daily checks for engine coolant	See 4000-02-04-03 “Inspecting the Engine Coolant System”.

4. Urea Water (Applicable only to EU Stage V certified models)

NOTICE

The quality and composition of the urea water are very important. Using low-quality urea water can degrade the NOx purification rate, and cause system failure. Always use urea water with the following specifications.

4.1 Urea water solution standard

Use urea water that meets or exceeds the following guidelines and classifications:

- ISO22241 (International Organization for Standardization)
- JIS K2247-1 (Japan)
- DIN V70070 (Germany)

AdBlue® is a registered trademark of the German Automotive Industry Association (Verband der Automobilindustrie e.V. <VDA>).

4.2 Properties and characteristics of urea water

- Urea water is clear, odorless fluid, and is nontoxic.
- If the concentration of the urea is 32.5 %, it is called AdBlue® in Japan and Europe, and DEF (Diesel Exhaust Fluid) in the US.
- Urea water is a liquid that freezes very easily. AdBlue® freezes at -11.5 °C. (32.5 % is the concentration at which it is most difficult for it to freeze.)
- Urea water produces some ammonia at room temperature, but when it is heated, it hydrolyzes and produces a large amount of ammonia. Care is therefore necessary.

4.3 Prohibition

- Do not use any fluids other than AdBlue® or DEF.
- Do not mix any substances with AdBlue® or DEF.
- Do not use urea water that has been stored for a long time (including urea water remaining inside the tank) and has expired.
  Doing so will cause the urea water to freeze, ammonia slip, the NOx purification rate to drop, and damage to the device.
  (Refer to the separate table for the urea water lifetime.)
- When handling the urea water, do not use items like gloves or the like. Fibers may get into the urea water. It may clog the urea water filter, or cause urea deposit at the Dosing Module (DM) exhaust nozzle.

NOTICE

If you use urea water other than AdBlue®

- It may cause the urea water injector system to fail or break, or the SCR catalyst/ASC catalyst performance to deteriorate. If any of these things happens, you will need to replace the device.
- It may change the urea water's freezing point and change the temperature at which the urea water is thawed or kept. This may in turn prevent compliance with the regulations.
- The risk of urea deposits and clogging the DM jet nozzle will increase. This may in turn cause system failure.
- More ammonia may be produced than predicted, causing the amount of ammonia slip to increase. This will cause an ammonia odor to emanate from the exhaust tail pipe.

4.4 Precautions

- Urea water can freeze very easily, and expand its volume by approximately 13 %.
  Be careful no to break the device when handling at low temperature.
- If you spill any urea water, wipe it up immediately and rinse with water as necessary.
  (Failure to do so will cause a bad odor, and white crystals to form, etc.)
- If any urea water gets on the vehicle body or other easily-corroded parts (things made from iron, gun-metal, aluminum, etc.), wipe it off with a cloth, then rinse the part with water to wash off any remaining urea water in order to prevent corrosion.
- When disposing urea water, you can drain through the sink if diluting with a large amount of water. However, if there is a local rule of nitrogen regulation, dispose it as industrial waste.
- With regard to the handling of urea water, check the urea water manufacturer's instruction manual.

4.5 Storing urea water

Urea water life differs depending on the storage temperature as shown in the chart below.
Please store at as low a temperature as possible. With regard to driven machines that may remain unused for a long time, we recommend that you leave the urea water inside the machine, and replace it when you use the machine again. Refer to the manual provided by the manufacturer of the urea water for details.

(Reference) Storing period based on JIS K2447-2/ISO22241-1

Storing temperature	Estimated urea water expiry
≤ 10 °C	36 months
10 °C < T ≤ 25 °C	18 months
25 °C < T ≤ 30 °C	12 months
30 °C < T ≤ 35 °C	6 months

At > 35 °C, you will need to check the quality every time. (Test the alkalinity according to JIS K2247-2/ ISO 22241-2.)

With regard to urea water that has been taken out of storage, we recommend checking that it meets ISO22241-1 or JIS22247-1.

4.6 Refilling urea water

- Because urea water is injected into exhaust gas while the engine is running, it is necessary to refill urea water before starting the engine. Refill the urea water according to the alarm provided on the driven machine. See the Operation Manual provided by the driven machine manufacturer for the details of the alarm.
- When urea water freezes, its volume expands by 7 %. In order to prevent the urea water tank from bursting, you need to ensure that the tank has a certain amount of spare capacity even when it is full. When filling the tank with urea water, stop filling before urea water reaches the bottom of the filler port pipe. Make sure that the driven machine is level. See the Operation Manual provided by the driven machine manufacturer for the urea water tank capacity.
- Also, do not fill the fuel tank with the urea water.

1. Electric Wiring

1.1 Electric wiring precautions

Failure to follow these precautions may result in the failure of an electrical component and the loss of warranty coverage on that item as well as related items. Make sure that all users read and understand these precautions.

NOTICE

- Do not reverse the positive (+) and negative (-) ends of the battery cable. The alternator diode and starter coil will be damaged.
- When the battery indicator goes out, it should not come on again. The battery indicator only comes on during operation if the alternator fails or if the V-belt breaks. However, if an LED is used in the battery indicator, the LED will shine faintly during normal operation.
- Make sure that the combined total resistance of the battery cable in both directions between the starter motor and the battery is within the value indicated in the battery cable resistance in the electric wiring section. The starter motor will malfunction or break down if the resistance is higher than the specified value.
- Reversing the battery cable connections at the battery or on the engine will destroy the SCR diode in the current limiter. If the SCR diode is broken, the charging system will not properly operate, resulting in damage to the electrical wiring.

1.2 Electric wire resistance

AWG	Nominal cross-sectional area (mm^2)	Ohms/Foot
20	0.5	0.009967
18	0.8	0.006340
16	1.25	0.004359
14	2	0.002685
12	3	0.001704
10	5	0.001073
8	8	0.000707
6	15	0.000421
4	20	0.000270
2	30	0.000158
1	40	0.000130
0 (1/0)	50	0.000103
00 (2/0)	60	0.000087
000 (3/0)	85	0.000066
0000 (4/0)	100	0.000051

Wiring voltage drop should not exceed 5 % [0.05] × 12 V = 0.6 V.
Voltage drop = Current (A) × Wire length (Feet) × Resistance per foot (Ohm)

Example: Current draw of 100 A × 3 Feet of 4 AWG wire
100 A × 3 Feet × 0.000270 = 0.08 V [Voltage drop]

1.3 Battery cable resistance

AWG	mm^2	Maximum total battery cable length (Positive cable + negative cable + a*) 12 V starter motor output	
		Less than 2 kW m	2 kW or above m
6	15	1.5	N/A
4	20	2.3	N/A
2	30	3.8	2.3
1	40	4.6	2.8
0 (1/0)	50	5.9	3.5
00 (2/0)	60	7.0	4.2
000 (3/0)	85	9.3	5.6
0000 (4/0)	100	11.9	7.1
00000 (5/0)	125	N/A	8.3
000000 (6/0)	150	N/A	10.1

- 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 kW: the total resistance must be less than 0.002 Ω.
  For starter motors of greater than 2 kW: the total resistance must be less than 0.0012 Ω.

1.4 Electrical wire sizes - voltage drop

Total current on the circuit (A)	Length of conductor from source of current to device and back to source (in feet)																		
	10	15	20	25	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170
12 V	Wire size (AWG)																		
5	18	16	14	12	12	10	10	10	8	8	8	6	6	6	6	6	6	6	6
10	14	12	10	10	10	8	6	6	6	6	4	4	4	4	2	2	2	2	2
15	12	10	10	8	8	6	6	6	4	4	2	2	2	2	2	1	1	1	1
20	10	10	8	6	6	6	4	4	2	2	2	2	1	1	1	0	0	0	2/0
25	10	8	6	6	6	4	4	2	2	2	1	1	0	0	0	2/0	2/0	2/0	2/0
30	10	8	6	6	4	4	2	2	1	1	0	0	0	2/0	2/0	3/0	3/0	3/0	3/0
40	8	6	6	4	4	2	2	1	0	0	2/0	2/0	3/0	3/0	3/0	4/0	4/0	4/0	4/0
50	6	6	4	4	2	2	1	0	2/0	2/0	3/0	3/0	4/0	4/0	4/0				
60	6	4	4	2	2	1	0	2/0	3/0	3/0	4/0	4/0	4/0						
70	6	4	2	2	1	0	2/0	3/0	3/0	4/0	4/0								
80	6	4	2	2	1	0	3/0	3/0	4/0	4/0									
90	4	2	2	1	0	2/0	3/0	4/0	4/0										
100	4	2	2	1	0	2/0	3/0	4/0											
24 V																			
5	18	18	18	16	16	14	12	12	12	10	10	10	10	10	8	8	8	8	8
10	18	16	14	12	12	10	10	10	8	8	8	6	6	6	6	6	6	6	6
15	16	14	12	12	10	10	8	8	6	6	6	6	6	4	4	4	4	4	2
20	14	12	10	10	10	8	6	6	6	6	4	4	4	4	2	2	2	2	2
25	12	12	10	10	8	6	6	6	4	4	4	4	2	2	2	2	2	2	1
30	12	10	10	8	8	6	6	4	4	4	2	2	2	2	2	1	1	1	1
40	10	10	8	6	6	6	4	4	2	2	2	2	1	1	1	0	0	0	2/0
50	10	8	6	6	6	4	4	2	2	2	1	1	0	0	0	2/0	2/0	2/0	3/0
60	10	8	6	6	4	4	2	2	1	1	0	0	0	2/0	2/0	3/0	3/0	3/0	3/0
70	8	6	6	4	4	2	2	1	1	0	0	2/0	2/0	3/0	3/0	3/0	3/0	4/0	4/0
80	8	6	6	4	4	2	2	1	0	0	2/0	2/0	3/0	3/0	3/0	4/0	4/0	4/0	4/0
90	8	6	4	4	2	2	1	0	0	2/0	2/0	3/0	3/0	4/0	4/0	4/0	4/0	4/0	
100	6	6	4	4	2	2	1	0	2/0	2/0	3/0	3/0	4/0	4/0	4/0				

1.5 Conversion of AWG to European standards

Wire size (AWG)	Conductor diameter (mm)	Conductor cross-sectional area (mm^2)
25	0.455	0.163
24	0.511	0.205
23	0.573	0.259
22	0.644	0.325
21	0.723	0.412
20	0.812	0.519
19	0.992	0.653
18	1.024	0.823
17	1.15	1.04
16	1.29	1.31
15	1.45	1.65
14	1.63	2.08
13	1.83	2.63
12	2.05	3.31
11	2.30	4.15
10	2.59	5.27
9	2.91	6.62
8	3.26	8.35
7	3.67	10.6
6	4.11	13.3
5	4.62	16.8
4	5.19	21.2
3	5.83	26.7
2	6.54	33.6
1	7.35	42.4
0 (1/0)	8.25	53.4
00 (2/0)	9.27	67.5
000 (3/0)	10.40	85.0
0000 (4/0)	11.68	107.2
00000 (5/0)	13.12	135.1
000000 (6/0)	14.73	170.3

1.1 circular mil (CM) ≈ 0.0005067 mm^2

2. Electronic Control Harness Connections

2.1 POWER

1- EU Stage III A equivalent certified model

(1/2)

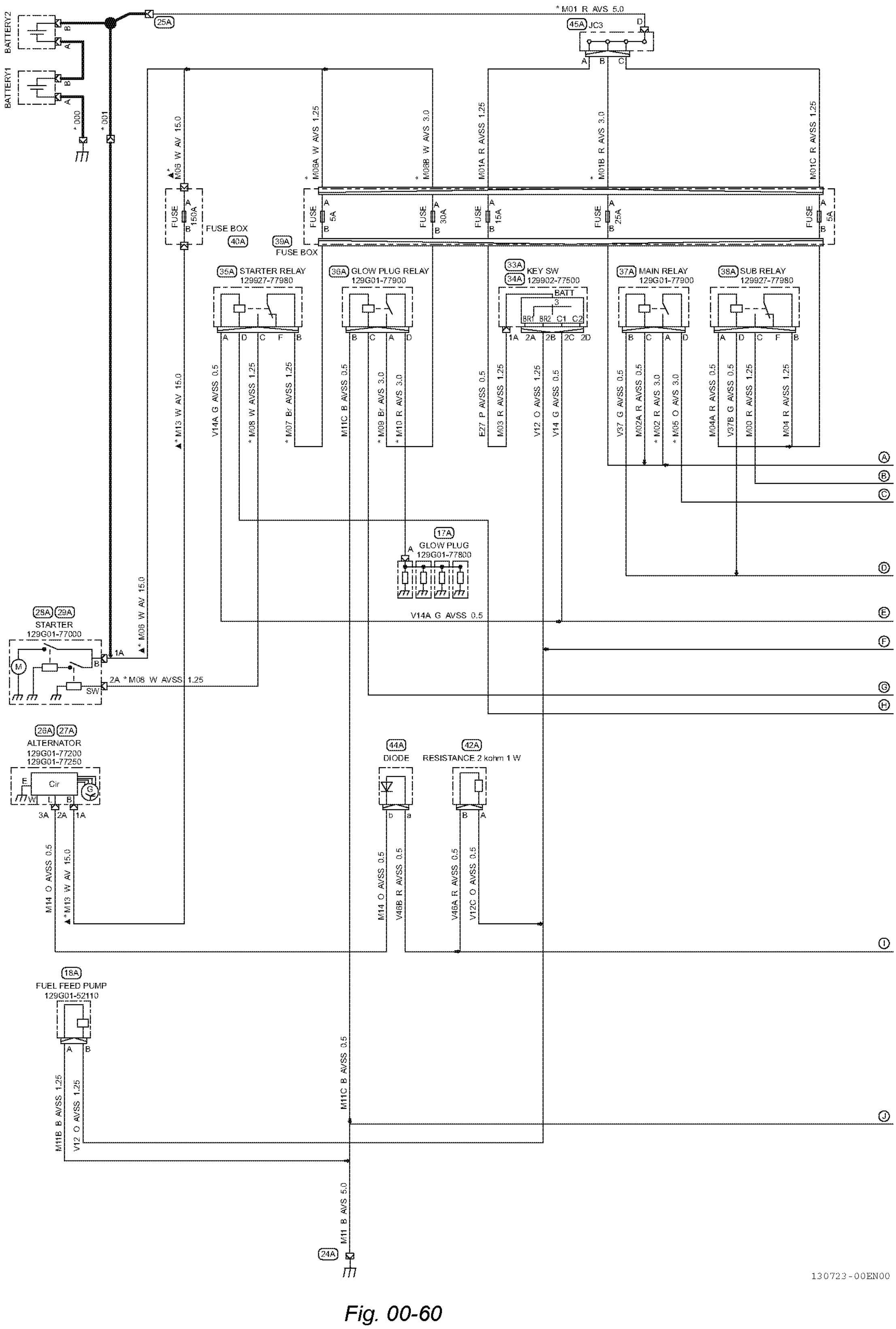


Fig. 00-60

Electric wiring, electronic control harness connections

(2/2)

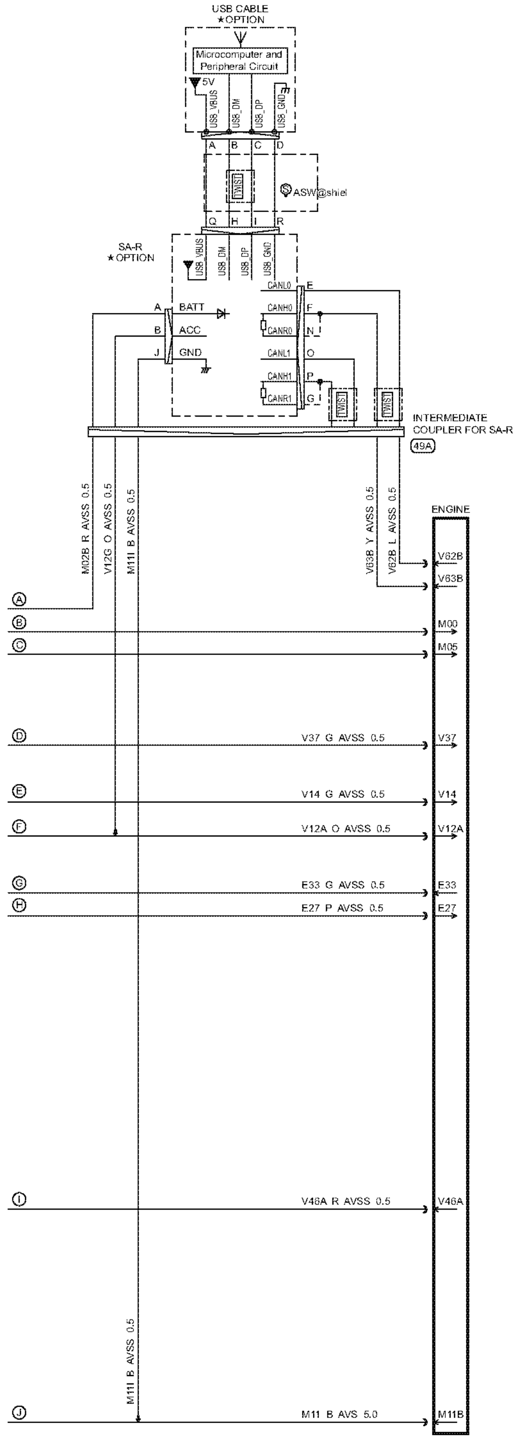
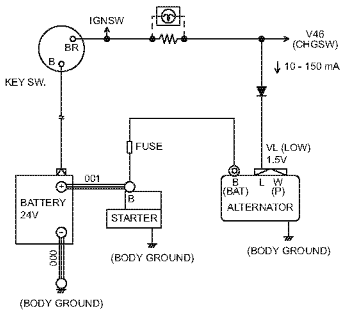
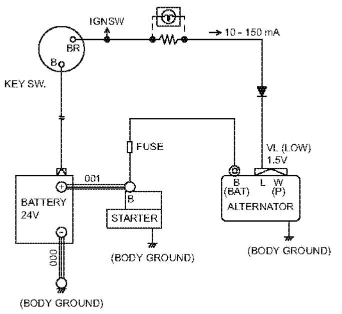


Fig1.
When following alternator (seg) is used, refer to wiring diagram as below.
Alternator: 129G01-77200 (SEG24V-80A)
129G01-77250 (SEG24V-150A)

In case alternator is connected to E-ECU.

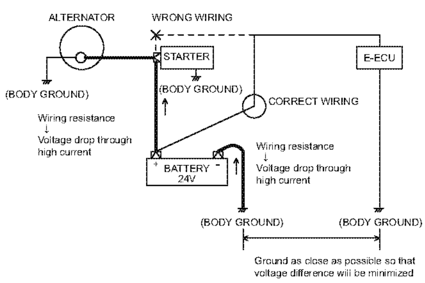


In case alternator is not connected to E-ECU.



Notes
1. Connect resistor or resistor+lamp between key-switch (on) and L-terminal of alternator in order to flow current of 10 - 150 mA into L-terminal. Outside the above range, the alternator does not operate noramally, or alternator could be broken.
2. Connect diode between branch point of ignsw and L-terminal of alternator. If diode is not connected, engine could not stop.

Fig2.
Connect the E-ECU power wiring directly to the battery's + terminal.



130723-00EN00

Fig. 00-61

2- EU Stage V certified models

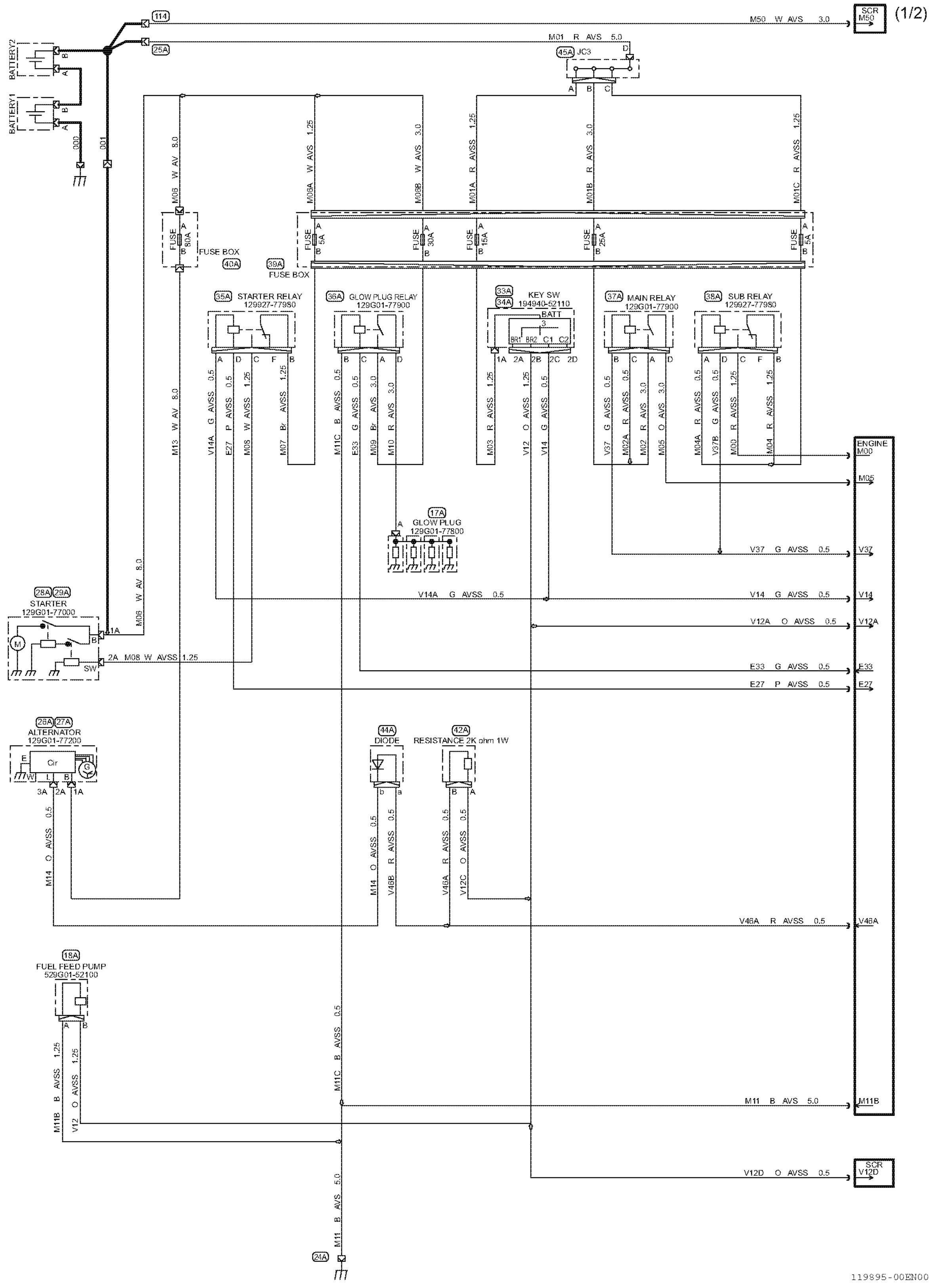
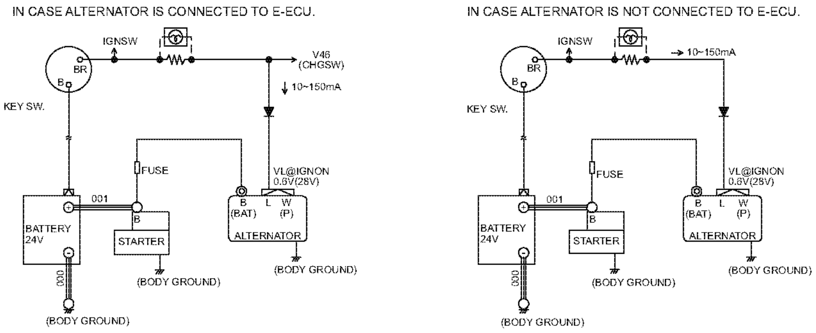


Fig. 00-62

Electric wiring, electronic control harness connections

(2/2)

Fig1.
WHEN FOLLOWING ALTERNATOR(BOSCH) IS USED, REFER TO WIRING DIAGRAM AS BELOW.
ALTERNATOR:129G01-77200(BOSCH24V-80A)
129G01-77250(BOSCH24V-150A)



NOTES
1.CONNECT RESISTOR OR RESISTOR+LAMP BETWEEN KEY-SWITCH(ON) AND
L-TERMINAL OF ALTERNATOR IN ORDER TO FLOW CURRENT OF 10~150mA ON L-TERMINAL.
WITHIN THE ABOVE RANGE,THE ALTERNATOR DOES NOT OPERATE NORAMALLY, OR ALTERNATOR COULD BE BROKEN.
2.CONNECT DIODE BETWEEN BRANCH POINT OF IGNSW AND L-TERMINAL OF ALTERNATOR.
IF DIODE IS NOT CONNECTED, ENGINE COULD NOT STOP.

119895-00EN00

Fig. 00-63

2.2 ENGINE

1- EU Stage III A equivalent certified model

(1/3)

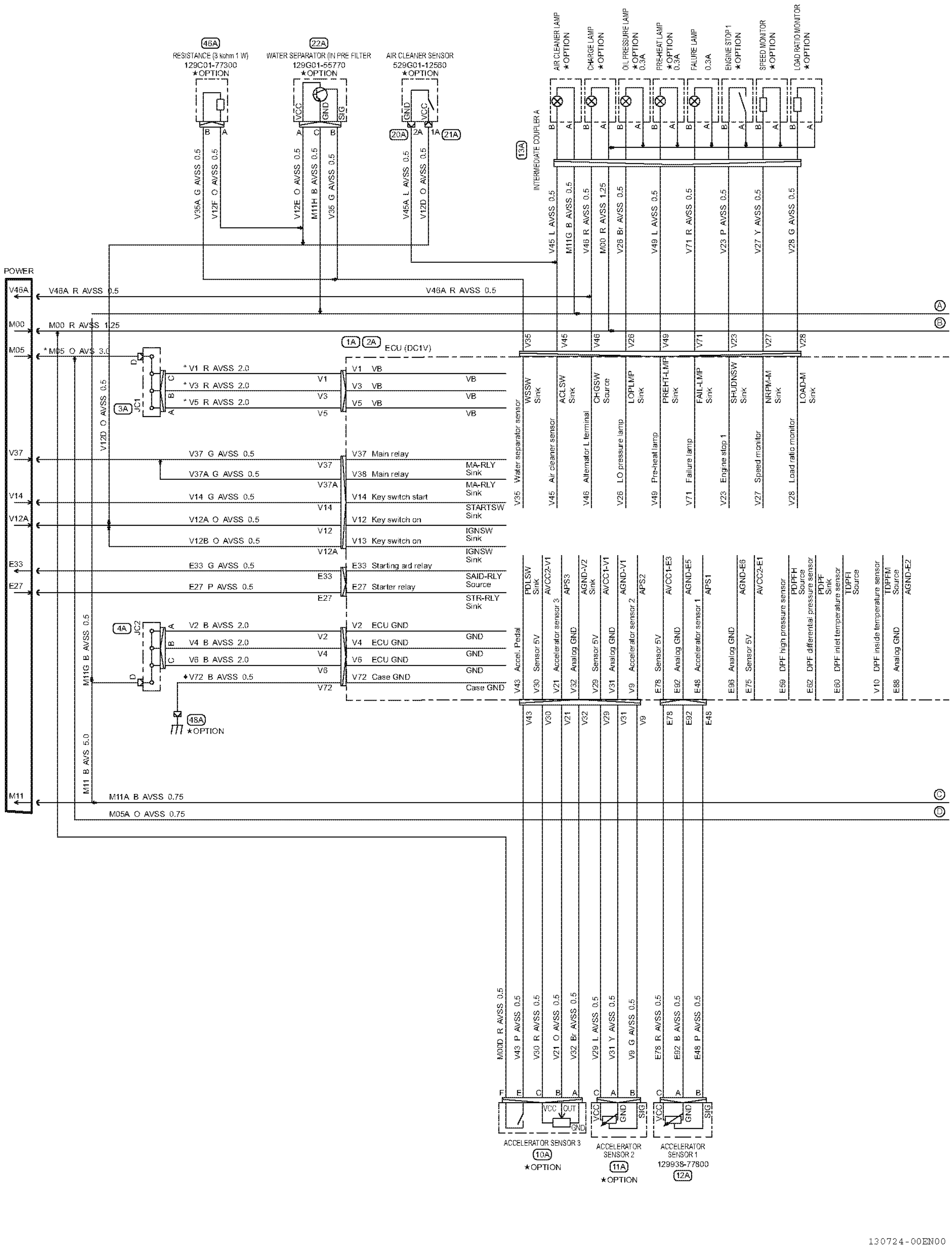


Fig. 00-64

Electric wiring, electronic control harness connections

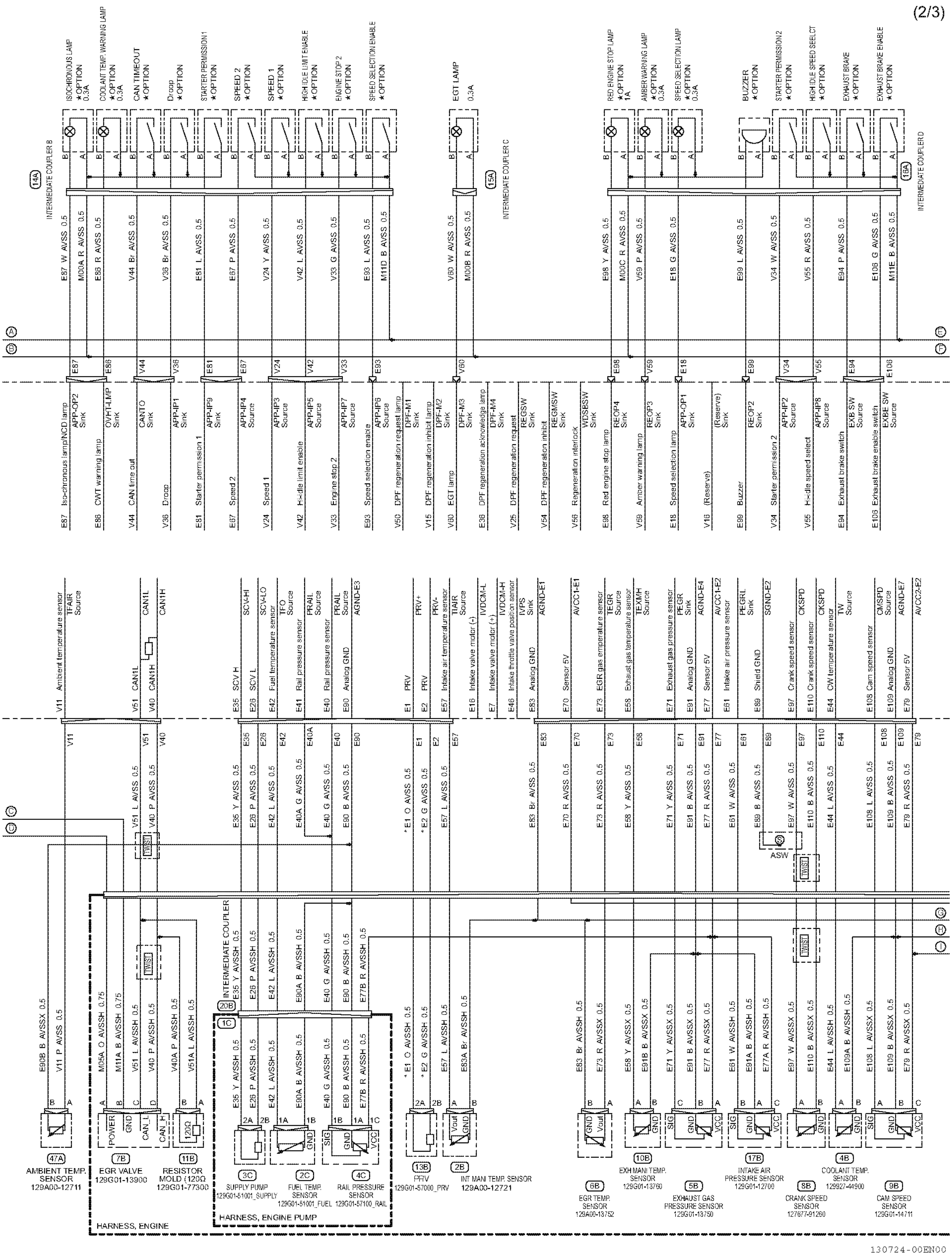
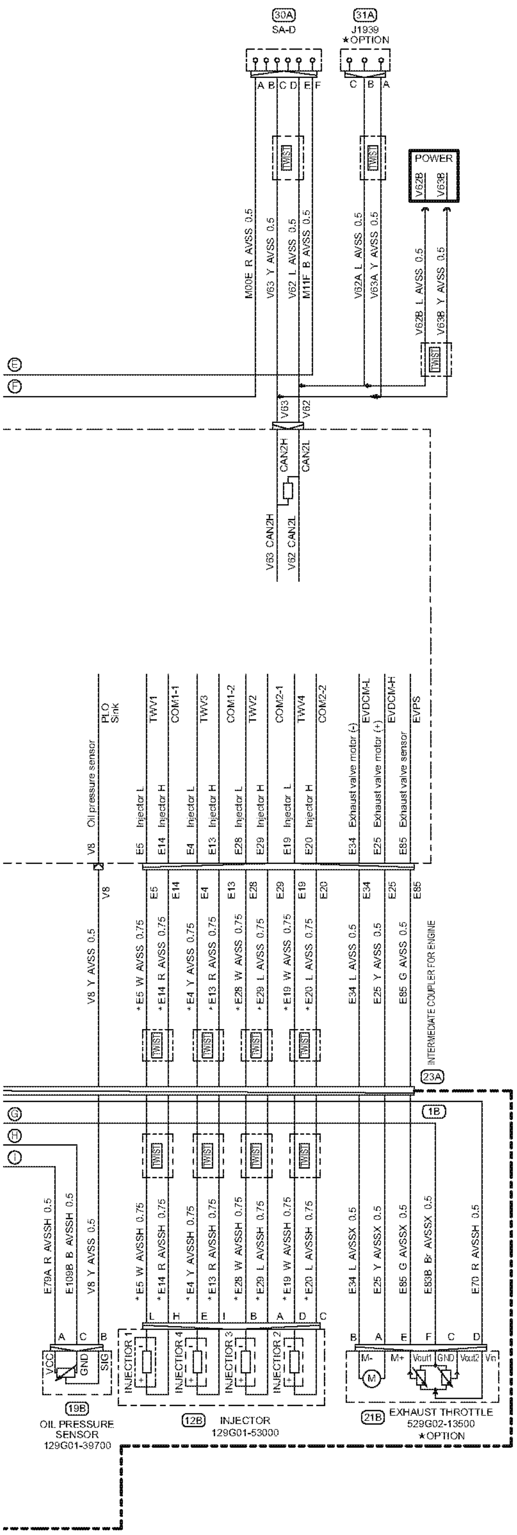


Fig. 00-65

Electric wiring, electronic control harness connections

(3/3)

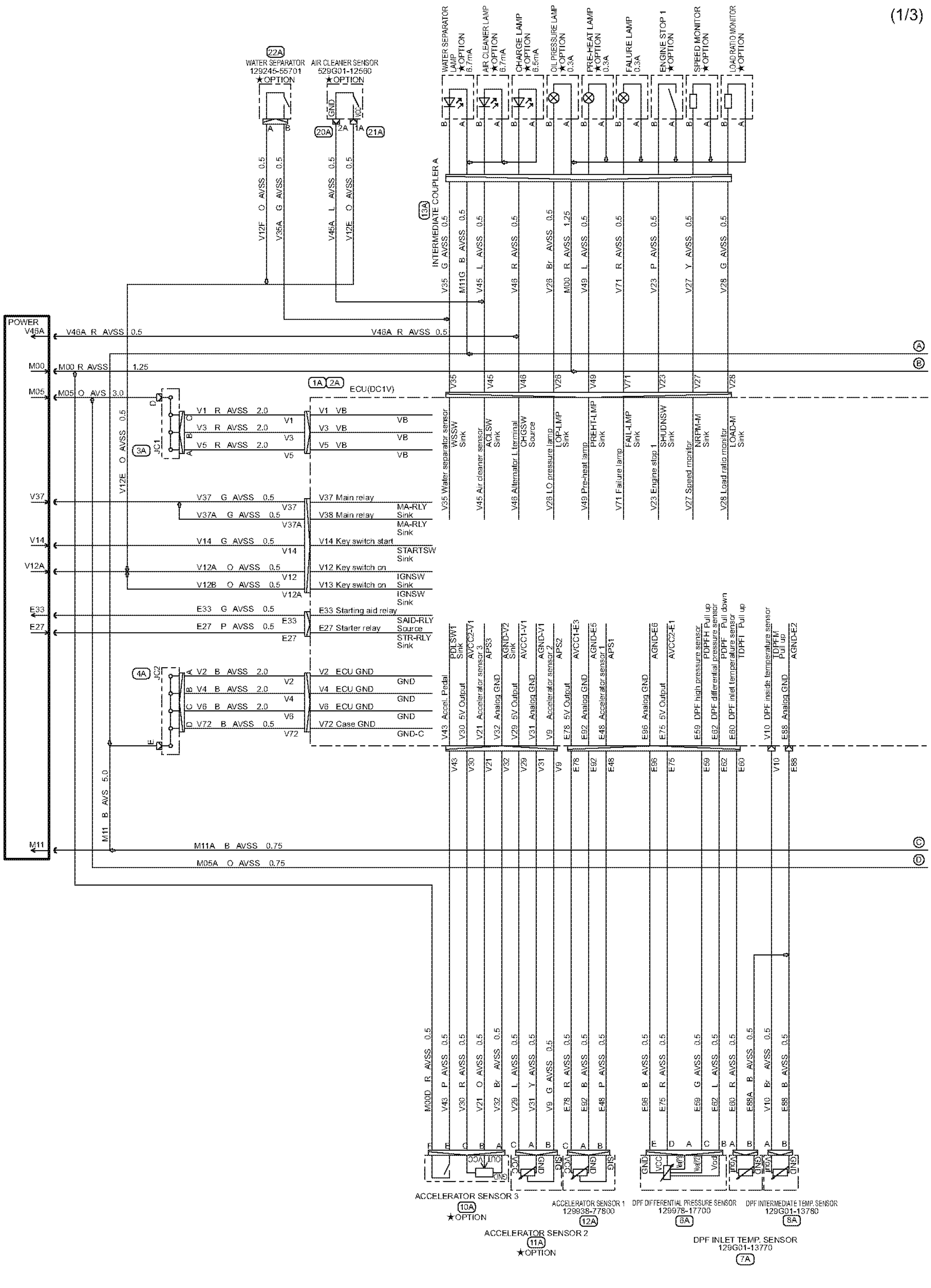


130724-00EN00

Fig. 00-66

2- EU Stage V certified models

(1/3)



119896-00EN00

Fig. 00-67

Electric wiring, electronic control harness connections

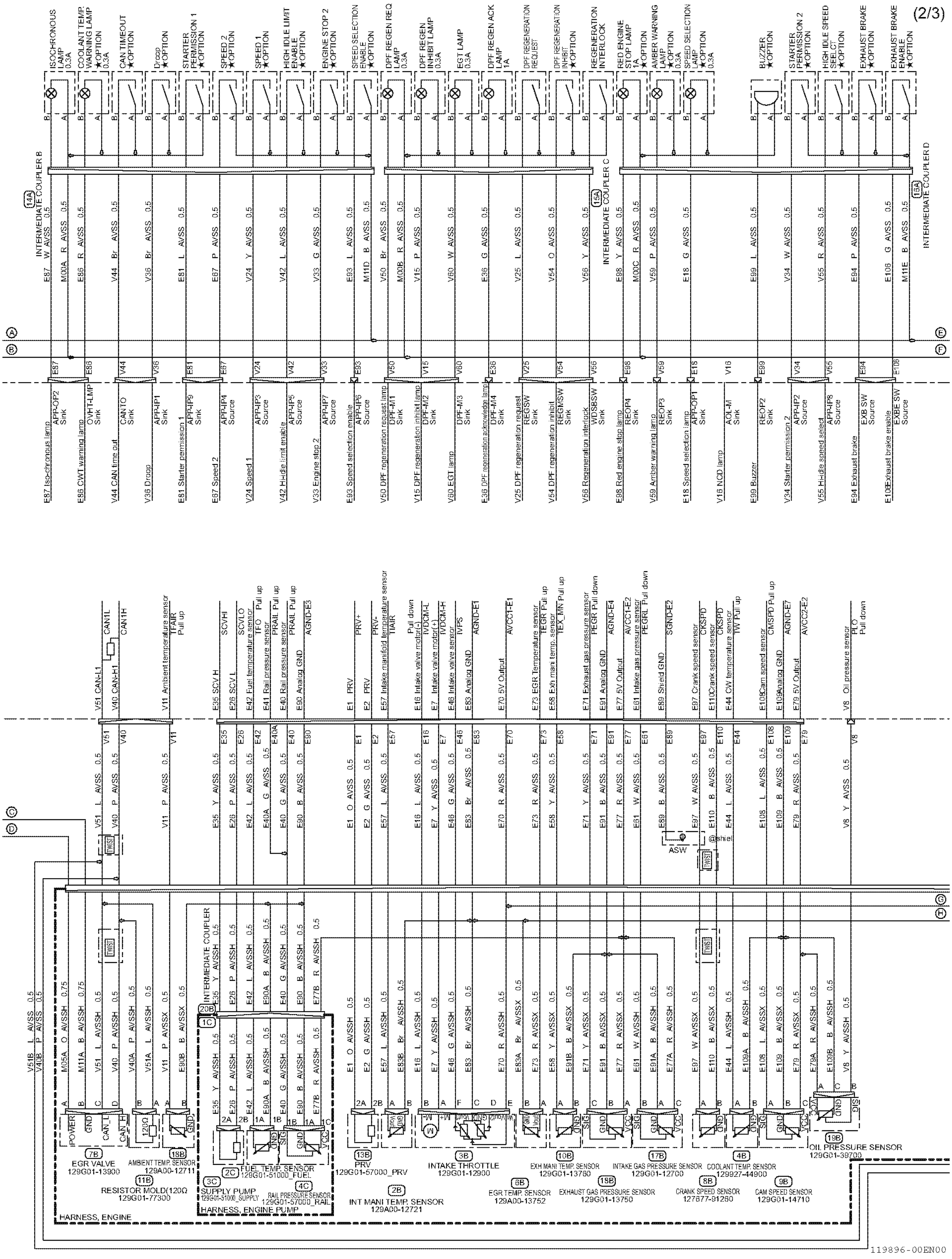
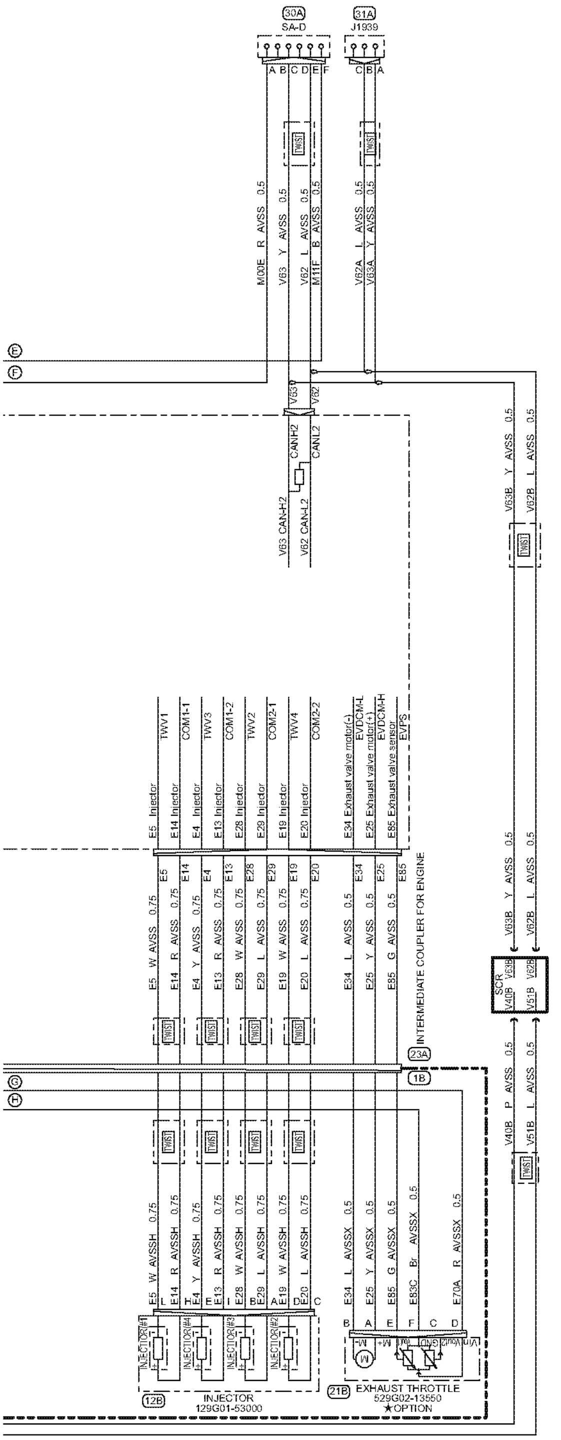


Fig. 00-68

Electric wiring, electronic control harness connections

(2/3)

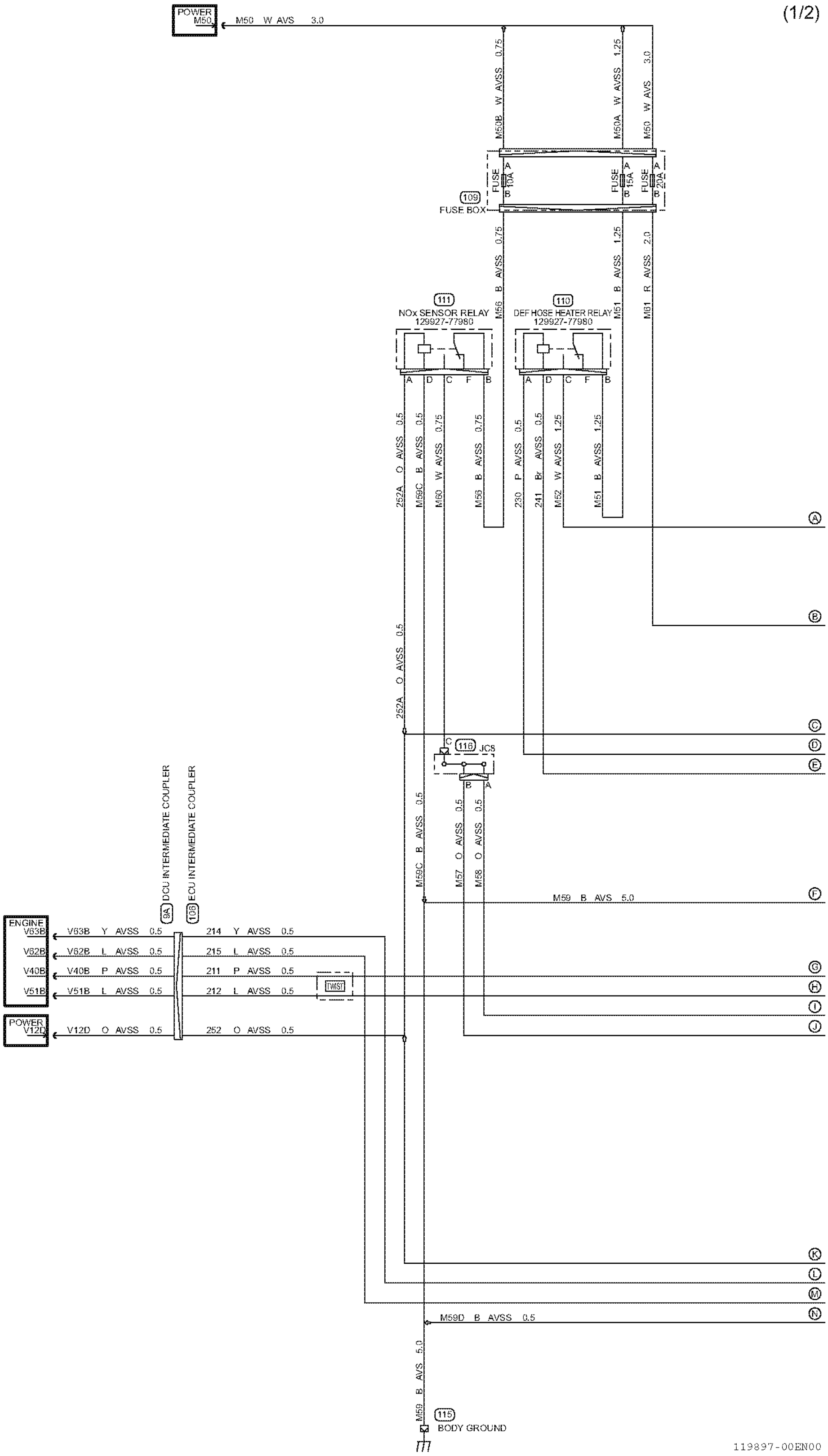


119896-00EN00

Fig. 00-69

2.3 SCR (applicable only to EU Stage V certified models)

(1/2)

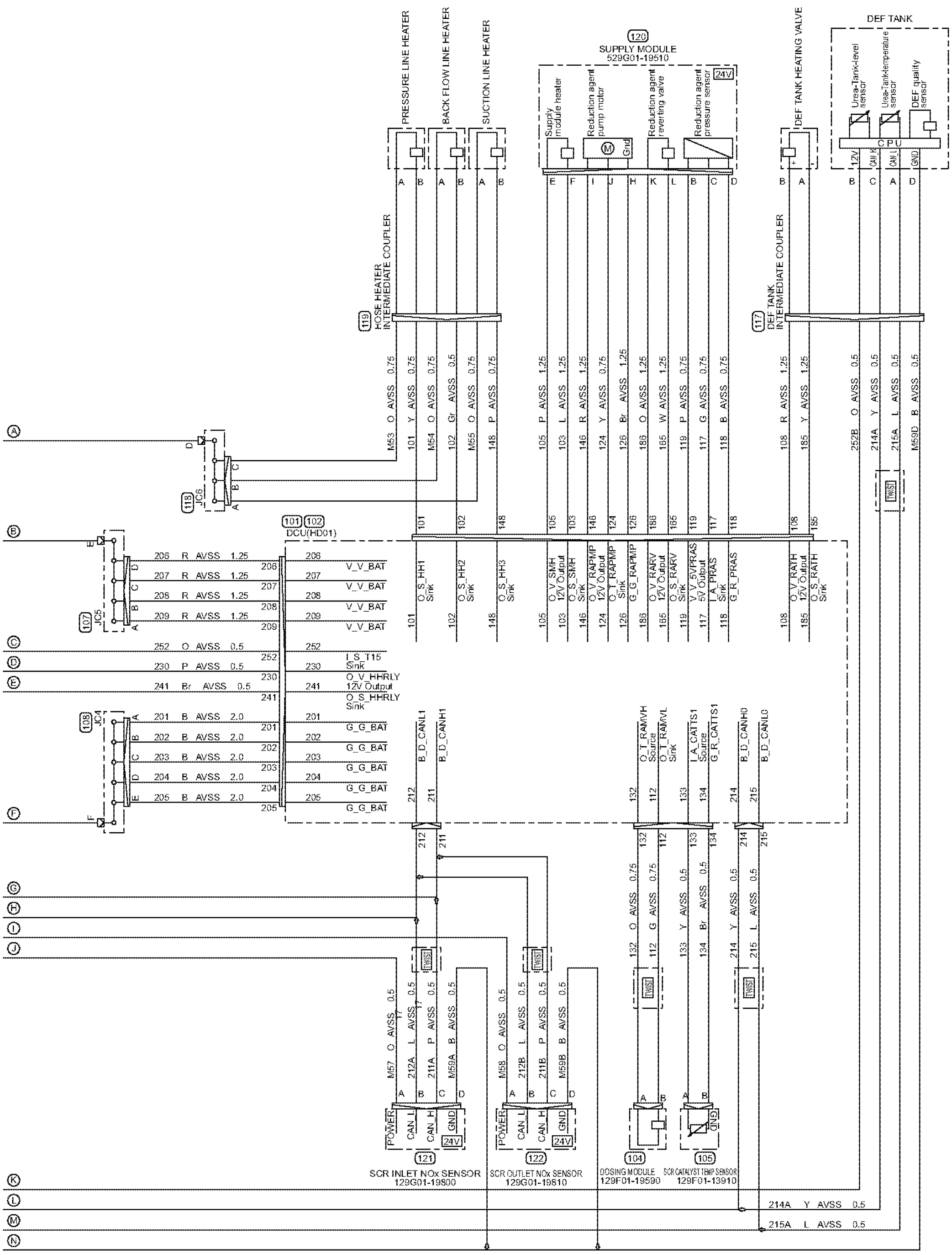


119897-00EN00

Fig. 00-70

Electric wiring, electronic control harness connections

(2/2)



119897-00EN00

Fig. 00-71

2.4 Note

1- EU Stage III A equivalent certified model

Notes

1. Starter wiring
   - 1-1. The resistance of battery cable (000+001) to follow in the table 1 (No. 1).
   - 1-2. The resistance of starter wiring (000+001+M06+M06A+M07+M08) to follow in the table 1 (No. 2).
   - 1-3. Body ground cable (000) must be connected securely. Do not be painted on surface to avoid misconnection.
2. Instruction of the battery.
   Mishandling of the battery may cause failures of electric equipment or components.
   E-ECU and alternator etc. Failure caused by a reversed battery cable connection is not warranted.
   - 2-1. Battery should be firmly secured and immovable.
   - 2-2. Battery cable length should be adjusted properly and clamped.
     Never reverse battery cable connections.
   - 2-3. Never loosen a battery cable terminal, or turn the battery switch off while the engine is running.
   - 2-4. E-ECU perform self-holding of power supply (after run) after key will be OFF. Battery should not switch off while self-holding.
     E-ECU self-holding time: Maximum 1 min.
3. Instruction of the alternator
   - 3-1. Only connect specified loads to the "L" and "W" alternator terminals.
     Never connect the unspecified load without YANMAR approval.
   - 3-2. Never disconnect the alternator "B" terminal or battery terminal during alternator operation.
   - 3-3. Refer to table 1 (No. 3) for the resistance of b terminal cable. (000+001+M06+M13).
     B terminal cable should be clamped properly and covered by corrugated tube to protect from shorting with body ground. If necessary, to be protected by fuse etc.
   - 3-4. L terminal of alternator (M14) should be separated e-ecu terminal (V12, V13) or connected with diode.
     The current from the L terminal (M14) of the alternator flows back to the ignsw terminals (V12, V13) of the E-ECU, which may make it impossible to stop the engine.
   - 3-5. Refer to the figure 1 for recommended wiring of alternator.
4. E-ECU wiring
   - 4-1. Refer to table 3 for the twisted pair wiring and the twisted pair wiring with shield. Also make the pitch of the twisted pair wire within 25 mm.
   - 4-2. CAN Bus length (use twisted pair) : Max 40 m
     It becomes easy to generate the mis-operetion by the noise when it doesn't follow it.
   - 4-3. For the potential voltage difference between E-ECU GND and battery GND, refer to table 2 about the E-ECU power supply and the battery.
   - 4-4. The ground terminals should be grounded to a single point.
     The grounding cable that connected to battery (–) terminal should be low impedance.
   - 4-5. Refer to table 1 (No. 6, 7, 8, 9) for the resistance of the injector wiring.
   - 4-6. All E-ECU terminal, except those connected to the optional parts, shall be in accordance with the standard wiring diagram.
   - 4-7. Battery cable should be directly connected to battery (+) terminal. Especially, do not share E-ECU power supply (M05) with large current equipment such as starter "b" terminal and starting aid etc.
   - 4-8. Do not connect any load which is not specified in the standard wiring diagram to the E-ECU terminals. It is not allowed to connect any unspecified load without YANMAR approval.
   - 4-9. Do not connect any load which is not specified in the standard wiring diagram to the E-ECU IGNSW Terminal (V12, V13/252). The E-ECU power supply might not cut by sneak current.
   - 4-10. Lamps load and contact current of switches connected to the E-ECU must be kept in this diagram.
   - 4-11. The crank speed sensor (E97, E110) must not be connected reversely. If connected reversely, the sensor accuracy would get worse and it would cause the engine speed unstable performance deterioration.
   - 4-12. Do not connect other loads with the coolant temperature sensor of E-ECU. The egr control etc. Might not operate correctly. And they influence the durability of the engine and the low temperature start.
   - 4-13. Refer to table 1 (No. 5) for the total resistance of starting aid wiring (M06+M06B+M09+M10).
   - 4-14. Do not connect E-ECU power wiring (M01) through the "b" terminal of starter or glow wiring.
     Refer to fig. 2
   - 4-15. Refer to table 4 for the clamp of harness that connected to each electric devices.
   - 4-16. Power suply of external load connected to E-ECU should be supplied from downstream of sub relay.
   - 4-17. Be sure to select a key switch that does not allow the ECU power supply circuit (the circuit between the "B" and "BR2" terminals) to open anywhere between the ON position and START position.
   - 4-18. If intermediate connectors are used in the harness that connect to engine devices, water-proof connectors should be used.
   - 4-19. Refer to table 2 when using air cleaner (529G01-12560).
   - 4-20. The total resistance of each wiring shall be in accordance with table 1.
   - 4-21. The wire type shall be in accordance with table 3.
   - 4-22. ♦ For EMC, connect either the E-ECU chassis or the CASE-GND terminal to the body ground.
     (even if e-ecu is installed via the vibration-proof rubber)
     When connecting the CASE-GND terminal to the body ground, connect it to the body ground separately.
     When connecting the E-ECU chassis to the body ground, the CASE-GND terminal should be opened or be connected to the body ground separately. (Refer to table 5)
     Do not connect CASE-GND terminal (V72) and ECU-GND terminal (V2, V4, V6).
5. General
   - 5-1. Be sure to comply with the wire type and fuse capacity as specified in the standard wiring diagram.
   - 5-2. Use the proper wires to ambient temperature.
   - 5-3. When mating connectors, be caution to avoid entry of water into the connectors.
   - 5-4. Clamp the harness at proper position so that it will not be shaken by vibration.
   - 5-5. Clamp the harness with proper length to prevent any tension.
   - 5-6. It is recommended to make the joint parts waterproof using joint couplers, butyl tape, etc.
   - 5-7. Make sure that there is no surge current or voltage under a normal operation or expected misuse.
   - 5-8. Make sure that there is no instantaneous interruption of the power supply voltage (equal to or less than 6.0 V, under a normal operation or expected misuse.
   - 5-9. Devices with parts code are able to be supplied by YANMAR.
     (The parts which code starting with "5" is under developoing)
   - 5-10. ★ marked are option parts.
   - 5-11. Make sure that the failure lamp are attached to a position that can be seen easily by operator.
   - 5-12. The harness shall not contact any sharp edges.
   - 5-13. The harness should be protected from water, chemicals, external pressure and heat.
   - 5-14. Do not clamp the harness with exhaust systems.
   - 5-15. The connector for SMART ASSIST-DIRECT (SA-D) should be easily accessible.
   - 5-16. The connector for SMART ASSIST-DIRECT (SA-D) should be connected with a mating connector to protect from water.
   - 5-17. Harness coat in the clamp should be protected not to wear. And do not clamp any cables (wires) with metal clamp directly.
   - 5-18. Do not tie harness with fuel system, lubricants system and exhaust system.
   - 5-19. Any fuel should not be dropped on harness at fueling and air bleeding.
   - 5-20. Harness should be installed with enough space from rotation parts and vibration parts.
   - 5-21. Harness (connector) needs any preventions for wrong wiring. Same connectors should not be in a same place.
   - 5-22. If you install intermediate connector which connects engine's harness and machine's harness in the machine, set it in place that connnector spec. Is met. Connector should be fixed with blacket or band not to vibrate surely.
   - 5-23. * marked wires should be designed with proper diameter and length in accordance table1.
   - 5-24. ▲ Marked fuse and wire diameter should be designed according to the capacity of alternator.

Table 1. Wiring resistances

No.	Item	Electric wiring No.	Resistance [m ohm]
1	Battery cable	000+001	≤ 2
2	Starter wiring	000+001+M06+M06A+M07+M08	≤ 50
3	Terminal B cable of alternator	000+001+M06+M13	≤ 5
4	E-ECU VB wiring	M01+M01B+M02+M05+V1 (V3, V5)	≤ 150
5	Glow plug wiring	M06+M06B+M09+M10	≤ 25
6	Injector 1 (No. 1 cylinder)	E5+E14	≤ 150
7	Injector 2 (No. 2 cylinder)	E19+E20	≤ 150
8	Injector 3 (No. 3 cylinder)	E28+E29	≤ 150
9	Injector 4 (No. 4 cylinder)	E4+E13	≤ 150
10	PRV	E1+E2	≤ 150
11	Connection cable for vehicle GND (body ground) and engine gnd (body ground)	–	≤ 1

Table 2. Notes about harness design

No.	Item	Criteria	Remarks
1	Difference in potential between E-ECU GND and battery GND and between E-ECU power and battery	< 1 V	
2	Point of contact current of air cleaner	0.1 - 1 A	529G01-12560

Table 3. Twisted pair cables and twisted pair cables with shield

No.	Item	Electric wiring No.		Recommended wiring	Remarks
1	Crank speed sensor	E97	E110	Twisted pair with shield	
2	EGR valve	V40	V51	Twisted pair	MAX: 40 m
3	Injector 1	E5	E14	Twisted pair	
4	Injector 2	E19	E20	Twisted pair	
5	Injector 3	E28	E29	Twisted pair	
6	Injector 4	E4	E13	Twisted pair	
7	SA-D	V62	V63	Twisted pair	MAX: 40 m
	J1939	V62A	V63A		
	CAN2 (E-ECU side)	V62B	V63B		
	Intermediate coupler for SA-R	V62C	V63C		

* Pitch of twisted pair cable : MAX: 25 mm

Table 4. Notes about clamp of wire harness

No.	Item	Criteria [mm]
1	E-ECU connector - 1st clamp	≤ 200
2	Intermediate coupler (E - H) - 1st clamp	≤ 150
3	Ambient temperature sensor connector - 1st clamp	≤ 200

Table 5. Connect to body ground

		E-ECU shassis	
		Not connect	Connect
CASE-GND terminal	Not connect	×	◎
	Connect alone	O	△
	Connect to GND terminal	×	×

130725-00EN00

Fig. 00-72

2- EU Stage V certified models

NOTES

1.STARTER WIRING
- 1-1.THE RESISTANCE VALUE OF BATTERY CABLE(000+001) TO FOLLOW IN THE TABLE 1.
- 1-2.THE RESISTANCE VALUE OF STARTER WIRING(000+001+M06(A)+M07+M08)TO FOLLOW IN THE TABLE 1.
- 1-3.BODY GROUND CABLE(000) TO BE CONNECTED SECURELY. DO NOT BE PAINTED ON SURFACE TO AVOUID MISCONNECTION.

2.INSTRUCTION OF THE BATTERY AS FOLLOWS.
FAILURE TO COMPLY MAY CAUSE ELECTRIC EQUIPMENT OR COMPONENTS TO BURN.
ALTERNATOR BURNING CAUSED BY A REVERSED BATTERY CABLE CONNECTION IS NOT WARRANTED.
- 2-1.BATTERY SHOULD BE FIRMLY SECURED AND IMMOVABLE.
- 2-2.BATTERY CABLE LENGTH SHOULD BE ADJUSTED PROPERLY AND CLAMPED. NEVER REVERSE BATTERY CABLE CONNECTIONS.
- 2-3.NEVER LOOSEN A BATTERY CABLE TERMINAL, OR TURN THE BATTERY SWITCH OFF WHILE THE ENGINE IS RUNNING.
- 2-4.ECU AND DCU PERFORM SELF-HOLDING OF POWER SUPPLY (AFTER RUN) AFTER KEY WILL BE OFF. BATTERY SHOULD NOT BE OFF WHILE SELF-HOLDING.
  THE TIME OF ECU SELF-HOLDING:ABOUT 30SEC.
  THE TIME OF DCU SELF-HOLDING:MAXIMUM 7MIN.

3.INSTRUCTION OF THE ALTERNATOR AS FOLLOWS
- 3-1.ONLY CONNECT SPECIFIED LOADS TO THE 'L' AND 'P' ALTERNATOR TERMINALS. NEVER CONNECT A LOAD WHICH IS UNSPECIFIED WITHOUT YANMAR APPROVAL.
- 3-2.NEVER DISCONNECT THE ALTERNATOR 'B' TERMINAL OR BATTERY TERMINAL DURING ALTERNATOR OPERATION.
- 3-3.REFER TO TABLE 1 FOR THE ELECTRIC RESISTANCE OF TERMINAL B CABLE. (000+001+M06(A)+M07+M08). FIX APPROPRIATELY FOR FEAR OF SHORTING BODY AND PROTECT BY CORRUGATED TUBE. IF NECESSARY, TO BE PROTECTED BY FUSE ETC.
- 3-4.L TERMINAL OF ALTERNATOR(M14) SHOULD BE SEPARATED E-ECU TERMINAL(V12A,V12B) OR CONNECTED WITH DIODE.
- 3-5.FOR RECOMMENDED WIRING OF ALTERNATOR, REFER TO THE FIGURE 1.

4.E-ECU / DCU WIRING
- 4-1.REFER TO TABLE 3 FOR THE TWISTED PAIR WIRING AND THE TWISTED PAIR WIRING WITH SHIELD. ALSO MAKE THE PITCH OF THE TWISTED PAIR WIRE WITHIN 25MM.
- 4-2.CAN BUS LENGH (USE TWISTED PAIR) : MAX 40MM
  IT BECOMES EASY TO GENERATE THE MIS-OPERETION BY THE NOISE WHEN IT DOESN'T FOLLOW THIS.
- 4-3.REFER TO TABLE 2 FOR THE POTENTIAL DIFFERENCE BETWEEN E-ECU GND AND BATTERY GND, THE E-ECU POWER SUPPLY AND THE BATTERY.
- 4-4.THE GROUND TERMINALS SHOULD BE GROUNDED TO A SINGLE POINT.
  THE GROUNDING CABLE THAT CONNECTED TO BATTERY (-) TERMINAL SHOULD BE LOW IMPEDANCE.
- 4-5.REFER TO TABLE 1 FOR THE ELECTRICITY RESISTANCE OF THE INJECTOR WIRING.
- 4-6.OBEY THE STANDARD WIRING DIAGRAM FOR ALL ECU AND DCU TERMINAL, EXCEPT THOSE THAT CONNECT TO OPTIONAL PARTS.
- 4-7.BATTERY CABLE(B60) SHOULD BE DIRECTLY CONNECTED TO BATTERY (+) TERMINAL. ESPECIALLY, DO NOT SHARE E-ECU POWER SUPPLY(M03) WITH LARGE CURRENT EQUIPMENT SUCH AS STARTER 'B' TERMINAL AND STARTING AID ETC.
- 4-8.DO NOT CONNECT ANY LOAD WHICH IS NOT SPECIFIED IN THE STANDARD WIRING DIAGRAM TO THE ECU AND DCU TERMINALS.
- 4-9.NO LOAD OTHER THAN THE ONE SHOWN IN WIRING DIAGRAM SHOULD BE CONNECTED TO THE E-ECU IGNSW TERMINAL(V12,V13/252). THE E-ECU POWER SUPPLY MIGHT NOT CUT SNEAK CURRENT.
- 4-10.LAMPS LOAD AND CONTACT CURRENT OF SWITCHES CONNECTED TO THE E-ECU MUST BE KEPT IN THIS DIAGRAM.
- 4-11.THE CRANK SPEED SENSOR(E97,E110) MUST NOT BE CONNECTED REVERSELY. IF CONNECTED REVERSELY, THE SENSOR ACCURACY WOULD GET WORSE AND IT WOULD CAUSE THE ENGINE SPEED UNSTABLE.
- 4-12.DO NOT CONNECT OTHER LOADS WITH THE COOLANT TEMPERATURE SENSOR OF E-ECU. THE EGR CONTROL ETC. MIGHT NOT OPERATE CORRECTLY. AND THEY INFLUENCE THE DURABILITY OF THE ENGINE AND THE LOW TEMPERATURE START.
- 4-13.REFER TO TABLE 1 FOR THE TOTAL ELECTRICITY RESISTANCE OF STARTING AID WIRING (M08+M09+M10).
- 4-14.GROUND OF DCU MUST BE CONNECTED TO BODY GROUND.
  (DO NOT CONNECT TO BATTERY (-) DIRECTLY)
  REFER TO Fig.2
- 4-15.DO NOT CONNECT E-ECU POWER WIRING(M01/M50) THROUGH THE 'B' TERMINAL OF STARTER OR GLOW WIRING.
  REFER TO Fig.2
- 4-16.CASING OF THE E-ECU AND DCU SHOULD CONNECT TO BODY GROUND.
  CASING OF THE E-ECU AND DCU SHOULD CONNECT TO BODY GROUND IF THE E-ECU AND DCU ARE INSTALLED VIA THE VIBRATION-PROOF RUBBER.
- 4-17.REFER TO TABLE 4 FOR THE CLAMP OF HARNESS THAT CONNECTED TO EACH ELECTRIC DEVISES.
- 4-18.POWER SUPLY SHOULD BE SUPPLIED FROM DOWNSTREAM OF SUB RELAY TO EXTERNAL LOAD CONNECTED TO ECU.
- 4-19.BE SURE TO SELECT A KEY SWITCH THAT DOES NOT ALLOW THE ECU POWER SUPPLY CIRCUIT (THE CIRCUIT BETWEEN THE 'B' AND 'BR' TERMINALS) TO OPEN ANYWHERE BETWEEN THE ON POSITION AND START POSITION.
- 4-20.WIRE OF HARNESS AROUND DEVICE THAT DEF(ADBLUE) FLOWS IS USED DEF(ADBLUE)-PROOF WIRE.
- 4-21.IF BULKHEAD CONNECTORS ARE USED IN THE HARNESS THAT CONNECT TO ENGINE DEVICE, WATER-PROOF CONNECTORS SHOULD BE USE.
- 4-22.TO CONNECT A LOAD RESISTER(120Ω) TO THE WIRE OF AIR CLEANER SENSOR(INDICATOR) SO THAT THE CONTACT CURRENT IS 100mA OR HIGHER IF INDICATOR OF YANMAR STANDARD PART IS USED.
- 4-23.THE RATED CURRENT OF HOSE HEATER(PRESSURE LINE, SUCTION LINE BACKFLOW LINE) AND UREA TANK HEATING VALVE REFER TO THE VALUE IN DCU SYMBOL.
- 4-24.TO CONNECT A LOAD RESISTER(120Ω) TO THE WIRE OF AIR CLEANER SENSOR(INDICATOR) SO THAT THE CONTACT CURRENT IS 100mA OR HIGHER IF INDICATOR OF YANMAR STANDARD PART IS USED.
- 4-25.THE KIND OF WIRE TO FOLLOW IN THE TABLE 3.

5.GENERAL
- 5-1.BE SURE TO COMPLY WITH THE WIRE TYPE AND FUSE CAPACITY AS SPECIFIED IN THE STANDARD WIRING DIAGRAM.
- 5-2.TO USE WIRES WITH HEAT RESISTANCE THAT FITS THE AMBIENT TEMPERATURE OF THE ENVIRONMENT IN WHICH THE ENGINE WILL BE USED.
- 5-3.WHEN MATING CONNECTORS, USE CAUTION TO AVOID ENTRY OF WATER INTO THE COUPLER.
- 5-4.TO CLAMP THE HARNESS AT APPROPRIATE POSITION SO THAT IT WILL NOT BE SHAKEN BY VIBRATION.
- 5-5.TO CLAMP THE HARNESS MAKING ENOUGH ALLOWANCE TO PREVENT ANY TENSION.
- 5-6.IT IS RECOMMENDED TO MAKE THE JOINT PARTS WATERPROOF USING JOINT COUPLERS, BUTYL TAPE, ETC.
- 5-7.MAKE SURE THAT NO SURGE CURRENT OR VOLTAGE IS CAUSED UNDER A NORMAL OPERATION OR EXPECTED MISUSE.
- 5-8.MAKE SURE THAT NO INSTANTANEOUS INTERRUPTION OF THE POWER SUPPLY VOLTAGE (EQUAL TO OR LESS THAN 6.0, FOR EQUAL TO OR LONGER THAN 1MS) IS CAUSED UNDER A NORMAL OPERATION OR EXPECTED MISUSE.
- 5-9.DEVICES WITH PARTS CODE ARE ABLE TO BE SUPPLIED BY YANMAR.
- 5-10.★ MARKED ARE OPTION PARTS.
- 5-11.MAKE SURE THAT THE FAILURE LAMP AND SOME LAMPS AND SWITCHES FOR DPF OPERATOR INTERFACE ARE ATTACHED TO A POSITION THAT CAN EASILY BE SEEN BY OPERATOR.
- 5-12.THE HARNESS SHALL NOT CONTACT ANY SHARP EDGES.
- 5-13.THE HARNESS SHOULD BE PROTECTED APPROPRIATELY FROM WATER, CHEMICALS, EXTERNAL PRESSURE AND HEAT.
- 5-14.DO NOT CLAMP THE HARNESS WITH EXHAUST SYSTEMS.
- 5-15.THE CONNECTOR FOR SMART ASSIST-DIRECT(SA-D) SHOULD BE EASILY ACCESSIBLE.
- 5-16.THE CONNECTOR FOR SMART ASSIST-DIRECT(SA-D) SHOULD BE PROTECTED WITH A COVER OR MATING CONNECTOR.
- 5-17.HARNESS COAT IN THE CLAMP SHOULD BE PROTECTED NOT TO WEAR. AND DO NOT CLAMP ANY CABLES (WIRES) WITH METAL CLAMP DIRECTLY.
- 5-18. DO NOT TIE HARNESS WITH FUEL SYSTEM, LUBRICANTS SYSTEM AND EXHAUST SYSTEM.
- 5-19.ANY FUEL SHOULD NOT BE DROPPED ON HARNESS AT FUELING AND AIR BLEEDING.
- 5-20.HARNESS SHOULD BE SET IN PLACE SEPARATED SUFFICIENTLY FROM ROTATION PARTS AND VIBRATION PARTS.
- 5-21.HARNESS (CONNECTOR) NEEDS ANY PREVENTIONS FOR WRONG WIRING. SAME CONNECTORS SHOULD NOT BE IN A SAME PLACE.
- 5-22.IF YOU INSTALL RELAY CONNECTOR WHICH CONNECTS ENGINE'S HARNESS AND MACHINE'S HARNESS IN THE MACHINE, SET IT IN PLACE THAT CONNNECTOR SPEC. IS MET.CONNECTOR SHOULD BE FIXED WITH BLACKET OR BAND NOT TO VIBRATE SURELY.

TABLE1. WIRING RESISTANCE

No.	ITEM	ELECTRIC WIRING No.	RESISTANCE [m ohm]
1	BATTERY CABLE	000+001	≦2
2	STARTER WIRING	001+M06(A)+M07+M08	≦50
3	E-ECU VB WIRING	M01(B)+M02+M05+V1(V3,V5)	≦150
4	GLOW WIRING	M08(B)+M09+M10	≦25
5	INJECTOR(No.1 CYLINDER)	E5+E14	≦150
6	INJECTOR(No.2 CYLINDER)	E19+E20	≦150
7	INJECTOR(No.3 CYLINDER)	E28+E29	≦150
8	INJECTOR(No.4 CYLINDER)	E4+E13	≦150
9	DPF DIFFERANTIAL PRESSURE SENSOR	E75+E96	≦150
10	DPF INLET TEMP. SENSOR	E60+E88(A)	≦150
11	DPF INTERMEDIATE TEMP. SENSOR	V10+E88	≦150
12	DCU VB + GND WIRING	M50+M61+206,207,208,209 + M59+201,202,203,204,205	≦150
13	HEATER RELAY WIRING	230+241	≦150
14	DEF TANK HEATING VALVE	108+185	≦150
15	SUPPLY MODULE(HEATER)	105+103	≦150
16	SUPPLY MODULE(PUMP MOTOR)	146+126	≦150
17	SUPPLY MODULE(REVERTING VALVE)	186+165	≦150
18	PRESSURE LINE HEATER	101	≦150
19	BACK FLOW LINE HEATER	102	≦150
20	SUCTION LINE HEATER	148	≦150
21	DOSING MODULE	112+132	≦500

TABLE2. NOTE ABOUT HARNESS DESIGN

No.	ITEM	CRITERIA	REMARKS
1	DIFFERENCE IN POTENTIAL BETWEEN E-ECU GND AND BATTERY GND AND BETWEEN E-ECU POWER AND BATTERY	<1V	
2	DIFFERENCE IN POTENTIAL BETWEEN DCU GND AND BATTERY GND AND BETWEEN DCU POWER AND BATTERY	<1V	
3	DIFFERENCE IN POTENTIAL BETWEEN BATTERY and ALTERNATER (B TERMINAL CABLE)	<0.2V	

TABLE3. TWISTED PAIR CABLE AND TWISTED PAIR CABLE WITH SHIELD

	ITEM	ELECTRIC WIRING No.		RECOMMENDED WIRING	REMARKS
1	CRANK SPEED SENSOR	E97	E110	TWISTED PAIR WITH SHIELD	
	EGR VALVE	V40	V51	TWISTED PAIR	MAX:40m
	INJECTOR #1	E5	E14	TWISTED PAIR	
	INJECTOR #2	E19	E20	TWISTED PAIR	
	INJECTOR #3	E28	E29	TWISTED PAIR	
	INJECTOR #4	E4	E13	TWISTED PAIR	
	SA-D	V62	V63	TWISTED PAIR	MAX:40m
	DOSING MODULE	112	132	TWISTED PAIR	
	CAN0	214	215	TWISTED PAIR	MAX:40m
	CAN1	211	212	TWISTED PAIR	MAX:40m

PITCH OF TWISTED PAIR CABLE

TABLE4. NOTE ABOUT CLAMP OF WIRE HARNESS

No.	ITEM	CRITERIA [mm]
1	E-ECU CONNECTOR ~ 1ST CLAMP	≦200
2	DCU CONNECTOR ~ 1ST CLAMP	≦100
3	DPF INLET TEMP. SENSOR CONNECTOR ~ 1ST CLAMP	≦150
4	DPF INTERMEDIATE TEMP. SENSOR CONNECTOR ~ 1ST CLAMP	≦150
5	DPF DIFFERENTIAL PRESSURE SENSOR CONNECTOR ~ 1ST CLAMP	≦150
6	INTERMEDIATE COUPLER(E~H) ~ 1ST CLAMP	≦150
7	Nox SENSOR CONNECTOR ~ 1ST CLAMP	≦100
8	SUPPLY MODULE CONNECTOR ~ 1ST CLAMP	≦100
9	DOSING MODULE CONNECTOR ~ 1ST CLAMP	≦100
10	SCR CATALYST TEMP. SENSOR CONNECTOR ~ 1ST CLAMP	≦150
11	DEF TANK HEATING VALVE CONNECTOR ~ 1ST CLAMP	≦150

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Fig. 00-73

3. Electronic Control Harness Connector

3.1 Harness ECU

1- EU Stage III A equivalent certified model

No.	Wire type	Diame-ter	Wire color	Circuit sym-bol	Ter-minal	Circuit sym-bol	Ter-minal	Circuit mating end				Group
1	AVSS	1.25	R	M00		M00		38A	SUB RELAY	13A	INTERMEDIATE COUPLER A	
2	AVSS	0.5	R			M00A			M00	14A	INTERMEDIATE COUPLER B	
3	AVSS	0.5	R			M00B			M00	15A	INTERMEDIATE COUPLER C	
4	AVSS	0.5	R			M00C			M00	16A	INTERMEDIATE COUPLER D	
5	AVSS	0.5	R			M00D			M00	10A	ACCELERATOR SENSOR 3	
6	AVSS	0.5	R			M00E			M00	30A	SA-D	
7	AVS	5	R	M01		M01		25A	BATTERY CABLE (+)	45A	JC3	
8	AVSS	1.25	R			M01A		45A	JC3	39A	FUSE BOX (BLADE)	
9	AVS	3	R			M01B		45A	JC3	39A	FUSE BOX (BLADE)	
10	AVSS	1.25	R			M01C		45A	JC3	39A	FUSE BOX (BLADE)	
11	AVS	3	R	M02		M02		39A	FUSE BOX (BLADE)	37A	MAIN RELAY	
12	AVSS	0.5	R			M02A			M02	37A	MAIN RELAY	
13	AVSS	0.5	R			M02B			M02	49A	INTERMEDIATE COUPLER FOR SA-R	
14	AVSS	1.25	R	M03		M03		39A	FUSE BOX (BLADE)	33A	KEY SWITCH	
15	AVSS	1.25	R	M04		M04		39A	FUSE BOX (BLADE)	38A	SUB RELAY	
16	AVSS	0.5	R			M04A			M04	38A	SUB RELAY	
17	AVS	3	O	M05		M05		37A	MAIN RELAY	3A	JC1	
18	AVSS	0.75	O			M05A			M05	23A	INTERMEDIATE COUPLER FOR ENGINE	
19	AV	8	W	M06		M06		28A	STARTER B	40A	FUSE BOX	
20	AVS	1.25	W			M06A			M06	39A	FUSE BOX (BLADE)	
21	AVS	3	W			M06B			M06	39A	FUSE BOX (BLADE)	
22	AVSS	1.25	Br	M07		M07		35A	STARTER RELAY	39A	FUSE BOX (BLADE)	
23	AVSS	1.25	W	M08		M08		35A	STARTER RELAY	29A	STARTER S	
24	AVS	3	Br	M09		M09		39A	FUSE BOX (BLADE)	36A	GLOW PLUG RELAY	
25	AVS	3	R	M10		M10		36A	GLOW PLUG RELAY	17A	GLOW PLUG	
26	AVS	5	B	M11		M11		4A	JC2	24A	BATTERY CABLE (-)	
27	AVSS	0.75	B			M11A			M11	23A	INTERMEDIATE COUPLER FOR ENGINE	
28	AVSS	1.25	B			M11B			M11	18A	FUEL FEED PUMP	
29	AVSS	0.5	B			M11C			M11	36A	GLOW PLUG RELAY	
30	AVSS	0.5	B			M11D			M11	14A	INTERMEDIATE COUPLER B	
31	AVSS	0.5	B			M11E			M11	16A	INTERMEDIATE COUPLER D	
32	AVSS	0.5	B			M11F			M11	30A	SA-D	
33	AVSS	0.5	B			M11G			M11	13A	INTERMEDIATE COUPLER A	
34	AVSS	0.5	B			M11H			M11	22A	WATER SEPARATOR	
35	AVSS	0.5	B			M11I			M11	49A	INTERMEDIATE COUPLER FOR SA-R	
36	AV	8	W	M13		M13		40A	FUSE BOX	27A	ALTERNATOR B	
37	AVSS	0.5	O	M14		M14		44A	DIODE	26A	ALTERNATOR L	
38	AVSS	0.5	O	E1		E1		1A	ENGINE ECU	23A	INTERMEDIATE COUPLER FOR ENGINE	
39	AVSS	0.5	G	E2		E2		1A	ENGINE ECU	23A	INTERMEDIATE COUPLER FOR ENGINE	
40	AVSS	0.75	Y	E4		E4		1A	ENGINE ECU	23A	INTERMEDIATE COUPLER FOR ENGINE	TWST1
41	AVSS	0.75	W	E5		E5		1A	ENGINE ECU	23A	INTERMEDIATE COUPLER FOR ENGINE	TWST2
42	AVSS	0.75	R	E13		E13		1A	ENGINE ECU	23A	INTERMEDIATE COUPLER FOR ENGINE	TWST1
43	AVSS	0.75	R	E14		E14		1A	ENGINE ECU	23A	INTERMEDIATE COUPLER FOR ENGINE	TWST2
44	AVSS	0.5	G	E18		E18		1A	ENGINE ECU	16A	INTERMEDIATE COUPLER D	
45	AVSS	0.75	W	E19		E19		1A	ENGINE ECU	23A	INTERMEDIATE COUPLER FOR ENGINE	TWST3
46	AVSS	0.75	L	E20		E20		1A	ENGINE ECU	23A	INTERMEDIATE COUPLER FOR ENGINE	TWST3
47	AVSS	0.5	Y	E25		E25		1A	ENGINE ECU	23A	INTERMEDIATE COUPLER FOR ENGINE	
48	AVSS	0.5	P	E26		E26		1A	ENGINE ECU	23A	INTERMEDIATE COUPLER FOR ENGINE	
49	AVSS	0.5	P	E27		E27		1A	ENGINE ECU	35A	STARTER RELAY	
50	AVSS	0.75	W	E28		E28		1A	ENGINE ECU	23A	INTERMEDIATE COUPLER FOR ENGINE	TWST4
51	AVSS	0.75	L	E29		E29		1A	ENGINE ECU	23A	INTERMEDIATE COUPLER FOR ENGINE	TWST4
52	AVSS	0.5	G	E33		E33		1A	ENGINE ECU	36A	GLOW PLUG RELAY	
53	AVSS	0.5	L	E34		E34		1A	ENGINE ECU	23A	INTERMEDIATE COUPLER FOR ENGINE	
54	AVSS	0.5	Y	E35		E35		1A	ENGINE ECU	23A	INTERMEDIATE COUPLER FOR ENGINE	

Electric wiring, electronic control harness connections

No.	Wire type	Diameter		Wire color	Circuit symbol	Terminal	Circuit symbol	Terminal	Circuit mating end				Group
55	AVSS	0.5		G	E40		E40		1A	ENGINE ECU	23A	INTERMEDIATE COUPLER FOR ENGINE	
56	AVSS	0.5		G			E40A			E40	1A	ENGINE ECU	
57	AVSS	0.5		L	E42		E42		1A	ENGINE ECU	23A	INTERMEDIATE COUPLER FOR ENGINE	
58	AVSS	0.5		L	E44		E44		1A	ENGINE ECU	23A	INTERMEDIATE COUPLER FOR ENGINE	
59	AVSS	0.5		P	E48		E48	Au	1A	ENGINE ECU	12A	ACCELERATOR SENSOR 1	
60	AVSS	0.5		L	E57		E57		1A	ENGINE ECU	23A	INTERMEDIATE COUPLER FOR ENGINE	
61	AVSS	0.5		Y	E58		E58		1A	ENGINE ECU	23A	INTERMEDIATE COUPLER FOR ENGINE	
62	AVSS	0.5		W	E61		E61		1A	ENGINE ECU	23A	INTERMEDIATE COUPLER FOR ENGINE	
63	AVSS	0.5		L	E62		E62	Au	1A	ENGINE ECU	6A	DPF DIFFERENTIAL PRESSURE SENSOR	
64	AVSS	0.5		P	E67		E67		1A	ENGINE ECU	14A	INTERMEDIATE COUPLER B	
65	AVSS	0.5		R	E70		E70		1A	ENGINE ECU	23A	INTERMEDIATE COUPLER FOR ENGINE	
66	AVSS	0.5		Y	E71		E71		1A	ENGINE ECU	23A	INTERMEDIATE COUPLER FOR ENGINE	
67	AVSS	0.5		R	E73		E73		1A	ENGINE ECU	23A	INTERMEDIATE COUPLER FOR ENGINE	
68	AVSS	0.5		R	E77		E77		1A	ENGINE ECU	23A	INTERMEDIATE COUPLER FOR ENGINE	
69	AVSS	0.5		R	E78		E78	Au	1A	ENGINE ECU	12A	ACCELERATOR SENSOR 1	
70	AVSS	0.5		R	E79		E79		1A	ENGINE ECU	23A	INTERMEDIATE COUPLER FOR ENGINE	
71	AVSS	0.5		L	E81		E81		1A	ENGINE ECU	14A	INTERMEDIATE COUPLER B	
72	AVSS	0.5		Br	E83		E83		1A	ENGINE ECU	23A	INTERMEDIATE COUPLER FOR ENGINE	
73	AVSS	0.5		G	E85		E85		1A	ENGINE ECU	23A	INTERMEDIATE COUPLER FOR ENGINE	
74	AVSS	0.5		R	E86		E86		1A	ENGINE ECU	14A	INTERMEDIATE COUPLER B	
75	AVSS	0.5		W	E87		E87		1A	ENGINE ECU	14A	INTERMEDIATE COUPLER B	
76	AVSS	0.5		B	E89		E89		1A	ENGINE ECU	–		ASW1
77	AVSS	0.5		B	E90		E90		1A	ENGINE ECU	23A	INTERMEDIATE COUPLER FOR ENGINE	
78	AVSS	0.5		B			E90B			E90	47A	AMBIENT TEMP. SENSOR	
79	AVSS	0.5		B	E91		E91		1A	ENGINE ECU	23A	INTERMEDIATE COUPLER FOR ENGINE	
80	AVSS	0.5		B	E92		E92	Au	1A	ENGINE ECU	12A	ACCELERATOR SENSOR 1	
81	AVSS	0.5		L	E93		E93		1A	ENGINE ECU	14A	INTERMEDIATE COUPLER B	
82	AVSS	0.5		P	E94		E94		1A	ENGINE ECU	16A	INTERMEDIATE COUPLER D	
83	AVSS	0.5		W	E97		E97		1A	ENGINE ECU	23A	INTERMEDIATE COUPLER FOR ENGINE	TWST5
84	AVSS	0.5		Y	E98		E98		1A	ENGINE ECU	16A	INTERMEDIATE COUPLER D	
85	AVSS	0.5		L	E99		E99		1A	ENGINE ECU	16A	INTERMEDIATE COUPLER D	
86	AVSS	0.5		G	E106		E106		1A	ENGINE ECU	16A	INTERMEDIATE COUPLER D	
87	AVSS	0.5		L	E108		E108		1A	ENGINE ECU	23A	INTERMEDIATE COUPLER FOR ENGINE	
88	AVSS	0.5		B	E109		E109		1A	ENGINE ECU	23A	INTERMEDIATE COUPLER FOR ENGINE	
89	AVSS	0.5		B	E110		E110		1A	ENGINE ECU	23A	INTERMEDIATE COUPLER FOR ENGINE	TWST5
90	AVSS	2		R	V1		V1		2A	VEHICLE ECU	3A	JC1	
91	AVSS	2		B	V2		V2		2A	VEHICLE ECU	4A	JC2	
92	AVSS	2		R	V3		V3		2A	VEHICLE ECU	3A	JC1	
93	AVSS	2		B	V4		V4		2A	VEHICLE ECU	4A	JC2	
94	AVSS	2		R	V5		V5		2A	VEHICLE ECU	3A	JC1	
95	AVSS	2		B	V6		V6		2A	VEHICLE ECU	4A	JC2	
96	AVSS	0.5		Y	V8		V8		2A	VEHICLE ECU	23A	INTERMEDIATE COUPLER FOR ENGINE	
97	AVSS	0.5		G	V9		V9	Au	2A	VEHICLE ECU	11A	ACCELERATOR SENSOR 2	
98	AVSS	0.5		P	V11		V11		2A	VEHICLE ECU	47A	AMBIENT TEMP. SENSOR	
99	AVSS	1.25		O	V12		V12		34A	KEY SWITCH	18A	FUEL FEED PUMP	
100	AVSS	0.5		O			V12A			V12	2A	VEHICLE ECU	
101	AVSS	0.5		O			V12B			V12	2A	VEHICLE ECU	
102	AVSS	0.5		O			V12C			V12	42A	RESISTANCE 2k ohm 1W	
103	AVSS	0.5		O			V12D			V12	21A	AIR CLEANER SENSOR	
104	AVSS	0.5		O			V12E			V12	22A	WATER SEPARATOR	
105	AVSS	0.5		O			V12F			V12	46A	RESISTANCE 3k ohm 1W	
106	AVSS	0.5		O			V12G			V12	49A	INTERMEDIATE COUPLER FOR SA-R	
107	AVSS	0.5		G	V14		V14		2A	VEHICLE ECU	34A	KEY SWITCH	
108	AVSS	0.5		G			V14A			V14	35A	STARTER RELAY	
109	AVSS	0.5		O	V21		V21		2A	VEHICLE ECU	10A	ACCELERATOR SENSOR 3	
110	AVSS	0.5		P	V23		V23		2A	VEHICLE ECU	13A	INTERMEDIATE COUPLER A	
111	AVSS	0.5		Y	V24		V24		2A	VEHICLE ECU	14A	INTERMEDIATE COUPLER B	
112	AVSS	0.5		Br	V26		V26		2A	VEHICLE ECU	13A	INTERMEDIATE COUPLER A	
113	AVSS	0.5		Y	V27		V27		2A	VEHICLE ECU	13A	INTERMEDIATE COUPLER A	
114	AVSS	0.5		G	V28		V28		2A	VEHICLE ECU	13A	INTERMEDIATE COUPLER A	

Electric wiring, electronic control harness connections

No.	Wire type	Diame-ter		Wire color	Circuit sym-bol	Ter-minal	Circuit sym-bol	Ter-minal	Circuit mating end				Group
115	AVSS	0.5		L	V29		V29	Au	2A	VEHICLE ECU	11A	ACCELERATOR SENSOR 2	
116	AVSS	0.5		R	V30		V30		2A	VEHICLE ECU	10A	ACCELERATOR SENSOR 3	
117	AVSS	0.5		Y	V31		V31	Au	2A	VEHICLE ECU	11A	ACCELERATOR SENSOR 2	
118	AVSS	0.5		Br	V32		V32		2A	VEHICLE ECU	10A	ACCELERATOR SENSOR 3	
119	AVSS	0.5		G	V33		V33		2A	VEHICLE ECU	14A	INTERMEDIATE COUPLER B	
120	AVSS	0.5		W	V34		V34		2A	VEHICLE ECU	16A	INTERMEDIATE COUPLER D	
121	AVSS	0.5		G	V35		V35		2A	VEHICLE ECU	22A	WATER SEPARATOR	
122	AVSS	0.5		G			V35A			V35	46A	RESISTANCE 3k ohm 1W	
123	AVSS	0.5		Br	V36		V36		2A	VEHICLE ECU	14A	INTERMEDIATE COUPLER B	
124	AVSS	0.5		G	V37		V37		2A	VEHICLE ECU	37A	MAIN RELAY	
125	AVSS	0.5		G			V37A			V37	2A	VEHICLE ECU	
126	AVSS	0.5		G			V37B			V37	38A	SUB RELAY	
127	AVSS	0.5		P	V40		V40		2A	VEHICLE ECU	23A	INTERMEDIATE COUPLER FOR ENGINE	TWST6
128	AVSS	0.5		L	V42		V42		2A	VEHICLE ECU	14A	INTERMEDIATE COUPLER B	
129	AVSS	0.5		P	V43		V43		2A	VEHICLE ECU	10A	ACCELERATOR SENSOR 3	
130	AVSS	0.5		Br	V44		V44		2A	VEHICLE ECU	14A	INTERMEDIATE COUPLER B	
131	AVSS	0.5		L	V45		V45		2A	VEHICLE ECU	13A	INTERMEDIATE COUPLER A	
132	AVSS	0.5		L			V45A			V45	20A	AIR CLEANER SENSOR	
133	AVSS	0.5		R	V46		V46		2A	VEHICLE ECU	13A	INTERMEDIATE COUPLER A	
134	AVSS	0.5		R			V46A			V46	42A	RESISTANCE 2k ohm 1W	
135	AVSS	0.5		R			V46B			V46	44A	DIODE	
136	AVSS	0.5		L	V49		V49		2A	VEHICLE ECU	13A	INTERMEDIATE COUPLER A	
137	AVSS	0.5		L	V51		V51		2A	VEHICLE ECU	23A	INTERMEDIATE COUPLER FOR ENGINE	TWST6
138	AVSS	0.5		R	V55		V55		2A	VEHICLE ECU	16A	INTERMEDIATE COUPLER D	
139	AVSS	0.5		P	V59		V59		2A	VEHICLE ECU	16A	INTERMEDIATE COUPLER D	
140	AVSS	0.5		W	V60		V60		2A	VEHICLE ECU	15A	INTERMEDIATE COUPLER C	
141	AVSS	0.5		L	V62		V62		2A	VEHICLE ECU	30A	SA-D	TWST7
142	AVSS	0.5		L			V62A			V62	31A	J1939	TWST8
143	AVSS	0.5		L			V62B			V62	49A	INTERMEDIATE COUPLER FOR SA-R	TWST9
144	AVSS	0.5		Y	V63		V63		2A	VEHICLE ECU	30A	SA-D	TWST7
145	AVSS	0.5		Y			V63A			V63	31A	J1939	TWST8
146	AVSS	0.5		Y			V63B			V63	49A	INTERMEDIATE COUPLER FOR SA-R	TWST9
147	AVSS	0.5		R	V71		V71		2A	VEHICLE ECU	13A	INTERMEDIATE COUPLER A	
148	AVSS	0.5		B	V72		V72		2A	VEHICLE ECU	48A	CASE-GND	

Electric wiring, electronic control harness connections

(1/2)

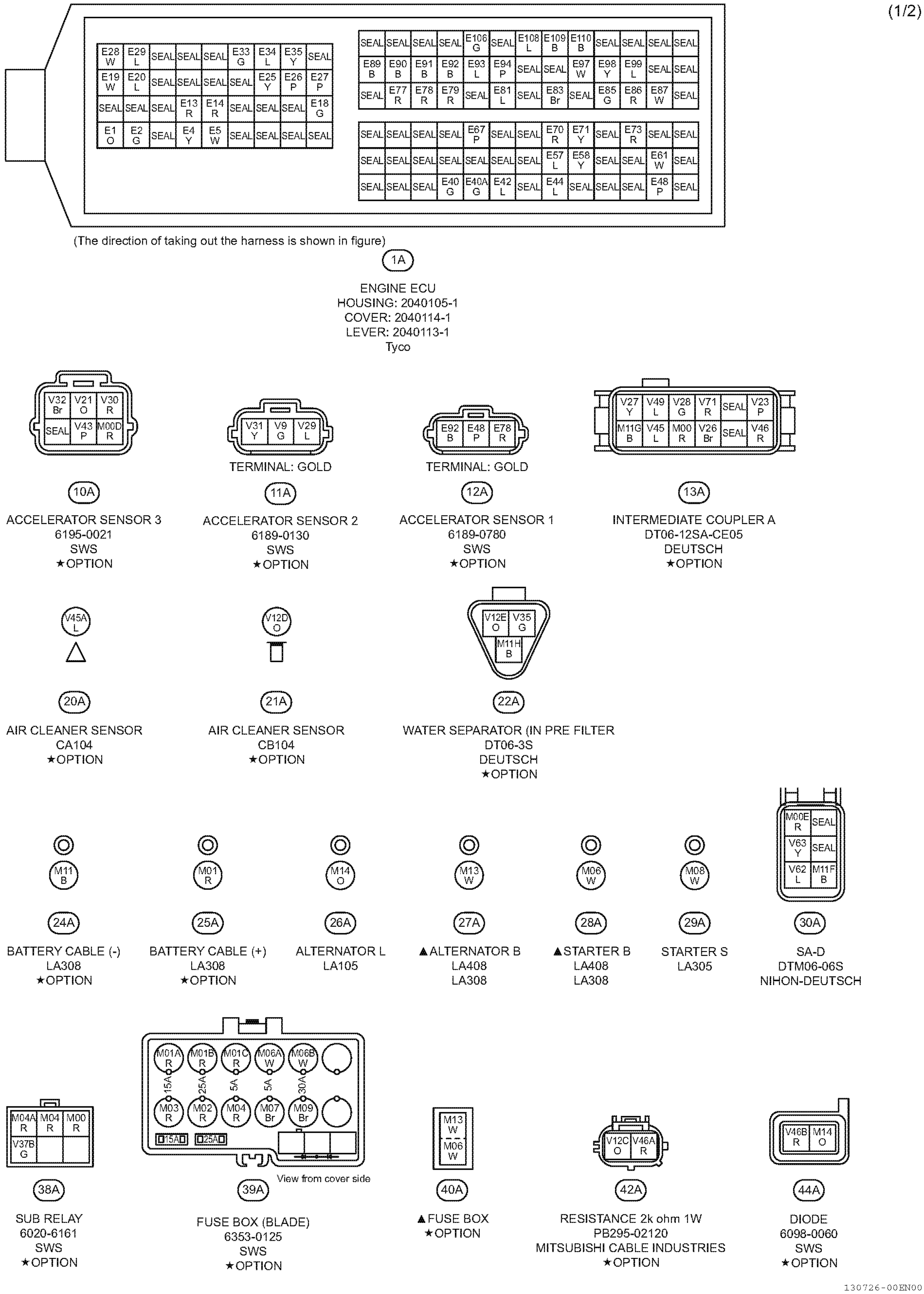


Fig. 00-74

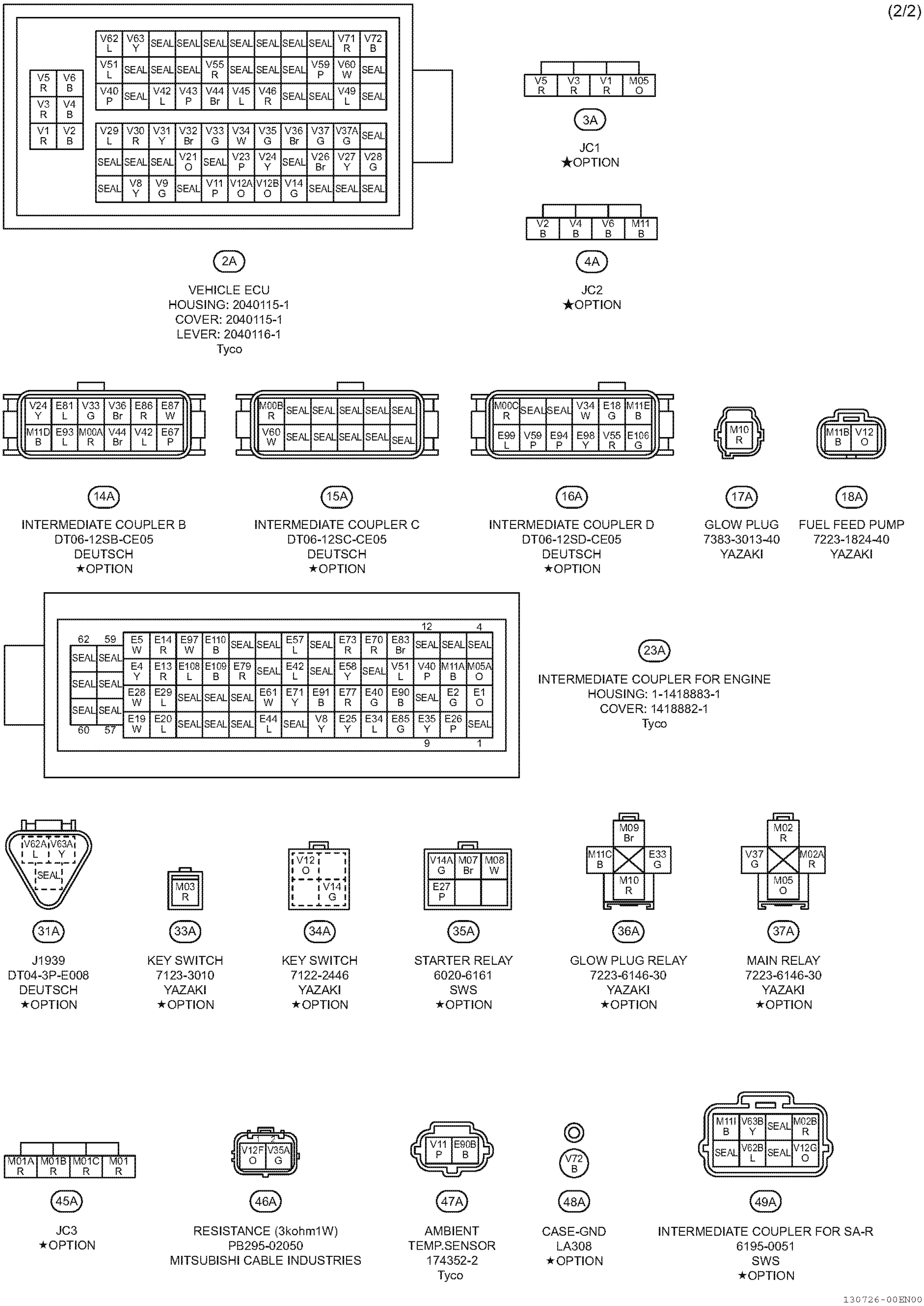

(2/2)
2A
VEHICLE ECU
HOUSING: 2040115-1
COVER: 2040115-1
LEVER: 2040116-1
Tyco
3A
JC1
★OPTION
4A
JC2
★OPTION
14A
INTERMEDIATE COUPLER B
DT06-12SB-CE05
DEUTSCH
★OPTION
15A
INTERMEDIATE COUPLER C
DT06-12SC-CE05
DEUTSCH
★OPTION
16A
INTERMEDIATE COUPLER D
DT06-12SD-CE05
DEUTSCH
★OPTION
17A
GLOW PLUG
7383-3013-40
YAZAKI
18A
FUEL FEED PUMP
7223-1824-40
YAZAKI
23A
INTERMEDIATE COUPLER FOR ENGINE
HOUSING: 1-1418883-1
COVER: 1418882-1
Tyco
31A
J1939
DT04-3P-E008
DEUTSCH
★OPTION
33A
KEY SWITCH
7123-3010
YAZAKI
★OPTION
34A
KEY SWITCH
7122-2446
YAZAKI
★OPTION
35A
STARTER RELAY
6020-6161
SWS
★OPTION
36A
GLOW PLUG RELAY
7223-6146-30
YAZAKI
★OPTION
37A
MAIN RELAY
7223-6146-30
YAZAKI
★OPTION
45A
JC3
★OPTION
46A
RESISTANCE (3kohm1W)
PB295-02050
MITSUBISHI CABLE INDUSTRIES
47A
AMBIENT
TEMP.SENSOR
174352-2
Tyco
48A
CASE-GND
LA308
★OPTION
49A
INTERMEDIATE COUPLER FOR SA-R
6195-0051
SWS
★OPTION
130726-00EN00

Fig. 00-75

2- EU Stage V certified models

No.	Wire type	Diame-ter		Wire color	Circuit sym-bol	Ter-minal	Circuit sym-bol	Ter-minal	Circuit mating end				Group
1	AVSS	1.25		R	M00		M00		38A	SUB RELAY	13A	INTERMEDIATE COUPLER A	
2	AVSS	0.5		R			M00A				14A	INTERMEDIATE COUPLER B	
3	AVSS	0.5		R			M00B				15A	INTERMEDIATE COUPLER C	
4	AVSS	0.5		R			M00C				16A	INTERMEDIATE COUPLER D	
5	AVSS	0.5		R			M00D				10A	ACCELERATOR SENSOR 3	
6	AVSS	0.5		R			M00E				30A	SA-D	
7	AVS	5		R	M01		M01		25A	BATTERY CABLE (+)	45A	JC3	
8	AVSS	1.25		R			M01A		45A	JC3	39A	FUSE BOX (BLADE)	
9	AVS	3		R			M01B		45A	JC3	39A	FUSE BOX (BLADE)	
10	AVSS	1.25		R			M01C		45A	JC3	39A	FUSE BOX (BLADE)	
11	AVS	3		R	M02		M02		39A	FUSE BOX (BLADE)	37A	MAIN RELAY	
12	AVSS	0.5		R			M02A				37A	MAIN RELAY	
13	AVSS	1.25		R	M03		M03		33A	KEY SWITCH	39A	FUSE BOX (BLADE)	
14	AVSS	1.25		R	M04		M04		38A	SUB RELAY	39A	FUSE BOX (BLADE)	
15	AVSS	0.5		R			M04A				38A	SUB RELAY	
16	AVS	3		O	M05		M05		3A	JC1	37A	MAIN RELAY	
17	AVSS	0.75		O			M05A				23A	INTERMEDIATE COUPLER FOR ENGINE	
18	AV	8		W	M06		M06		28A	STARTER B	40A	FUSE BOX	
19	AVS	1.25		W			M06A				39A	FUSE BOX (BLADE)	
20	AVS	3		W			M06B				39A	FUSE BOX (BLADE)	
21	AVSS	1.25		Br	M07		M07		39A	FUSE BOX (BLADE)	35A	STARTER RELAY	
22	AVSS	1.25		W	M08		M08		29A	STARTER S	35A	STARTER RELAY	
23	AVS	3		Br	M09		M09		36A	GLOW PLUG RELAY	39A	FUSE BOX (BLADE)	
24	AVS	3		R	M10		M10		17A	GLOW PLUG	36A	GLOW PLUG RELAY	
25	AVS	5		B	M11		M11		4A	JC2	24A	BATTERY CABLE (-)	
26	AVSS	0.75		B			M11A				23A	INTERMEDIATE COUPLER FOR ENGINE	
27	AVSS	1.25		B			M11B				18A	FUEL FEED PUMP	
28	AVSS	0.5		B			M11C				36A	GLOW PLUG RELAY	
29	AVSS	0.5		B			M11D				14A	INTERMEDIATE COUPLER B	
30	AVSS	0.5		B			M11E				16A	INTERMEDIATE COUPLER D	
31	AVSS	0.5		B			M11F				30A	SA-D	
32	AVSS	0.5		B			M11G				13A	INTERMEDIATE COUPLER A	
33	AV	8		W	M13		M13		40A	FUSE BOX	27A	ALTERNATOR B	
34	AVSS	0.5		O	M14		M14		44A	DIODE	26A	ALTERNATOR L	
35	AVSS	0.5		O	E1		E1		1A	ENGINE ECU	23A	INTERMEDIATE COUPLER FOR ENGINE	
36	AVSS	0.5		G	E2		E2		1A	ENGINE ECU	23A	INTERMEDIATE COUPLER FOR ENGINE	
37	AVSS	0.75		Y	E4		E4		1A	ENGINE ECU	23A	INTERMEDIATE COUPLER FOR ENGINE	TWST1
38	AVSS	0.75		W	E5		E5		1A	ENGINE ECU	23A	INTERMEDIATE COUPLER FOR ENGINE	TWST2
39	AVSS	0.5		Y	E7		E7		1A	ENGINE ECU	23A	INTERMEDIATE COUPLER FOR ENGINE	
40	AVSS	0.75		R	E13		E13		1A	ENGINE ECU	23A	INTERMEDIATE COUPLER FOR ENGINE	TWST1
41	AVSS	0.75		R	E14		E14		1A	ENGINE ECU	23A	INTERMEDIATE COUPLER FOR ENGINE	TWST2
42	AVSS	0.5		L	E16		E16		1A	ENGINE ECU	23A	INTERMEDIATE COUPLER FOR ENGINE	
43	AVSS	0.5		G	E18		E18		1A	ENGINE ECU	16A	INTERMEDIATE COUPLER D	
44	AVSS	0.75		W	E19		E19		1A	ENGINE ECU	23A	INTERMEDIATE COUPLER FOR ENGINE	TWST3
45	AVSS	0.75		L	E20		E20		1A	ENGINE ECU	23A	INTERMEDIATE COUPLER FOR ENGINE	TWST3
46	AVSS	0.5		Y	E25		E25		1A	ENGINE ECU	23A	INTERMEDIATE COUPLER FOR ENGINE	
47	AVSS	0.5		P	E26		E26		1A	ENGINE ECU	23A	INTERMEDIATE COUPLER FOR ENGINE	
48	AVSS	0.5		P	E27		E27		1A	ENGINE ECU	35A	STARTER RELAY	
49	AVSS	0.75		W	E28		E28		1A	ENGINE ECU	23A	INTERMEDIATE COUPLER FOR ENGINE	TWST4
50	AVSS	0.75		L	E29		E29		1A	ENGINE ECU	23A	INTERMEDIATE COUPLER FOR ENGINE	TWST4
51	AVSS	0.5		G	E33		E33		1A	ENGINE ECU	36A	GLOW PLUG RELAY	
52	AVSS	0.5		L	E34		E34		1A	ENGINE ECU	23A	INTERMEDIATE COUPLER FOR ENGINE	
53	AVSS	0.5		Y	E35		E35		1A	ENGINE ECU	23A	INTERMEDIATE COUPLER FOR ENGINE	
54	AVSS	0.5		G	E36		E36		1A	ENGINE ECU	15A	INTERMEDIATE COUPLER C	
55	AVSS	0.5		G	E40		E40		1A	ENGINE ECU	23A	INTERMEDIATE COUPLER FOR ENGINE	
56	AVSS	0.5		G			E40A		1A	ENGINE ECU	–		
57	AVSS	0.5		L	E42		E42		1A	ENGINE ECU	23A	INTERMEDIATE COUPLER FOR ENGINE	
58	AVSS	0.5		L	E44		E44		1A	ENGINE ECU	23A	INTERMEDIATE COUPLER FOR ENGINE	
59	AVSS	0.5		G	E46		E46		1A	ENGINE ECU	23A	INTERMEDIATE COUPLER FOR ENGINE	

Electric wiring, electronic control harness connections

No.	Wire type	Diame-ter		Wire color	Circuit sym-bol	Ter-minal	Circuit sym-bol	Ter-minal	Circuit mating end				Group
60	AVSS	0.5		P	E48		E48	Au	1A	ENGINE ECU	12A	ACCELERATOR SENSOR 1	
61	AVSS	0.5		L	E57		E57		1A	ENGINE ECU	23A	INTERMEDIATE COUPLER FOR ENGINE	
62	AVSS	0.5		Y	E58		E58		1A	ENGINE ECU	23A	INTERMEDIATE COUPLER FOR ENGINE	
63	AVSS	0.5		G	E59		E59	Au	1A	ENGINE ECU	6A	DPF DIFFERENTIAL PRESSURE SENSOR	
64	AVSS	0.5		R	E60		E60	Au	1A	ENGINE ECU	7A	DPF INLET TEMP. SENSOR	
65	AVSS	0.5		W	E61		E61		1A	ENGINE ECU	23A	INTERMEDIATE COUPLER FOR ENGINE	
66	AVSS	0.5		L	E62		E62	Au	1A	ENGINE ECU	6A	DPF DIFFERENTIAL PRESSURE SENSOR	
67	AVSS	0.5		P	E67		E67		1A	ENGINE ECU	14A	INTERMEDIATE COUPLER B	
68	AVSS	0.5		R	E70		E70		1A	ENGINE ECU	23A	INTERMEDIATE COUPLER FOR ENGINE	
69	AVSS	0.5		Y	E71		E71		1A	ENGINE ECU	23A	INTERMEDIATE COUPLER FOR ENGINE	
70	AVSS	0.5		R	E73		E73		1A	ENGINE ECU	23A	INTERMEDIATE COUPLER FOR ENGINE	
71	AVSS	0.5		R	E75		E75	Au	1A	ENGINE ECU	6A	DPF DIFFERENTIAL PRESSURE SENSOR	
72	AVSS	0.5		R	E77		E77		1A	ENGINE ECU	23A	INTERMEDIATE COUPLER FOR ENGINE	
73	AVSS	0.5		R	E78		E78	Au	1A	ENGINE ECU	12A	ACCELERATOR SENSOR 1	
74	AVSS	0.5		R	E79		E79		1A	ENGINE ECU	23A	INTERMEDIATE COUPLER FOR ENGINE	
75	AVSS	0.5		L	E81		E81		1A	ENGINE ECU	14A	INTERMEDIATE COUPLER B	
76	AVSS	0.5		Br	E83		E83		1A	ENGINE ECU	23A	INTERMEDIATE COUPLER FOR ENGINE	
77	AVSS	0.5		G	E85		E85		1A	ENGINE ECU	23A	INTERMEDIATE COUPLER FOR ENGINE	
78	AVSS	0.5		R	E86		E86		1A	ENGINE ECU	14A	INTERMEDIATE COUPLER B	
79	AVSS	0.5		W	E87		E87		1A	ENGINE ECU	14A	INTERMEDIATE COUPLER B	
80	AVSS	0.5		B	E88		E88	Au	1A	ENGINE ECU	8A	DPF INSIDE TEMP. SENSOR	
81	AVSS	0.5		B			E88A	Au			7A	DPF INLET TEMP. SENSOR	
82	AVSS	0.5		B	E89		E89		1A	ENGINE ECU	–		ASW1
83	AVSS	0.5		B	E90		E90		1A	ENGINE ECU	23A	INTERMEDIATE COUPLER FOR ENGINE	
84	AVSS	0.5		B	E91		E91		1A	ENGINE ECU	23A	INTERMEDIATE COUPLER FOR ENGINE	
85	AVSS	0.5		B	E92		E92	Au	1A	ENGINE ECU	12A	ACCELERATOR SENSOR 1	
86	AVSS	0.5		L	E93		E93		1A	ENGINE ECU	14A	INTERMEDIATE COUPLER B	
87	AVSS	0.5		P	E94		E94		1A	ENGINE ECU	16A	INTERMEDIATE COUPLER D	
88	AVSS	0.5		B	E96		E96	Au	1A	ENGINE ECU	6A	DPF DIFFERENTIAL PRESSURE SENSOR	
89	AVSS	0.5		W	E97		E97		1A	ENGINE ECU	23A	INTERMEDIATE COUPLER FOR ENGINE	TWST5
90	AVSS	0.5		Y	E98		E98		1A	ENGINE ECU	16A	INTERMEDIATE COUPLER D	
91	AVSS	0.5		L	E99		E99		1A	ENGINE ECU	16A	INTERMEDIATE COUPLER D	
92	AVSS	0.5		G	E106		E106		1A	ENGINE ECU	16A	INTERMEDIATE COUPLER D	
93	AVSS	0.5		L	E108		E108		1A	ENGINE ECU	23A	INTERMEDIATE COUPLER FOR ENGINE	
94	AVSS	0.5		B	E109		E109		1A	ENGINE ECU	23A	INTERMEDIATE COUPLER FOR ENGINE	
95	AVSS	0.5		B	E110		E110		1A	ENGINE ECU	23A	INTERMEDIATE COUPLER FOR ENGINE	TWST5
96	AVSS	2		R	V1		V1		2A	VEHICLE ECU	3A	JC1	
97	AVSS	2		B	V2		V2		2A	VEHICLE ECU	4A	JC2	
98	AVSS	2		R	V3		V3		2A	VEHICLE ECU	3A	JC1	
99	AVSS	2		B	V4		V4		2A	VEHICLE ECU	4A	JC2	
100	AVSS	2		R	V5		V5		2A	VEHICLE ECU	3A	JC1	
101	AVSS	2		B	V6		V6		2A	VEHICLE ECU	4A	JC2	
102	AVSS	0.5		Y	V8		V8		2A	VEHICLE ECU	23A	INTERMEDIATE COUPLER FOR ENGINE	
103	AVSS	0.5		G	V9		V9	Au	2A	VEHICLE ECU	11A	ACCELERATOR SENSOR 2	
104	AVSS	0.5		Br	V10		V10	Au	2A	VEHICLE ECU	8A	DPF INSIDE TEMP. SENSOR	
105	AVSS	0.5		P	V11		V11		2A	VEHICLE ECU	23A	INTERMEDIATE COUPLER FOR ENGINE	
106	AVSS	1.25		O	V12		V12		34A	KEY SWITCH	18A	FUEL FEED PUMP	
107	AVSS	0.5		O			V12A				2A	VEHICLE ECU	
108	AVSS	0.5		O			V12B				2A	VEHICLE ECU	
109	AVSS	0.5		O			V12C				42A	RESISTANCE 2k ohm 1W	
110	AVSS	0.5		O			V12D				9A	DCU INTERMEDIATE COUPLER	
111	AVSS	0.5		O			V12E				21A	AIR CLEANER SENSOR	
112	AVSS	0.5		O			V12F				22A	WATER SEPARATOR	
113	AVSS	0.5		G	V14		V14		2A	VEHICLE ECU	34A	KEY SWITCH	
114	AVSS	0.5		G			V14A				35A	STARTER RELAY	
115	AVSS	0.5		P	V15		V15		2A	VEHICLE ECU	15A	INTERMEDIATE COUPLER C	
116	AVSS	0.5		O	V21		V21		2A	VEHICLE ECU	10A	ACCELERATOR SENSOR 3	
117	AVSS	0.5		P	V23		V23		2A	VEHICLE ECU	13A	INTERMEDIATE COUPLER A	
118	AVSS	0.5		Y	V24		V24		2A	VEHICLE ECU	14A	INTERMEDIATE COUPLER B	
119	AVSS	0.5		L	V25		V25		2A	VEHICLE ECU	15A	INTERMEDIATE COUPLER C	
120	AVSS	0.5		Br	V26		V26		2A	VEHICLE ECU	13A	INTERMEDIATE COUPLER A	

Electric wiring, electronic control harness connections

No.	Wire type	Diame-ter		Wire color	Circuit sym-bol	Ter-minal	Circuit sym-bol	Ter-minal	Circuit mating end				Group
121	AVSS	0.5		Y	V27		V27		2A	VEHICLE ECU	13A	INTERMEDIATE COUPLER A	
122	AVSS	0.5		G	V28		V28		2A	VEHICLE ECU	13A	INTERMEDIATE COUPLER A	
123	AVSS	0.5		L	V29		V29	Au	2A	VEHICLE ECU	11A	ACCELERATOR SENSOR 2	
124	AVSS	0.5		R	V30		V30		2A	VEHICLE ECU	10A	ACCELERATOR SENSOR 3	
125	AVSS	0.5		Y	V31		V31	Au	2A	VEHICLE ECU	11A	ACCELERATOR SENSOR 2	
126	AVSS	0.5		Br	V32		V32		2A	VEHICLE ECU	10A	ACCELERATOR SENSOR 3	
127	AVSS	0.5		G	V33		V33		2A	VEHICLE ECU	14A	INTERMEDIATE COUPLER B	
128	AVSS	0.5		W	V34		V34		2A	VEHICLE ECU	16A	INTERMEDIATE COUPLER D	
129	AVSS	0.5		G	V35		V35		2A	VEHICLE ECU	13A	INTERMEDIATE COUPLER A	
130	AVSS	0.5		G			V35A				22A	WATER SEPARATOR	
131	AVSS	0.5		Br	V36		V36		2A	VEHICLE ECU	14A	INTERMEDIATE COUPLER B	
132	AVSS	0.5		G	V37		V37		2A	VEHICLE ECU	37A	MAIN RELAY	
133	AVSS	0.5		G			V37A				2A	VEHICLE ECU	
134	AVSS	0.5		G			V37B				38A	SUB RELAY	
135	AVSS	0.5		P	V40		V40		2A	VEHICLE ECU	23A	INTERMEDIATE COUPLER FOR ENGINE	TWST6
136	AVSS	0.5		P			V40B				9A	DCU INTERMEDIATE COUPLER	TWST7
137	AVSS	0.5		L	V42		V42		2A	VEHICLE ECU	14A	INTERMEDIATE COUPLER B	
138	AVSS	0.5		P	V43		V43		2A	VEHICLE ECU	10A	ACCELERATOR SENSOR 3	
139	AVSS	0.5		Br	V44		V44		2A	VEHICLE ECU	14A	INTERMEDIATE COUPLER B	
140	AVSS	0.5		L	V45		V45		2A	VEHICLE ECU	13A	INTERMEDIATE COUPLER A	
141	AVSS	0.5		L			V45A				20A	AIR CLEANER SENSOR	
142	AVSS	0.5		R	V46		V46		2A	VEHICLE ECU	13A	INTERMEDIATE COUPLER A	
143	AVSS	0.5		R			V46A				42A	RESISTANCE 2k ohm 1W	
144	AVSS	0.5		R			V46B				44A	DIODE	
145	AVSS	0.5		L	V49		V49		2A	VEHICLE ECU	13A	INTERMEDIATE COUPLER A	
146	AVSS	0.5		Br	V50		V50		2A	VEHICLE ECU	15A	INTERMEDIATE COUPLER C	
147	AVSS	0.5		L	V51		V51		2A	VEHICLE ECU	23A	INTERMEDIATE COUPLER FOR ENGINE	TWST6
148	AVSS	0.5		L			V51B				9A	DCU INTERMEDIATE COUPLER	TWST7
149	AVSS	0.5		O	V54		V54		2A	VEHICLE ECU	15A	INTERMEDIATE COUPLER C	
150	AVSS	0.5		R	V55		V55		2A	VEHICLE ECU	16A	INTERMEDIATE COUPLER D	
151	AVSS	0.5		Y	V56		V56		2A	VEHICLE ECU	15A	INTERMEDIATE COUPLER C	
152	AVSS	0.5		P	V59		V59		2A	VEHICLE ECU	16A	INTERMEDIATE COUPLER D	
153	AVSS	0.5		W	V60		V60		2A	VEHICLE ECU	15A	INTERMEDIATE COUPLER C	
154	AVSS	0.5		L	V62		V62		2A	VEHICLE ECU	30A	SA-D	TWST8
155	AVSS	0.5		L			V62A				31A	J1939	TWST21
156	AVSS	0.5		L			V62B				9A	DCU INTERMEDIATE COUPLER	TWST22
157	AVSS	0.5		Y	V63		V63		2A	VEHICLE ECU	30A	SA-D	TWST8
158	AVSS	0.5		Y			V63A				31A	J1939	TWST21
159	AVSS	0.5		Y			V63B				9A	DCU INTERMEDIATE COUPLER	TWST22
160	AVSS	0.5		R	V64		V64		2A	VEHICLE ECU	3A	JC1	
161	AVSS	0.5		R	V71		V71		2A	VEHICLE ECU	13A	INTERMEDIATE COUPLER A	
162	AVSS	0.5		B	V72		V72		2A	VEHICLE ECU	4A	JC2	

Electric wiring, electronic control harness connections

(1/2)

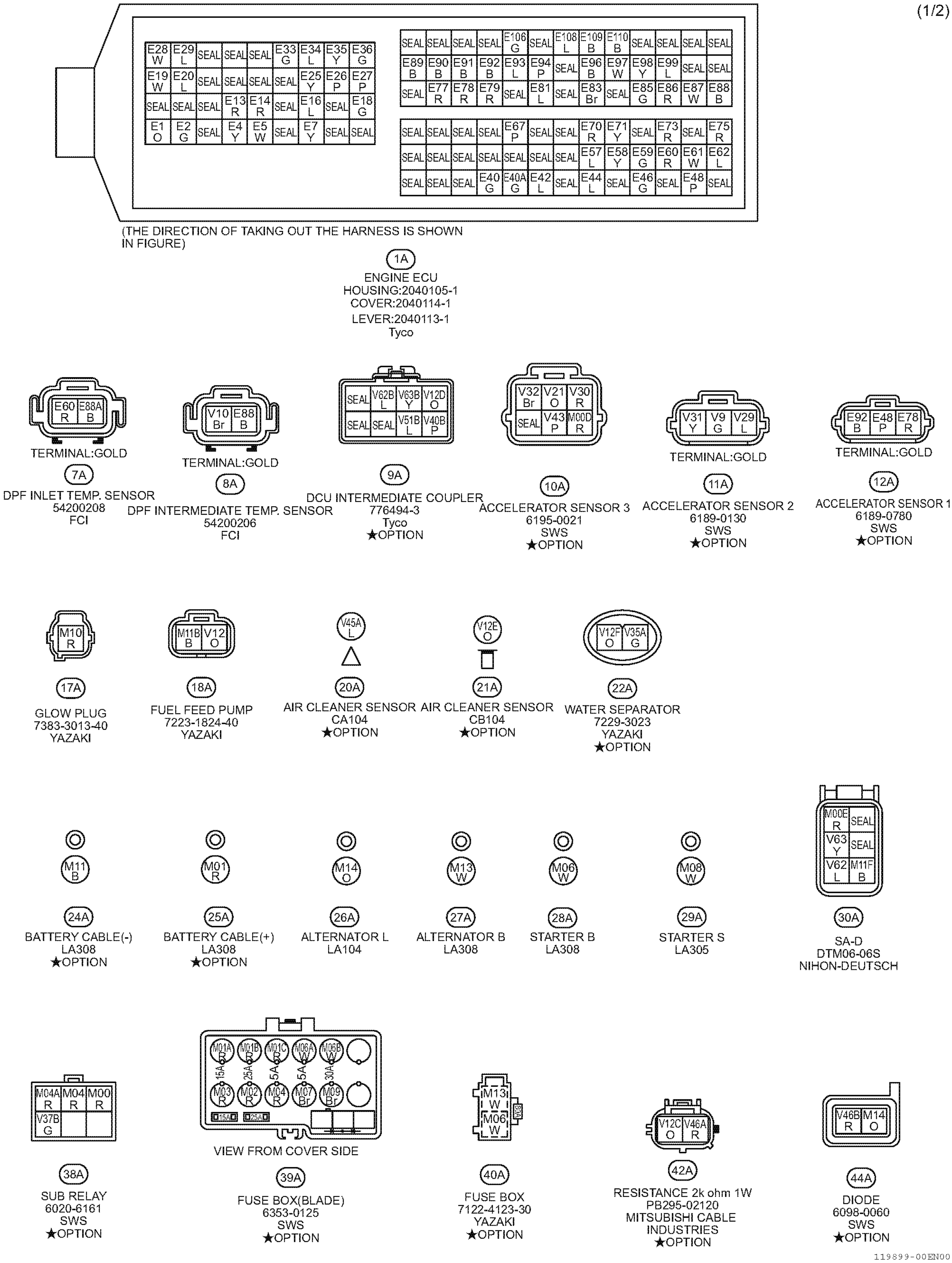


Fig. 00-76

Electric wiring, electronic control harness connections

(2/2)

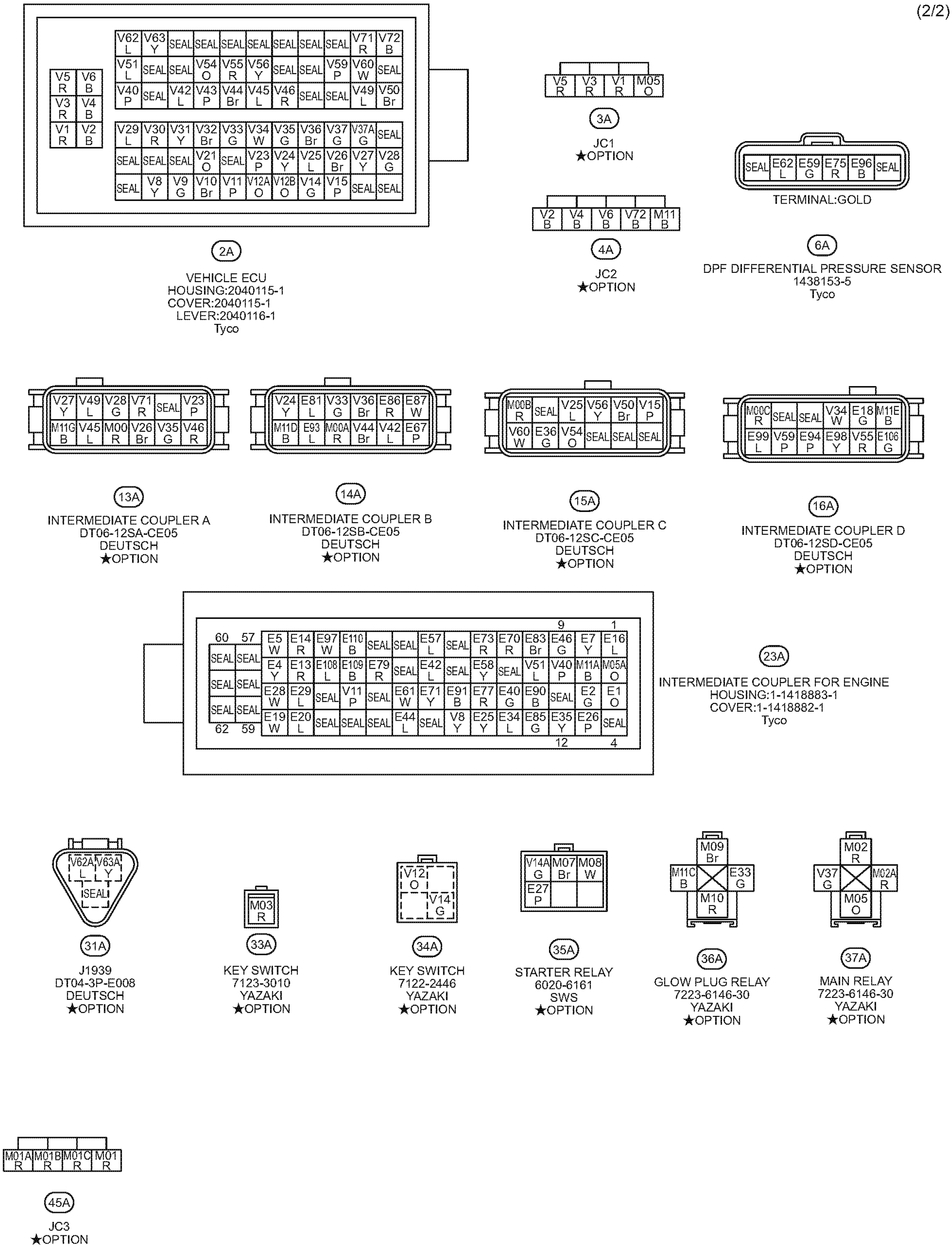


Fig. 00-77

3.2 Harness engine

1- EU Stage III A equivalent certified model

No.	Wire type	Diameter		Wire color	Circuit symbol	Terminal	Circuit symbol	Terminal	Circuit mating end				Group
1	AVSSH	0.75		O	M05A		M05A		1B	INTERMEDIATE COUPLER FOR ENGINE	7B	EGR VALVE	
2	AVSSH	0.75		B	M11A		M11A		1B	INTERMEDIATE COUPLER FOR ENGINE	7B	EGR VALVE	
3	AVSSH	0.5		O	E1		E1		1B	INTERMEDIATE COUPLER FOR ENGINE	13B	PRV	
4	AVSSH	0.5		G	E2		E2		1B	INTERMEDIATE COUPLER FOR ENGINE	13B	PRV	
5	AVSSH	0.75		Y	E4		E4		1B	INTERMEDIATE COUPLER FOR ENGINE	12B	INJECTOR	TWST10
6	AVSSH	0.75		W	E5		E5		1B	INTERMEDIATE COUPLER FOR ENGINE	12B	INJECTOR	TWST11
8	AVSSH	0.75		R	E13		E13		1B	INTERMEDIATE COUPLER FOR ENGINE	12B	INJECTOR	TWST10
9	AVSSH	0.75		R	E14		E14		1B	INTERMEDIATE COUPLER FOR ENGINE	12B	INJECTOR	TWST11
11	AVSSH	0.75		W	E19		E19		1B	INTERMEDIATE COUPLER FOR ENGINE	12B	INJECTOR	TWST12
12	AVSSH	0.75		L	E20		E20		1B	INTERMEDIATE COUPLER FOR ENGINE	12B	INJECTOR	TWST12
13	AVSSX	0.5		Y	E25		E25		1B	INTERMEDIATE COUPLER FOR ENGINE	21B	EXHAUST THROTTLE	
14	AVSSH	0.5		P	E26		E26		1B	INTERMEDIATE COUPLER FOR ENGINE	20B	INTERMEDIATE COUPLER	
15	AVSSH	0.75		W	E28		E28		1B	INTERMEDIATE COUPLER FOR ENGINE	12B	INJECTOR	TWST13
16	AVSSH	0.75		L	E29		E29		1B	INTERMEDIATE COUPLER FOR ENGINE	12B	INJECTOR	TWST13
17	AVSSX	0.5		L	E34		E34		1B	INTERMEDIATE COUPLER FOR ENGINE	21B	EXHAUST THROTTLE	
18	AVSSH	0.5		Y	E35		E35		1B	INTERMEDIATE COUPLER FOR ENGINE	20B	INTERMEDIATE COUPLER	
19	AVSSH	0.5		G	E40		E40		1B	INTERMEDIATE COUPLER FOR ENGINE	20B	INTERMEDIATE COUPLER	
20	AVSSH	0.5		L	E42		E42		1B	INTERMEDIATE COUPLER FOR ENGINE	20B	INTERMEDIATE COUPLER	
21	AVSSH	0.5		L	E44		E44	Au	1B	INTERMEDIATE COUPLER FOR ENGINE	4B	COOLANT TEMP. SENSOR	
23	AVSSH	0.5		L	E57		E57	Au	1B	INTERMEDIATE COUPLER FOR ENGINE	2B	INT MANI TEMP. SENSOR	
24	AVSSX	0.5		Y	E58		E58	Au	1B	INTERMEDIATE COUPLER FOR ENGINE	10B	EXH MANI TEMP. SENSOR	
25	AVSSH	0.5		W	E61		E61	Au	1B	INTERMEDIATE COUPLER FOR ENGINE	17B	INTAKE AIR PRESSURE SENSOR	
26	AVSSX	0.5		R	E70		E70	Au	1B	INTERMEDIATE COUPLER FOR ENGINE	21B	EXHAUST THROTTLE	
28	AVSSX	0.5		Y	E71		E71	Au	1B	INTERMEDIATE COUPLER FOR ENGINE	5B	EXHAUST GAS PRESSURE SENSOR	
29	AVSSX	0.5		R	E73		E73	Au	1B	INTERMEDIATE COUPLER FOR ENGINE	6B	EGR TEMP. SENSOR	
30	AVSSX	0.5		R	E77		E77	Au	1B	INTERMEDIATE COUPLER FOR ENGINE	5B	EXHAUST GAS PRESSURE SENSOR	
31	AVSSH	0.5		R			E77A	Au		E77	17B	INTAKE AIR PRESSURE SENSOR	
32	AVSSH	0.5		R			E77B			E77	20B	INTERMEDIATE COUPLER	
33	AVSSX	0.5		R	E79		E79		1B	INTERMEDIATE COUPLER FOR ENGINE	9B	CAM SPEED SENSOR	
34	AVSSH	0.5		R			E79A			E79	19B	OIL PRESSURE SENSOR	
35	AVSSX	0.5		Br	E83		E83	Au	1B	INTERMEDIATE COUPLER FOR ENGINE	6B	EGR TEMP. SENSOR	
36	AVSSH	0.5		Br			E83A	Au		E83	2B	INT MANI TEMP. SENSOR	
37	AVSSX	0.5		Br			E83B	Au		E83	21B	EXHAUST THROTTLE	
39	AVSSX	0.5		G	E85		E85	Au	1B	INTERMEDIATE COUPLER FOR ENGINE	21B	EXHAUST THROTTLE	
40	AVSSH	0.5		B	E90		E90		1B	INTERMEDIATE COUPLER FOR ENGINE	20B	INTERMEDIATE COUPLER	
41	AVSSH	0.5		B			E90A			E90	20B	INTERMEDIATE COUPLER	
42	AVSSX	0.5		B	E91		E91	Au	1B	INTERMEDIATE COUPLER FOR ENGINE	5B	EXHAUST GAS PRESSURE SENSOR	
43	AVSSH	0.5		B			E91A	Au		E91	17B	INTAKE AIR PRESSURE SENSOR	
44	AVSSX	0.5		B			E91B	Au		E91	10B	EXH MANI TEMP. SENSOR	
45	AVSSX	0.5		W	E97		E97		1B	INTERMEDIATE COUPLER FOR ENGINE	8B	CRANK SPEED SENSOR	TWST14
46	AVSSX	0.5		L	E108		E108		1B	INTERMEDIATE COUPLER FOR ENGINE	9B	CAM SPEED SENSOR	
47	AVSSX	0.5		B	E109		E109		1B	INTERMEDIATE COUPLER FOR ENGINE	9B	CAM SPEED SENSOR	
48	AVSSH	0.5		B			E109A	Au		E109	4B	COOLANT TEMP. SENSOR	
49	AVSSH	0.5		B			E109B			E109	19B	OIL PRESSURE SENSOR	
50	AVSSX	0.5		B	E110		E110		1B	INTERMEDIATE COUPLER FOR ENGINE	8B	CRANK SPEED SENSOR	TWST14
51	AVSSH	0.5		Y	V8		V8		1B	INTERMEDIATE COUPLER FOR ENGINE	19B	OIL PRESSURE SENSOR	
52	AVSSH	0.5		P	V40		V40		1B	INTERMEDIATE COUPLER FOR ENGINE	7B	EGR VALVE	TWST15
53	AVSSH	0.5		P			V40A			V40	11B	RESISTOR MOLD (120 ohm	
54	AVSSH	0.5		L	V51		V51		1B	INTERMEDIATE COUPLER FOR ENGINE	7B	EGR VALVE	TWST15
55	AVSSH	0.5		L			V51A			V51	11B	RESISTOR MOLD (120 ohm	

Electric wiring, electronic control harness connections

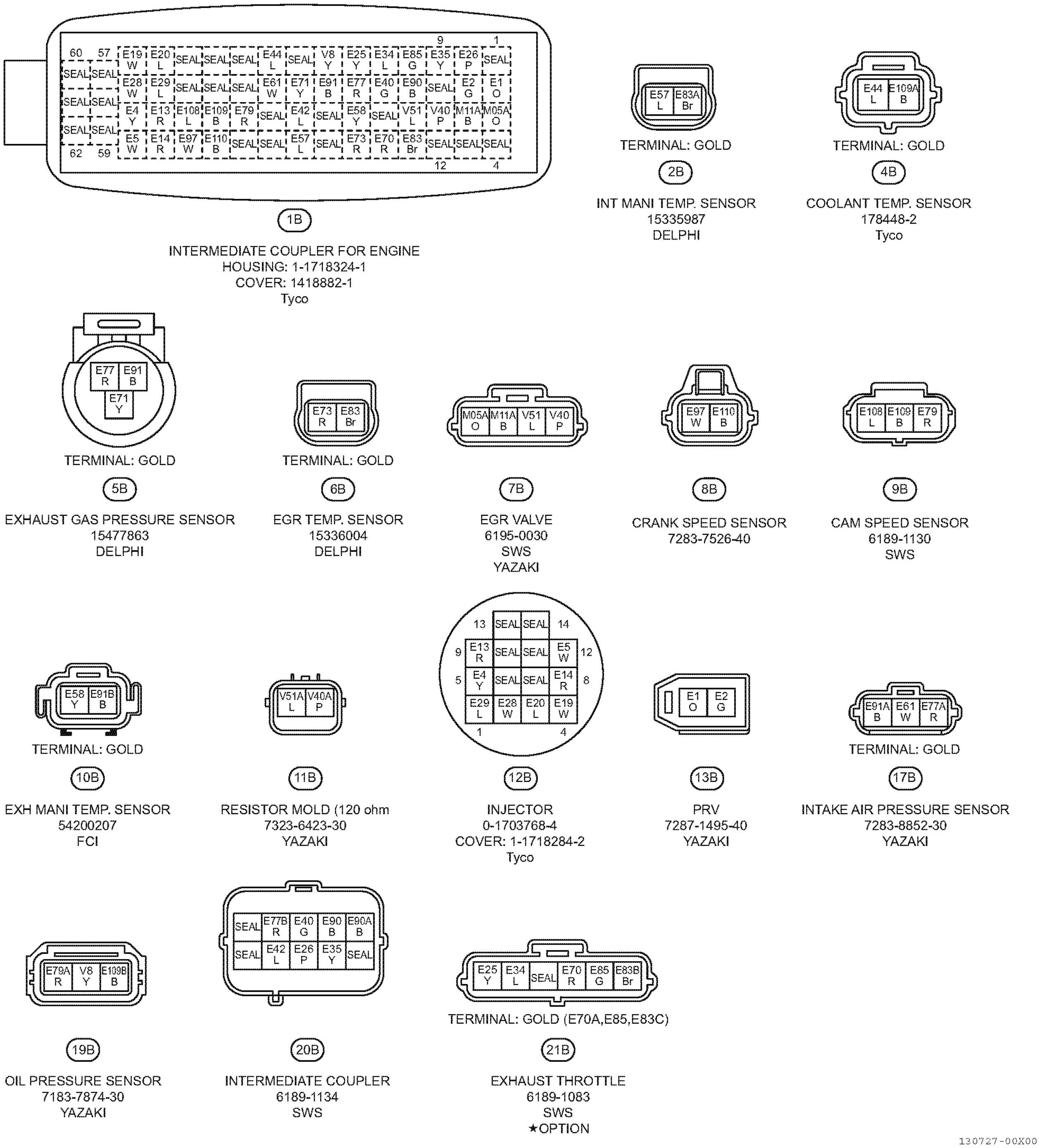


Fig. 00-78

2- EU Stage V certified models

No.	Wire type	Diame- ter	Wire color	Circuit sym- bol	Ter- minal	Circuit sym- bol	Ter- minal	Circuit mating end				Group
1	AVSSH	0.75	O	M05A		M05A		1B	INTERMEDIATE COUPLER FOR ENGINE	7B	EGR VALVE	
2	AVSSH	0.75	B	M11A		M11A		1B	INTERMEDIATE COUPLER FOR ENGINE	7B	EGR VALVE	
3	AVSSH	0.5	O	E1		E1		1B	INTERMEDIATE COUPLER FOR ENGINE	13B	PRV	
4	AVSSH	0.5	G	E2		E2		1B	INTERMEDIATE COUPLER FOR ENGINE	13B	PRV	
5	AVSSH	0.75	Y	E4		E4		1B	INTERMEDIATE COUPLER FOR ENGINE	12B	INJECTOR	TWST9
6	AVSSH	0.75	W	E5		E5		1B	INTERMEDIATE COUPLER FOR ENGINE	12B	INJECTOR	TWST10
7	AVSSH	0.5	Y	E7		E7		1B	INTERMEDIATE COUPLER FOR ENGINE	3B	INTAKE THROTTLE	
8	AVSSH	0.75	R	E13		E13		1B	INTERMEDIATE COUPLER FOR ENGINE	12B	INJECTOR	TWST9
9	AVSSH	0.75	R	E14		E14		1B	INTERMEDIATE COUPLER FOR ENGINE	12B	INJECTOR	TWST10
10	AVSSH	0.5	L	E16		E16		1B	INTERMEDIATE COUPLER FOR ENGINE	3B	INTAKE THROTTLE	
11	AVSSH	0.75	W	E19		E19		1B	INTERMEDIATE COUPLER FOR ENGINE	12B	INJECTOR	TWST11
12	AVSSH	0.75	L	E20		E20		1B	INTERMEDIATE COUPLER FOR ENGINE	12B	INJECTOR	TWST11
13	AVSSX	0.5	Y	E25		E25		1B	INTERMEDIATE COUPLER FOR ENGINE	21B	EXHAUST THROTTLE	
14	AVSSH	0.5	P	E26		E26		1B	INTERMEDIATE COUPLER FOR ENGINE	20B	INTERMEDIATE COUPLER	
15	AVSSH	0.75	W	E28		E28		1B	INTERMEDIATE COUPLER FOR ENGINE	12B	INJECTOR	TWST12
16	AVSSH	0.75	L	E29		E29		1B	INTERMEDIATE COUPLER FOR ENGINE	12B	INJECTOR	TWST12
17	AVSSX	0.5	L	E34		E34		1B	INTERMEDIATE COUPLER FOR ENGINE	21B	EXHAUST THROTTLE	
18	AVSSH	0.5	Y	E35		E35		1B	INTERMEDIATE COUPLER FOR ENGINE	20B	INTERMEDIATE COUPLER	
19	AVSSH	0.5	G	E40		E40		1B	INTERMEDIATE COUPLER FOR ENGINE	20B	INTERMEDIATE COUPLER	
20	AVSSH	0.5	L	E42		E42		1B	INTERMEDIATE COUPLER FOR ENGINE	20B	INTERMEDIATE COUPLER	
21	AVSSH	0.5	L	E44		E44	Au	1B	INTERMEDIATE COUPLER FOR ENGINE	4B	COOLANT TEMP. SENSOR	
22	AVSSH	0.5	G	E46		E46	Au	1B	INTERMEDIATE COUPLER FOR ENGINE	3B	INTAKE THROTTLE	
23	AVSSH	0.5	L	E57		E57	Au	1B	INTERMEDIATE COUPLER FOR ENGINE	2B	INT MANI TEMP. SENSOR	
24	AVSSX	0.5	Y	E58		E58	Au	1B	INTERMEDIATE COUPLER FOR ENGINE	10B	EXH MANI TEMP. SENSOR	
25	AVSSH	0.5	W	E61		E61	Au	1B	INTERMEDIATE COUPLER FOR ENGINE	17B	INTAKE GAS PRESSURE SENSOR	
26	AVSSH	0.5	R	E70		E70	Au	1B	INTERMEDIATE COUPLER FOR ENGINE	3B	INTAKE THROTTLE	
27	AVSSX	0.5	R			E70A	Au			21B	EXHAUST THROTTLE	
28	AVSSX	0.5	Y	E71		E71	Au	1B	INTERMEDIATE COUPLER FOR ENGINE	5B	EXHAUST GAS PRESSURE SEN- SOR	
29	AVSSX	0.5	R	E73		E73	Au	1B	INTERMEDIATE COUPLER FOR ENGINE	6B	EGR TEMP. SENSOR	
30	AVSSX	0.5	R	E77		E77	Au	1B	INTERMEDIATE COUPLER FOR ENGINE	5B	EXHAUST GAS PRESSURE SEN- SOR	
31	AVSSH	0.5	R			E77A	Au			17B	INTAKE GAS PRESSURE SENSOR	
32	AVSSH	0.5	R			E77B				20B	INTERMEDIATE COUPLER	
33	AVSSX	0.5	R	E79		E79		1B	INTERMEDIATE COUPLER FOR ENGINE	9B	CAM SPEED SENSOR	
34	AVSSH	0.5	R			E79A				19B	OIL PRESSURE SENSOR	
35	AVSSH	0.5	Br	E83		E83	Au	1B	INTERMEDIATE COUPLER FOR ENGINE	3B	INTAKE THROTTLE	
36	AVSSX	0.5	Br			E83A	Au			6B	EGR TEMP. SENSOR	
37	AVSSH	0.5	Br			E83B	Au			2B	INT MANI TEMP. SENSOR	
38	AVSSX	0.5	Br			E83C	Au			21B	EXHAUST THROTTLE	
39	AVSSX	0.5	G	E85		E85	Au	1B	INTERMEDIATE COUPLER FOR ENGINE	21B	EXHAUST THROTTLE	
40	AVSSX	0.5	B	E90		E90		1B	INTERMEDIATE COUPLER FOR ENGINE	20B	INTERMEDIATE COUPLER	
41	AVSSH	0.5	B			E90A				20B	INTERMEDIATE COUPLER	
42	AVSSX	0.5	B			E90B				18B	AMBIENT TEMP.SENSOR	
43	AVSSX	0.5	B	E91		E91	Au	1B	INTERMEDIATE COUPLER FOR ENGINE	5B	EXHAUST GAS PRESSURE SEN- SOR	
44	AVSSH	0.5	B			E91A	Au			17B	INTAKE GAS PRESSURE SENSOR	
45	AVSSX	0.5	B			E91B	Au			10B	EXH MANI TEMP. SENSOR	
46	AVSSX	0.5	W	E97		E97		1B	INTERMEDIATE COUPLER FOR ENGINE	8B	CRANK SPEED SENSOR	TWST13
47	AVSSX	0.5	L	E108		E108		1B	INTERMEDIATE COUPLER FOR ENGINE	9B	CAM SPEED SENSOR	
48	AVSSX	0.5	B	E109		E109		1B	INTERMEDIATE COUPLER FOR ENGINE	9B	CAM SPEED SENSOR	
49	AVSSH	0.5	B			E109A	Au			4B	COOLANT TEMP. SENSOR	
50	AVSSH	0.5	B			E109B				19B	OIL PRESSURE SENSOR	
51	AVSSX	0.5	B	E110		E110		1B	INTERMEDIATE COUPLER FOR ENGINE	8B	CRANK SPEED SENSOR	TWST13
52	AVSSH	0.5	Y	V8		V8		1B	INTERMEDIATE COUPLER FOR ENGINE	19B	OIL PRESSURE SENSOR	
53	AVSSX	0.5	P	V11		V11		1B	INTERMEDIATE COUPLER FOR ENGINE	18B	AMBIENT TEMP.SENSOR	
54	AVSSH	0.5	P	V40		V40		1B	INTERMEDIATE COUPLER FOR ENGINE	7B	EGR VALVE	TWST14
55	AVSSH	0.5	P			V40A				11B	RESISTOR MOLD (120 ohm	
56	AVSSH	0.5	L	V51		V51		1B	INTERMEDIATE COUPLER FOR ENGINE	7B	EGR VALVE	TWST14
57	AVSSH	0.5	L			V51A				11B	RESISTOR MOLD (120 ohm	

Electric wiring, electronic control harness connections

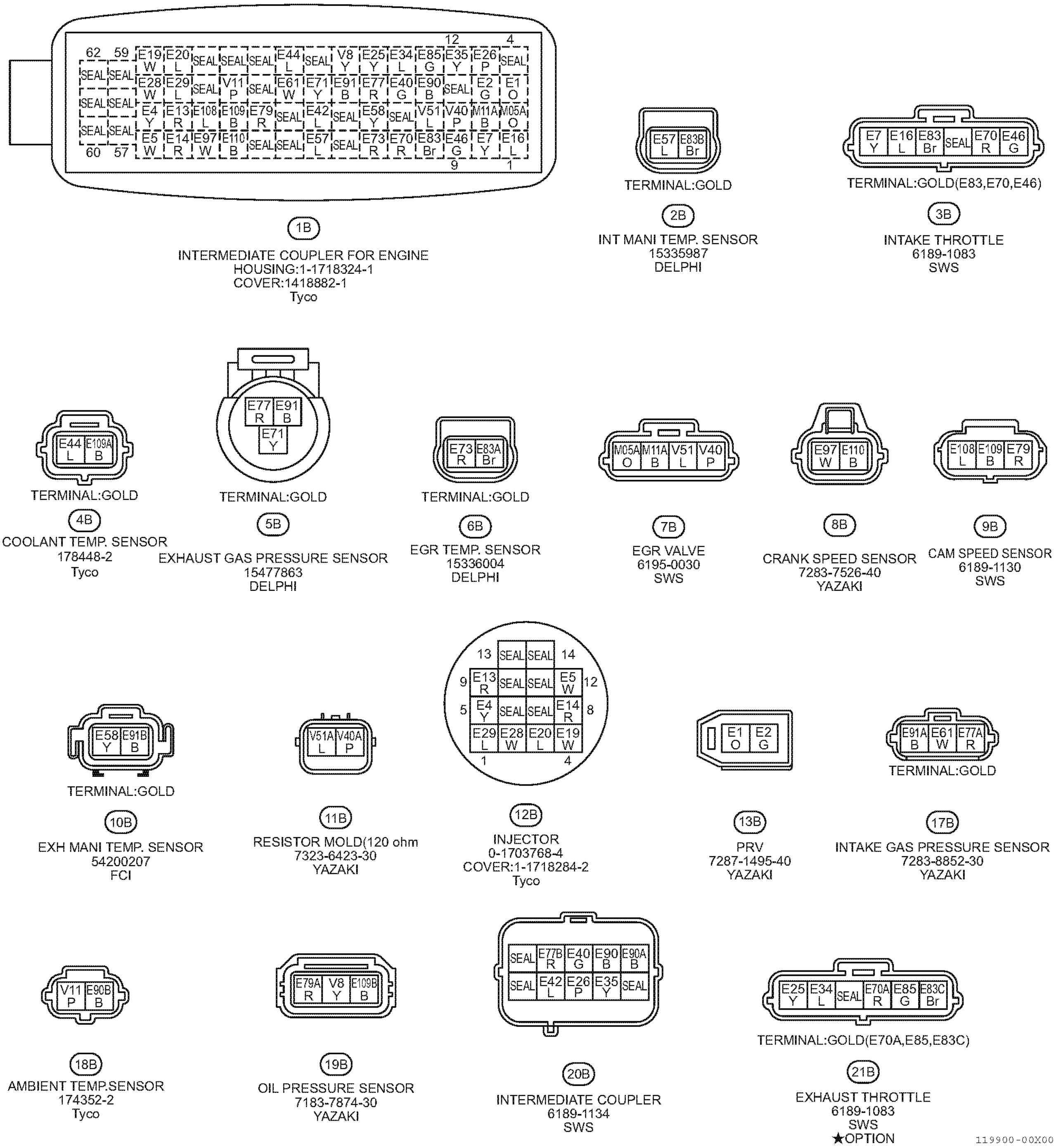


Fig. 00-79

3.3 Harness engine pump
(Common to certified models: EU Stage III A equivalent and EU stage V)

No.	Wire type	Diame-ter		Wire color	Circuit sym-bol	Ter-minal	Circuit sym-bol	Ter-minal	Circuit mating end				Group
1	AVSSH	0.5		P	E26		E26		1C	INTERMEDIATE COUPLER FOR ENGINE	3C	SUPPLY PUMP	
2	AVSSH	0.5		Y	E35		E35		1C	INTERMEDIATE COUPLER FOR ENGINE	3C	SUPPLY PUMP	
3	AVSSH	0.5		G	E40		E40		1C	INTERMEDIATE COUPLER FOR ENGINE	4C	RAIL PRESSURE SENSOR	
4	AVSSH	0.5		L	E42		E42	Au	1C	INTERMEDIATE COUPLER FOR ENGINE	2C	FUEL TEMP. SENSOR	
5	AVSSH	0.5		R	E77B		E77B		1C	INTERMEDIATE COUPLER FOR ENGINE	4C	RAIL PRESSURE SENSOR	
6	AVSSH	0.5		B	E90		E90		1C	INTERMEDIATE COUPLER FOR ENGINE	4C	RAIL PRESSURE SENSOR	
7	AVSSH	0.5		B	E90A		E90A	Au	1C	INTERMEDIATE COUPLER FOR ENGINE	2C	FUEL TEMP. SENSOR	

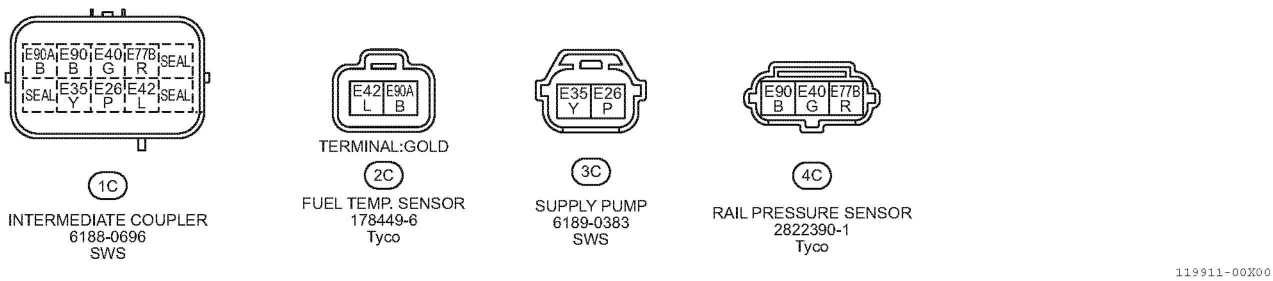


Fig. 00-80

3.4 Harness SCR (applicable only to EU Stage V certified models)

No.	Wire type	Diameter		Wire color	Circuit symbol	Terminal	Circuit symbol	Terminal	Circuit mating end				Group
1	AVS	3		W	M50		M50		114	BATTERY CABLE (+)	109	FUSE BOX	
2	AVSS	1.25		W			M50A				109	FUSE BOX	
3	AVSS	0.75		W			M50B				109	FUSE BOX	
4	AVSS	1.25		B	M51		M51		109	FUSE BOX	110	HEATER RELAY	
5	AVSS	1.25		W	M52		M52		110	HEATER RELAY	118	JC7	
6	AVSS	0.75		O	M53		M53		118	JC7	119	HOSE HEATER INTERMEDIATE COUPLER	
7	AVSS	0.75		O	M54		M54		118	JC7	119	HOSE HEATER INTERMEDIATE COUPLER	
8	AVSS	0.75		O	M55		M55		118	JC7	119	HOSE HEATER INTERMEDIATE COUPLER	
9	AVSS	0.75		B	M56		M56		109	FUSE BOX	111	NOx SENSOR RELAY	
10	AVSS	0.5		O	M57	Ag	M57		121	SCR INLET NOx SENSOR	116	JC8	
11	AVSS	0.5		O	M58	Ag	M58		122	SCR OUTLET NOx SENSOR	116	JC8	
12	AVS	5		B	M59		M59		115	BODY EARTH	108	JC5	
13	AVSS	0.5		B			M59A	Ag			121	SCR INLET NOx SENSOR	
14	AVSS	0.5		B			M59B	Ag			122	SCR OUTLET NOx SENSOR	
15	AVSS	0.5		B			M59C				111	NOx SENSOR RELAY	
16	AVSS	0.5		B			M59D				117	DEF TANK INTERMEDIATE COUPLER	
17	AVSS	0.75		W	M60		M60		116	JC8	111	NOx SENSOR RELAY	
18	AVSS	2		R	M61		M61		109	FUSE BOX	107	JC6	
19	AVSS	0.75		Y	101	Ag	101		101	DCU1	119	HOSE HEATER INTERMEDIATE COUPLER	
20	AVSS	0.5		Gr	102	Ag	102		101	DCU1	119	HOSE HEATER INTERMEDIATE COUPLER	
21	AVSS	1.25		L	103	Ag	103	Ag	101	DCU1	120	SUPPY MODULE	
22	AVSS	1.25		P	105	Ag	105	Ag	101	DCU1	120	SUPPY MODULE	
23	AVSS	1.25		R	108	Ag	108		101	DCU1	117	DEF TANK INTERMEDIATE COUPLER	
24	AVSS	0.75		G	112	Ag	112	Ag	101	DCU1	104	DOSING MODULE	TWST15
25	AVSS	0.75		G	117	Ag	117	Ag	101	DCU1	120	SUPPY MODULE	
26	AVSS	0.75		B	118	Ag	118	Ag	101	DCU1	120	SUPPY MODULE	
27	AVSS	0.75		P	119	Ag	119	Ag	101	DCU1	120	SUPPY MODULE	
28	AVSS	0.75		Y	124	Ag	124	Ag	101	DCU1	120	SUPPY MODULE	
29	AVSS	1.25		Br	126	Ag	126	Ag	101	DCU1	120	SUPPY MODULE	
30	AVSS	0.75		O	132	Ag	132	Ag	101	DCU1	104	DOSING MODULE	TWST15
31	AVSS	0.5		Y	133	Ag	133	Au	101	DCU1	105	SCR CATALYST TEMP SENSOR	
32	AVSS	0.5		Br	134	Ag	134	Au	101	DCU1	105	SCR CATALYST TEMP SENSOR	
33	AVSS	1.25		R	146	Ag	146	Ag	101	DCU1	120	SUPPY MODULE	
34	AVSS	0.75		P	148	Ag	148		101	DCU1	119	HOSE HEATER INTERMEDIATE COUPLER	
35	AVSS	1.25		W	165	Ag	165	Ag	101	DCU1	120	SUPPY MODULE	
36	AVSS	1.25		Y	185	Ag	185		101	DCU1	117	DEF TANK INTERMEDIATE COUPLER	
37	AVSS	1.25		O	186	Ag	186	Ag	101	DCU1	120	SUPPY MODULE	
38	AVSS	2		B	201	Ag	201		102	DCU2	108	JC5	
39	AVSS	2		B	202	Ag	202		102	DCU2	108	JC5	
40	AVSS	2		B	203	Ag	203		102	DCU2	108	JC5	
41	AVSS	2		B	204	Ag	204		102	DCU2	108	JC5	
42	AVSS	2		B	205	Ag	205		102	DCU2	108	JC5	
43	AVSS	1.25		R	206	Ag	206		102	DCU2	107	JC6	
44	AVSS	1.25		R	207	Ag	207		102	DCU2	107	JC6	
45	AVSS	1.25		R	208	Ag	208		102	DCU2	107	JC6	
46	AVSS	1.25		R	209	Ag	209		102	DCU2	107	JC6	
47	AVSS	0.5		P	211	Ag	211		102	DCU2	106	ECU INTERMEDIATE COUPLER	TWST16
48	AVSS	0.5		P			211A	Ag			121	SCR INLET NOx SENSOR	TWST17
49	AVSS	0.5		P			211B	Ag			122	SCR OUTLET NOx SENSOR	TWST18
50	AVSS	0.5		L	212	Ag	212		102	DCU2	106	ECU INTERMEDIATE COUPLER	TWST16
51	AVSS	0.5		L			212A	Ag			121	SCR INLET NOx SENSOR	TWST17
52	AVSS	0.5		L			212B	Ag			122	SCR OUTLET NOx SENSOR	TWST18
53	AVSS	0.5		Y	214	Ag	214		102	DCU2	106	ECU INTERMEDIATE COUPLER	TWST19
54	AVSS	0.5		Y			214A				117	DEF TANK INTERMEDIATE COUPLER	TWST20
55	AVSS	0.5		L	215	Ag	215		102	DCU2	106	ECU INTERMEDIATE COUPLER	TWST19
56	AVSS	0.5		L			215A				117	DEF TANK INTERMEDIATE COUPLER	TWST20
57	AVSS	0.5		P	230	Ag	230		102	DCU2	110	DEF HOSEHEATER RELAY	
58	AVSS	0.5		Br	241	Ag	241		102	DCU2	110	DEF HOSEHEATER RELAY	
59	AVSS	0.5		O	252	Ag	252		102	DCU2	106	ECU INTERMEDIATE COUPLER	
60	AVSS	0.5		O			252A				111	NOx SENSOR RELAY	
61	AVSS	0.5		O			252B				117	DEF TANK INTERMEDIATE COUPLER	

Electric wiring, electronic control harness connections

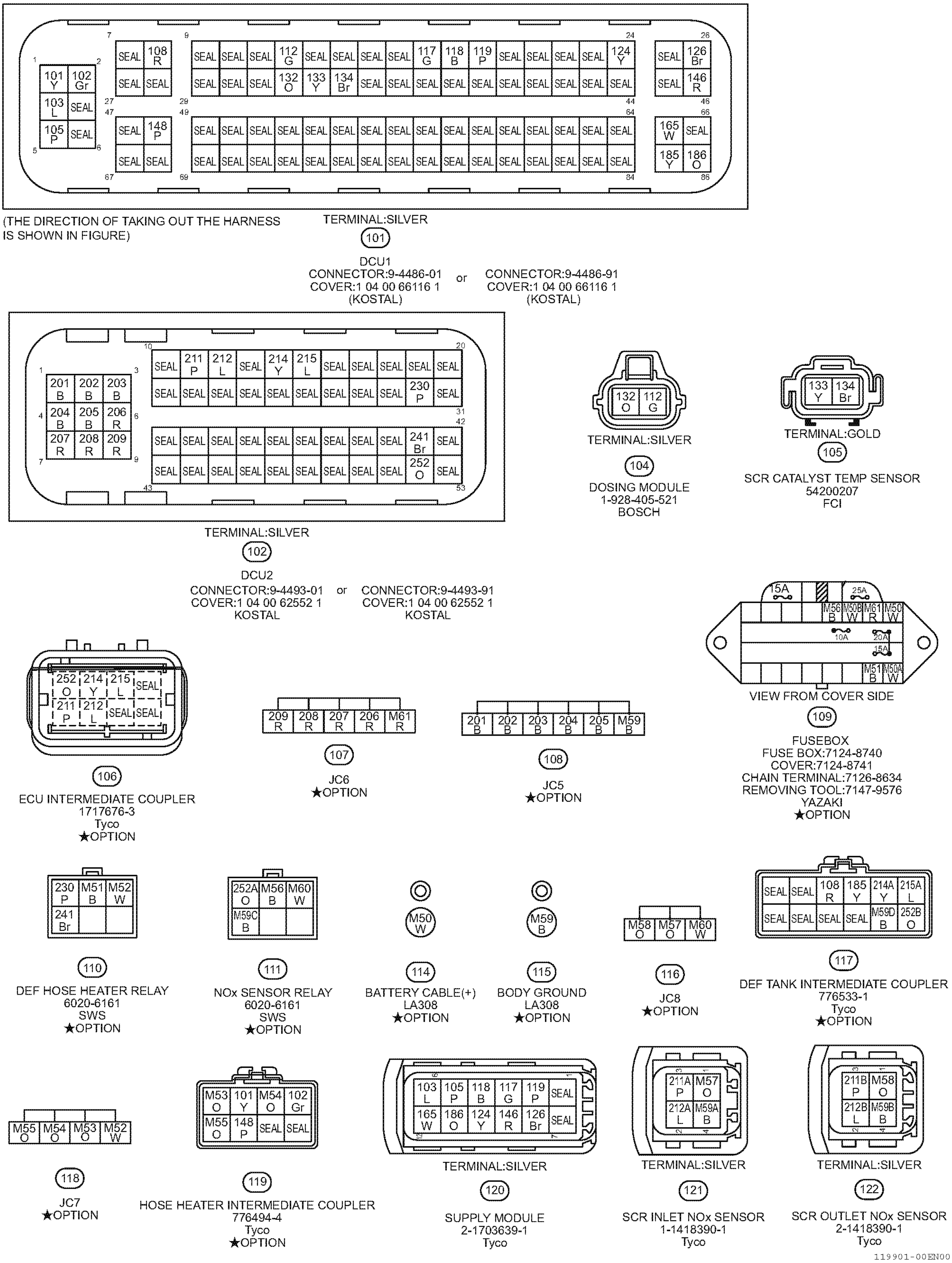


Fig. 00-81

1. Main Engine Components (Cylinder Block) and Components of Main Moving Parts (Around Crankshaft and Camshaft)

The main engine components and components of main moving parts (around crankshaft and camshaft) are shown below.

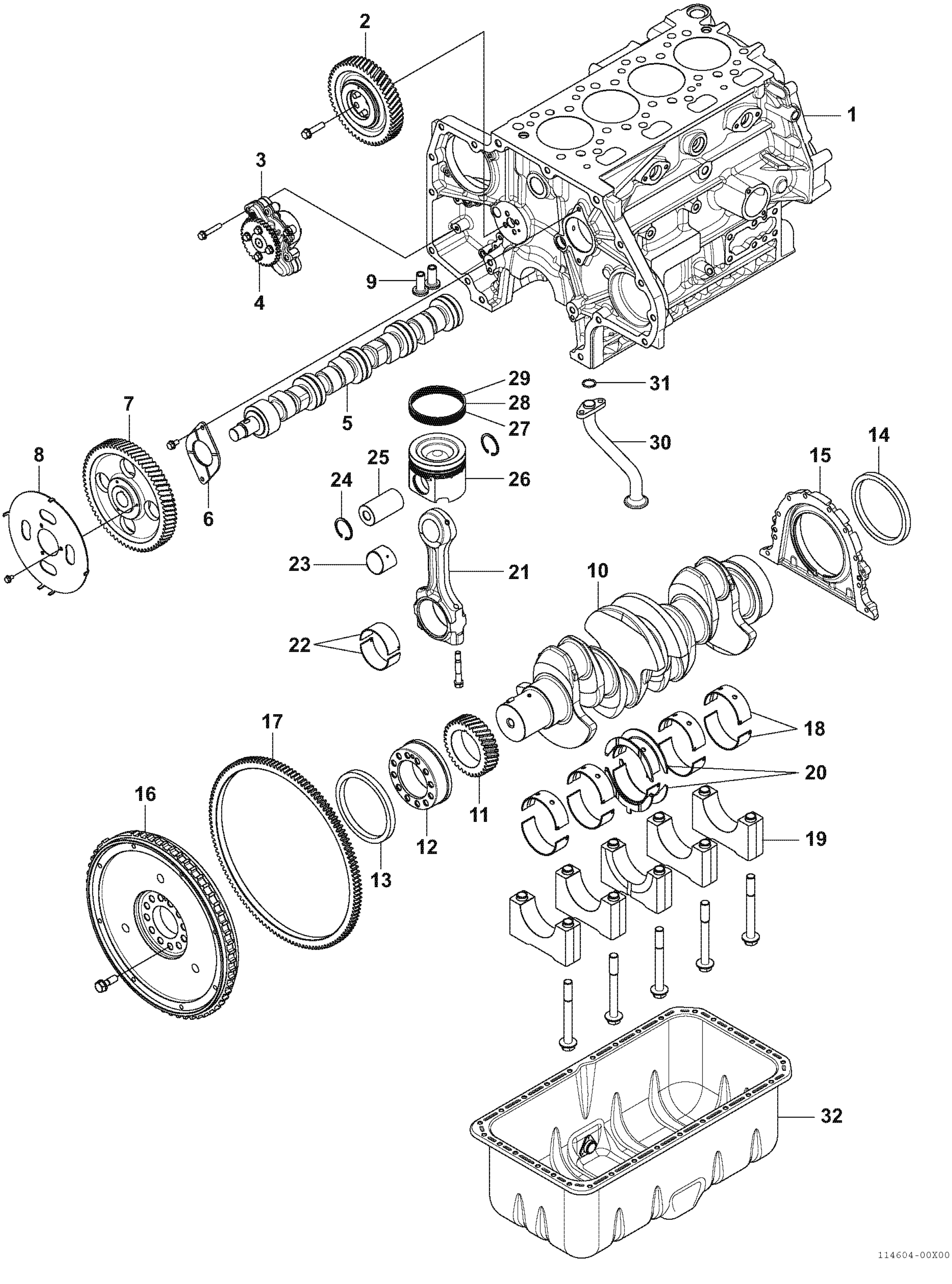


Fig. 01-1

Part name

1 -	Cylinder block	17 -	Flywheel ring gear
2 -	Idle gear	18 -	Main bearing
3 -	Lubricating oil pump	19 -	Main bearing cap
4 -	Lubricating oil pump gear	20 -	Thrust bearing
5 -	Camshaft	21 -	Connecting rod
6 -	Camshaft end plate	22 -	Connecting rod bearing insert
7 -	Camshaft gear	23 -	Piston pin bearing
8 -	Pulser gear	24 -	Circlip
9 -	Tappet	25 -	Piston pin
10 -	Crankshaft	26 -	Piston
11 -	Crank gear	27 -	Oil ring
12 -	Crankshaft flange	28 -	Second compression ring
13 -	Flywheel-side crankshaft oil seal	29 -	Top compression ring
14 -	Fan-side oil seal	30 -	Lubricating oil suction pipe
15 -	Fan-side oil seal case	31 -	O-ring for lubricating oil suction pipe
16 -	Flywheel	32 -	Oil pan

2. Components of Main Engine Moving Parts (Around Cylinder Head)

The components of main engine moving parts (around cylinder head) are shown below.

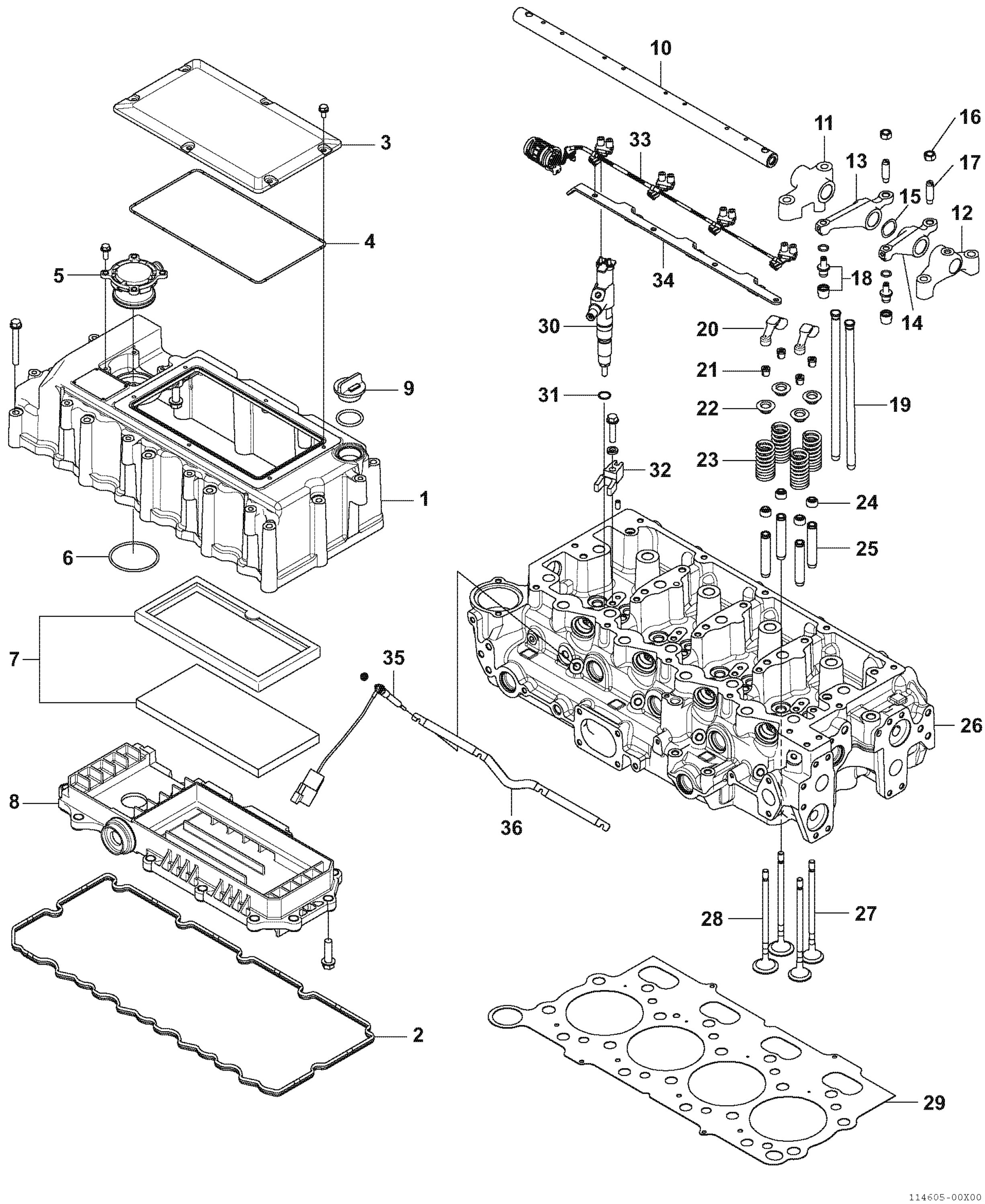


Fig. 01-2

Part name

1 -	Bonnet	19 -	Push rod
2 -	Bonnet gasket	20 -	Valve bridge
3 -	Breather cover	21 -	Valve cotter
4 -	Breather cover gasket	22 -	Spring retainer
5 -	Breather valve	23 -	Valve spring
6 -	O-ring	24 -	Valve stem seal
7 -	Breather element	25 -	Valve guide
8 -	Blowby gas filter	26 -	Cylinder head
9 -	Fuel filter cover	27 -	Exhaust valve
10 -	Rocker arm shaft	28 -	Intake valve
11 -	Rocker arm shaft support A	29 -	Cylinder head gasket
12 -	Rocker arm shaft support B	30 -	Injector
13 -	Rocker arm (intake valve)	31 -	Injector gasket
14 -	Rocker arm (exhaust valve)	32 -	Injector retainer
15 -	Wave washer	33 -	Injector wire harness
16 -	Valve adjustment screw lock nut	34 -	Injector bracket
17 -	Valve adjustment screw	35 -	Glow plug
18 -	Elephant foot	36 -	Glow plug connector

1. Disassembling the Engine

Follow the procedure below when completely disassembling the engine from the driven machine.

- Prepare a clean, flat working surface on a workbench large enough to accommodate the engine components.
- Discard all used gaskets, O-rings and seals. Use new gaskets, O-rings and seals on reassembly of engine.
- An engine that includes a common rail requires a clean work environment. Be careful to keep the environment clean at all times.

NOTICE

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

---

1. Before removing the engine from the driven machine, make sure to disconnect the following parts from the engine.
   - Battery cable
   - Throttle cable (when necessary)
   - Electrical equipment wires from the driven machine
   - Fuel pipe between the fuel filter and tank (close the water separator valve before disconnection.)
   - Intake and exhaust system piping (Duct connecting to air cleaner, exhaust gas pipe to ATD unit, etc.)
   - Engine transmission system
2. Drain the engine coolant from the radiator and cylinder block.
   → See 4000-02-04-01 “Draining Engine Coolant”.
3. Disconnect the coolant system piping from the engine. (Piping connected to the radiator and driven machine body)
4. Remove the engine from the machine, and attach engine feet to the engine. The dissembling procedure from here on is explained in a state where the engine feet are attached. When setting the engine to the engine repairing stand, be sure that the stand is strong enough.
5. Clean the engine by washing with solvent, air or steam cleaning.
   Note: Carefully operate so as to prevent any foreign matter or fluids from entering the engine or any fuel system or electrical components remaining on the engine.
6. Loosen the fan belt and remove the cooling fan and belt.
   → See 4000-02-01-01 “Removing the Cooling System”
7. Remove the discharge/return fuel hoses connected to the fuel filter, and remove the fuel filter together with the fuel filter bracket.
8. Remove the harness cover and wire harnesses.
   → See 7200-02-01-01 “Removing the Wire Harness Assembly”
9. Drain the engine lubricating oil into a suitable container.
   → See 3000-02-04-01 “Draining the Engine Lubricating Oil”.
10. Remove the turbocharger (including lubricating oil piping).
    - 2-stage turbocharger → See 2400-02-01-01 “Disassembling the 2-stage Turbocharger”
    - Single-stage turbocharger → See 2400-02-01-02 “Disassembling the Single-stage Turbocharger”
11. Remove the exhaust manifold (including exhaust pressure pipe).
12. Remove the intake system parts (intake throttle valve, intake collector, EGR valve, etc.).
    → See 2300-02-01-01 “Disassembling and Removing the EGR Valve System”

13. Remove the high-pressure fuel pipe.
→ See 5400-02-01-01 “Removing the High-pressure Pipes”

14. Remove the bonnet.
→ See 1404-02-01-01 “Removing the bonnet”

15. Remove the harness for injector signal.
→ See 5300-02-01-01 “Removing the Injectors”

16. Remove the injector fuel leakage line assembly.
→ See 5300-02-01-01 “Removing the Injector”

17. Remove injectors.
→ See 5300-02-01-01 “Removing the Injector”

18. Remove glow plugs.
→ See 7103-02-01-01 “Removing the Glow Plug”

Note: For No. 15 to No. 18, it can be removed with the cylinder head taken out.

19. Remove the rocker arm assembly, valve bridge, and push rod.
→ See 1402-02-01-01 “Removing the Rocker Arm Assembly”

20. Remove the EGR cooler.
→ See 2300-02-01-02 “Removing the EGR Cooler”

21. Remove the thermostat case.
→ See 4000-02-01-02 “Removing the thermostat”

22. Remove the cylinder head.
→ See 1401-02-01-01 “Removing the Cylinder Head Assembly”

23. Remove the cooling-related parts such as the coolant pump, each pulley, and auto-tensioner.
→ See 4000-02-01-01 “Removing the Cooling System”

24. Remove the rail. (The high-pressure pipes are already removed in “13.”)
→ See 5200-02-01-01 “Removing the Common Rail”

25. Remove the alternator.
→ See 7102-02-01-01 “Removing the Alternator”

26. Remove the starter.
→ See 7101-02-01-01 “Removing the Starter”

27. Remove the crankshaft pulley.
→ See 1304-02-01-01 “Removing the Crankshaft Pulley”

28. Remove the oil seal case.
→ See 1305-02-01-01 “Removing the Oil Seal Case”

29. Remove the lubricating oil filter and lubricating oil cooler.
→ See 3200-02-01-01 “Removing the Lubricating Oil Filter” and 3300-02-01-01 “Removing the Lubricating Oil Cooler”

Above are the preparation for disassembling the main engine component (cylinder block) and the main moving parts (such as the crankshaft, camshaft, and pistons).

The appearance of the disassembled engine up to step “29.” are shown in Fig.01-3.

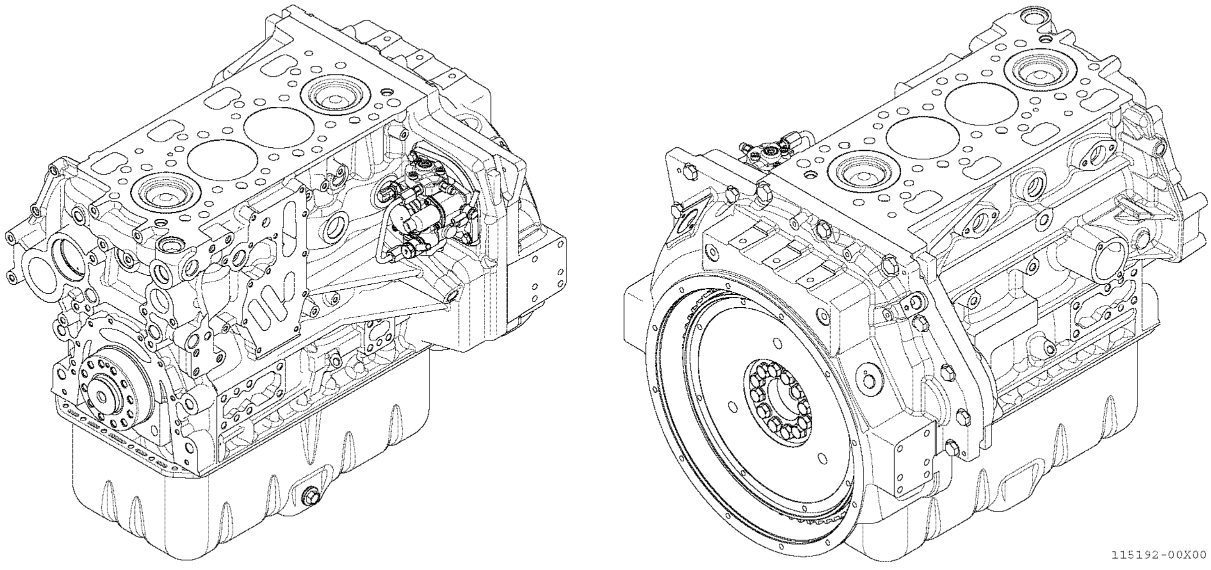


Fig.01-3

2. Disassembling the Main Engine Components (Cylinder Block) and Components of Main Moving Parts (Crankshaft and Camshaft)

Next, the procedures on how to disassemble the main engine component (cylinder block) and the main moving parts (such as the crankshaft, camshaft, and pistons) are described.

- Discard all used gaskets, O-rings and seals. Replace to new gaskets, O-rings and seals on reassembly of engine.

NOTICE

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

1. Remove the crank shaft speed sensor, and then remove the flywheel.
   → See 0300-02-01-01 “Removing the Flywheel”
2. Lift the engine to stand up by positioning the flywheel side upward.
3. Remove the oil pan.
   → See 0300-02-01-02 “Removing the Oil Pan”
4. Remove the lubricating oil suction pipe.
5. Remove the cam speed sensor, and then remove the flywheel housing.
   → See 0300-02-01-03 “Removing the Flywheel Housing”
6. Remove supply pump.
   → See 5100-02-01-01 “Removing the Supply Pump”
7. Remove the lubricating oil pump.
   → See 3100-02-01-01 “Removing the Lubricating Oil Pump”
8. Remove the idle gear.
   → See 0400-02-01-01 “Removing the Timing Gears”
9. Remove the camshaft pulser gear, and remove the camshaft.
   → See 1100-02-01-01 “Removing the Camshaft And Tappet”
10. Remove the piston and connecting rod.
    → See 1202-02-01-01 “Removing the Piston And Connecting Rod”
11. Position crankshaft upward, and lay down the cylinder block.
12. Remove the metal cap, and then remove the crankshaft.
    → See 1301-02-01-01 “Removing the Crankshaft”
13. Remove the tappets.
    → See 1100-02-01-01 “Removing the Camshaft And Tappet”
14. Remove the piston cooling nozzle.

1. Assembling the Main Engine Components (Cylinder Block) and Components of Main Moving Parts (Crankshaft and Camshaft)

Procedures on how to assemble the main engine component (cylinder block) and the main moving parts (such as the crankshaft, camshaft, and pistons) are described.

1. Place the cylinder block with the cylinder head side facing down.
2. Attach the piston cooling nozzle.
3. Attach the tappets.
   → See 1100-02-03-01 “Attaching the Camshaft and Tappet”
4. Attach the crankshaft.
   → See 1301-02-03-01 “Attaching the Crankshaft”
5. Measure the crankshaft end play.
   → See 1301-02-02-01 “Measuring the crankshaft end play”
6. Lift the cylinder block to stand up by positioning the flywheel side up.
7. Insert the piston, and attach the connecting rod.
   → See 1202-02-03-01 “Assembling the Pistons”
8. Attach the camshaft (temporarily fix until the timing mark is matched).
   → See 1100-02-03-01 “Attaching the Camshaft and Tappet”
9. Attach the supply pump.
   → See 5100-02-03-01 “Attaching the Supply Pump”
10. Attach the lubricating oil pump (without pump gear).
    → See 3100-02-03-01 “Reassembling the Lubricating Oil Pump”
11. Match the timing marks, and attach idle gear.
    → See 0400-02-03-01 “Installing the Timing Gears”
12. Attach the lubricating oil pump gear.
    → See 3100-02-03-01 “Reassembling the Lubricating Oil Pump”
13. Measure the timing gear backlash.
    → See 0400-02-02-01 “Measuring Timing Gear Backlash”
14. Attach the camshaft pulser gear.
15. Attach the flywheel housing.
    → See 0300-02-03-01 “Attaching the Flywheel Housing”
16. Attach the lubricating oil suction pipe.
17. Attach the oil pan.
    → See 0300-02-03-02 “Attaching the Oil Pan”
18. Attach the engine feet, and lift the engine with the cylinder head side facing up.
19. Attach the flywheel.
    → See 0300-02-03-03 “Attaching the Flywheel”
20. Attach the crank speed sensor and cam speed sensor.

2. Assembling the Engine

Procedures on how to complete the assembly after assembling the main engine component (cylinder block) and the main moving parts (such as the crankshaft, camshaft, and pistons) are described below.

For assembly, basically follow the reverse procedure of disassembling.

1. Attach the oil seal case.
   → See 1305-02-03-01 “Attaching the Oil Seal Case”
2. Attach the crankshaft pulley.
   → See 1304-02-03-01 “Attaching the Crankshaft Pulley”
3. Attach the cylinder head.
   → See 1400-02-03-01 “How to Attach the Cylinder Head”
   Note: Assemble the injector, injector harness, fuel return pipe, and glow plug before attaching to the cylinder head.
4. Attach the push rod.
5. Attach the rocker arm assembly.
   → See 1402-02-03-01 “Reassembling the Rocker Arm Assembly”
6. Adjust the valve clearance.
   → See 1403-03-02-01 “Measuring and Adjusting Valve Clearance”
7. Attach the rail.
   → See 5200-02-03-01 “Attaching the Common Rail”
8. Attach the high-pressure fuel pipes (From injector to rail to supply pump).
   → See 5400-02-03-01 “Attaching the High Pressure Pipes”
9. Attach the bonnet.
   → See 1404-02-03-02 “Installing the bonnet”
10. Attach the parts of the exhaust system and intake system that are with the cylinder head.
    - Exhaust manifold → See 2201-02-03-01 “Attaching the Exhaust Manifold”
    - Turbocharger → See 2400-02-03-01 “Installing the 2-stage Turbocharger”
    - EGR System → See 2300-02-03-01 “Assembling the EGR Valve System”
11. Attach the coolant pump, idler, and cooling fan bracket.
    → See 4000-02-03-01 “Installing the Cooling System”
12. Attach the auto tensioner.
    → See 4000-02-03-01 “Installing the Cooling System”
13. Attach the cooling fan pulley, and then attach the belt.
    → See 4000-02-03-01 “Installing the Cooling System”
14. Attach the cooling fan.
    → See 4000-02-03-01 “Installing the Cooling System”
15. Assemble the alternator.
    → See 7102-02-03-01 “Installing the Alternator”
16. Assemble the lubricating oil filter and lubricating oil cooler.
    → See 3200-02-03-01 “Installing the Lubricating Oil Filter” and 3300-02-03-01 “Installing the Lubricating Oil Cooler”
17. Install the starter motor.
    → See 7101-02-03-01 “Installing the Starter”

18. Assemble the wire harnesses and harness cover.

    → See 7200-02-03-01 “Installing the Wire Harness Assembly”

19. Attach the fuel filter.
20. Pipe the fuel hoses.
21. Install the engine to the driven machine.
22. Attach the parts that are connected to the driven machine, that were removed when removing the engine from the driven machine.
    - Connect the coolant system piping. (Piping to the radiator and vehicle body side)
    - Fuel piping to the fuel filter
    - Pipings of intake/exhaust fuel system
    - Engine transmission system
    - Electrical equipment wires from the machine side
    - Throttle cable (if equipped)
    - Battery cable (connect the negative (-) cable at last)
23. Add engine lubricating oil.

    → See 3000-02-04-02 “Filling Engine Lubricating Oil”

24. Fill engine coolant.

    → See 4000-02-04-02 “Filling Radiator with Engine Coolant”

    Warm up the engine for about 15 minutes, and make sure that the engine lubricating oil pressure is normal, and that there are no leaks of fuel, engine lubricating oil, coolant, or urea water. Make sure that the instrument and alarms are properly working. Avoid prolonged operation at maximum engine speeds and loads for the remainder of the first hour of operation.

The inspection of the cylinder block after engine disassembly is explained below.

1. Inspecting the Cylinder Block

1. Ensure that oil passages are clear and unobstructed.
2. Check for discoloration or evidence of cracks. If a fracture is suspected, use the color check method or the Magnaflux method to determine if the cylinder block is fractured.
3. Inspect cylinders for roundness, taper, or evidence of scoring. Collect and record the measurements. Consider honing, reboring or replacing the cylinder block if the measurements are not within specification.
   - Take measures at three places (Fig.02-1) (a, b, c), and in two directions (d, e) in each location.

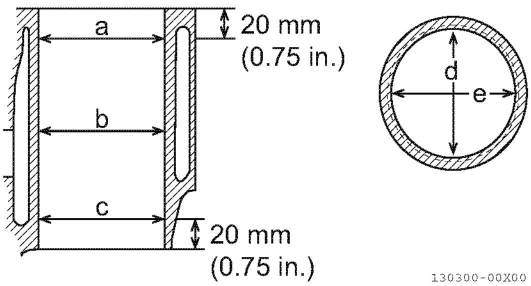


Fig.02-1

4. Use a cylinder gauge (1, Fig.02-2) from the head side of the cylinder block to measure the diameter of the tappet bore. For standard values, see 0000-07-01-02 “Tappet”.

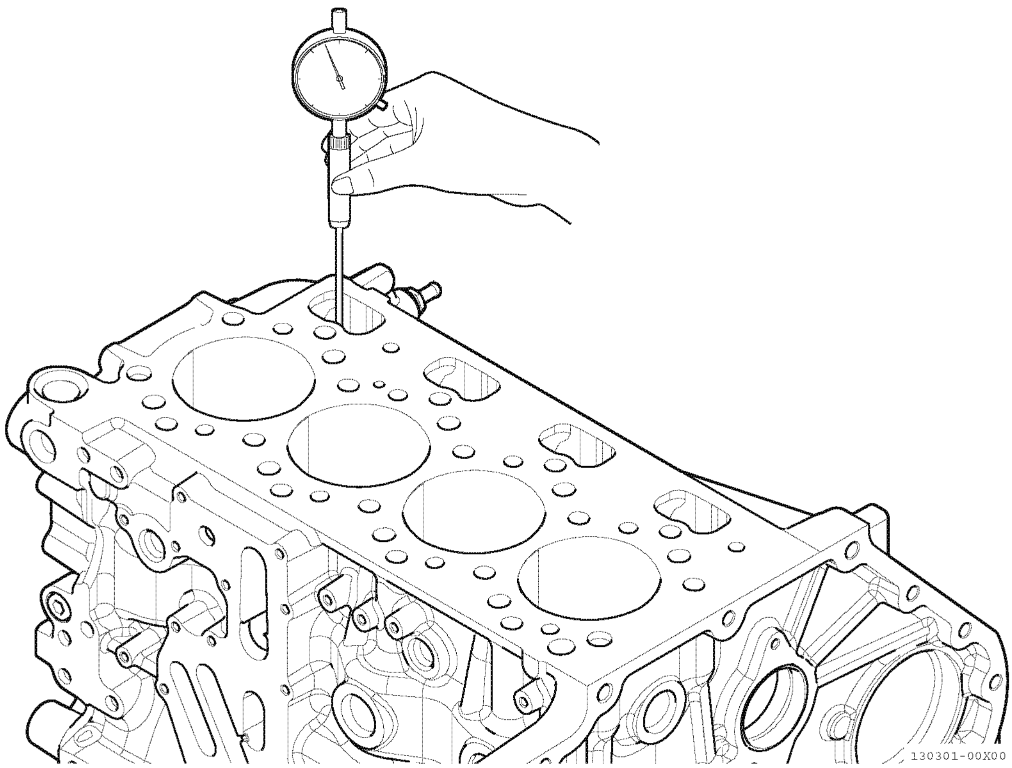


Fig.02-2

1. Cylinder Block 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 tapered beyond specifications, rebore and hone to restore cylinders to usable condition. Slight imperfections can be corrected by honing alone.

1. Boring: Significant cylinder damage may be corrected by boring the cylinder to an oversize dimension. See the appropriate parts catalog for available oversize pistons and piston rings.
   - Boring a cylinder should always be done in a properly equipped machine shop.
   - A bored cylinder should always be finished with a hone to properly prepare the cylinder surface so the new piston rings will seat properly.
   - After the cylinder has been bored and honed, install the appropriate oversize pistons and piston rings.
2. Honing: Minor cylinder imperfections may be corrected by using a rigid cylinder hone (1, Fig.02-4). Be sure not to exceed the maximum cylinder bore specification.
3. Deglazing: A used cylinder that did not require boring or honing should always be deglazed with a ball hone (2, Fig.02-4) before installing the new piston rings. This will properly prepare the cylinder surface to allow new piston rings to seat properly.

Note: When honing a cylinder with either a ridged hone or a ball hone (1, Fig.02-3), move the rotating hone up and down in the cylinder bore to accomplish a 30° to 40° crosshatch pattern (Fig.02-3). This will provide the ideal surface for the proper seating of new piston rings.

NOTICE

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

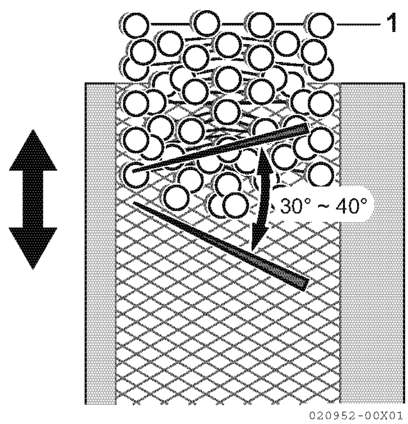


Fig.02-3

- Use a 50:50 mixture of diesel fuel and engine lubricating oil as a honing fluid.

- Use a 300-grit hone at a speed of 300 - 1200 min^{-1}. (Fig.02-4)

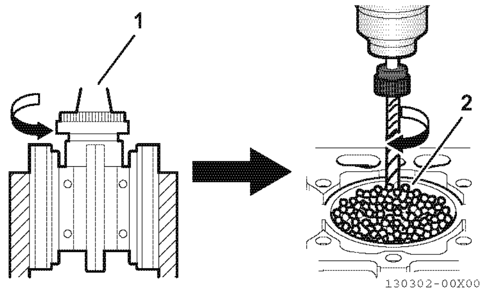


Fig.02-4

NOTICE

Solvents will not adequately remove honing residue, resulting in premature piston and ring wear. Always wash cylinders using hot, soapy water.

- When honing is completed, wash the cylinder block with hot water and soap. The cylinder wall is adequately cleaned when a white rag wiped in cylinder comes out clean. Use brushes to clean all passages and crevices. Rinse with hot water and dry with compressed air. Apply clean engine lubricating oil to all steel surfaces to prevent rusting.

1. Removing the Flywheel

Before disassembling main moving parts such as the crankshaft, camshaft, and pistons, it is necessary to first remove the flywheel, oil pan, and flywheel housing.

1. When removing the flywheel, remove the crank speed sensor first to prevent the sensor from being damaged by the ring gear contacting the crank speed sensor (1, Fig.03-1).
2. When removing the flywheel mounting bolts, in order to prevent the crankshaft from turning, attach a stopper (4. Fig.03-1) by using the thread hole (2, Fig.03-1) on the flywheel housing side and the thread hole (2, Fig.03-1) on the flywheel side.
3. Out of the flywheel bolts, remove the 2 bolts (5, Fig.03-1) that are in the horizontal position in the center part.

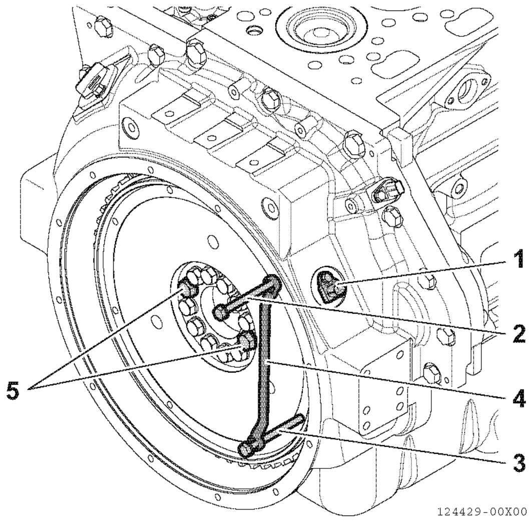


Fig.03-1

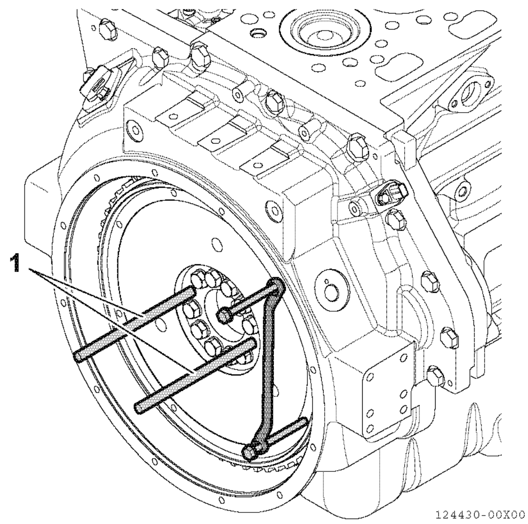


Fig.03-2

4. Attach 2 guide bars (1, Fig.03-2) to the 2 flywheel attaching bolt holes. Then, remove the remaining 10 flywheel attaching bolts, and remove the stopper.
5. Attach 2 bolts (1, Fig.03-3) to the flywheel as a handle, and while turning along the guide bar (2, Fig.03-3), remove the flywheel. Remove the guide bar.

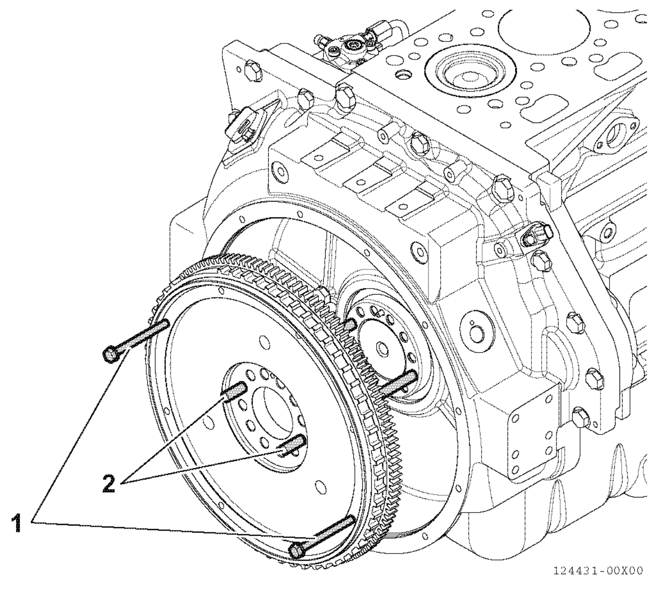


Fig.03-3

When removing the flywheel alone, you do not need to completely disassemble the engine as explained in 0100-02-01-01 “Disassembling the engine”.

2. Removing the Oil Pan

Before disassembling main moving parts such as the crankshaft, camshaft, and pistons, it is necessary to first remove the flywheel, oil pan, and flywheel housing.

1. After completing the procedure in 0100-02-01-01 “Disassembling the Engine”, invert the cylinder block with the fan side facing down, and remove the oil pan (1, Fig.03-4).

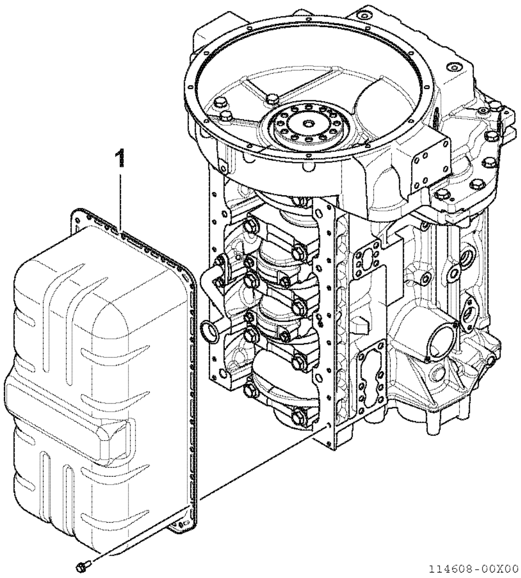


Fig.03-4

2. Remove the lubricating oil suction pipe (1, Fig.03-5) and O-ring (2, Fig.03-5).

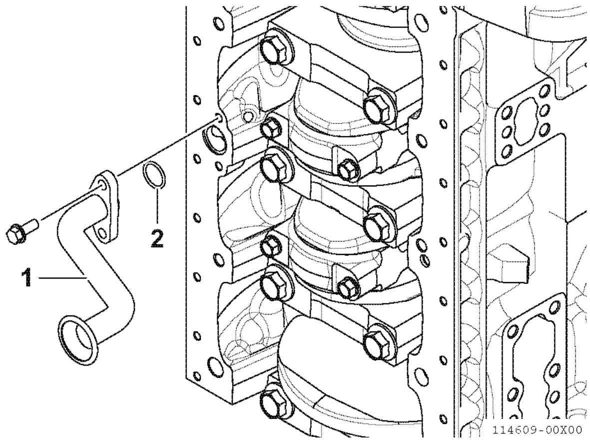


Fig.03-5

3. If the engine is placed on an engine stand, turn it so that the oil pan side is facing up. Remove the oil pan.

   If the engine is placed on an engine stand, it is possible to remove the oil pan alone. In this case, except for draining the engine lubricating oil, the disassembly procedure in 0100-02-01-01 “Disassembling the Engine” is not necessary.

3. Removing the Flywheel Housing

At the stage before disassembling main moving parts such as the crankshaft, camshaft, and pistons, it is necessary to first remove the flywheel, oil pan, and flywheel housing.

After completing the procedure in 0100-02-01-01 “Disassembling the Engine”, perform the procedures in 0300-02-01-01 “Removing the Flywheel” and 0300-02-01-02 “Removing the Oil Pan”, then remove the flywheel housing (2, Fig.03-6).

With 4TN107 engines, the timing gears are located on the flywheel side. Therefore, it is necessary to remove the flywheel housing when inspecting or maintaining the timing gears.

Remove the bolts (1, Fig.03-6) that mount the flywheel housing, and then remove the flywheel housing (2, Fig.03-6) from the cylinder block. If the liquid gasket is sticking and hard to remove, screw the M8 bolt into the three jack bolt holes (Fig.03-7) indicated by the arrows to remove the flywheel housing.

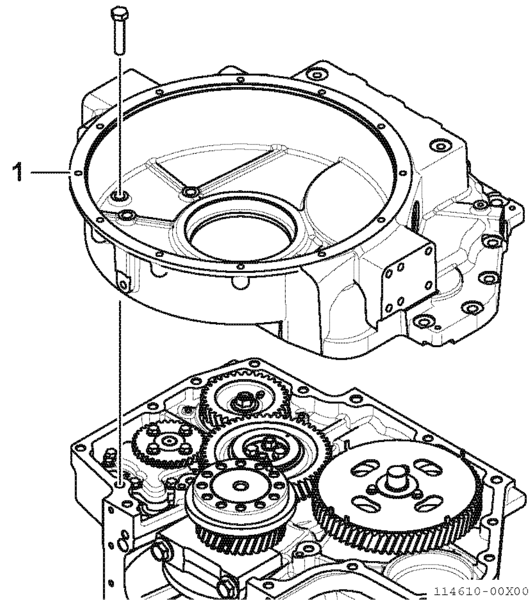


Fig.03-6

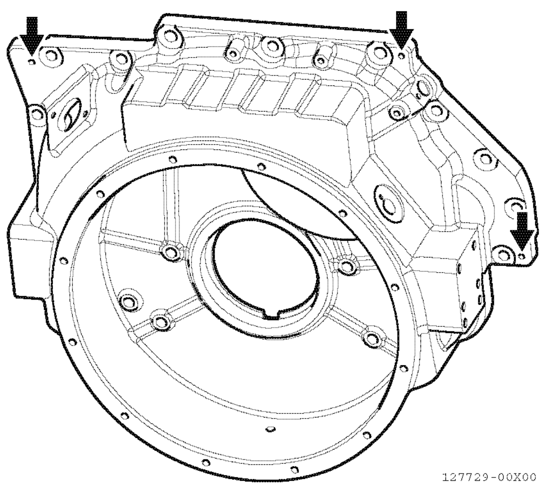


Fig.03-7

1. Attaching the Flywheel Housing

Attach the flywheel housing with the cylinder block stood.

1. Apply liquid gasket to the flywheel housing attaching part (1, Fig.03-8) on the cylinder block side. Also apply lubricating oil around the two bolt holes (2, Fig.03-8) in the center.
2. Lift the flywheel housing (3, Fig.03-8) with a crane, and slowly place it down and attach to the cylinder block while matching to the parallel pin attaching hole (4, Fig.03-8) on the left and right of the crankshaft.
3. Tighten the flywheel housing attaching bolts (5, Fig.03-8) to the specified torque.

Tightening torque	M12 × 60 × p1.75 (×6)	88.2 ± 9.8 N·m
	M12 × 45 × p1.75 (×10)	88.2 ± 9.8 N·m
	M14 × 45 × p2.0 (×2)	132.5 ± 15 N·m

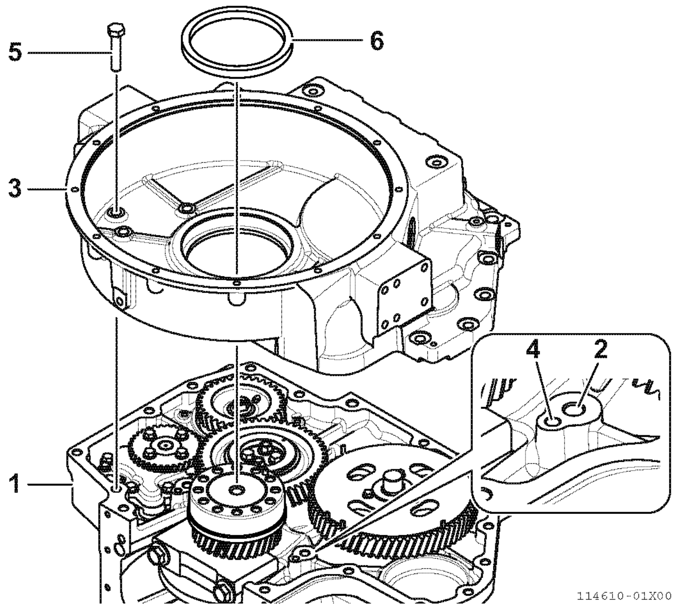


Fig.03-8

4. Apply clean engine lubricating oil to the crankshaft oil seal (6, Fig.03-8), and fit to the crankshaft.

   If the crankshaft is provided with the oil seal lip line, slightly move the oil seal. At that time, make sure that the oil seal does not tilt with respect to the crankshaft.

2. Attaching the Oil Pan

Attach the oil pan with the cylinder block lifted, or, if the engine is placed on an engine stand, turn it so that the oil pan side is facing up.

1. Attach the lubricating oil suction pipe (1, Fig.03-9). Replace the O-ring with a new one (2, Fig.03-9).

Tightening torque	Bolts for attaching lubricating oil suction pipe (M8 × 1.25)	25.5 ± 2.9 N·m

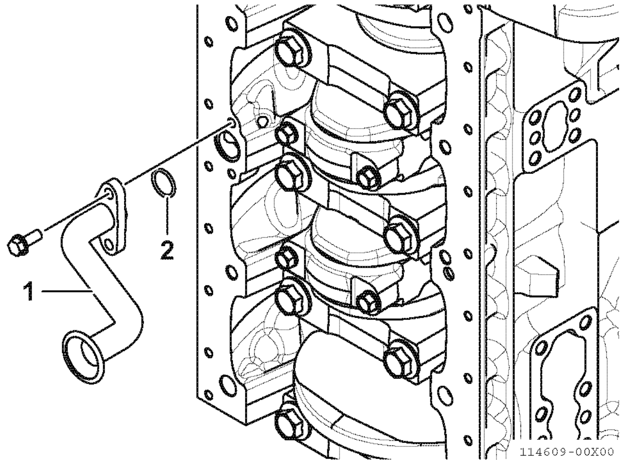


Fig.03-9

2. Apply liquid gasket to the attaching face of the oil pan (1, Fig.03-10), and then attach the cylinder block and tighten the bolts (2, Fig.03-10) to the specified torque.

Tightening torque	Oil pan attaching bolts (M8 × 1.25)	25.5 ± 2.9 N·m

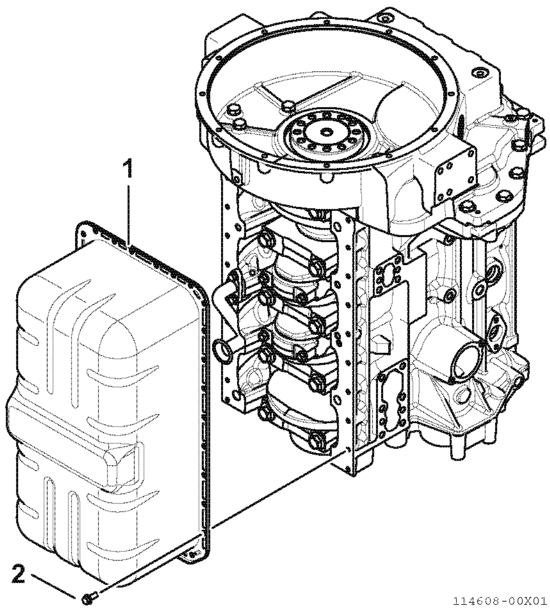


Fig.03-10

3. Attaching the Flywheel

Attach the engine feet, and lift the engine and set to level.

1. Attach 2 guide bars (1, Fig.03-11) to the flywheel attaching bolt hole of the crankshaft.
2. Attach 2 bolts (2, Fig.03-11) to the flywheel as a handle. Along the guide bar, attach the retaining pin of the crankshaft (3, Fig.03-11) and the flywheel pin hole. Apply lubricating oil to the flywheel attaching bolts, and screw in until it is tightened (without tools) to temporarily tighten them.

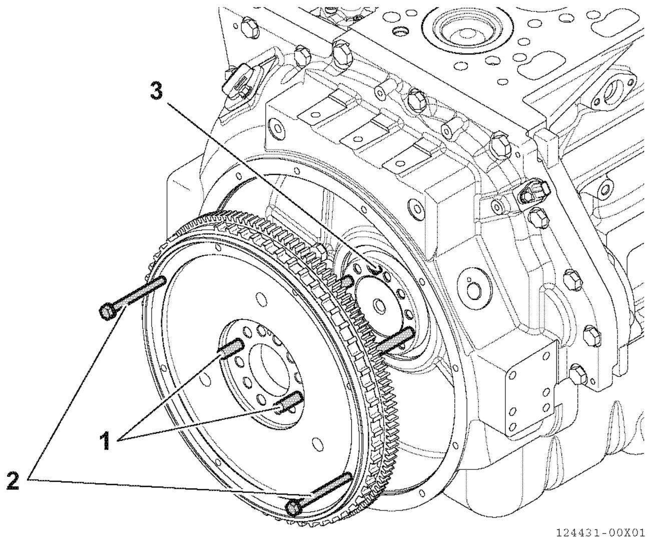


Fig.03-11

3. Remove the guide bar and the handle bolts, attach a stopper (1, Fig.03-12) to the flywheel and the flywheel housing so that the crankshaft does not turn. Tighten the flywheel attaching bolts to the specified torque.

Tightening torque	Flywheel attaching bolt (M12 × 1.25)	150 ± 5 N·m

4. Tighten each attaching bolt to the specified torque to attach the crank speed sensor (2, Fig.03-12), and cam speed sensor (3, Fig.03-12).

Tightening torque	Crank speed sensor attaching bolt (M6 × 1.0)	6.5 ± 1.5 N·m
	Cam speed sensor attaching bolt (M6 × 1.0)	10.0 ± 2.0 N·m

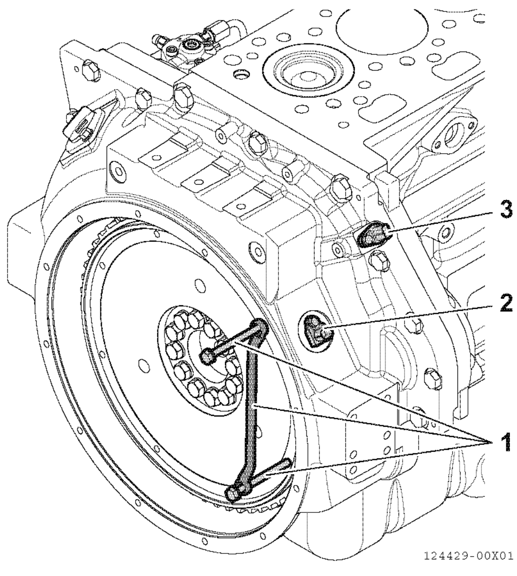
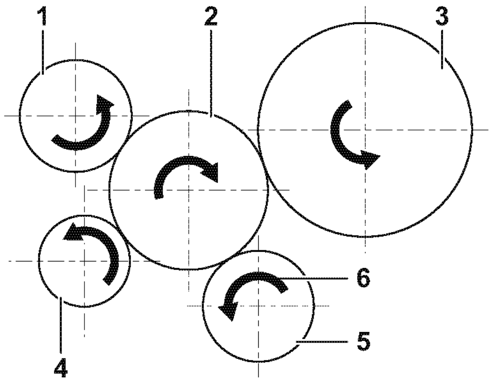


Fig.03-12

1. Measuring Timing Gear Backlash

After removing the flywheel housing and prior to removing the timing gears, measure the gear backlash and determine the gear wear.

Measure the backlash for each pair of mating gears (Fig.04-1). Refer to the following procedures for the measurement method. If not within specification, replace both mating gears. See 0000-07-01-02 “Timing Gear Backlash” for limited values.



1 - Supply pump drive gear
2 - Idle gear
3 - Camshaft drive gear
4 - Engine lubricating oil pump gear
5 - Crankshaft gear
6 - Direction of rotation

114613-00EN00

Fig.04-1

Note: Do not allow the gear being checked to move axially as excess end play could cause a false reading.

1. Measuring the idle gear-to-crankshaft gear backlash

1 - Install a dial indicator as shown in Fig.04-2.

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

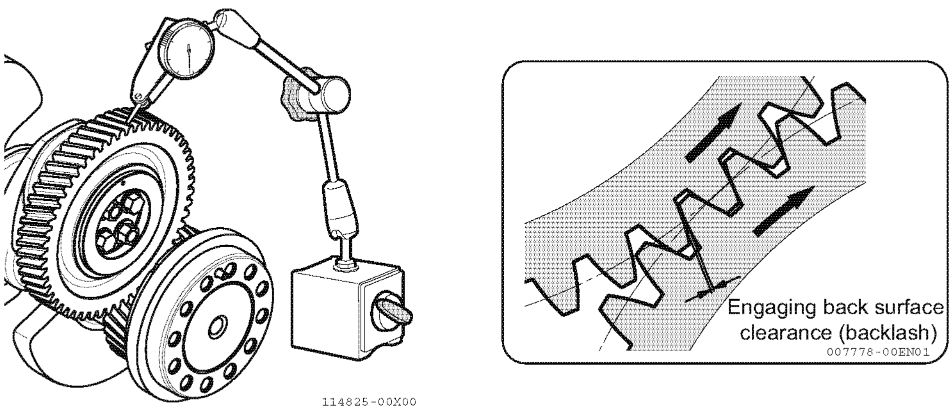


Fig.04-2

2. Measuring the idle gear-to-camshaft gear backlash

1 - Insert a small wooden wedge between the crankshaft gear and idle gear to prevent the idle gear from rotating.

2 - Install the dial indicator to read the camshaft gear backlash. Rotate the camshaft drive gear against the idle gear to measure the backlash. Record the measurement.

3 - Check the idle gear-to-fuel injection pump drive gear backlash in the same manner as the camshaft drive gear. Record the measurement.

1. Removing the Timing Gears

1. Do not remove the crankshaft gear unless it is damaged or requires replacement. When removing the crankshaft gear, use a gear puller.
2. Do not remove the camshaft gear unless the gear or camshaft is damaged or requires replacement. When removing the camshaft gear, it is necessary to use a press.
3. Use a gear puller to remove the supply pump drive gear (1, Fig.04-3).
4. Remove the lubricating oil pump drive gear (2, Fig.04-3).

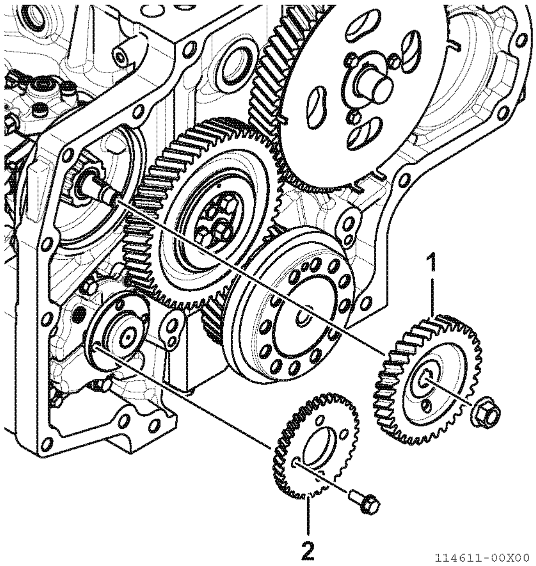


Fig.04-3

5. Remove the bolts and nuts from the idle gear shaft (1, Fig.04-4), and remove the idle gear (2, Fig.04-4), bushing (3, Fig.04-4) and idle shaft plate (4, Fig.04-4).

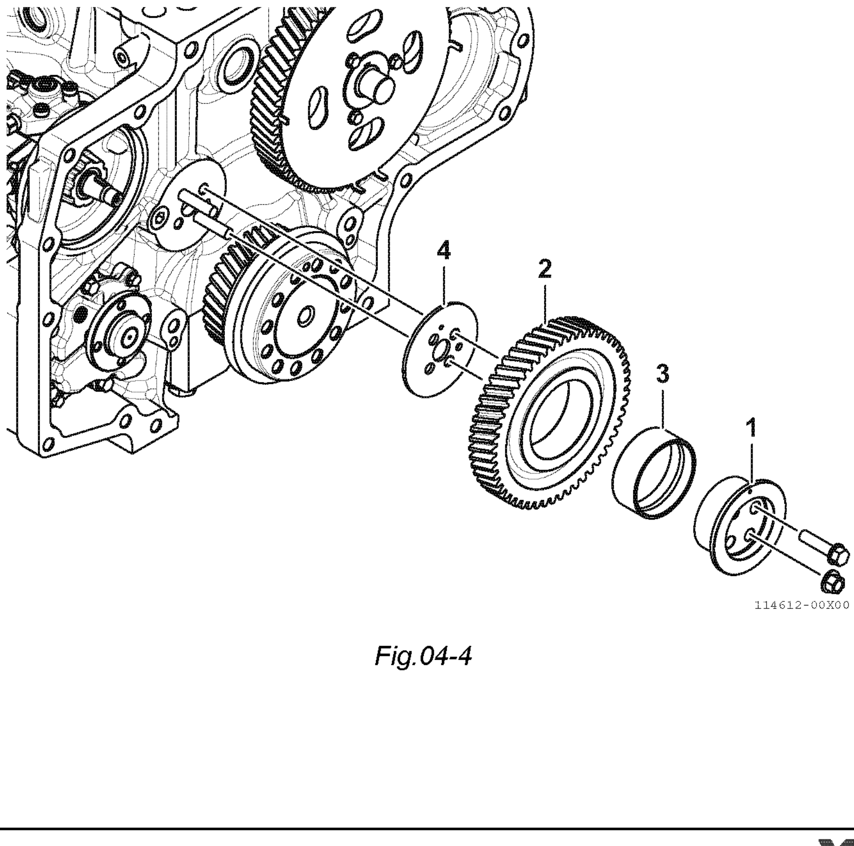


Fig.04-4

1. Inspecting the Idle Gear and Idle Gear Shaft

1. Measure the outer diameter (2, Fig.04-5) of the idle gear shaft (1, Fig.04-5).
   For standard values, see 0000-07-01-02 “Idle gear shaft and bushing”. If the value exceeds the standard, replace the part.
2. Measure the inner diameter (5, Fig.04-5) of the idle gear (3, Fig.04-5) bushing (4, Fig.04-5).
   For standard values, see 0000-07-01-02 “Idle gear shaft and bushing”. If the value exceeds the standard, replace the part.

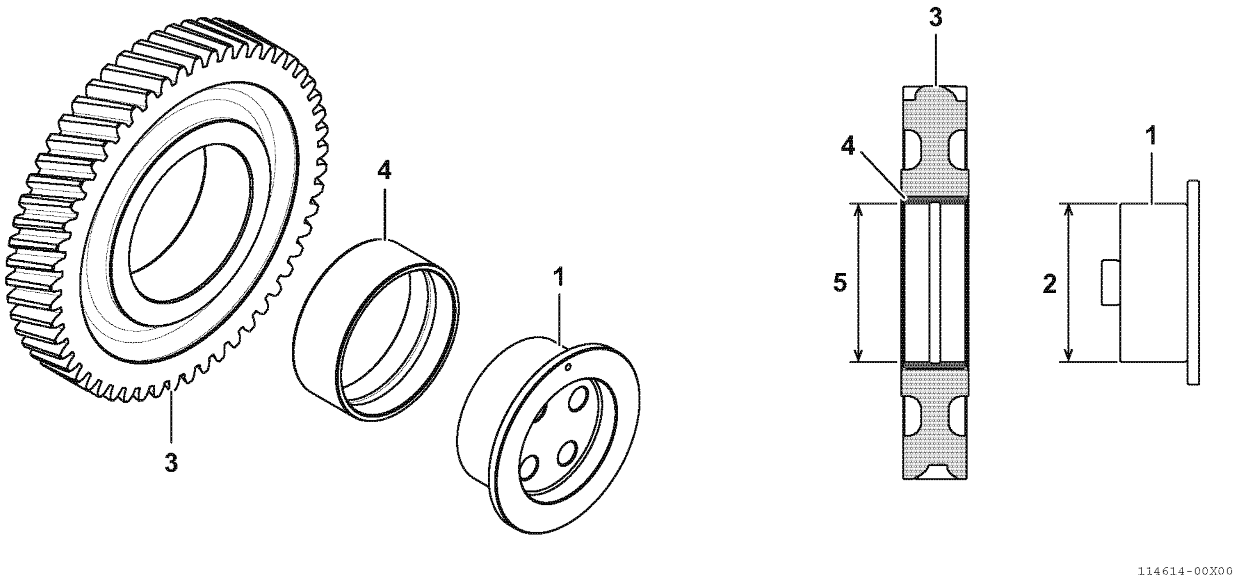


Fig.04-5

1. Installing the Timing Gears

1.1 Attaching the idle gear

Attach the crankshaft, piston, connecting rod, camshaft, supply pump, and lubricating oil pump to the cylinder block. Then, attach the idle gear assembly.

1 - Set the piston of the No. 1 cylinder to the top dead center. Timing mark A of the crank gear (1, Fig.04-6) comes to the position in Fig.04-6. However, there is no A mark graving on the crank gear. The notch part (3, Fig.04-6) of the shaft flange (2, Fig.04-6) in front of the crank gear equals to the A mark.

2 - Set the camshaft so that the timing mark C of the cam gear comes to the position shown in Fig.04-6, and attach the idle gear by matching the timing marks A and C of the idle gear to the matching side. In order, attach the idle shaft plate (1, Fig.04-7), the idle gear and the idle gear bush (2, Fig. 04-7), and then the idle shaft (3, Fig.04-7). Then, tighten the idle gear bolts and nuts (4, Fig.04-7). Before attaching, apply clean engine lubricating oil to the idle gear, bush, and idle shaft.

Tightening torque	Idle gear bolt (M10 × 1.5)	49.0 ± 4.9 N·m

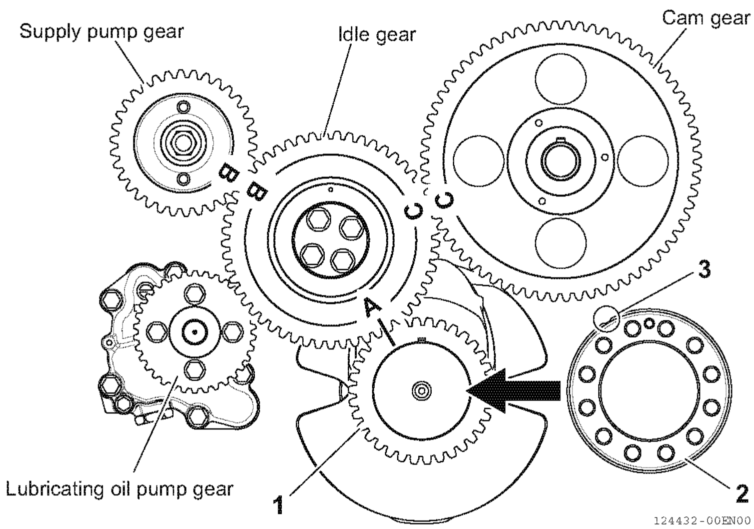


Fig.04-6

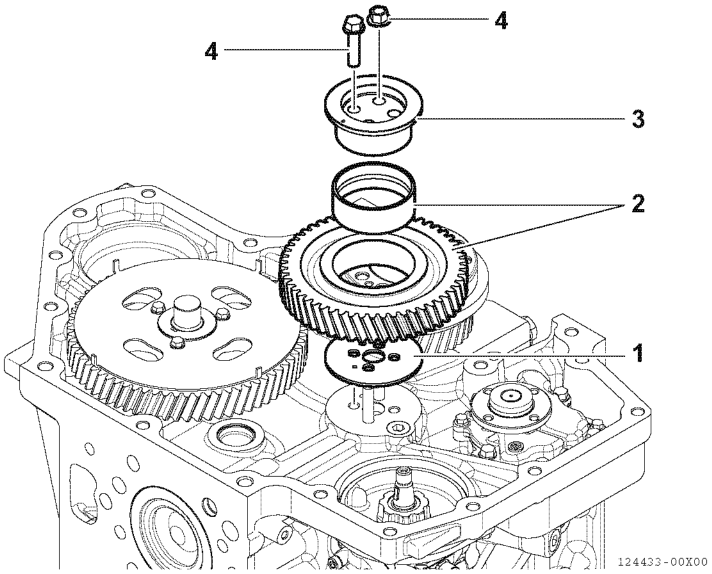


Fig.04-7

1.2 Attaching the supply pump gear

Lightly fit the key groove of the supply pump gear to the shaft key of the supply pump, and match the timing mark B to the timing mark B of the idle gear to attach the supply pump gear. Then, tighten with the M14 flange nut.

Tightening torque	Supply pump gear nut (M8 × 1.25)	64 ± 4 N·m

1.3 Attaching the lubricating oil pump gear

At last, attach the lubricating oil pump gear. The lubricating oil pump gear does not have a match mark. Install the lubricating oil pump gear to the flange of the lubricating oil pump, and tighten the bolts.

Tightening torque	Lubricating oil pump gear attaching bolt (M8 × 1.25)	25.5 ± 2.9 N·m

1.4 Attaching the camshaft pulser gear

Attach the pulser gear (2, Fig.04-8) to the camshaft (1, Fig.04-8), and tighten with the bolt (3, Fig.04-8).

Tightening torque	Pulser gear attaching bolt (M6 × 1.0)	10.8 ± 1.0 N·m

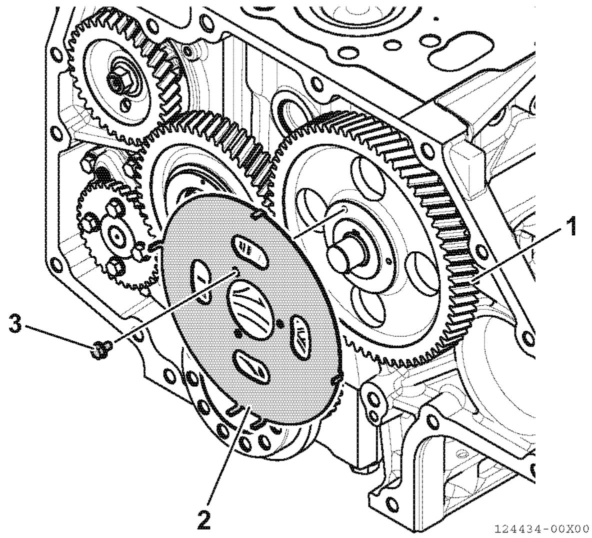


Fig.04-8

1. Inspecting the Camshaft (Before Disassembly)

Before removing the camshaft, inspect the camshaft end play.

1. Method A: Install a dial gauge (1, Fig.11-1) onto the cylinder block. Rotate the camshaft (2, Fig.11-1) back and forth to check the end play. Record the measurement. For standard value, see 0000-07-01-02 “Camshaft”.

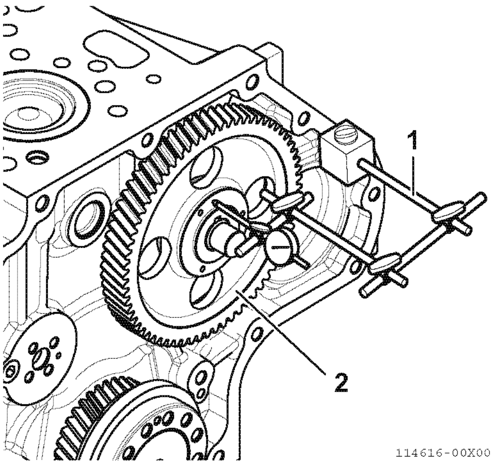


Fig.11-1

2. Method B: Use a feeler gauge to measure the clearance (3, Fig.11-2) between the thrust bearing (1, Fig.11-2) and camshaft gear-side bearing (2, Fig.11-2). Record the measurement. For standard value, see 0000-07-01-02 “Camshaft”.

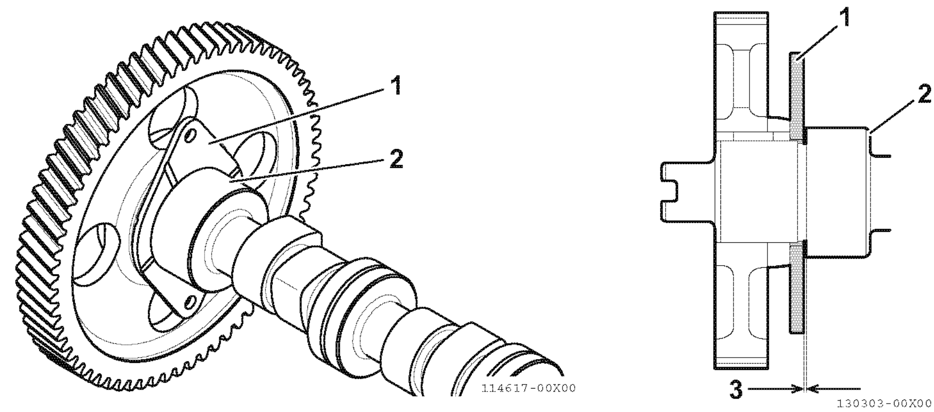


Fig.11-2

If the value exceeds the standard, replace the camshaft.

1. Removing the Camshaft and Tappet

1. Remove the two bolts (3, Fig.11-3) retaining the camshaft thrust plate (1, Fig.11-3).

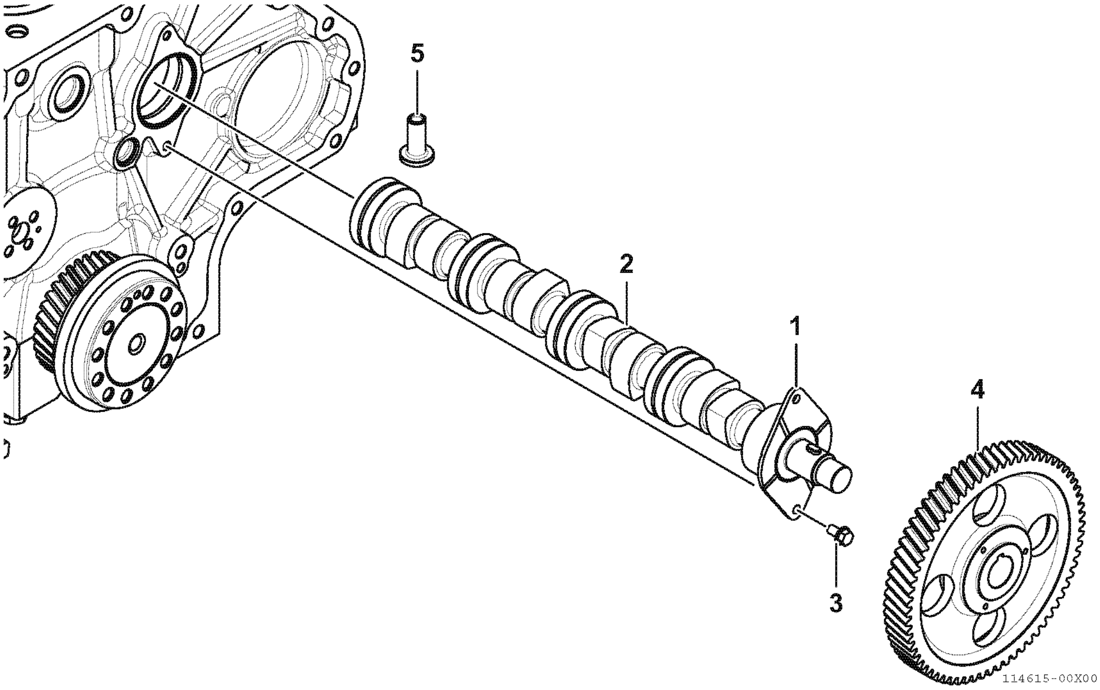


Fig.11-3

2. Rotate the engine in the engine stand so that gravity causes the tappets (5, Fig.11-3) to drop away from the camshaft lobes.

   Note: Rotate the camshaft at least two turns to "bump" any sticking tappets away from the camshaft.

3. Slowly pull the camshaft assembly (1, 2, 4, Fig.11-3) straight out from the engine being careful not to damage the camshaft bearings.
4. If the engine is not installed on an engine stand, stand the engine so that the camshaft gear side is facing up.

   Rotate the camshaft at least two turns to bump the tappets out of the way to prevent the tappets from interfering with the removal of the camshaft.

5. Remove the tappets. Mark the tappets so they can be reinstalled in the same location.
6. Remove the camshaft drive gear (4, Fig.11-3) only if the gear or camshaft require replacement.
   Use a knife-edge puller and a press to remove the gear. The gear is a shrink-fit and will need to be heated to 180 to 200 °C to remove.

1. Inspecting the Camshaft (After Disassembly)

1.1 Measuring camshaft bend, runout, cam lobe height, and outer diameter

Inspect the removed camshaft.

1 - Use V-blocks and dial indicator to check camshaft bend (Fig.11-4).
Place the indicator on the center bearing journal. Rotate the camshaft and measure the runout.
For standard values, see 0000-07-01-02 “Camshaft”.

2 - Measure the height of each cam lobe (1, Fig.11-5) using a micrometer. For standard values, see 0000-07-01-02 “Camshaft”.

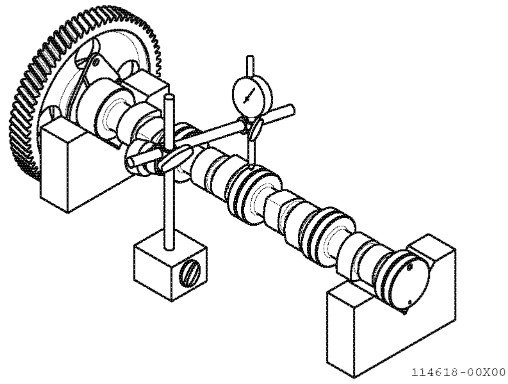


Fig.11-4

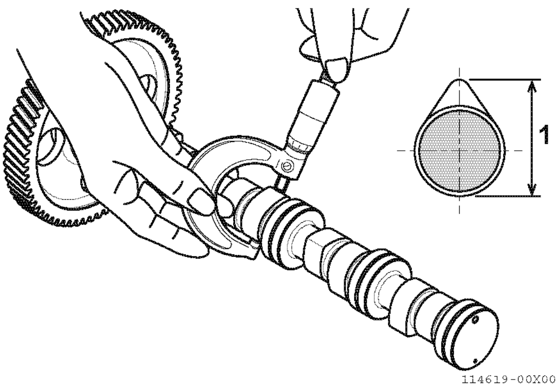


Fig.11-5

3 - Measure the journal outer diameter at three locations: the gear end (1, Fig.11-6), intermediate (2, Fig.11-6), and flywheel end (3, Fig.11-6). For standard values, see 0000-07-01-02 “Camshaft”.

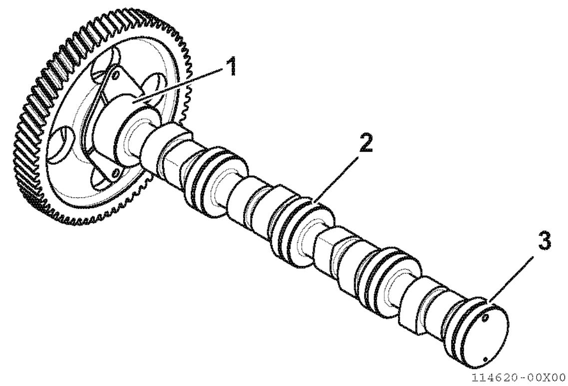


Fig.11-6

1.2 Inspecting the camshaft bushing

Inspect the camshaft bushing.

1 - Measure the inner diameter of the camshaft gear-side bushing (1, Fig.11-7) and the inner diameters of the remaining 4 bushings. Measure the inner diameter diameters at the other 4 locations after removing the crankshaft, pistons, and connecting rods. For reference value, see 0000-07-01-02 “Camshaft”.

2 - The camshaft bushing is inserted into the cylinder block. Therefore, if the camshaft bushing needs to be replaced, it should be replaced together with the cylinder block. If the measured value of the camshaft bushing exceeds the standard, replace the cylinder block.

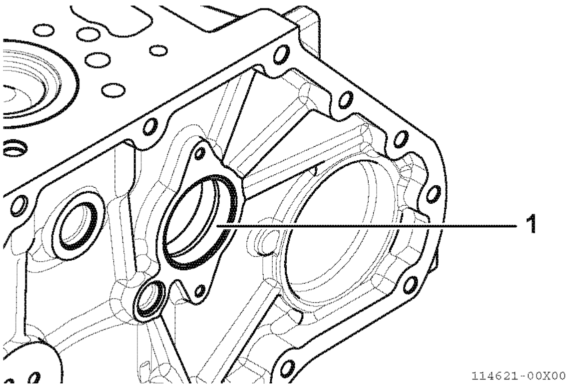


Fig.11-7

2. Inspecting the Tappets

1. Inspect the tappet contact surfaces for abnormal wear(1, Fig.11-8). Normal wear will be even as shown in (2, Fig.11-8). Slight surface defects can be corrected using an oilstone.

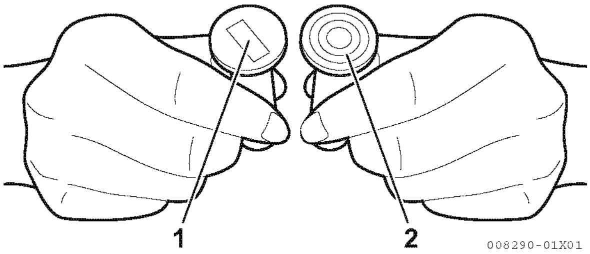


Fig.11-8

2. Measure the outer diameter of the tappet stem (1, Fig.11-9) using a micrometer. For standard values, see 0000-07-01-02 “Tappet”. If the value exceeds the standard, replace the tappet.

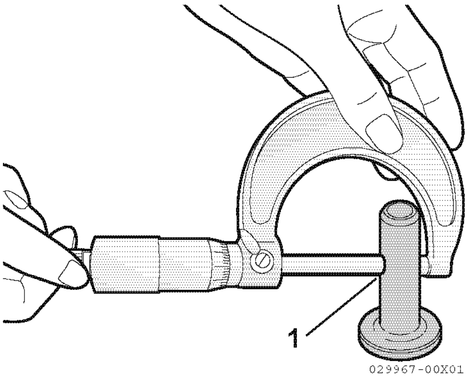


Fig.11-9

1. Attaching the Camshaft and Tappet

1.1 Attaching the tappets

1 - Apply engine lubricating oil to each tappet (1, Fig.11-10), and attach to its original tappet hole (2, Fig.11-10) of the cylinder block with the oil pan side facing up.

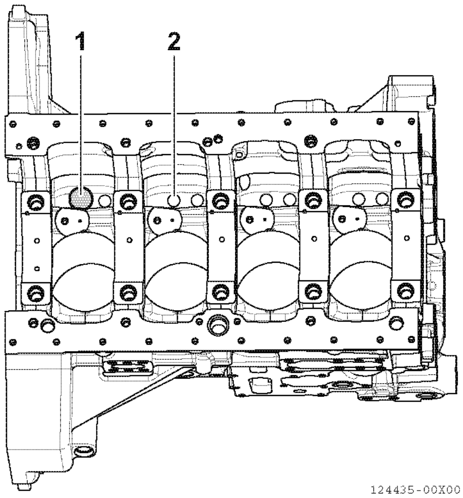


Fig.11-10

1.2 Attaching the camshaft

1 - Apply clean engine lubricating oil to the camshaft (1, Fig.11-11), attach the crankshaft, and slowly insert to the camshaft hole (2, Fig.11-11) of the cylinder block with the flywheel side facing up.

2 - Turn and insert the camshaft while making sure that it does not get caught to the tappet.

3 - Tighten the camshaft thrust bearing (3, Fig.11-11) attaching bolts (4, Fig.11-11) to the specified torque.

Tightening torque	Camshaft thrust bearing attaching bolt (M8 × 1.25)	25.5 ± 2.9 N·m

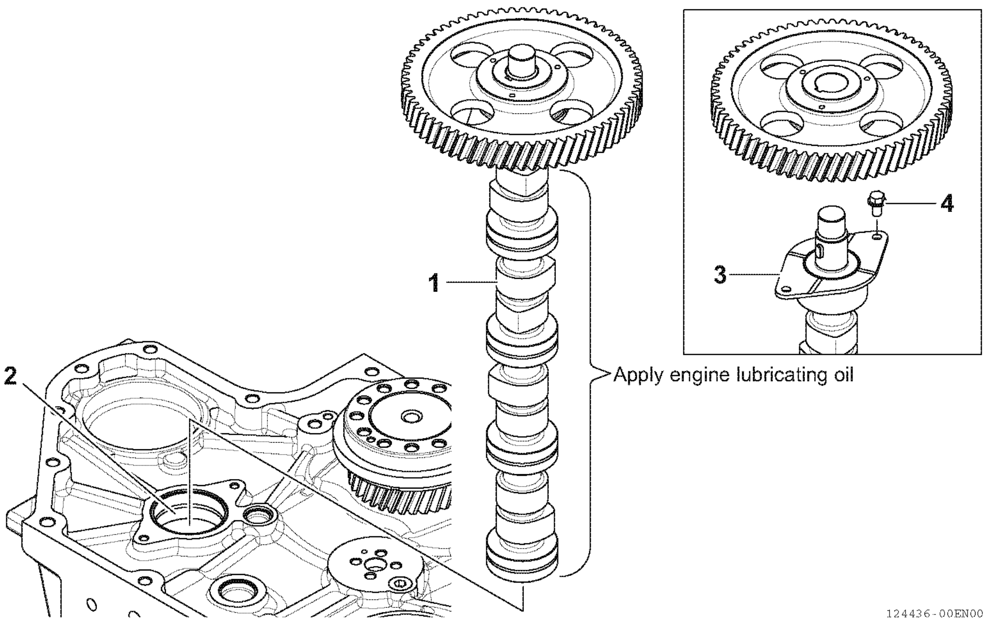


Fig.11-11

1. Inspecting the Connecting Rods (Before Disassembly)

Before removing the pistons, measure the end play at the connecting rod large end and bearing oil clearance.

NOTICE

If the engine is placed upside down, the pistons may fall out from the cylinder block when the connecting rod bearing cap is removed. When removing the bearing cap, change the engine orientation so that the connecting rods are level.

1.1 End play at large end of connecting rod

Use a feeler gauge and measure the end play (Fig.12-1) at the large end of each connecting rod. For standard values, see 0000-07-01-03 “Connecting rod”. If the end play exceeds the standard, replace the corresponding crankshaft, connecting rod, or both.

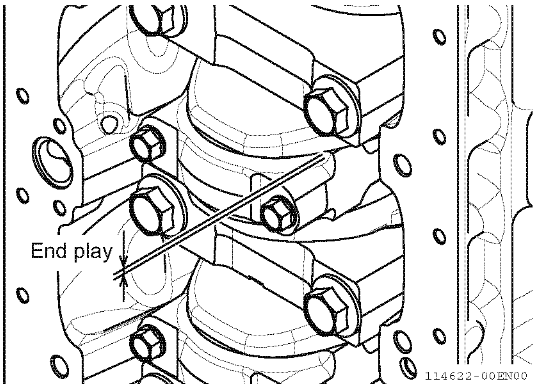


Fig.12-1

1.2 Connecting rod bearing oil clearance

Measure bearing oil clearance prior to removing the pistons and connecting rods to determine extent of wear. Record the measurement.

NOTICE

Mark both the bearing cap and connecting rod to identify the combination, so that they can be re-installed to the original positions.

1 - Remove the bearing cap. Do not remove the bearing at this time.

2 - Remove the engine lubricating oil from bearing and crankshaft journal.

3 - Place PLASTIGAGE (1, Fig.12-2) along the full width of the bearing.

NOTICE

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

4 - Install the bearing cap and tighten the bolts to the specified torque. See 0000-07-03-01 “Standard Torque”.

5 - Remove the bearing cap.

6 - Compare the width of the flattened part of the PLASTIGAGE (1, Fig.12-3) to the graduation marks on the package (2, Fig.12-3). The mark that most closely matches the width of the flattened PLASTIGAGE will indicate the bearing oil clearance.

7 - Repeat the same procedure for the remaining connecting rods.

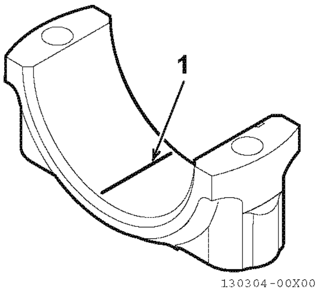


Fig.12-2

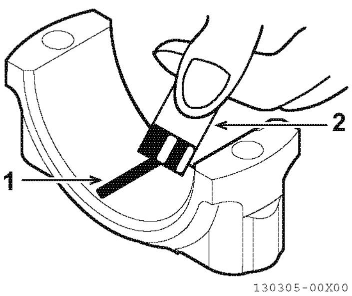


Fig.12-3

1. Removing the Piston and Connecting Rod

The procedure of how to remove the piston and the connecting rod after measuring the oil clearance of the connecting rod bearing is explained hereafter. The bearing cap is removed.

NOTICE

Keep the piston pin parts, piston assemblies, and connecting rod assemblies together to be returned to the same position during the reassembly process. Label the parts using an appropriate method.

1. Place the pistons at the TDC position, and insert a wooden rod or similar item from the oil pan side to hold the piston and connecting rod assemblies on the cylinder head side when removing them. At this time, do not allow the connecting rod to contact the crank pin.
2. Mark the cylinder number on the piston and connecting rod, and place together with the removed bearing cap (1, Fig.12-4) and crank pin bearing (2, Fig.12-4) so that they can be returned to the same positions during the reassembly process.
3. Remove the crank pin bearing (3, Fig.12-4) on the piston side.
4. Remove the circlip (5, Fig.12-4) from one end of the piston pin (4, Fig.12-4).
5. Take out the piston pin and remove the connecting rod (7, Fig.12-4) from the piston (6, Fig.12-4).
6. Remove the piston rings (8, Fig.12-4) and oil ring (9, Fig.12-4) using a piston ring expander.

   Repeat the above procedure until all pistons are removed and disassembled.

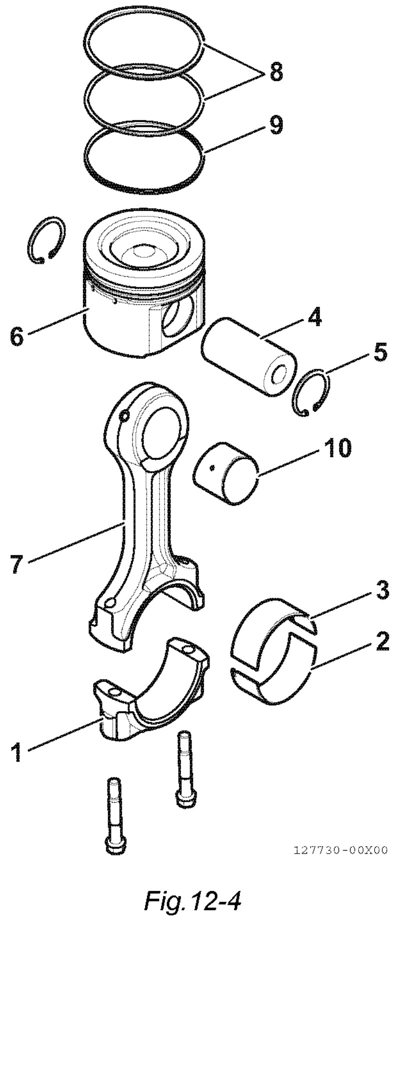


Fig.12-4

1. Inspecting the Pistons

Inspect the removed pistons, piston rings, and piston pins.

Note • *On an engine with low hours, the pistons and piston rings may be reused if they are found to be within specifications. The pistons and piston rings must be reinstalled in the same cylinders from which they were originally removed.*

• *On an engine with high hours, the pistons rings should be replaced and the cylinder honed (see 0200-02-04-01 "Cylinder Block Honing and Boring") or replaced. The piston should be replaced as necessary.*

1.1 Piston cleaning

1 - Clean the piston ring grooves using a piston ring groove cleaning tool. Follow manufacturer's instructions for correct operation.

2 - Wash the pistons in an appropriate solvent using a soft brush.

3 - Visually inspect each piston for cracks. Pay particular attention to the ring lands between the piston ring grooves.

1.2 Measuring the piston outer diameter

Measure the outer diameter of the piston in the direction perpendicular to the piston pin hole using a micrometer (Fig.12-5). Measure it at the specified position (23.5 mm) from the bottom of the piston, and record the measured value. For standard value, see 0000-07-01-03 "Piston".

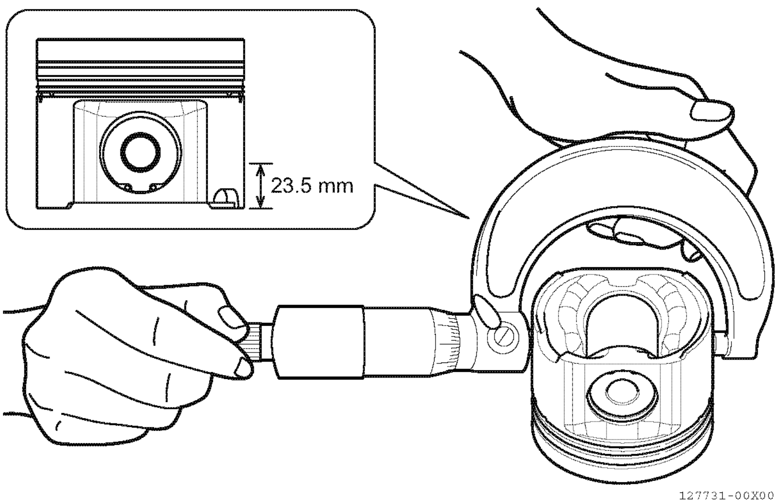


Fig.12-5

1.3 Clearance between piston and cylinder

Subtract the measured piston skirt outer diameter from the maximum value of the cylinder inner diameter acquired during cylinder block inspection. Record the measurement. For standard values, see 0000-07-01-03 "Piston".

1.4 Measuring the inner diameter of the piston pin bore

Measure the inner diameter of the piston pin bore on both sides of the piston (Fig.12-6). Record the measurement. For standard values, see 0000-07-01-03 “Piston”.

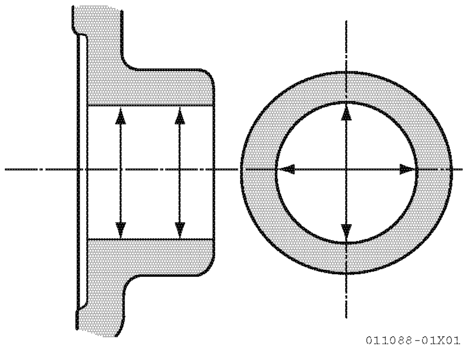


Fig.12-6

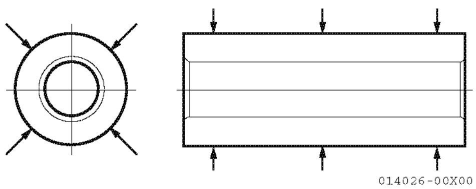


Fig.12-7

1.5 Measuring the piston pin outer diameter

Measure the outside diameter of the piston pin in three places and at 90° (Fig.12-7). Record the measurement. For standard values, see 0000-07-01-03 “Piston”.

1.6 Measuring the piston ring thickness

Using a micrometer, measure the thickness of each piston ring. Record the measurement. For standard values, see 0000-07-01-03 “Piston”.

Note
- *On an engine with low hours, the pistons, piston rings and cylinders may be reused if they are found to be within specifications.*
- *On an engine with high hours, the pistons rings should be replaced and the cylinder honed (see 0200-02-04-01 “Cylinder Block Honing and Boring”) or replaced. The piston should be replaced as necessary.*

1.7 Measuring the clearance between the piston ring and groove

Use a feeler gauge and measure the clearance between the piston ring and groove for each piston ring and corresponding groove as shown in Fig.12-8. Record the measurement. For standard values, see 0000-07-01-03 “Piston ring”. If the value exceeds the standard, replace the ring or piston.

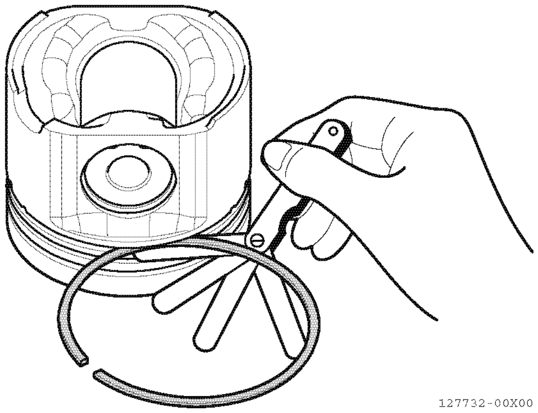


Fig.12-8

1.8 Measuring the piston ring end gap

To measure the piston ring end gap, insert each piston ring (1, Fig.12-9) one at a time into the cylinder. Use a piston with the piston rings removed to slide the ring into the cylinder bore until it is approximately 30 mm from the bottom of the cylinder (2, Fig.12-9). Then remove the piston, and measure the piston ring end gap inside the cylinder using a gauge (3, Fig.12-9). Measure the end gap of each piston ring. Record the measurement. For standard values, see 0000-07-01-03 “Piston ring”.

Note: Always check the piston ring end gap when installing new piston rings. For standard values, see 0000-07-01-03 “Piston ring”. Use a piston ring end gap filing tool to adjust the piston ring end gap on new piston rings.

Repeat the above steps for each cylinder and piston assembly.

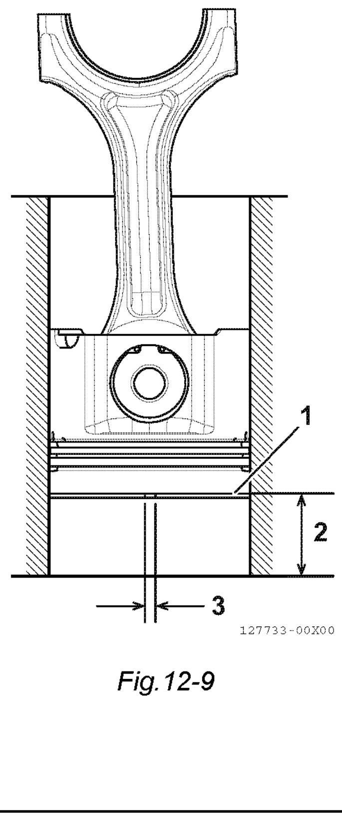


Fig.12-9

2. Inspecting the Connecting Rods (After Disassembly)

Inspect the removed connecting rods.

2.1 Measuring the connecting rod and piston pin bearing inner diameter

Use a cylinder gauge (1, Fig.12-10) and measure the inner diameter of the piston pin bearing (2, Fig.12-10). If the value exceeds the standard, replace the bearing. For standard values, see 0000-07-01-03 “Connecting rod”. If the bearing was removed, measure the inner diameter of the connecting rod small end. For standard values, see 0000-07-01-03 “Connecting rod”.

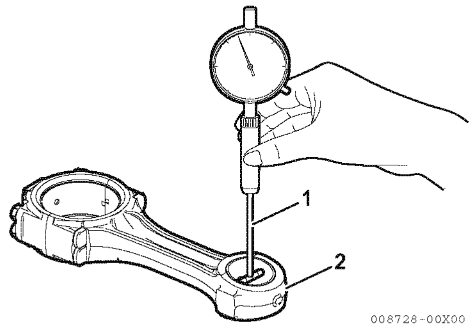


Fig.12-10

2.2 Measuring the inner diameter of the connecting rod crank pin bearing

Install the crank pin bearing (1, Fig.12-11) to the connecting rod large end (2, Fig.12-11) and bearing cap (3, Fig.12-11). Install the bearing cap on the connecting rod, and tighten to the specified torque (4, Fig.12-11). Measure the crank pin bearing inner diameter (5, Fig.12-11). For standard values, see 0000-07-01-03 “Crankshaft”.

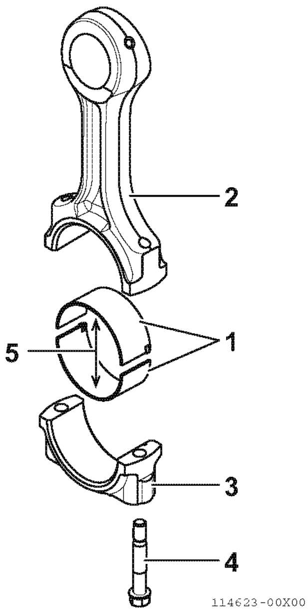


Fig.12-11

1. Assembling the Pistons

1. If the piston pin bearing (8, Fig.12-12) is removed, prepare a new piston pin bushing, and use a press and an appropriate service tool to attach while aligning the oil holes. Align the lubricating oil holes.
2. Attach one circlip (5, Fig.12-12) to the piston (6, Fig.12-12). Make sure that the circlip fits the groove.
3. Be careful not to mistake the direction when assembling the piston and the connecting rod (Fig.12-13).
   - Outer diameter identification mark (L, ML, MS, S) (1, Fig.12-13) and “107” identification mark (2, Fig.12-13) of the piston should face the intake side, and the piston notch (3, Fig.12-13) should be on the exhaust side.
   - Rod embossed mark (4, Fig.12-13) of the connecting rod should face the flywheel side, and the matching mark of the connecting rod and the cap (5, Fig.12-13) should be on the exhaust side.
4. Apply lubricating oil to the piston pin (4, Fig.12-12), and penetrate through the piston and connecting rod.
5. Attach the other circlip (9, Fig.12-12) and make sure it is securely seated in the groove.

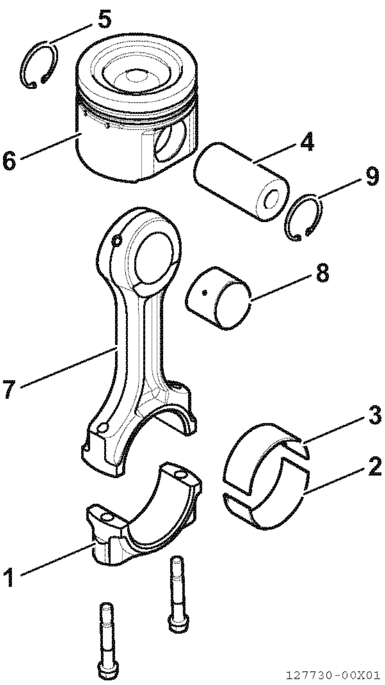


Fig.12-12

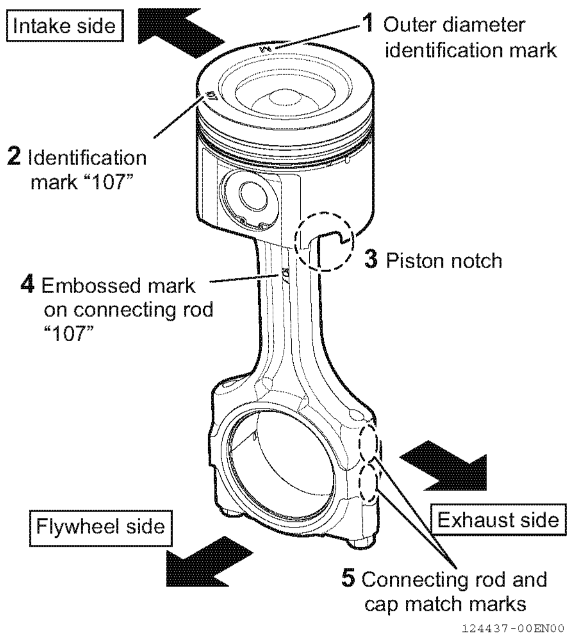


Fig.12-13

If the piston ring is removed, attach the piston ring.

NOTICE

When installing the piston ring, always use the piston ring expander.
Never attempt to install piston rings by hand.

6. Attach the coil expander (4, Fig.12-14) of the oil ring. Install the oil ring (3, Fig.12-14) so that the end gap of the oil ring is positioned 180 degrees from the end gap of the coil expander. The oil ring and the coil expander does not have a specific direction.
7. Attach a second compression ring (2, Fig.12-14). The second ring has a certain face. A mark (1, Fig.12-15) is embossed on the upper face by the end gap. The second ring says “2T”. Attach the ring so that this mark faces the upper side of the piston. The top and bottom of the cross section of the second ring are flat (parallel).
8. Attach a top compression ring (1, Fig.12-14). The top ring also has a certain face. A mark is embossed on the upper face by the end gap, same as the second ring. The top ring says “T”. Attach the ring so that this mark faces the upper face of the piston. The inside of the cross section of the top ring is thin.

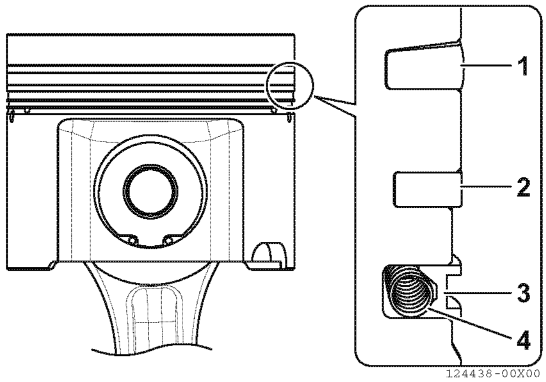


Fig.12-14

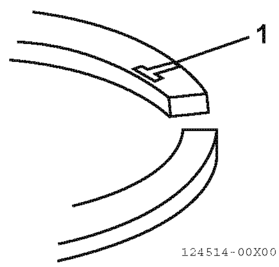
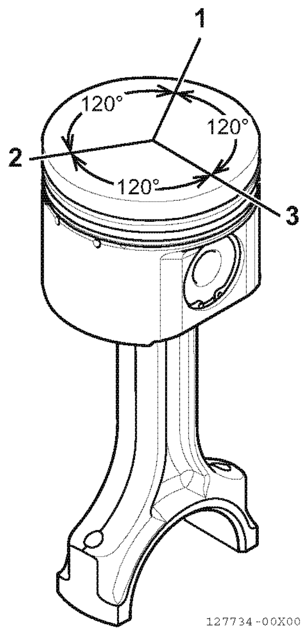


Fig.12-15

9. Alternately arrange the end gap of each piston ring so that there is 120° space between each other (1, 2, 3, Fig.12-16). Do not position the top compression ring end gap (1, Fig.12-16) in line with the piston pin.



1 -	End gap of top compression ring
2 -	End gap of second compression ring
3 -	End gap of oil ring

Fig.12-16

*Note: If installing new piston rings, the end gap must be checked, and adjusted as necessary.
For inspection, see 1202-02-02-02 “Inspecting the Pistons: Measuring the piston ring end gap”.
Use a piston ring end gap filing tool to adjust the piston ring end gap.*

2. Attaching the Piston and Connecting Rod

The procedure to insert the piston and connecting rod assembly to the cylinder block and to attach to the crankshaft is explained below.

1. Make sure that each end gap in the piston rings is in the correct position. (See Fig.12-16).
2. Apply clean lubricating oil to piston, piston ring, and cylinder.
3. Rotate the crankshaft so that the crankpin of the piston being installed is near the bottom dead center.
4. Compress the piston ring by using a piston ring compressor tool.
5. Check the inserting direction of the piston and connecting rod assembly to the cylinder block.
   - Outer diameter identification mark (1, Fig.12-13) and “107” identification mark (2, Fig.12-13) of the piston should face the intake side, and the piston notch (3, Fig.12-13) should be on the exhaust side.
   - Rod embossed mark (4, Fig.12-13) of the connecting rod should face the flywheel side, and the matching mark of the connecting rod and the cap (5, Fig.12-13) should be on the exhaust side.
6. Attach the piston-side crank pin bearing (1, Fig.12-17) to the connecting rod (2, Fig.12-17), and apply clean engine lubricating oil to the bearing surface. Also attach the bearing cap-side (3, Fig.12-17) crank pin bearing (4, Fig.12-17) to the cap, and apply engine lubricating oil to the bearing surface.
7. Slowly insert the piston and connecting rod assembly to the cylinder block, and attach to the crankshaft.
8. Attach the bearing cap, apply engine lubricating oil to the thread part of the connecting rod bolt (5, Fig.12-17) and the bolt seat, and temporarily tighten with 25 N·m first. Next, after tightening the rod bolt on the other side with 49 N·m, angle-tighten at 45°. Return to the first bolt, and after tightening with 49 N·m, angle-tighten at 45°.

Tightening torque	Connecting rod bolt (M10 × 1.0)	Refer to the above angle tightening procedure

9. Attach the remaining pistons and connecting rods in their respective cylinders.

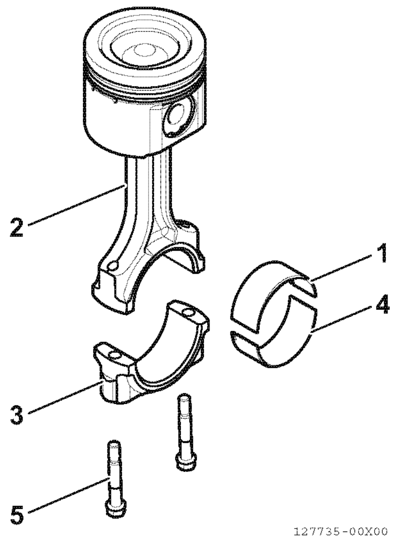


Fig.12-17

When disassembling and removing the crankshaft, the flywheel and the crankshaft oil seal case should be removed beforehand. For removal of the flywheel, see 0300-02-01-01 “Removing the flywheel”. Here, procedures for removing the crankshaft pulley on the cooling fan side and removing the oil seal case are described.

1. Removing the Crankshaft Pulley

After removing the cooling system such as the cooling fan belt, belt tensioner, and the cooling water pump, loosen the 4 pulley attaching bolts (2, Fig.13-1) from the crankshaft (1, Fig.13-1), and remove the crankshaft pulley (3, Fig.13-1) and oil seal cover (4, Fig.13-1). When loosening the pulley attaching bolt, attach a stopper on the flywheel side so that the crankshaft does not turn. Therefore, carry on before removing the flywheel.

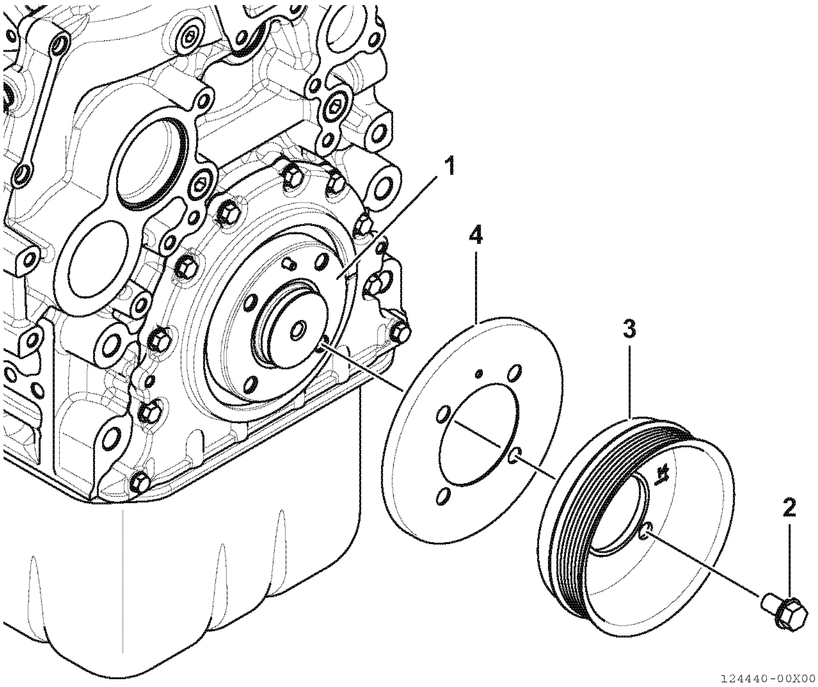


Fig.13-1

2. Removing the Oil Seal Case

Remove the M8 bolts × 10 (2, Fig.13-2) that fix the oil seal case (1, Fig.13-2) to the cylinder block.
Next, loosen the M8 bolts × 6 (4, Fig.13-2) fastening the oil pan (3, Fig.13-2), and remove the oil seal case and oil seal (5, Fig.13-2). If the liquid gasket is sticking and is hard to remove, insert the M8 bolts into two jack bolt holes as shown in the arrows, and remove it.

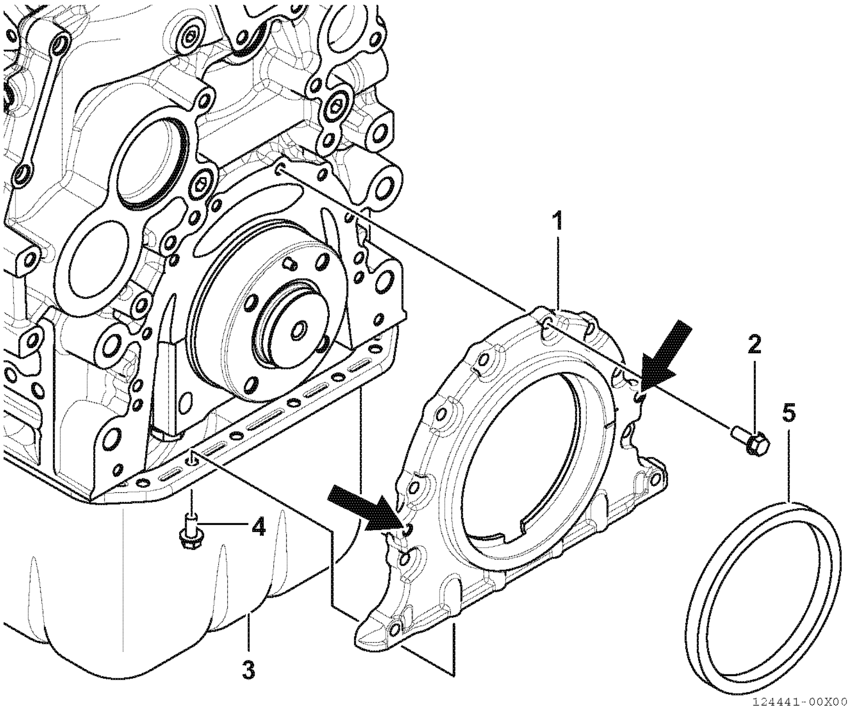


Fig.13-2

1. Inspecting the Crankshaft (Before Disassembly)

Prior to removing the crankshaft, place the engine with the cylinder head side is facing down.

1.1 Measuring the crankshaft end play

Before removing the main bearing cap, measure the crankshaft end play. Use either of the following two methods.

1 - Install a dial gauge (1, Fig.13-3) on the cylinder block. Move the crankshaft (2, Fig.13-3) back and forth to measure the end play. Record the measurement.

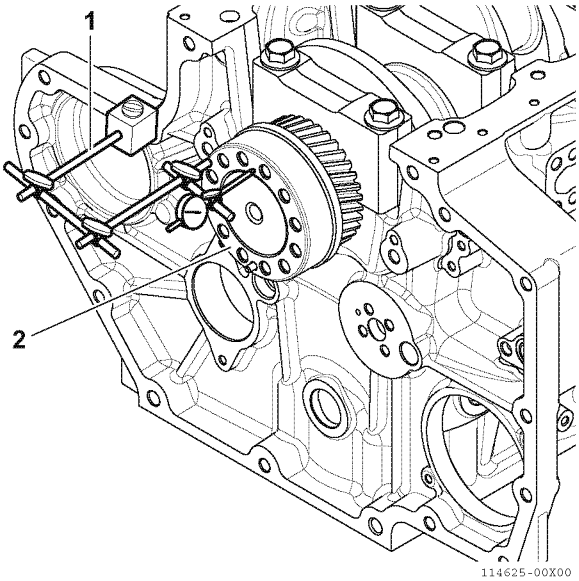


Fig.13-3

2 - Use a feeler gauge to measure the clearance (3, Fig.13-4) between the thrust bearing (1, Fig.13-4) and crankshaft (2, Fig.13-4). Record the measurement. For limit values, see 0000-07-01-03 “Thrust bearing”. If not within specifications, replace the thrust bearing or crankshaft.

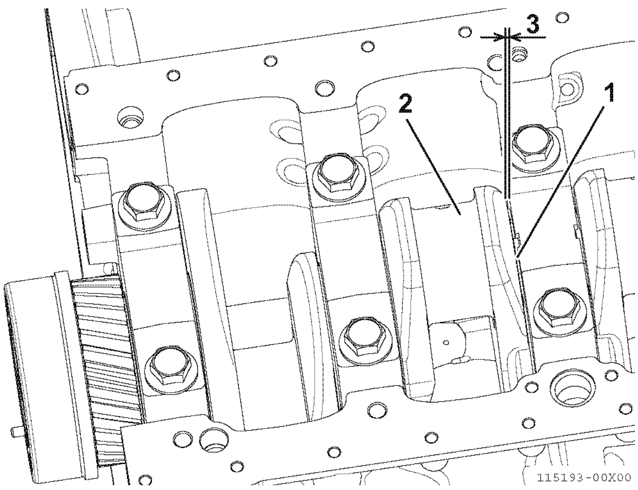


Fig.13-4

1.2 Measuring the crankshaft bearing oil clearance

Measure bearing oil clearance prior to removing the crankshaft to determine extent of wear.

1 - Loosen the bearing cap bolts (1, Fig.13-5) and remove the bearing cap (2, Fig.13-5). Each bearing cap has the journal number punch mark. Make sure they can be reinstalled with the same pair.

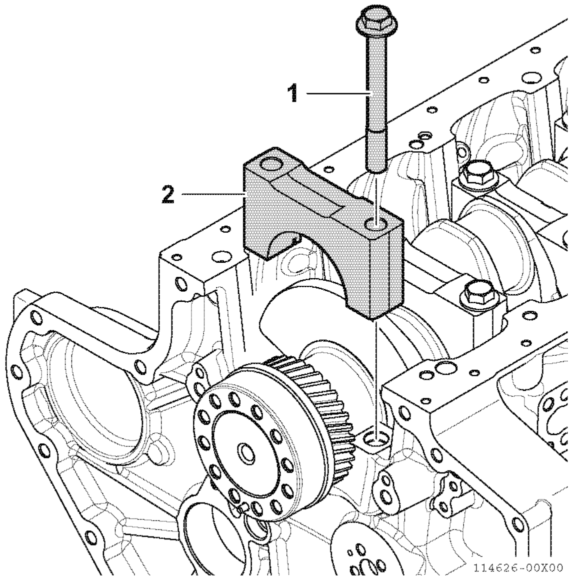


Fig.13-5

2 - Remove the engine lubricating oil from the bearing and crankshaft journals.

3 - Place PLASTIGAGE (1, Fig.13-6) along the full width of the bearing.

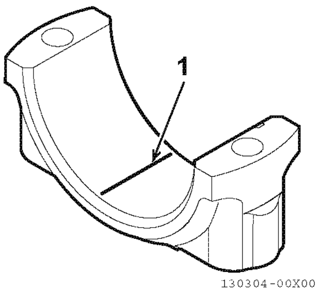


Fig.13-6

NOTICE

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

4 - Install the bearing cap and tighten the bolt to the specified torque.

See 1301-02-03-01 “Attaching the Crankshaft”.

5 - Remove the bearing cap.

6 - Compare the width of the flattened part of the PLASTIGAGE (1, Fig.13-7) to the graduation marks on the package (2, Fig.13-7).
The mark that most closely matches the width of the flattened PLASTIGAGE will indicate the bearing oil clearance. Record the measurement. For standard values, see 0000-07-01-03 “Crankshaft”.
If the value exceeds the standard, replace the bearing.

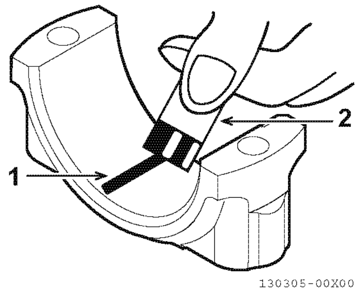


Fig.13-7

1. Removing the Crankshaft

After completing measurement of the crankshaft bearing oil clearance, remove the crankshaft from the engine.

1. Remove the bearing cap (1, Fig.13-8), bearing on the oil pan side (2, Fig.13-8), and thrust bearing (3, Fig.13-8). Mark each part so that they can be reinstalled in the same sequence.
2. Remove the crankshaft (4, Fig.13-8). The crankshaft is heavy. Use a crane or other means to hoist it up.

   Note: Do not remove the crankshaft gear unless the crankshaft gear or crankshaft is damaged or requires replacement.
3. Remove the bearing on the piston side (5, Fig.13-8) and thrust bearing (6, Fig.13-8). Mark each part so that they can be reinstalled in the same sequence.

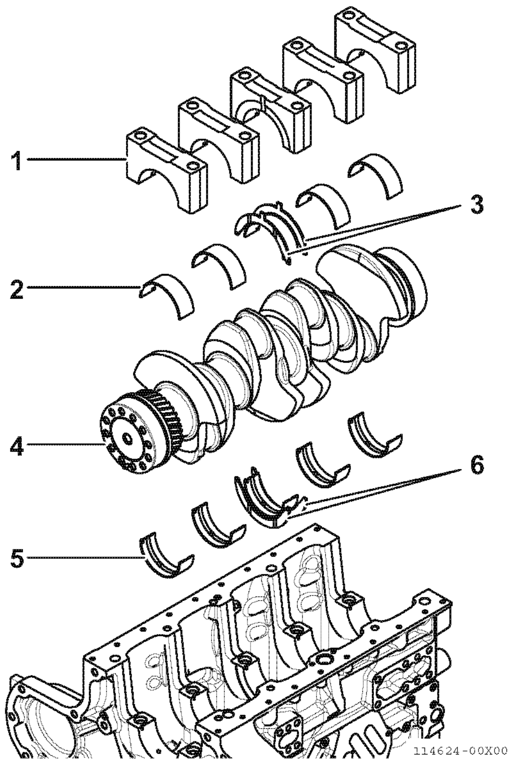


Fig.13-8

2. Inspecting the Crankshaft (After Disassembly)

Inspect the removed crankshaft.

1. Place the crankshaft end journals (4, Fig.13-9) on V-blocks.
2. Place the dial indicator (3, Fig.13-9) on a center main bearing surface.

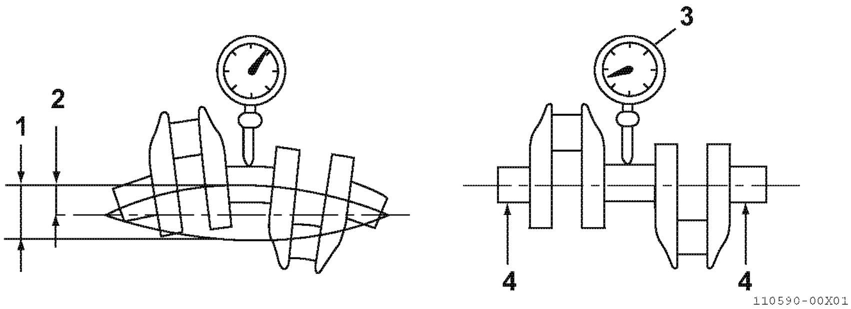
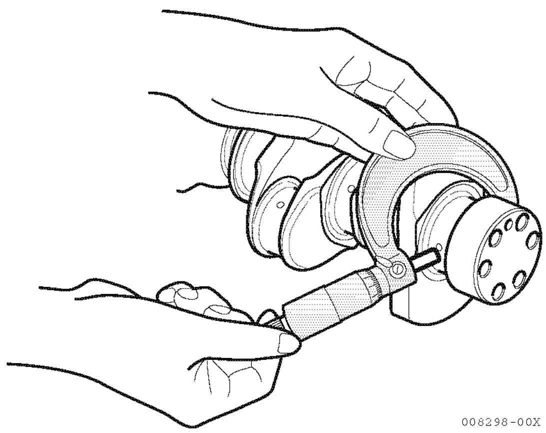


Fig.13-9

3. Rotate the crankshaft, and measure the crankshaft runout (1, Fig.13-9). The crankshaft bend (2, Fig.13-9) is 1/2 of the value measured on the dial gauge. If the bending value exceeds the standard value, replace the crankshaft. For standard value, see 0000-07-01-03 “Crankshaft”.
4. Use the color check method or Magnaflux to inspect the crankshaft for cracks. Replace the crankshaft if evidence of fractures are found.
5. Using a micrometer, measure the outer diameter of each crankshaft journal (1, Fig.13-10) and crank pin (2, Fig.13-10). Take measurements at several places around each bearing surface. For standard values, see 0000-07-01-03 “Crankshaft”. If the value exceeds the standard, grind the journals and install undersize bearings, or replace the crankshaft.



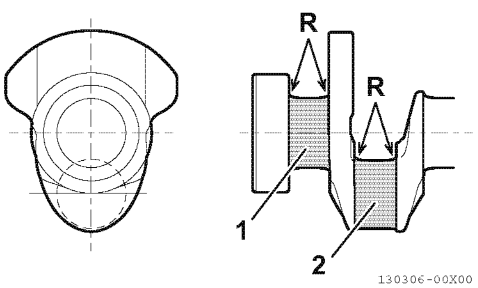


Fig.13-10

1. Attaching the Crankshaft

1. Attach the removed crank pin bearing (up) (piston side) (1, Fig.13-11) to the original position of the cylinder block. Here, attach the protruded part of the bearing (2, Fig.13-11) so that it fits the groove on the block side (3, Fig.13-11). Apply plenty of clean engine lubricating oil to the gasket surface.
2. Lift the crankshaft (4, Fig.13-11) using a crane, and slowly place it on the cylinder block.
3. On both sides of the center bearing, insert a thrust bearing (up) (5, Fig.13-11) with its flat surface facing to the middle.
4. Apply clean lubricating oil to the journal part of the crankshaft. Then, attach the removed crank bearing (low) (oil pan side) (6, Fig.13-11) to the original position of the crankshaft. Attach so that the protruded part of the bearing fits the groove of the bearing cap.
5. Attach the removed bearing cap (7, Fig.13-11) to the original position. The bearing cap is engraved with a journal number and an arrow facing up. The journal numbers 1 to 5 count up from the flywheel side, and the arrow points the flywheel. Check the number and the arrow, and attach with the correct position. Journal numbers 1 to 5 are engraved also on the cylinder block side corresponding to the metal cap.
6. On both sides of the center bearing, insert a thrust bearing (low) (8, Fig.13-11) with its flat surface facing to the middle.
7. Apply clean engine lubricating oil and extreme pressure additive (5 %) to the thread part of the bearing cap bolt (9, Fig.13-11) and the bolt seat, and temporarily tighten the No.1 bolt on the fan side with 25 N·m. Next, after tightening the No. 2 bolt with 65 N·m, angle-tighten it at 105°. Return to No. 1. Tighten with 65 N·m and angle-tighten at 105°. Repeat this from No. 3 and after.

Tightening torque	Bearing cap bolt (M16 × 1.5)	Refer to the above angle tightening procedure

8. Turn the crankshaft, and make sure that it moves smoothly.

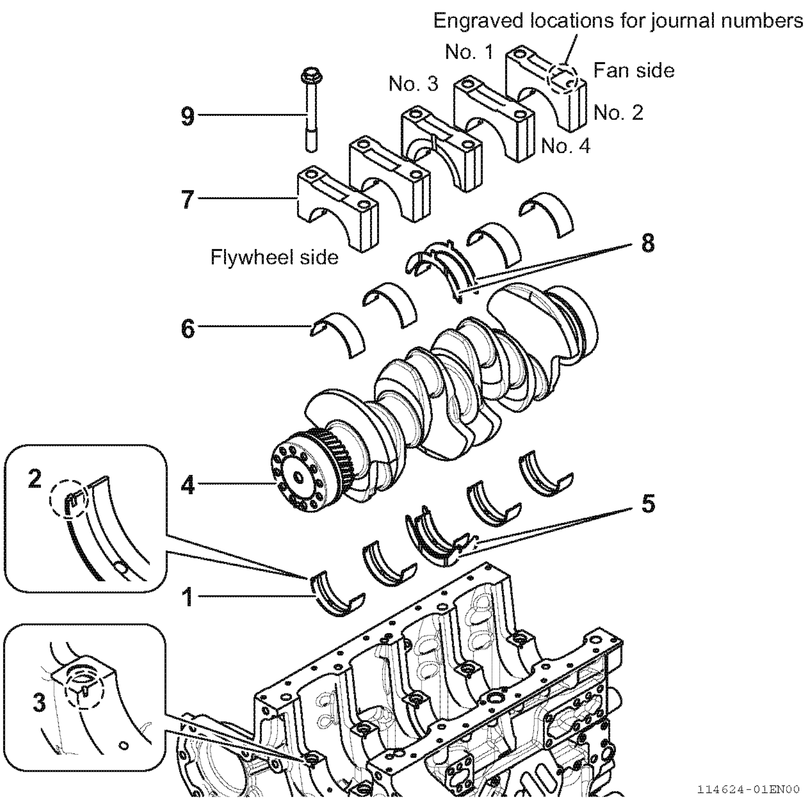


Fig.13-11

2. Attaching the Oil Seal Case

Install the oil seal case (1, Fig.13-12) on the cooling fan side to the cylinder block.
Apply liquid gasket to the oil seal case attaching surface (2, Fig.13-12) of the oil pan, and attaching surface with the cylinder block on the oil seal case side. Be sure to sufficiently apply the liquid gasket without gaps. Apply gasket in a circular motion to the bolt-attaching holes.
Attach the cylinder block positioning pin (3, Fig.13-12) to the pinhole of the oil seal case.
Tighten the M8 bolt ×10 (4, Fig.13-12) on the cylinder block side and M8 bolt × 6 (5, Fig.13-12) on the oil pan side with the standard specified torque.
Apply clean lubricating oil to the oil seal (6, Fig.13-12), and install the oil seal to the oil seal case.
If the crankshaft is provided with the oil seal lip line, slightly move the oil seal.
At that time, make sure that the oil seal does not tilt with respect to the crankshaft.

Liquid gasket	ThreeBond: YANMAR Part No. 977770-1207F

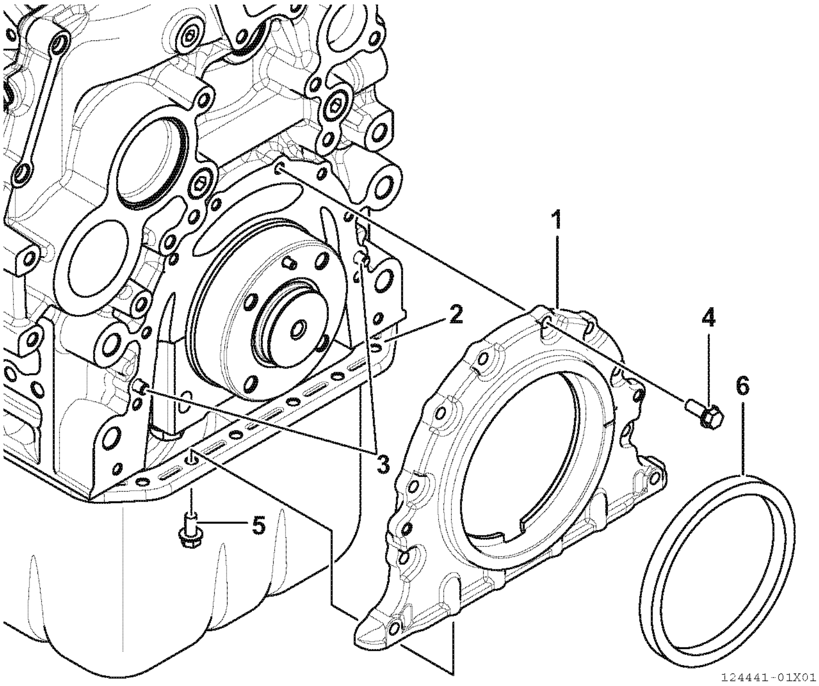


Fig.13-12

3. Attaching the Crankshaft Pulley

Attach a stopper on the flywheel side so that the crankshaft does not turn.
Match the pin hole of the oil seal cover (3, Fig.13-13) to the positioning pin (2, Fig.13-13) of the flange (1, Fig.13-13) on the cooling fan side of the crankshaft.
Attach the crankshaft pulley (4, Fig.13-13) by also matching the pin position.
Tighten the pulley attaching bolt M12 × 4 (5, Fig.13-13) to the standard specified torque.
Remove the stopper on the flywheel side.

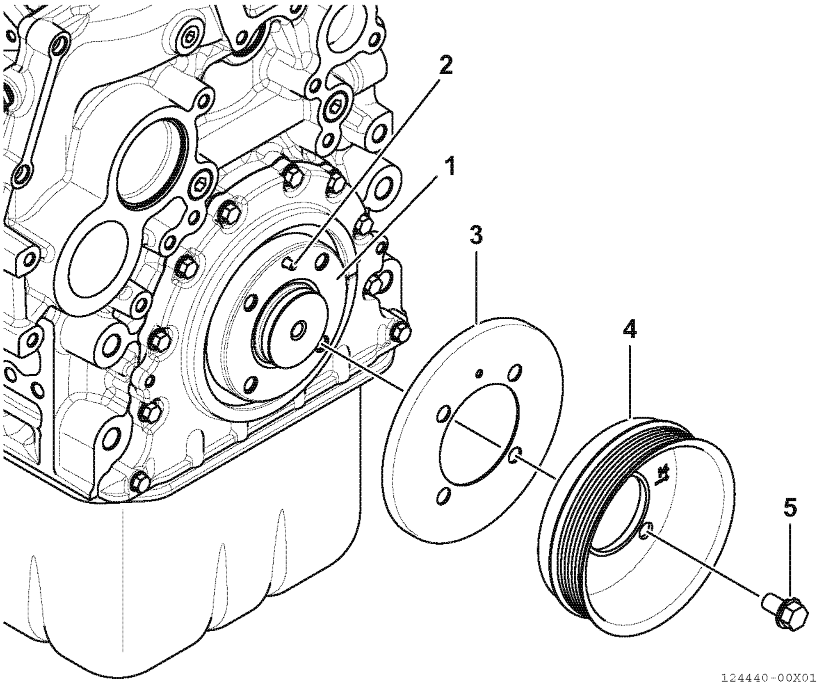


Fig.13-13

1. How to Remove the Cylinder Head

The procedure for how to only remove the cylinder head from the engine, when mounted on a driven machine, is described below. For removing the cylinder head while entirely disassembling a single engine, refer to 0100-02-01-01 “Disassembling the Engine”.

The procedures of the items marked with * are listed in this section.

1. Drain the engine coolant. 4000-02-04-01
2. Cut the fuel, remove the discharge/return fuel hoses connected to the fuel filter, and remove the fuel filter together with the fuel filter bracket. (1, Fig.14-1)
3. Open harness cover (bonnet), and take out the harness by removing the couplers of the sensors and valve signals that are connected to the cylinder head (2, Fig.14-1). Also remove the harness coupler connected to the glow plug. 7200-02-01-01
4. Remove the 2-stage turbocharger and the turbocharger lubricating oil pipe. (4TN107TT, 4TN107FTT) (3, Fig.14-1) 2400-02-01-01
5. Remove the single-stage turbocharger and the turbocharger lubricating oil pipe. (4TN107HT, 4TN107FHT) 2400-02-01-02
6. Remove the exhaust manifold. (4, Fig.14-1)
7. Remove the intake system parts (intake throttle valve, intake collector, EGR valve, etc.). (5, Fig.14-1) 2300-02-01-01

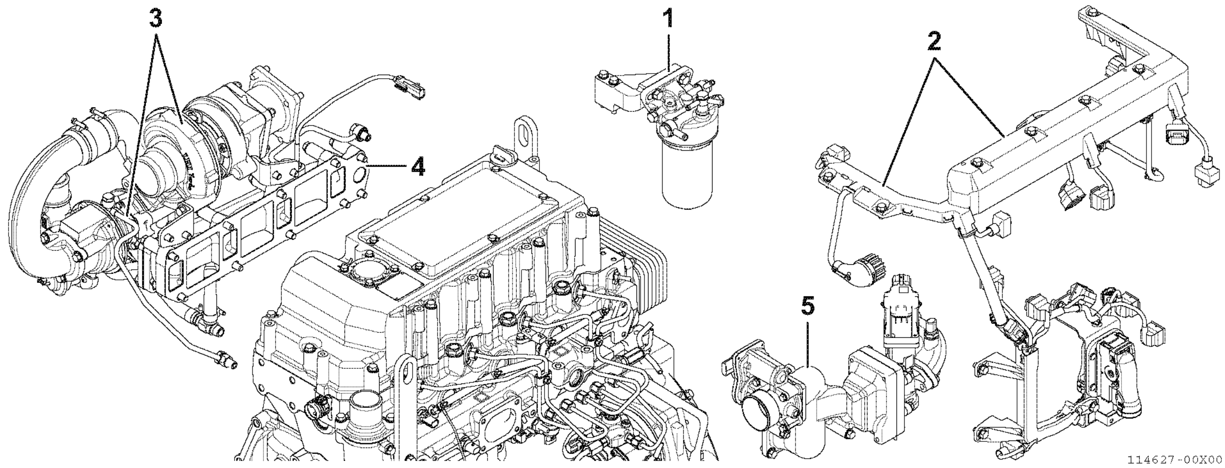


Fig.14-1

Inspection and maintenance

8. Remove the high-pressure fuel pipe. (1, Fig.14-2)	5400-02-01-01
9. Remove the bonnet and breather hose. (2, Fig.14-2)	1404-02-01-01*
10. Remove the harness for injector signal.	5300-02-01-01
11. Remove the injector fuel leakage line assembly.	5300-02-01-01
12. Remove injectors. (3, Fig.14-2)	5300-02-01-01
13. Remove glow plugs.	7103-02-01-01

Note: For No. 10 to No. 13, it can be removed with the cylinder head taken out. The removal procedure is the same. Inspections and maintenance service that do not require removing do not need to be done.

14. Remove the rocker arm assembly, valve bridge, and push rod. (4, Fig.14-2)	1402-02-01-01*
15. Remove the EGR cooler. (5, Fig.14-2)	2300-02-01-02
16. Remove the thermostat case.	4000-02-01-02
17. Remove the cylinder head assembly (with the intake/exhaust valves assembled). (6, Fig.14-2)	1401-02-01-01*

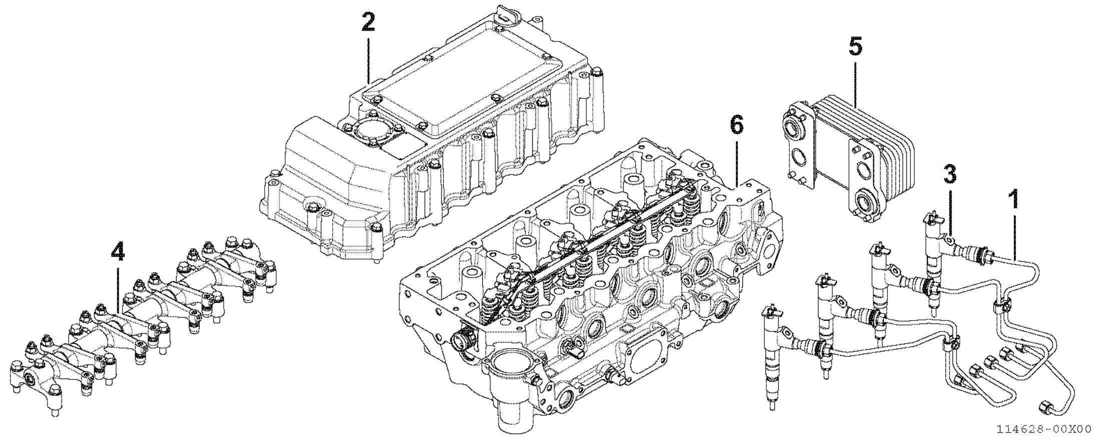


Fig.14-2

2. Removing the Cylinder Head Assembly (with the Intake/Exhaust Valves Assembled)

1. Remove the fuel return hose (1, Fig.14-3) from the injectors. According to the conditions of cylinder head disassembly and inspection, remove the coolant temperature sensor (2, Fig.14-3), intake temperature sensor (3, Fig.14-3), intake pressure sensor (4, Fig.14-3), and exhaust pressure sensor (5, Fig.14-3).

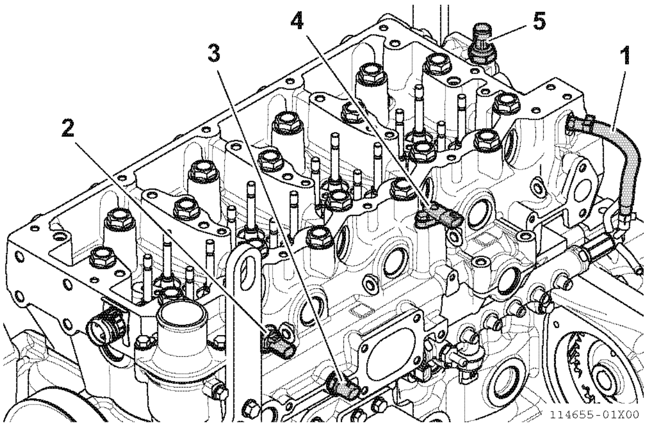


Fig.14-3

2. Loosen the cylinder head bolts following the sequence shown in Fig.14-4.

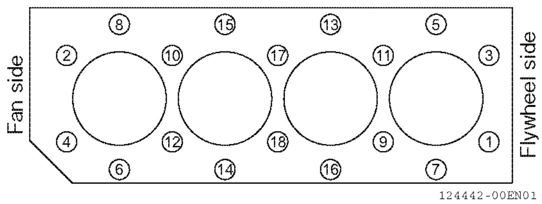


Fig.14-4

3. Remove the cylinder head bolts (1, Fig.14-5), then lift and remove the cylinder head from the cylinder block. Discard the cylinder head gasket (2, Fig.14-5). Position the cylinder head on the work bench to prevent damage to the combustion surface.

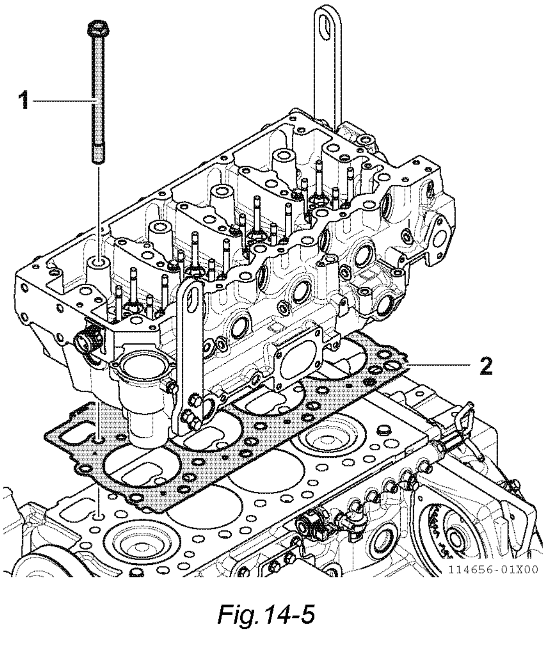


Fig.14-5

Inspect the removed cylinder head.

1. Inspecting the Cylinder Head Components

Visually inspect the parts. Replace any parts that are obviously discolored, heavily pitted or otherwise damaged. Discard all parts that exceed the standard value.

NOTICE

- Any part which is found defective as a result of inspection or any part whose measured value does not satisfy the standard must be replaced.
- Any part determined to not meet the service standard before the next service, as determined from the state of current rate of wear, should be replaced even if the part currently meets the service standard.

2. Cylinder Head Distortion

1. Place the cylinder head flat and inverted (combustion side up) on the bench. Use a straight edge and a feeler gauge to measure cylinder head distortion (Fig.14-6). Measure diagonally and along each side. For standard value, see 0000-07-01-01 “Cylinder head”.

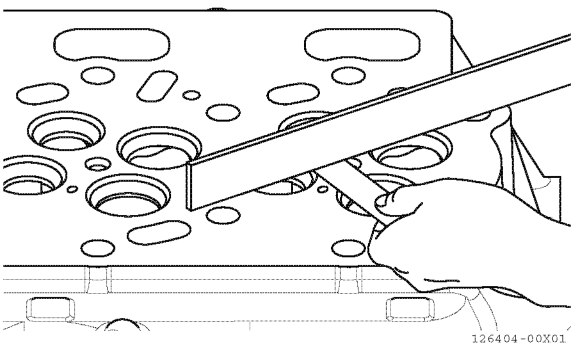


Fig.14-6

2. If distortion exceeds the standard, resurface or replace the cylinder head.
   Remove only enough material to make the cylinder head flat, but do not remove more than 0.20 mm.

1. How to Attach the Cylinder Head

The procedure for reassembling the cylinder head and surrounding parts to the engine is described below. For installing a cylinder head assembly after entirely disassembling a single engine, refer to 0100-02-03-02 “Engine assembly”.

The procedures of the items marked with * are listed in this section.

1.	Attach the cylinder head assembly (with the intake/exhaust valves assembled) to the cylinder block. (1,Fig.14-7)	1401-02-03-01*
2.	Set the push rod and valve bridge, and attach the rocker arm assembly. (2, Fig.14-7)	1402-02-03-01*
3.	Adjust the valve clearance.	1403-03-02-01*
4.	Install the injector, fuel return pipe, and the harness for injector signal. (3, Fig.14-7)	5300-02-03-01
5.	Attach glow plugs.	7103-02-03-01

Note: For No. 4 and No. 5, inspections and maintenance service that do not require removing are omitted.

6.	Attach the high-pressure fuel pipes. (4, Fig.14-7)	5400-02-03-01
7.	Attach the intake system parts (intake throttle valve, intake collector, EGR valve, etc.). (1, Fig.14-8)	2300-02-03-01
8.	Attach the exhaust manifold. (2, Fig.14-8)	
9.	Install the 2-stage turbocharger and the turbocharger lubricating oil pipe. (4TN107TT, 4TN107FTT) (3, Fig.14-8)	2400-02-03-01
10.	Remove the single-stage turbocharger and the turbocharger lubricating oil pipe. (4TN107HT, 4TN107FHT)	2400-02-03-02
11.	Attach the EGR cooler. (5, Fig.14-7)	2300-02-03-01
12.	Install the bonnet and breather hose. (6, Fig.14-7)	1404-02-03-01*
13.	Attach the thermostat assembly.	4000-02-03-01
14.	In the harness assembly, connect the harness couplers of the sensors and valve signals that are connected to the cylinder head, and install the harness cover (bonnet). (4, Fig.14-8) Also remove the harness coupler connected to the glow plug.	7200-02-03-01
15.	Attach the fuel filter (5, Fig.14-8) with the bracket, and then attach the fuel hose.	
16.	Refill the engine coolant.	4000-02-04-02

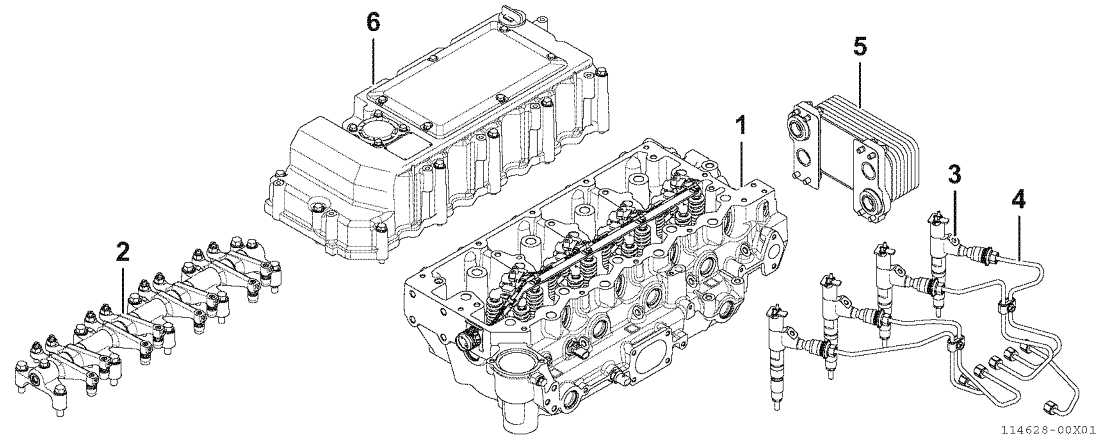


Fig.14-7

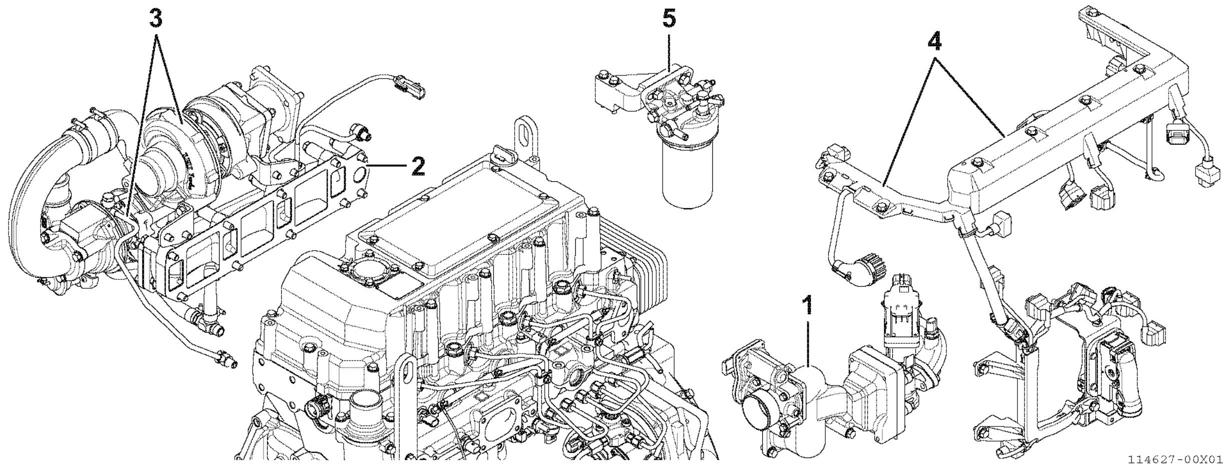


Fig.14-8

2. Attaching the Cylinder Head Assembly (with the Intake/Exhaust Valves Assembled)

1. Wash the combustion face of the cylinder head and the upper face of the cylinder head so that there are no residue.
2. Install the coolant gasket (1, Fig.14-9).
3. Install a new gasket (3, Fig.14-9) on to the cylinder block while matching to the two pipe knocks (2, Fig.14-9) on the cylinder block side.
4. Use a crane to place the cylinder head to the cylinder head gasket (4, Fig.14-9).
5. Apply clean lubricating oil to the thread part and the bolt seat of the cylinder bolt (5, Fig.14-9), and then attach the bolt.

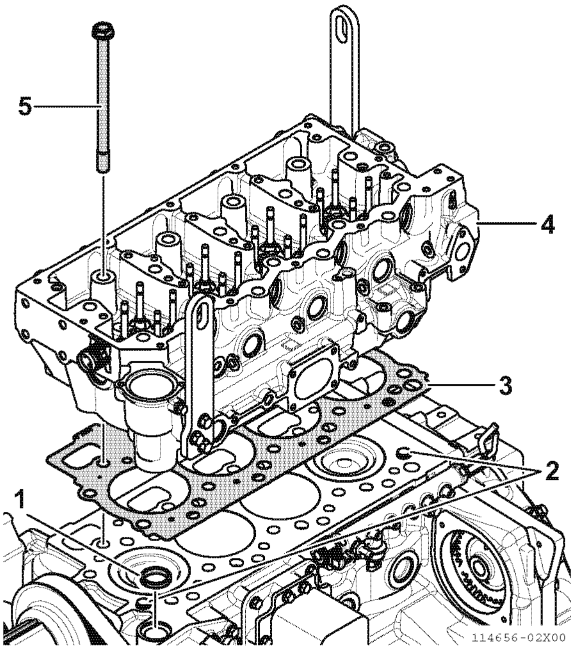


Fig.14-9

6. Tighten the cylinder head bolt with the following order.
   1 - Temporarily fasten all bolts by screwing them in without tools until they are tightened.
   2 - From (1) to (18), tighten with 30 N·m each, and then angle-tighten at 170°.
   3 - Return to bolt (1), and after tightening with 15 N·m, angle-tighten at 170°.
   Repeat this from (2) to (18).

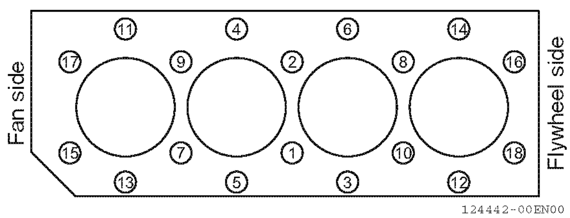


Fig.14-10

Tightening torque	Cylinder head bolt (M15 × 1.5)	Refer to the above angle tightening procedure

7. Attach the fuel return hose (1, Fig.14-11) from the injectors to the rail. Depending on the conditions when the cylinder head was disassembled, attach the coolant temperature sensor (2, Fig.14-11), intake temperature sensor (3, Fig.14-11), intake pressure sensor (4, Fig.14-11), and exhaust pressure sensor (5, Fig.14-11).

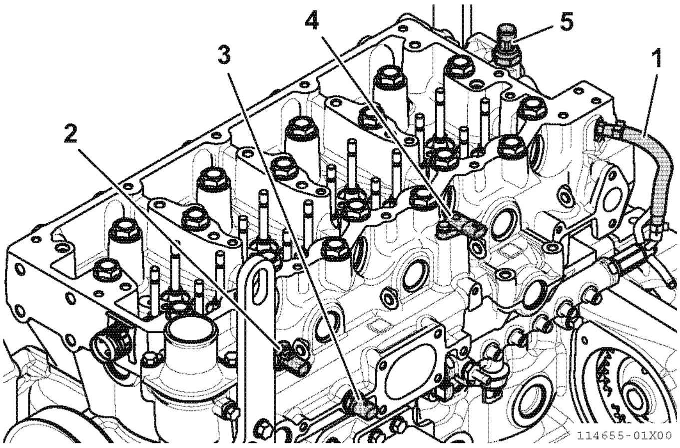


Fig.14-11

1. Cleaning the Cylinder Head Components

Thoroughly clean all components using a non-metallic brush and an appropriate solvent. Make sure that no carbon or filing scraps remain on the parts.

⚠ WARNING

Gas and Burn Hazard!

- **Always read and follow safety related precautions found on containers of hazardous substances like parts cleaners, primers, sealants and sealant removers.**
- **Failure to comply could result in death or serious injury.**

1. Components of Rocker Arm Assembly

As shown in Fig.14-12 rocker arm assembly includes a rocker arm shaft support B (2) that supports both ends of the rocker arm shaft (1), and a rocker arm shaft A (3) that supports the center part of the rocker arm shaft (1). Rocker arm shaft support B is fixed with fixing bolts (7). The rocker arm shaft has a rocker arm (intake) (4) and a rocker arm (exhaust) (5) to each cylinder, and the arms are retained by a wave washer (6).

One side of the rocker arm is pushed up with a push rod (8), and the intake/exhaust valves are pushed down via the valve bridge (9) on the opposite side.

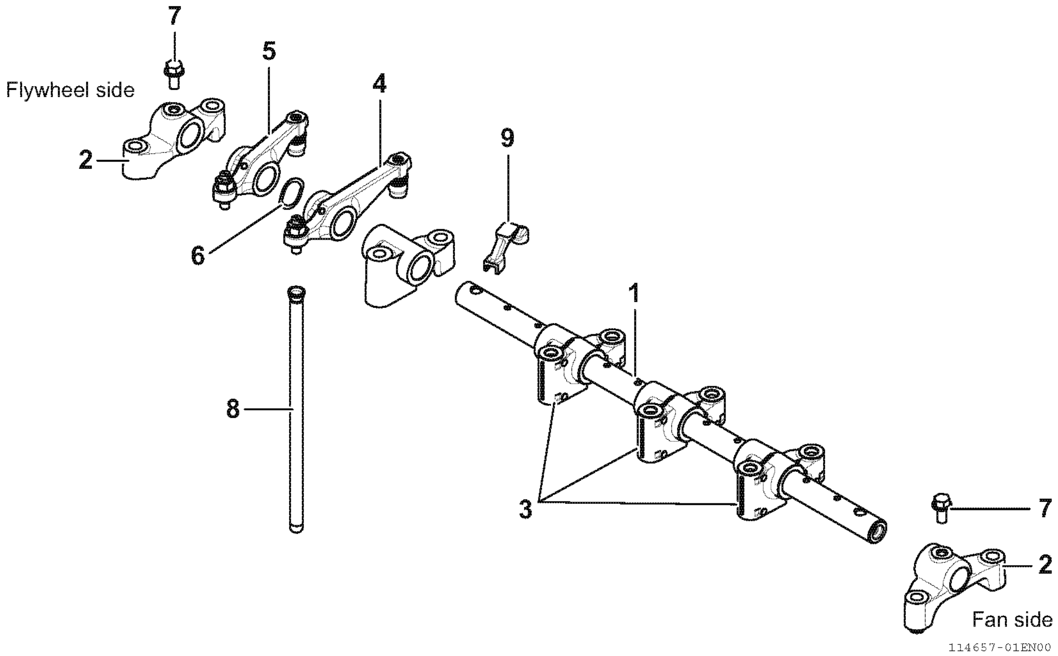


Fig.14-12

1 -	Rocker arm shaft	6 -	Wave washer
2 -	Rocker arm shaft support B	7 -	Rocker arm shaft support A fixing bolt
3 -	Rocker arm shaft support A	8 -	Push rod
4 -	Rocker arm (intake)	9 -	Valve bridge
5 -	Rocker arm (exhaust)		

2. Lubricating Oil Path of Rocker Arm Assembly

Lubricating oil of the rocker arm assembly is supplied from the oil hole (1, Fig.14-13) of the cylinder head, and goes through the oil hole (3, Fig.14-13) on the fan side out of the three parts of the rocker arm shaft support A into the support, and then into the rocker arm shaft (4, Fig.14-13). Lubricating oil sent to into the shaft goes through the holes (5, Fig.14-13) on the upper and lower parts of the shaft open at the attaching position of each rocker arm, into the oil hole (6, Fig.14-13) on the inside of the arm, to lubricate the contacting face (7, Fig.14-13) with the valve bridge from the tip of the arm.

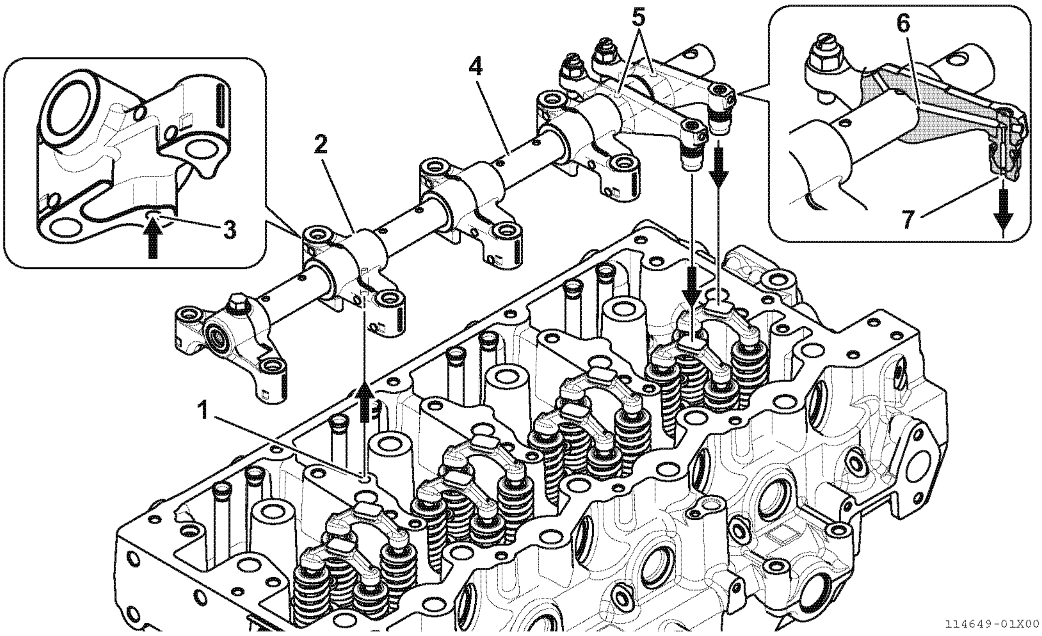


Fig.14-13

1. Removing the Rocker Arm Assembly

1. Remove the bolts that retain the rocker arm shaft support (1, Fig.14-14), and remove the rocker arm assembly (2, Fig.14-14) from the cylinder head.
2. Mark the push rods so that they can be reinstalled in the original positions. Remove the push rods (3, Fig.14-14). For the disassembly procedure of the rocker arm assembly, see 1402-02-01-02 “Disassembling the Rocker Arm Assembly”.

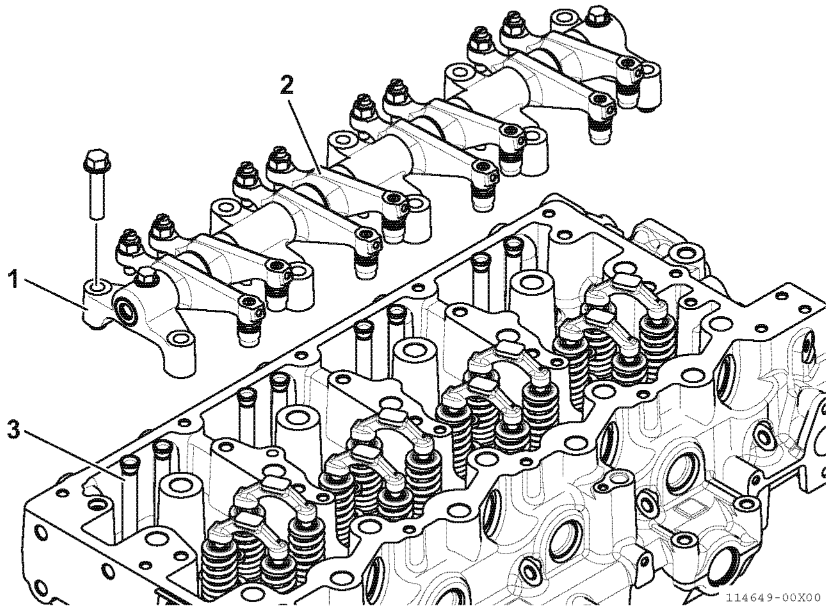


Fig.14-14

3. Remove the valve bridge (1, Fig.14-15). Mark it the so it can be reinstalled in the original position.

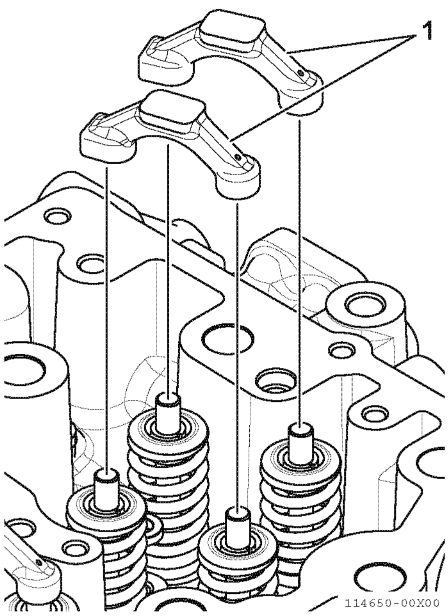


Fig.14-15

2. Disassembling the Rocker Arm Assembly

Inspect or maintain the rocker arm assembly in accordance with the following procedures.

1. After removing the rocker arm assembly from the cylinder head, remove the rocker arm shaft alignment studs (1, Fig.14-16) from the rocker arm shaft supports (2, Fig.14-16).
2. Slide the rocker arm shaft (3, Fig.14-16) out of the rocker arm shaft supports, rocker arms (4, Fig.14-16), and wave washer (5, Fig.14-16).

   Note: The rocker arm shaft fits tightly in the rocker arm supports. Clamp the support in a padded vise. Twist and pull out on the rocker arm shaft to remove. Reverse this process when you reinstall the rocker arm shaft into the supports.
3. Mark the rocker arms so that they can be reinstalled with the original matching valve and push rod (6, Fig.14-16).

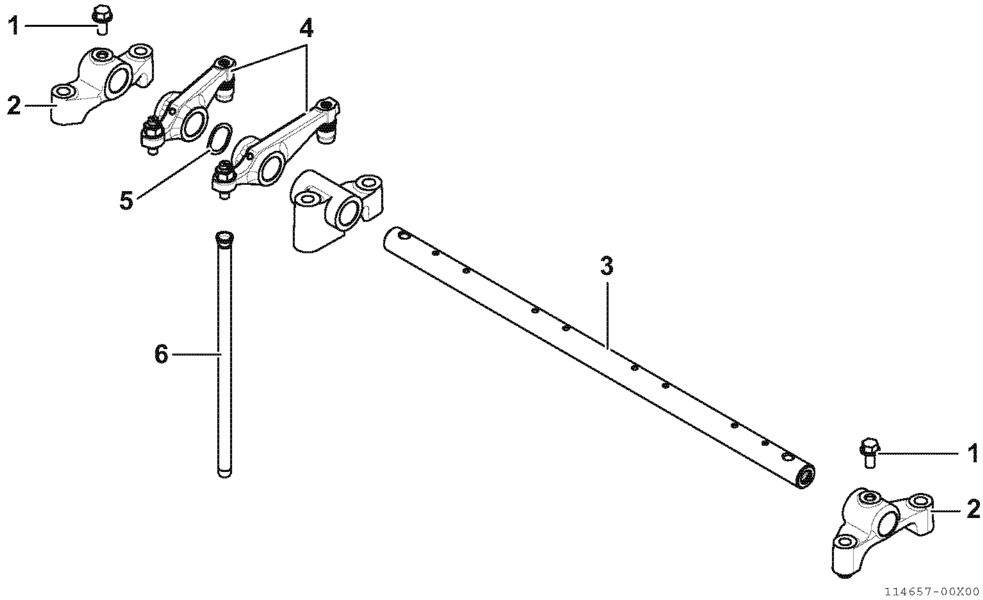


Fig.14-16

1. Rocker Arm Shaft Hole Diameter

Using a three-point micrometer or similar tool, measure the inner diameter of all rocker arms and the rocker arm supports to determine if the measured values are within the standard (Fig.14-17). For standard values, see 0000-07-01-01 “Rocker arm and shaft”.

Inspect the contact area of the push rod and valve bridge (1, 2, Fig.14-17), and check for excessive wear or damage. If the inner diameter exceeds the standard, or excessive wear is found on the contact area, replace the part.

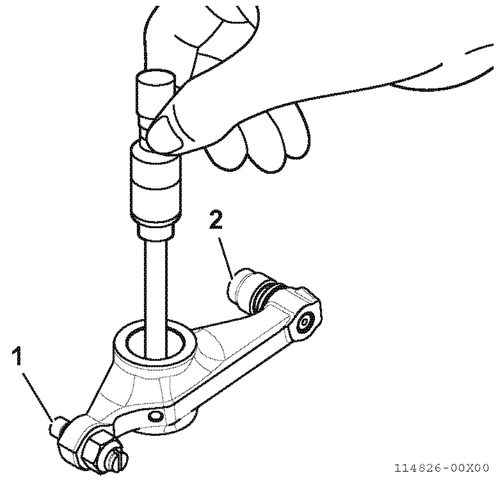


Fig.14-17

2. Rocker Arm Shaft Outer Diameter

Use a micrometer to measure the outer diameter of the rocker arm shaft. Measure at each rocker arm location in two directions 90° apart (Fig.14-18). For standard values, see 0000-07-01-01 “Rocker arm and shaft”.

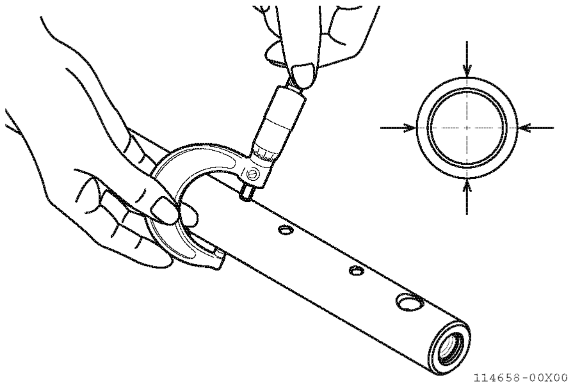


Fig.14-18

3. Push Rod Bend

Check if the bend of the push rods is within the standard.

1. Place the push rods on a flat inspection block or layout bed.
2. Roll the push rods until a gap can be observed between a portion of the push rod and the surface of the block or layout bed.
3. Use a feeler gauge to measure the gap (Fig.14-19).

   For standard values, see 0000-07-01-01 “Push rods”.

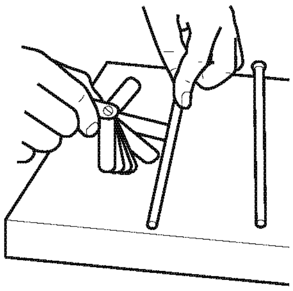


Fig.14-19

1. Reassembling the Rocker Arm Assembly

Steps for reassembling the disassembled rocker arm shaft are described below.

1. Lubricate the rocker arm shaft (1, Fig.14-20).
2. Insert the rocker arm shaft into the rocker arm shaft support B (2, Fig.14-20). The rocker arm shaft fits tightly in the rocker arm support B. Fix the support with a padded vise, and twist the rocker arm shaft to push it in.. Attach the fixing bolt (3, Fig.14-20) of the rocker arm shaft support B while matching with the hole position of the shaft (4, Fig.14-20).

Tightening torque	Rocker arm shaft support bolt (M8 × 1.25)	11.3 ± 2.5 N·m

3. In the order of rocker arm (intake) (5, Fig.14-20), wave washer (6, Fig.14-20), rocker arm (exhaust) (7, Fig.14-20), and rocker arm shaft support A (8, Fig.14-20), insert into the rocker arm shaft with the same position as disassembly, with the same valve and push rod combination.

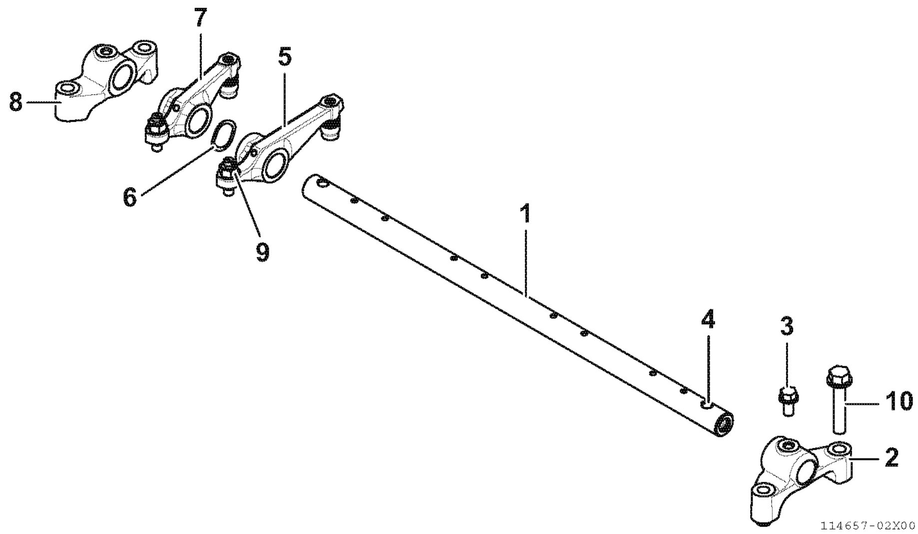


Fig.14-20

4. Fig.14-20 indicates the parts configuring one cylinder. The same direction applies for the rest of the cylinders as well.

2. Attaching the Rocker Arm Assembly

Attach the rocker arm assembly to the cylinder head.

1. Apply clean lubricating oil to the upper side of the push rod and the upper side of the valve bridge.
2. If the valve adjustment screw (9, Fig.14-20) is removed, attach the valve adjustment screw and the locknut.
3. Install the rocker arm assembly to the cylinder head, and tighten the fixing bolts (M10 × 45) (10, Fig.14-20) of the shaft support with the specified torque.

Tightening torque	Rocker arm assembly bolt (M10 × 1.5)	49.0 ± 4.9 N·m

4. Adjust the valve clearance. For adjusting the valve clearance, see 1403-03-02-01 “Measuring and Adjusting Valve Clearance”.

Disassembling the Intake and Exhaust Valves

1. Removing the Intake and Exhaust Valves

1. Place the removed cylinder head on the work bench with the combustion surface facing down.
2. Using the valve spring compressor tool, compress the valve spring (Fig.14-21).

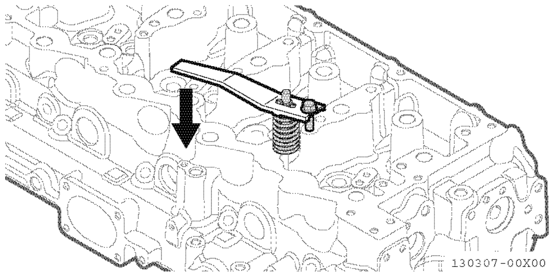


Fig.14-21

3. Remove the cotters (1, Fig.14-22).
4. Slowly release the tension in the valve spring.
5. Remove the spring retainers (2, Fig.14-22) and valve springs (3, Fig.14-22).

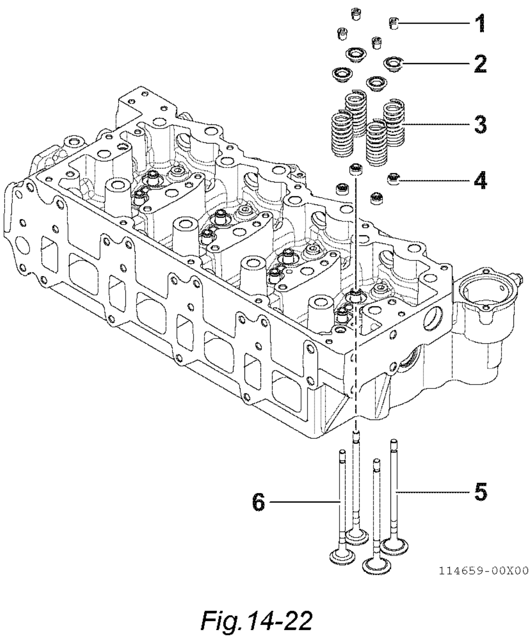


Fig.14-22

6. Repeat the procedure with all remaining valves.

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

7. Turn the cylinder head so the exhaust port faces down. Remove the intake valves (5, Fig.14-22) and exhaust valves (6, Fig.14-22) from the cylinder head.
8. Remove the valve stem seals (4, Fig.14-22).

2. Removing the Valve Guides

Inspect the valve guides. If a guide does not satisfy the standard value, use a drift pin and hammer to extract the valve guide (1, Fig.14-23) from the cylinder head.

Note: Removal of the valve guides should be postponed until inspection and measurement procedures have been performed. See 1403-02-02-01 "Inspecting the Valve Guides".

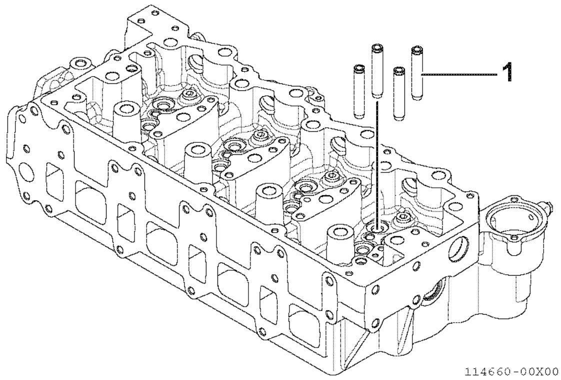


Fig.14-23

Inspecting the Intake and Exhaust Valves

1. Inspecting the Valve Guides

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

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

2. Use a telescoping gauge and micrometer to measure the inside diameter at each end of the valve guide. Measure in three places and 90° apart (Fig.14-24). For standard values, see 0000-07-01-01 “Intake/exhaust valves and valve guides”. If the value exceeds the standard, replace the valve guide.

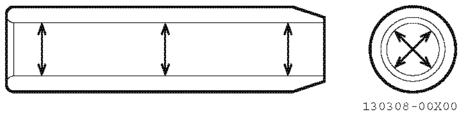


Fig.14-24

2. Inspecting the Intake and Exhaust Valves

Visually inspect the intake and exhaust valves. Replace any valve that is obviously discolored, heavily pitted or otherwise damaged.

2.1 Valve stem outer diameter

Use a micrometer to measure the valve stem outer diameter. Measure the outer diameter of the valve stem at the combustion end and the opposite end (1, Fig.14-25). For standard values, see 0000-07-01-01 "Intake/exhaust valves and valve guides".

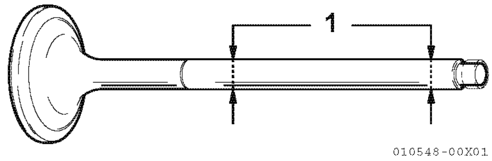


Fig.14-25

2.2 Valve stem bend

Place the valve stem on a flat inspection block or layout bed. Roll the valve until a gap can be observed between a portion of the valve stem and the surface of the block or bed. Use a feeler gauge to measure the clearance gap (Fig.14-26). For standard values, see 0000-07-01-01 "Intake/Exhaust valves and valve guides".

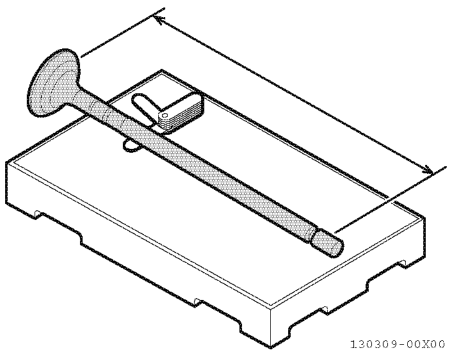


Fig.14-26

2.3 Valve recession

Note: The valve guides must be installed to perform this check.

Insert the valves into their original locations and press them down until they are fully seated. Use a depth micrometer (Fig.14-27) to measure the difference between the cylinder head gasket surface and the combustion surface of each exhaust and intake valve (Fig.14-28). For standard value, see 0000-07-01-01 “Cylinder head”.

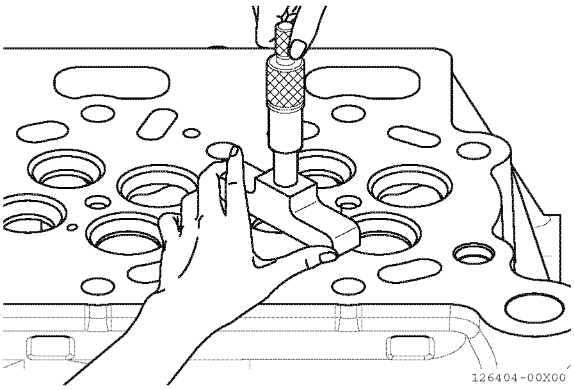


Fig.14-27

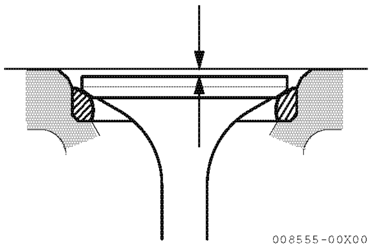


Fig.14-28

3. Inspecting the Valve Springs

Inspect the valve springs. If damage or corrosion is found, or if the measured value exceeds the standard, replace the valve springs.

3.1 Fractures

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

3.2 Corrosion

Check the valve springs for sulfur corrosion.

3.3 Inclination

Use a flat surface and a square to check each spring for squareness (Fig.14-29). For standard values, see 0000-07-01-01 “Valve spring”.

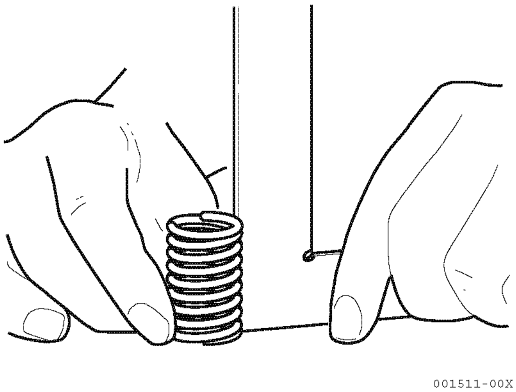


Fig.14-29

3.4 Free Length

Use a caliper to measure the length of the valve spring (Fig.14-30). For standard values, see 0000-07-01-01 “Valve spring”.

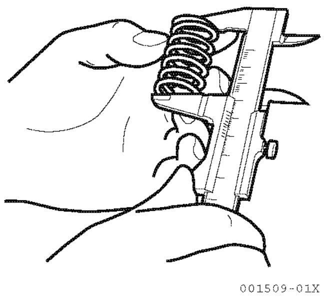


Fig.14-30

1. Reassembly of Valve Guides

If the result of the valve guide inspection does not meet the basic value, follow the procedure below for attaching a new valve guide.

1. Valve guides are cold-fitted in the cylinder head. When attaching a new valve guide, freeze it for at least 20 minutes beforehand. This makes the valve guide shrink, and makes the cylinder head easier to be attached.
2. Immediately after taking out the valve guides (1, Fig.14-31) from the freezer, insert them in the specified positions.

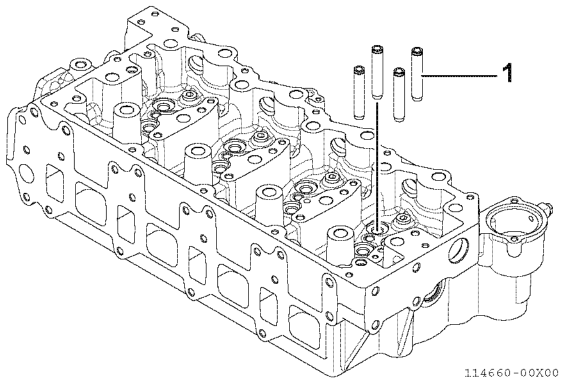


Fig.14-31

3. Using a valve guide inserting tool (1, Fig.14-32), attach the valve guide (3, Fig.14-32) to the cylinder head with the reference valve guide protrusion amount (2, Fig.14-32). For reference protrusion amount, see 0000-07-01-01 "Cylinder Head Specifications".

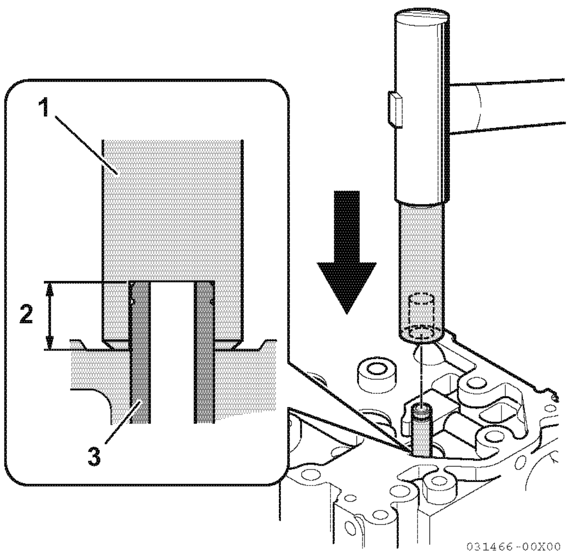


Fig.14-32

2. Reassembling the Intake and Exhaust Valves

For inspecting the intake/exhaust valves and valve springs, instructions for removing and re-attaching the intake/exhaust valve assembly are explained below. The intake/exhaust valve assembly is configured as shown in Fig.14-33.

1. Apply clean lubricating oil to the lip face of the valve stem seal (2, Fig.14-33), and attach to the valve guide (1, Fig.14-33). For attaching, use the valve stem seal installation tool (1, Fig.14-34) to insert a new valve stem seal (2, Fig.14-34) on each valve guide (3, Fig.14-34).
2. When inserting the valve stem seal, make sure that the protrusion amount from the cylinder head (from the cylinder head face to the shoulder part of the valve stem seal) (7, Fig.14-33) meets the reference value. For basic protrusion amount, see 0000-07-01-01 “Intake/exhaust valves and valve guide”.

NOTICE

- When attaching a valve stem seal, always use a new valve stem seal.
- The same valve stem seals are used for both intake and exhaust. The paint mark on the rubber part is identified with green color.

	Part number	ID
Intake side	129G01-11340	Rubber part green color
Exhaust side		

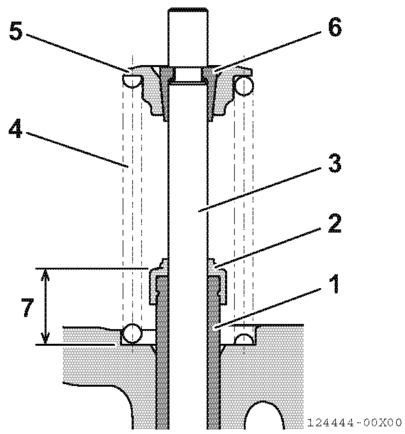


Fig.14-33

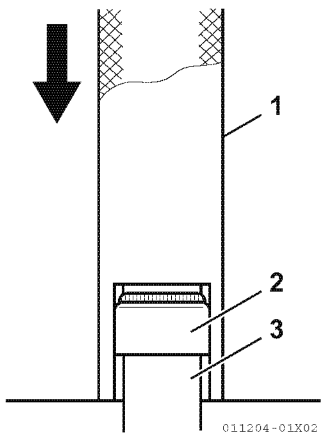


Fig.14-34

1 -	Valve guide
2 -	Valve stem seal
3 -	Valve stem
4 -	Valve spring
5 -	Spring retainer
6 -	Stem cotter

3. Place a single cylinder head (1, Fig.14-35) with the exhaust port side facing up.
4. Attach the removed intake/exhaust valve (2, Fig.14-35) to the original position on the combustion side of the cylinder head.

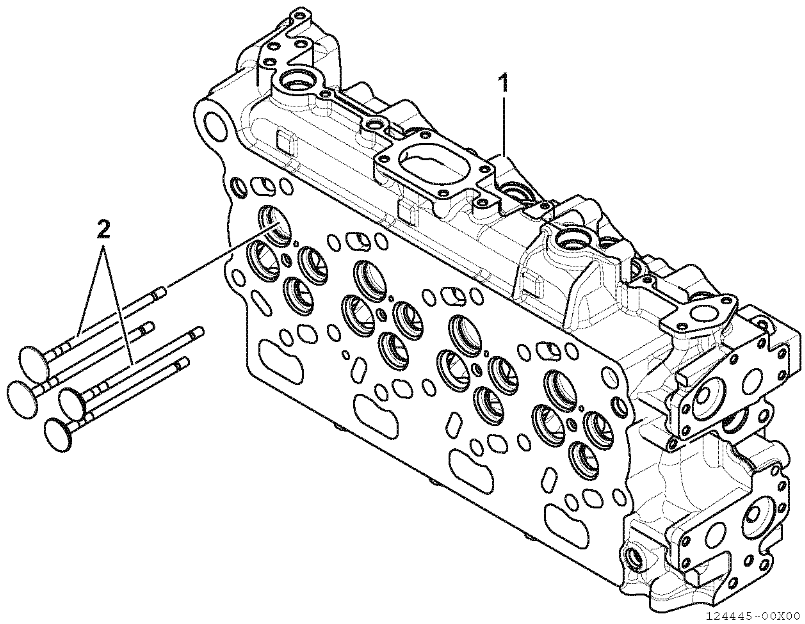


Fig.14-35

5. Place the cylinder head with the combustion side facing down. Attach the valve spring (1, Fig.14-36) and the spring retainer (2, Fig.14-36) to the valve stem (3, Fig.14-36).
6. Using the valve spring compressor tool, compress the valve spring. Insert the cotter (4, Fig.14-36) and slowly loosen the shrunk valve spring.
7. Repeat the same procedure with the rest of the valves.

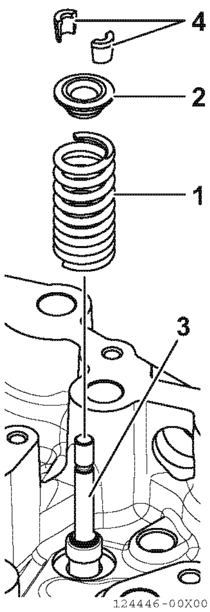


Fig.14-36

1. Grinding and Lapping the Valve Seats

1. Always check the clearance between the valve and valve guide before grinding or lapping the valve seats. For standard values, see 0000-07-01-01 “Intake/exhaust valves and valve guide”. If the clearance exceeds the standard, replace the valve or valve guide so that the clearance is within the standard, and then adjust the valve seat.
2. Roughness or burrs will cause poor seating of a valve. Visually inspect the seating surfaces of each valve and valve seat to determine if lapping or grinding is needed.
3. Visually inspect all valves and valve seats and check for pitting, distortion, cracking, or evidence of overheating. Usually the valves and valve seats can be lapped or ground to return them to serviceable condition. Severely worn or damaged components will require replacement.
4. Coat the valve seat with a thin coat of bluing compound. Install the valve and rotate it so that the bluing compound is spread to all parts of the valve contact surface. The contact pattern should be approximately centered on the valve face (1, Fig.14-37) and should be even in width.

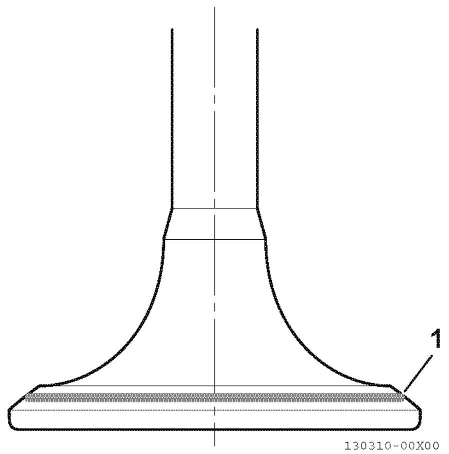


Fig. 14-37

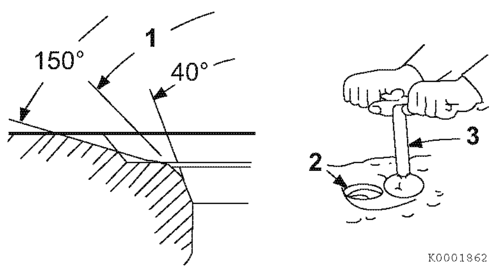


Fig. 14-38

Also visually inspect the valve seat for even contact.

5. Light cutting can be performed by the use of a hand-operated cutter (3, Fig.14-38). The valve seat diameter can be adjusted by top-grinding with a 150° stone to make the seat diameter smaller, and bottom-rinding using a 40° stone to make the seat diameter larger. Once the seat location has been corrected, grind and lap the seat angle to specification (1, Fig.14-38). For standard value, see 0000-07-01-01 “Cylinder head”.
6. 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 performing grinding.
7. If the valve seat requires grinding, lap the valve after grinding. Lap the valve face to the valve seat using a mixture of valve lapping compound and engine lubricating oil.
8. After lapping, be sure to thoroughly wash all parts to remove all grinding powder or compound.

2. Measuring and Adjusting Valve Clearance

[Important] Measure and adjust while the engine is cold.

- The No. 1 cylinder in the 4TN107 engine is on the flywheel side (opposite side from the cooling fan). The firing order is 1-3-4-2, and ignition occurs at every 180° rotation of the crankshaft.
- Valve clearance of both the intake and exhaust valves can be checked with the piston for that cylinder at top dead center (TDC) of the compression stroke. When a piston is at TDC of the compression stroke, both rocker arms will be loose and the cylinder TDC mark on the flywheel will be visible in the timing port of the flywheel housing.
- If adjusting each cylinder individually, the cylinder to be adjusted first does not have to be the No. 1 cylinder. Select and adjust the cylinder where the piston is nearest to the top dead center after turning. Make adjustment for the remaining cylinders in the order of firing by turning the crankshaft each time.
- If there is no valve clearance, and the cylinder is at TDC of the compression stroke, extreme wear, or damage to the cylinder head or valves may be possible.

Cylinder No.	1		2		3		4	
Valve	Intake	Exhaust	Intake	Exhaust	Intake	Exhaust	Intake	Exhaust
No. 1 cylinder at TDC compression	●	●	●			●		
No. 4 cylinder at TDC compression				●	●		●	●

2.1 Adjusting the valve clearance

The 4TN107 intake and exhaust valve mechanism consists of 4 valves: 2 intake valves and 2 exhaust valves. The rocker arm (1, Fig.14-39) operates 2 valves A and B (Fig.14-39) via the valve bridge (2, Fig.14-39). For valve clearance, measure and adjust the clearance between the valve bridge and rocker arm (3, Fig.14-39).

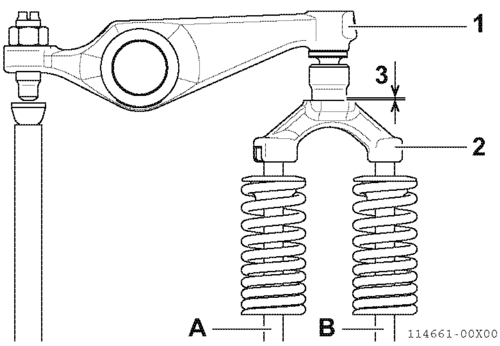


Fig.14-39

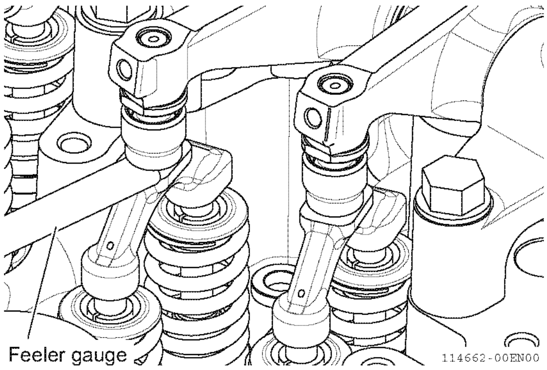


Fig.14-40

1 - Remove the bonnet for adjustment.

2 - Rotate the crankshaft clockwise as seen from the coolant pump end, to bring No. 1 piston to TDC on the compression stroke while watching the rocker arm motion and timing grid on the flywheel. (Position where both the intake and exhaust valves are closed.)

NOTICE

If adjusting each cylinder individually, the cylinder to be adjusted first does not have to be the No. 1 cylinder. Select and adjust the cylinder where the piston is nearest to the top dead center after turning, and make adjustment for other cylinders in the order of firing by turning the crankshaft.

3 - Insert a feeler gauge between the rocker arm and valve bridge (Fig.14-40) and record the measured valve clearance. Use the data for estimating the wear.

4 - If adjustment is required, proceed to the next step.

5 - Loosen the lock nut (1, Fig.14-41) of the valve adjusting screw (2, Fig.14-41) attached to the rocker arm.

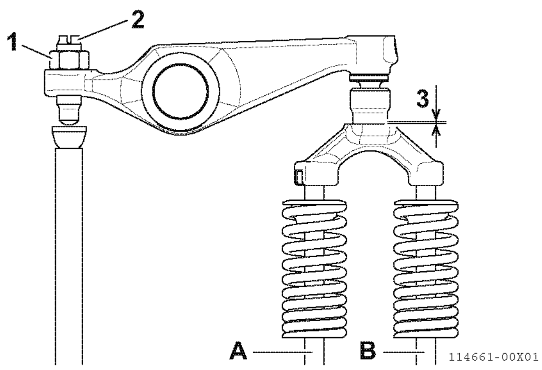


Fig.14-41

6 - Insert a clearance gauge of the correct thickness between the rocker arm and valve bridge, then turn the valve adjustment screw to adjust the valve clearance so that slight “drag” of the feeler gauge can be felt.

7 - Hold the valve adjustment screw while tightening the locknut. Check the valve clearance again.

NOTICE

There is a tendency for the clearance to decrease slightly when the lock nut is tightened. It is suggested that you make the initial clearance adjustment slightly on the “loose” side before tightening the lock nut.

8 - Apply engine lubricating oil to the contact surfaces of the valve adjustment screw and push rod.

9 - Rotate the crankshaft. Measure and adjust the valves of the next cylinder. Continue until all the valves have been measured and adjusted.

Structure and Function of the Breather

A pressure fluctuation is generated in the crankcase by the reciprocating motion of the pistons. Blow-by gas escapes through the clearance between the cylinder and the piston, and flows into the crankcase. The purpose of the breather system is to maintain normal pressure inside the crankcase. A breather system can be either a closed type air-bleeding system or atmospheric release system. However, all 4TN107 series engines use a atmospheric release system.

1. Structure of Breather System (Atmospheric Release System)

The overview of the structure and components for the breather system (atmospheric release system) is shown in Fig.14-42.
The blow-by assembly, equipped with a path for guiding the blow-by gas, is mounted inside the bonnet by using bolts. The filter element and cover are mounted to the opening on the top of the bonnet. In addition, the PCV (breather) valve is installed to the top of the bonnet to release the blow-by gas to the air.

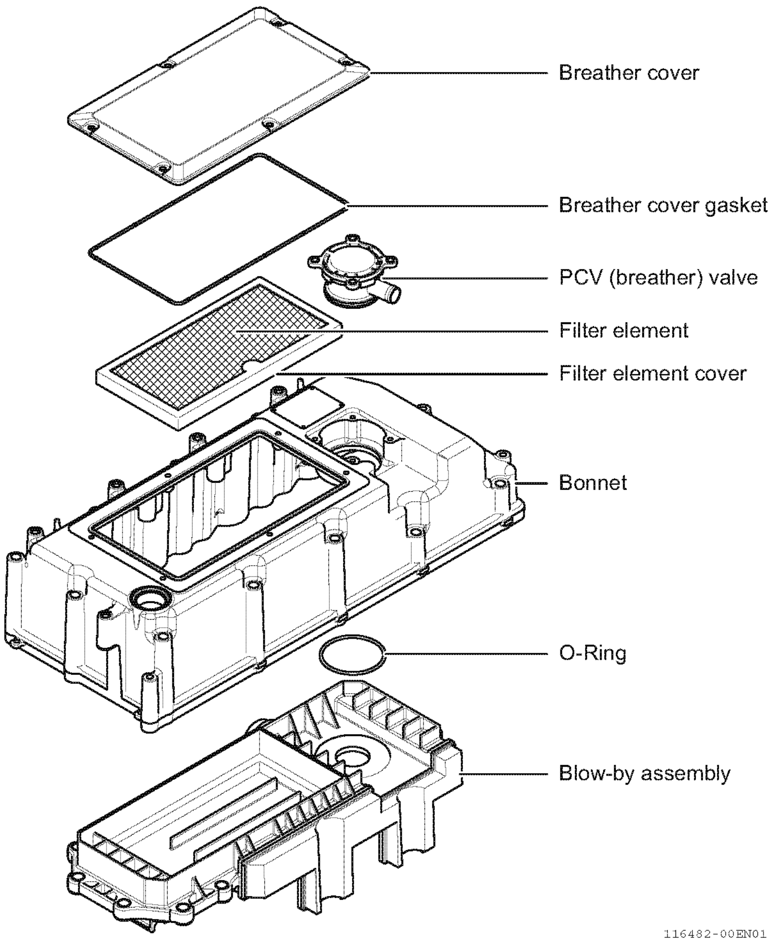


Fig.14-42

2. Function of the Breather System

2.1 Blow-by gas path (when normal)

- As shown in Fig.14-43, the blow-by gas passes through the blow-by assembly in the bonnet and filter element, and separates the oil mist. After that, the blow-by gas is released to the air through the PCV (breather) valve.
- Oil separated from the oil mist accumulates in the tank inside the blow-by assembly, is returned to the engine from the drain check valve on the tank bottom due to the pressure difference with the crankcase.

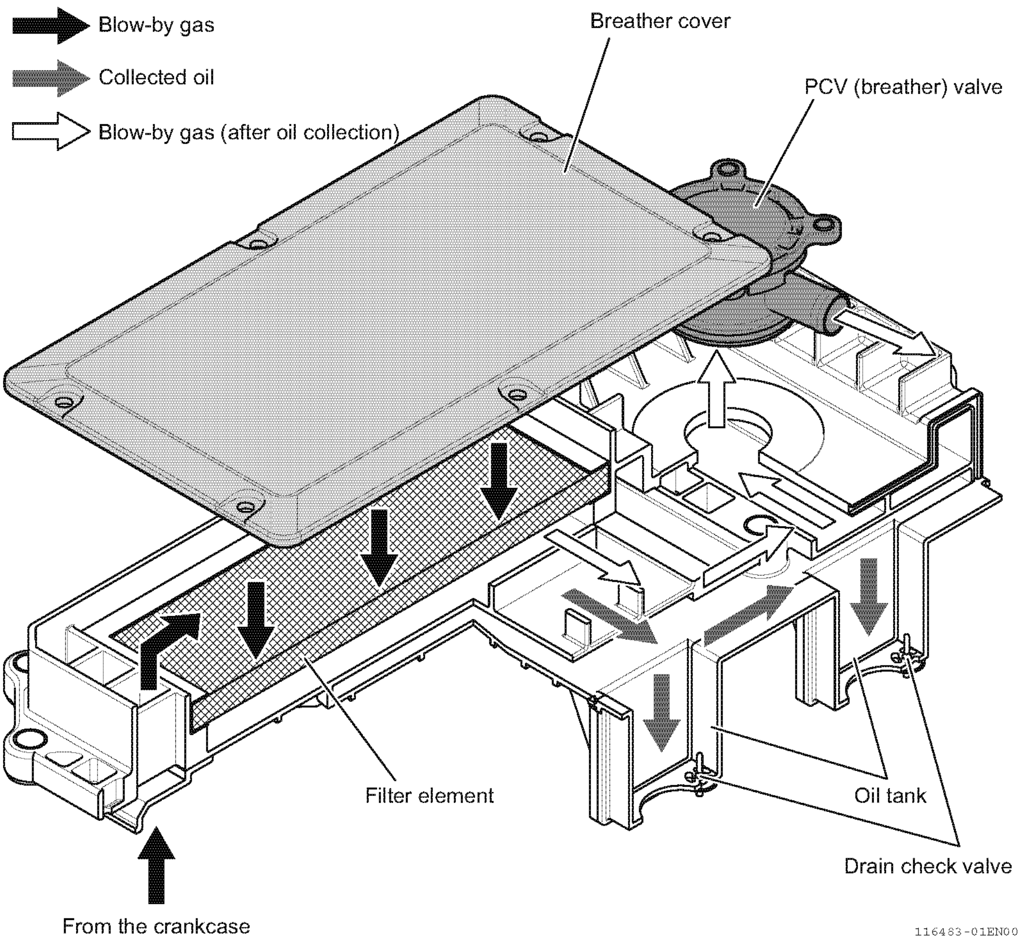


Fig.14-43

2.2 Blow-by gas path (during bypass)

- When the pressure loss has increased due to filter element clogging, the bypass valve on the intake side of the blow-by assembly will open because of the pressure difference, and blow-by gas will be released to the air through the bypass path before separation of the oil mist. (See Fig.14-44 and Fig.14-45.)
  Therefore, the filter element needs to be replaced as a part of periodic maintenance. Replace the filter element every 4500 hours of operation.

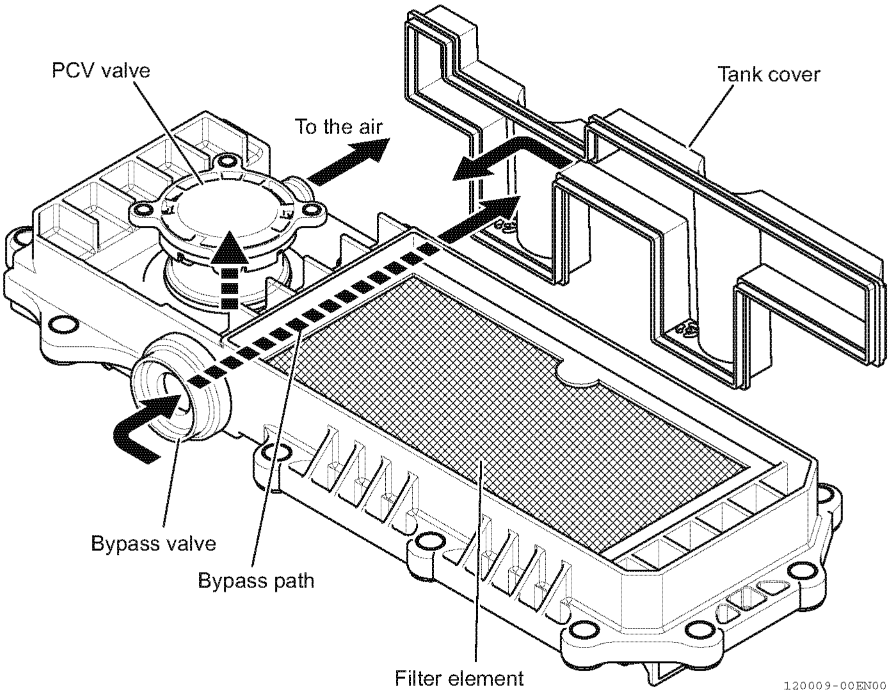


Fig.14-44

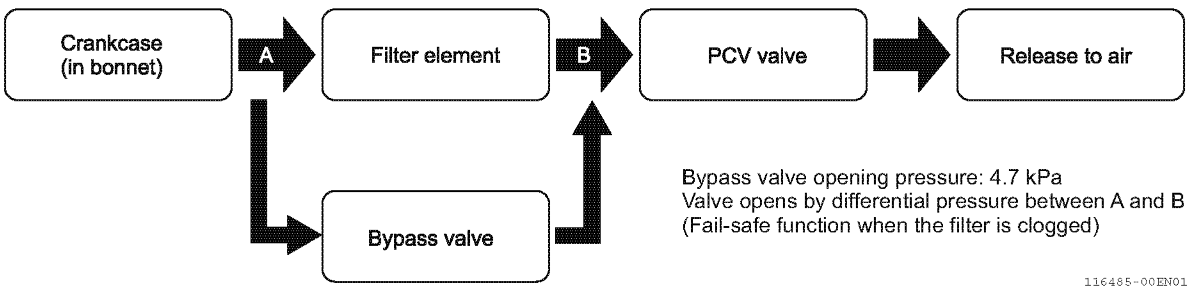


Fig.14-45

1. Disassembling the Bonnet and Related Parts

In order to disassemble the cylinder head, it is necessary to remove the bonnet. However, when replacing the filter element included in the breather system maintenance, it is not necessary to remove the bonnet. For replacing the filter element, see 1404-02-04-01 “Replacing the breather filter element”.

1.1 Removing the bonnet

1 - Removing the harness assembly

When disassembling the cylinder head after removing the bonnet, the entire wire harness assembly needs to be removed first. However, if removing the bonnet only, it only requires to remove the harness cover attached to the bonnet (1, Fig.14-46), then disconnect the new air temperature sensor coupler (2, Fig.14-46) and injector signal coupler (3, Fig.14-46).

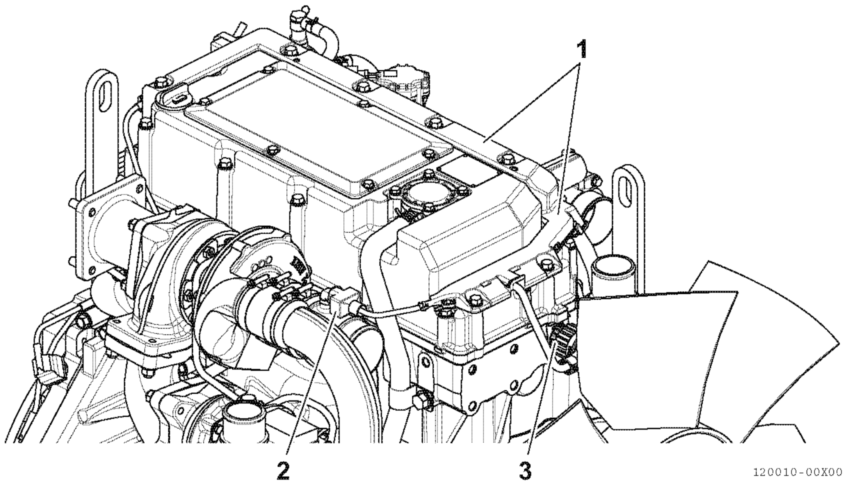


Fig.14-46

For removing the entire harness assembly, see 7200-02-01-01 “Removing the Wire Harness Assembly”.

2 - Removing the bonnet

- Loosen the bolt (3, Fig.14-47) of the clamp (2, Fig.14-47) that fastens the breather hose (1, Fig.14-47) to the cylinder block, then remove the clamp.
- Loosen the 12 bolts (1, Fig.14-48) that fasten the bonnet to the cylinder head, then remove the bonnet (2, Fig.14-48) together with the breather hose.

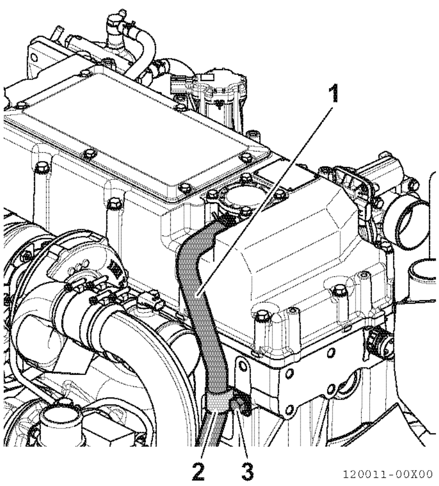


Fig.14-47

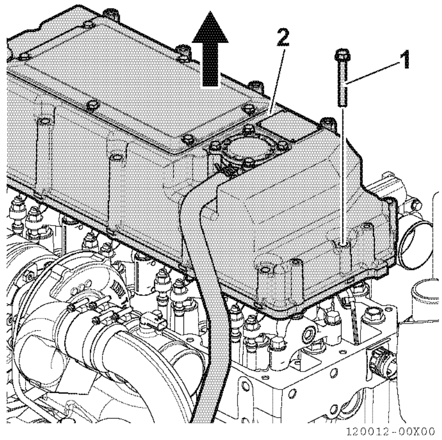


Fig.14-48

1.2 Removing the breather system

1 - Removing the blow-by system

When inspecting the bypass valve (1, Fig.14-49), remove the blow-by assembly (2, Fig.14-49) from the bonnet (3, Fig.14-49). The blow-by assembly is mounted and fastened inside the bonnet using 11 M10 bolts (4, Fig.14-49).

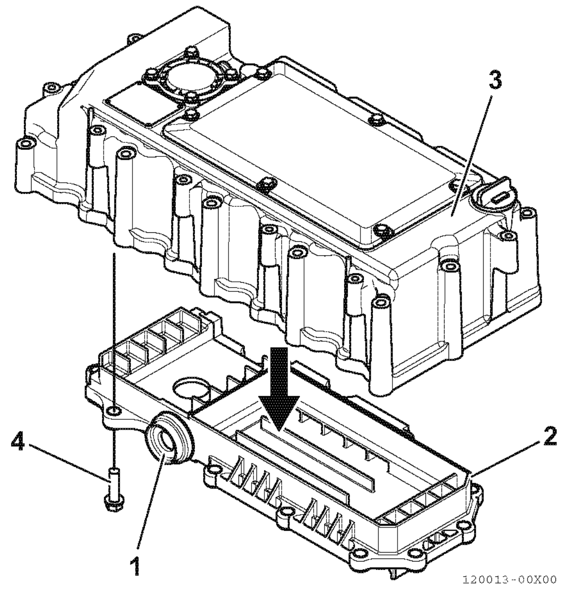


Fig.14-49

2 - Removing the filter element

The filter element (2, Fig.14-50) is installed inside the breather cover (1, Fig.14-50) on the top of the bonnet. When replacing the filter element, loosen the six bolts (3, Fig.14-50) that fasten the breather cover, and remove the breather cover together with the breather cover gasket (4, Fig.14-50), and then remove the filter element.

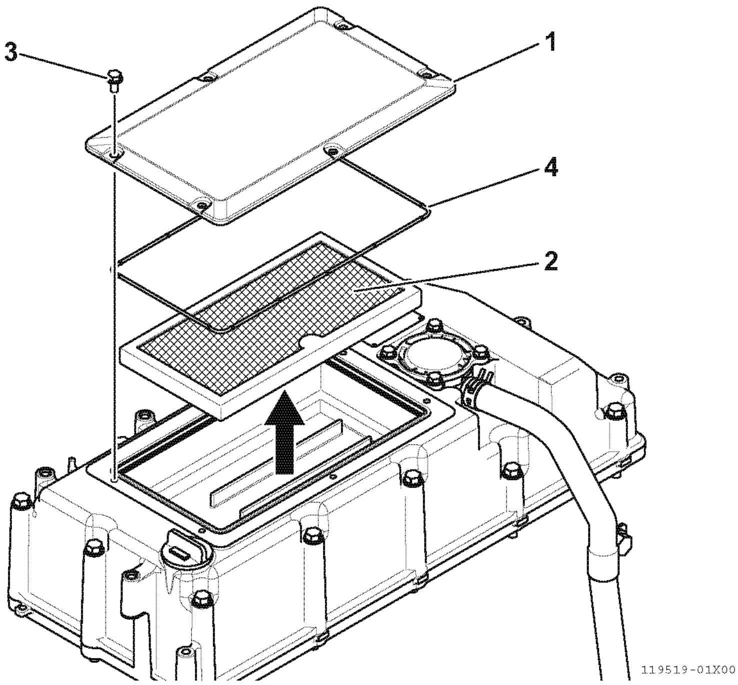


Fig.14-50

1. Inspecting the Breather System

1.1 Inspecting the breather valve

1 - Inspecting the PCV (breather)

Loosen four bolts (2, Fig.14-51) that fasten the PCV (breather) valve (1, Fig.14-51) to the bonnet, then remove the valve together with the breather hose (3, Fig.14-51). Make sure there are no sediments inside the hose or breather valve, and clean if necessary. If the breather valve is damaged, replace with a new one.

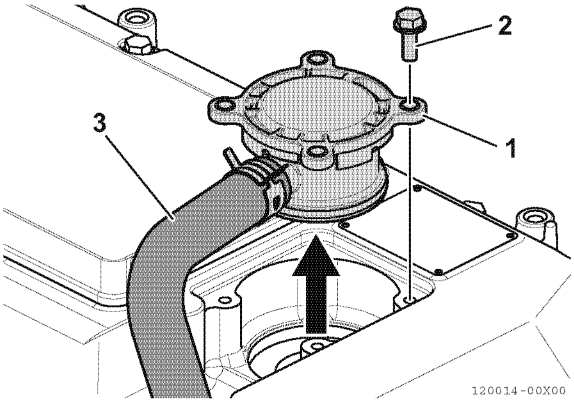


Fig.14-51

2 - Inspecting the bypass valve

When the breather performance is reduced due to filter element clogging, the bypass valve (1, Fig.14-52) on the blow-by assembly will open and blow-by gas will be released to the air through the PCV (breather) (2, Fig.14-52) valve before separation of the oil mist. To check the bypass valve, remove the blow-by assembly (4, Fig.14-52) from the bonnet (3, Fig.14-52), and press the center of the bypass valve to check if the valve operates properly. Since the bypass valve and the breather assembly are integrated as a unit, it is necessary to replace the valve together with the breather assembly if damaged.

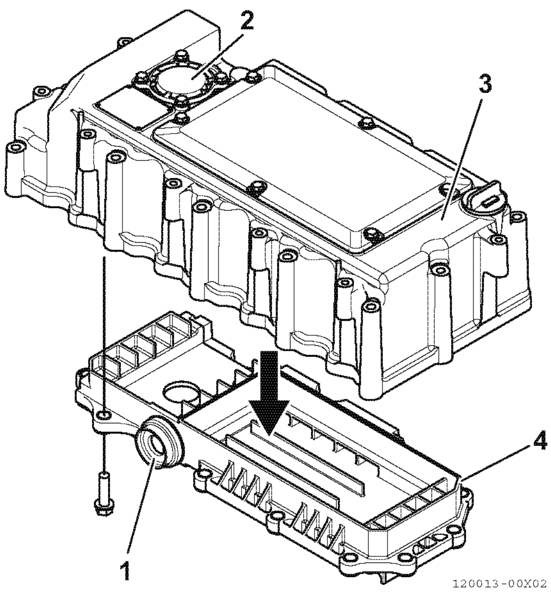


Fig.14-52

1. Assembling the Bonnet and Related Parts

1.1 Installing the breather system

For installing the blow-by assembly and breather cover to the bonnet, follow the reverse procedure to the removal procedure.

1 - Install the blow-by assembly (1, Fig.14-53) inside the bonnet using 12 M10 bolts (3, Fig.14-53).

Tightening torque	Blow-by assembly bolt (M10 × 1.5)	30 ± 3 N·m

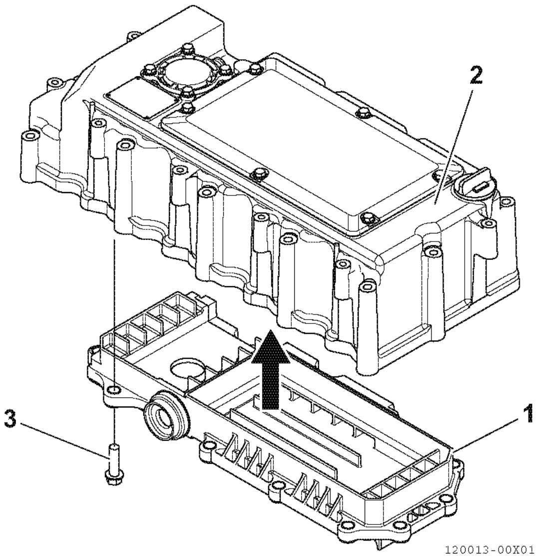


Fig.14-53

2 - When installing the breather cover (1, Fig.14-54) to the bonnet (2, Fig.14-54), replace the gasket (3, Fig.14-54) with a new one, and lightly apply grease to the new gasket, then insert it to the breather cover groove. Install the breather cover to the bonnet, and fasten it using six M6 bolts (4, Fig.14-54).

Tightening torque	Breather cover bolt (M6 × 1.0)	8.6 ± 0.8 N·m

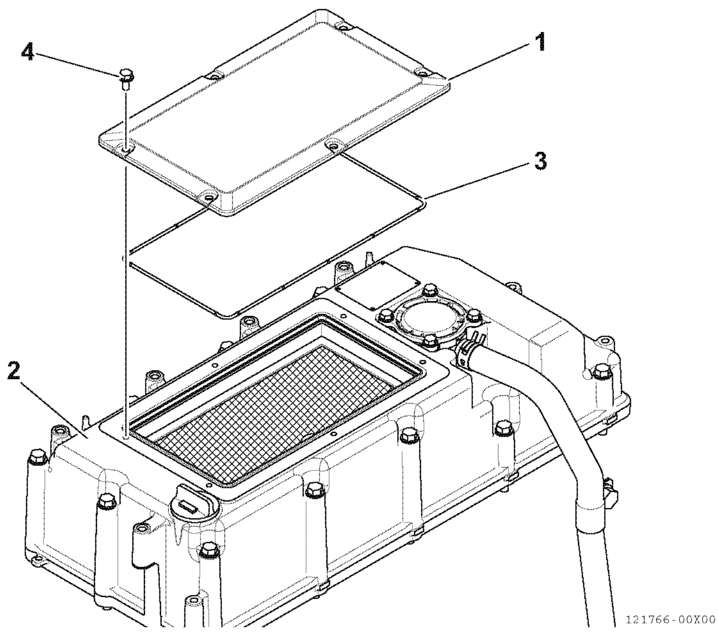


Fig.14-54

1.2 Installing the bonnet

For installation, follow the reverse procedure to the removal in 1404-02-01-01 “Removing the bonnet”.

1 - Replace the bonnet gasket (1, Fig.14-55) with a new one. Lightly apply grease to the new gasket, and insert it to the bonnet groove (2, Fig.14-55). Place the bonnet on the cylinder head, and tighten it using 12 M6 bolts (Fig.14-55).

Tightening torque	Bonnet bolt (M6 × 1.0)	8.6 ± 0.8 N·m

2 - Attach the breather hose clamp to the hose, and tighten it using the bolt.

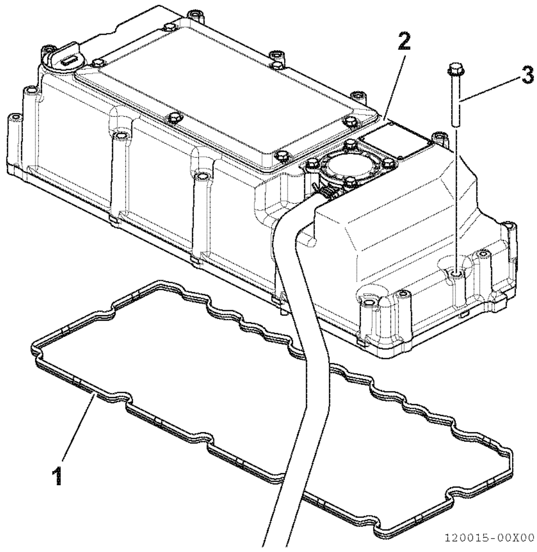


Fig.14-55

3 - Install the harness assembly. If only the harness cover (bonnet) has been removed, install the harness cover (1, Fig.14-56) to the bonnet, then connect the new air temperature sensor coupler (2, Fig.14-56) to the injector signal coupler (3, Fig.14-56).
If the entire harness assembly has been removed, follow the reserve procedure to the removal in 7200-02-01-01 “Removing the Wire Harness Assembly” to install the harness assembly.

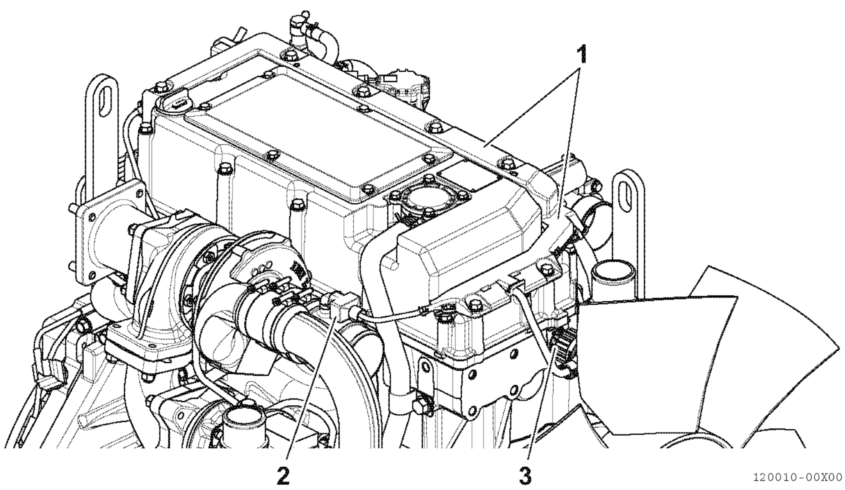


Fig.14-56

1. Maintenance of Bonnet Related Parts

1.1 Replacing the breather filter element

Replace the filter element every 4500 hours of operation.
For removing the filter element, see 1404-02-01-02 “Removing the filter element”. When replacing the filter element, replace the element (1, Fig.14-57) and the element cover (2, Fig.14-57) as a unit. When replacing the element cover, make sure that the tab (3, Fig.14-57) of the element cover is on the top.
For installing the breather cover after installing the filter element, see 1404-02-03-01 “Installing the breather system”.

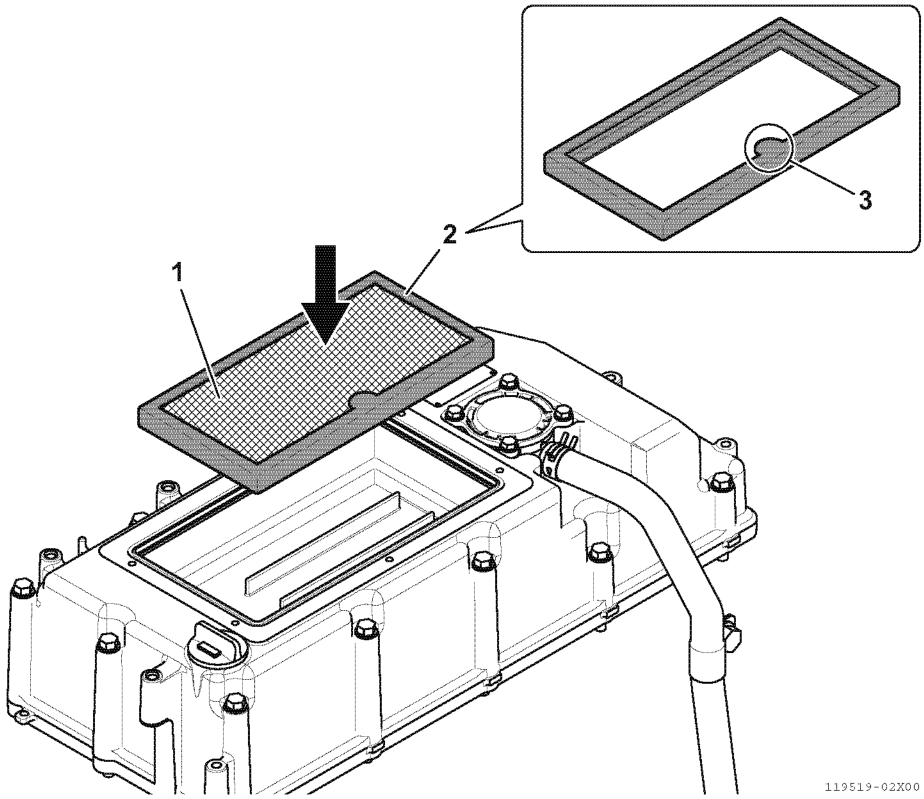


Fig.14-57

Air Intake System

The amount of air supplied to the engine combustion chamber greatly affects basic performance of the engine such as engine output, fuel consumption, exhaust system, engine life etc.
Configuration of the intake system of the 4TN107 engine is explained below.

1. Intake System Components

Fig.21-1 shows a reference of the intake/exhaust system of the 2-stage turbocharged engine.
Intake air is introduced to the engine via air cleaner, turbocharger compressor, and charge air cooler.

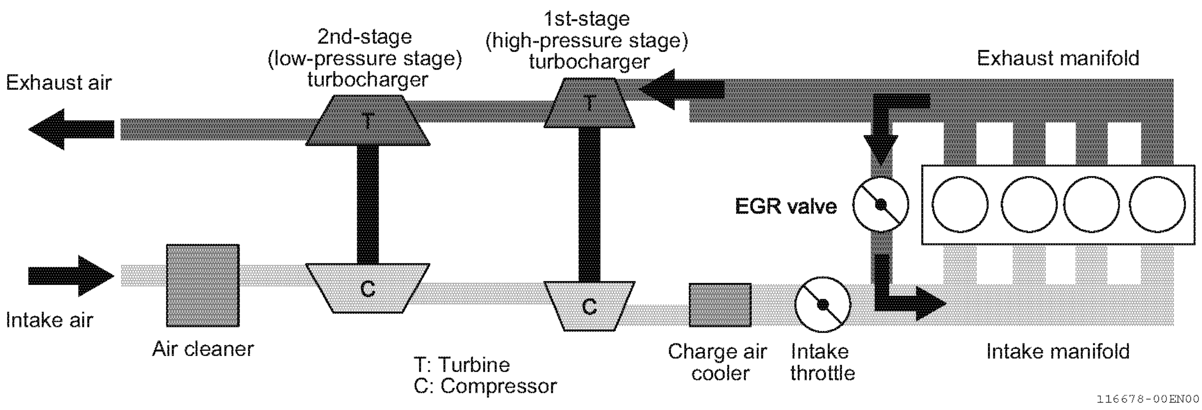


Fig.21-1

In detail, as shown in Fig.21-2, the intake air from the air cleaner enters from the fan side inlet of the low-pressure stage turbocharger, and after being turbocharged twice, it enters the charge air cooler from the outlet of the high pressure stage. As shown in Fig.21-3, in the heat exchanger that cools down the air compressed at the turbocharger, the air density increases by being cooled by the charge air cooler, and the combustion becomes optimal. Air from the charge air cooler enters the combustion chamber via the intake throttle.

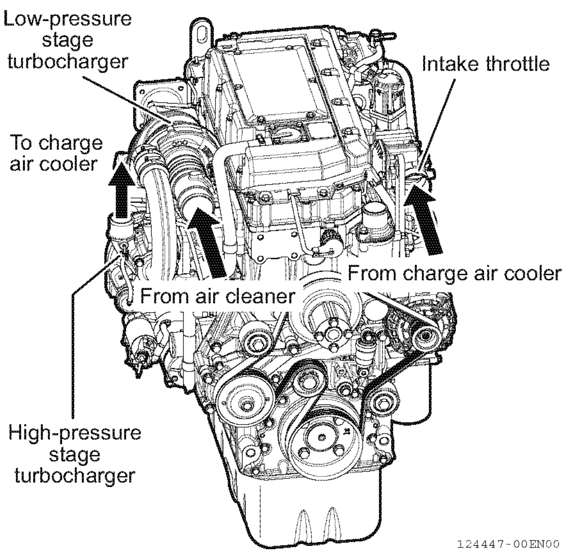


Fig.21-2

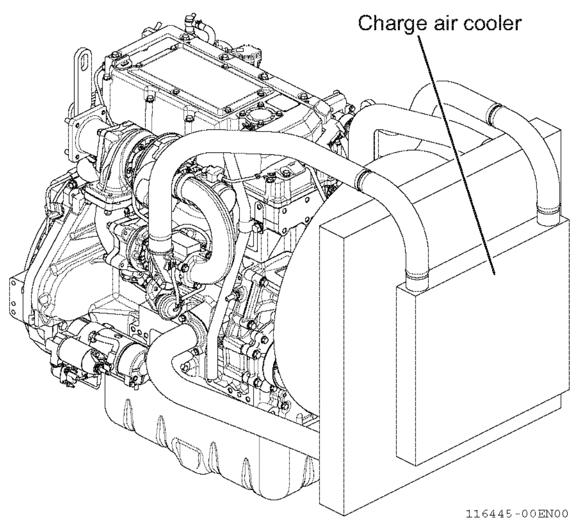


Fig.21-3

Exhaust System

The function of an engine exhaust system is to release high temperature gas generated during fuel combustion to the air, and to reduce exhaust noise using a muffler. Also, the engine exhaust system includes important functions such as the EGR as devices to decrease exhaust emissions/black smoke, an after-treatment device including DPF and SCR (applicable only to EU Stage V certified models), and a turbocharger to improve engine output performance and provide high-altitude capability.

1. Exhaust System Components

Fig.22-1 shows a reference of the intake/exhaust system of the 2-stage turbocharged engine.
Exhaust gas discharged from the combustion chamber is partially returned from the exhaust manifold to the air intake manifold through the EGR valve, and the rest drives the turbocharger. Then, it is discharged to the atmosphere through a processing device that includes DPF and SCR for EU Stage V certified models.

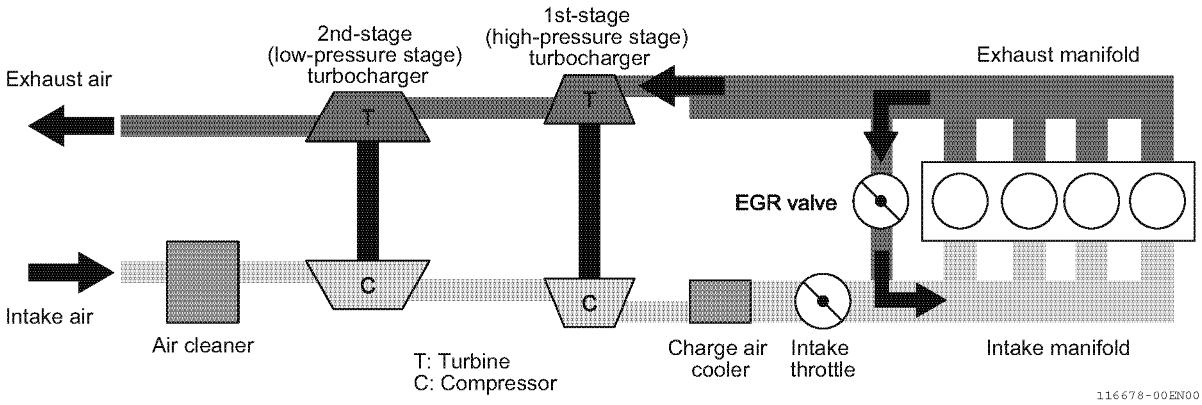


Fig.22-1

To be more specific, as shown in Fig.22-2, the flow of exhaust gas gathers from the combustion chamber to the exhaust manifold, and part of it returns to the EGR valve from the passage in the cylinder block, and the others are turbocharged in the first stage (high pressure stage) and the second stage (low pressure stage). For EU Stage V certified models, it then enters the after-treatment device.

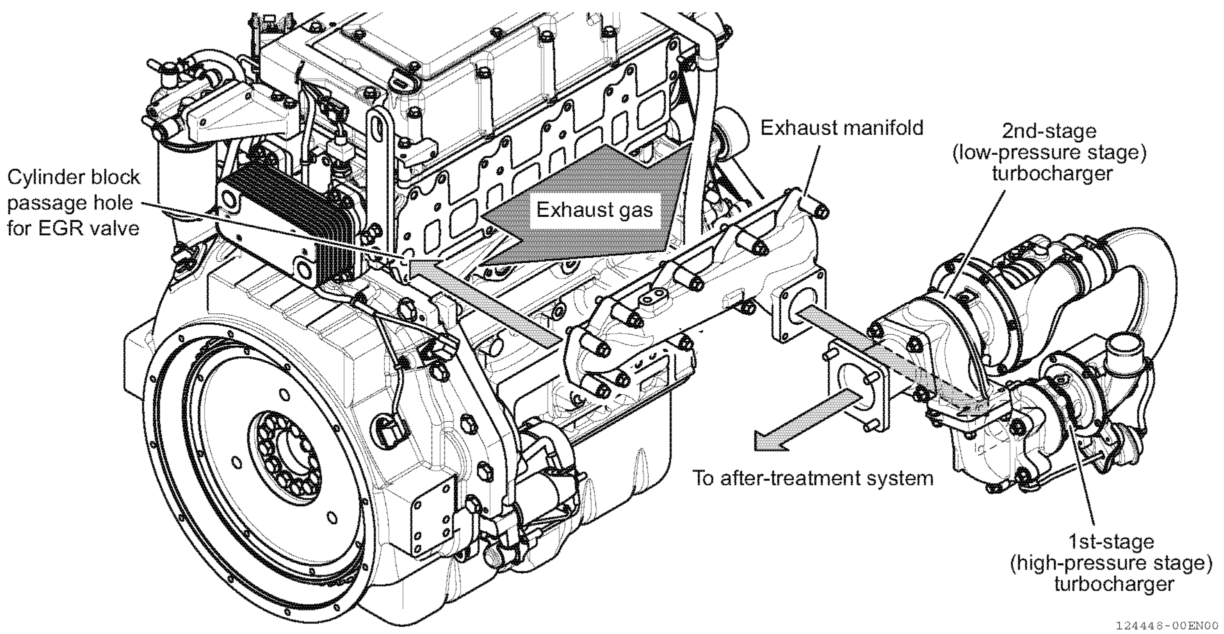


Fig.22-2

EGR (Exhaust Gas Recirculation) is a technology which has been widely used for automotive diesel engines. EGR lowers the combustion temperature by introducing a part of exhaust gas into the intake air and reduces NOx which is a composition subject to emission control regulations. By applying this EGR technology, we can now comply with emission control regulations in each country, including the emission control regulation Tier4 of the Environmental Protection Agency (EPA).

1. EGR System Components

The EGR system is composed of the parts shown Fig.23-1 below.
A portion of the exhaust gas that passed through the exhaust manifold is cooled by the EGR cooler, and its flow is reduced by the optimal opening of the EGR valve. It then passes through the EGR lead valve and then back through the intake manifold into the combustion chamber. The flow of EGR gas is indicated by the arrow.

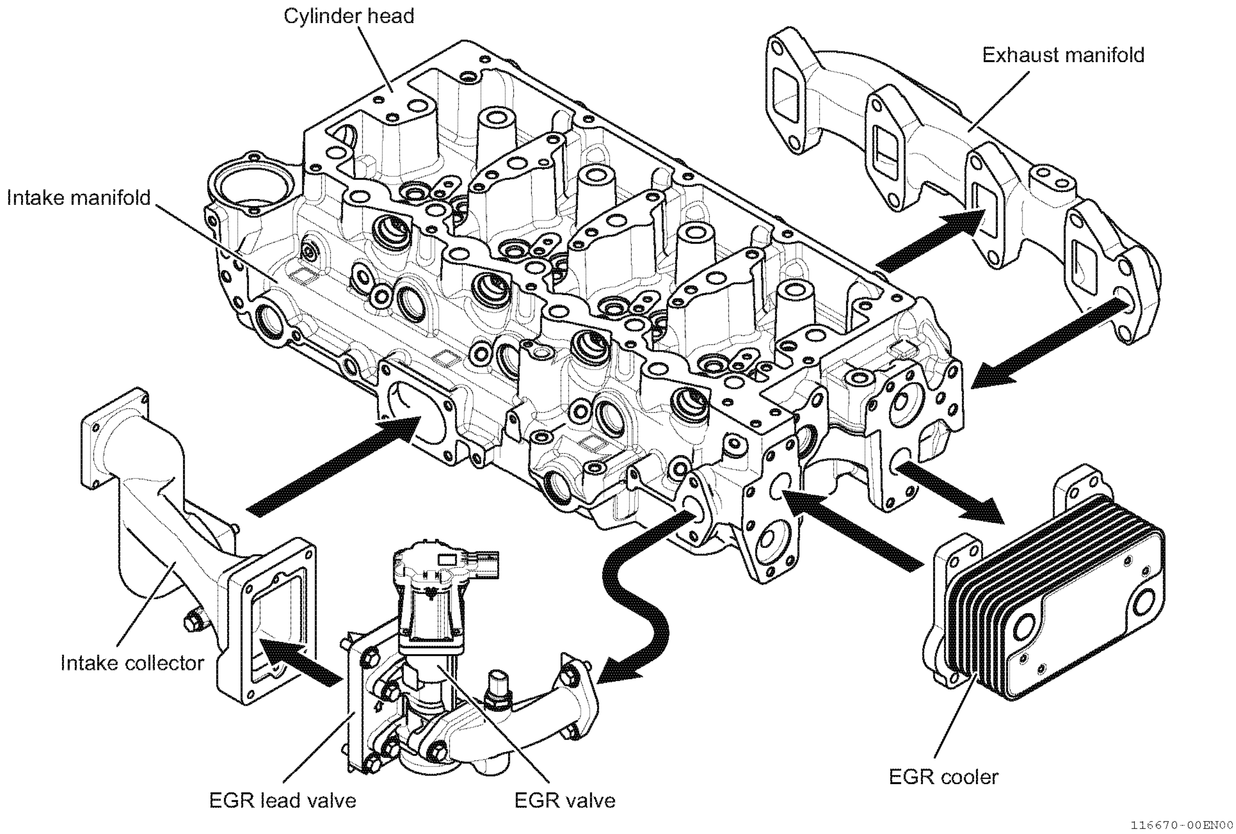


Fig.23-1

2. Structure of EGR Valve

Fig.23-2 shows the schematic diagram of the equipment. There is an appropriate value for the circulating exhaust gas volume (EGR rate), and it is controlled by the EGR valve which is installed between the intake and exhaust flow. EGR valves Fig.23-3 are driven by DC motors and they adjust the EGR rate according to the appropriate opening indicated by the ECU based on engine speed or load conditions.

The EGR valve part number is different depending on the voltage, 24 V or 12 V.

Voltage	Part number
24 V	129G01-13900
12 V	129G01-13950

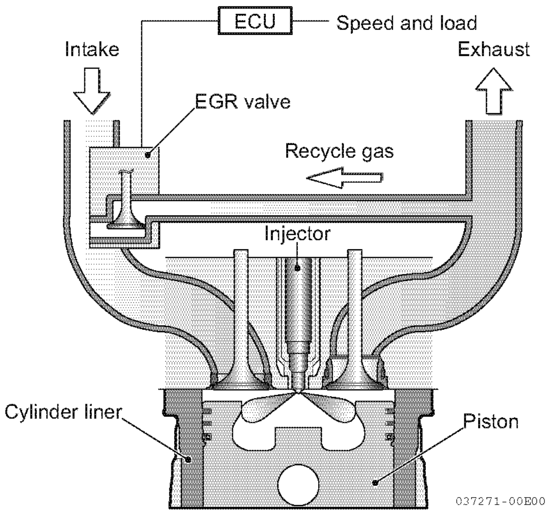


Fig.23-2

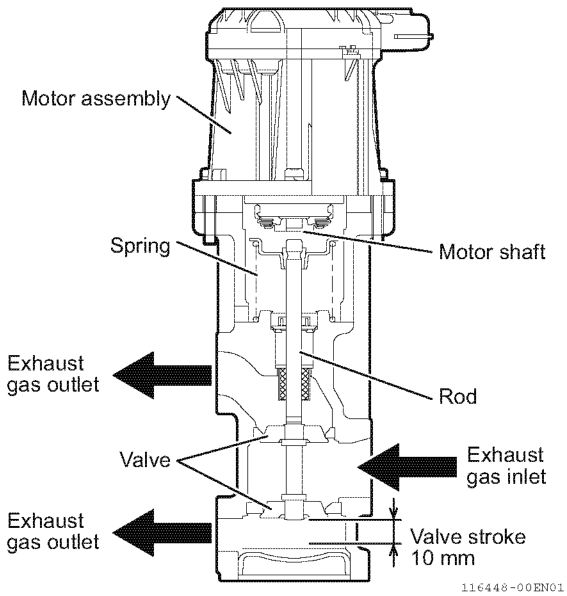


Fig.23-3

2.1 Definition of the EGR rate

The EGR rate indicates the percentage of EGR gas in the gases which are sent into the cylinder, and is defined as follows.

$$\text{EGR rate} = \frac{\text{Concentration of } CO_2 \text{ at cylinder inlet} - \text{Concentration of } CO_2 \text{ in atmosphere}}{\text{Concentration of } CO_2 \text{ in exhaust} - \text{Concentration of } CO_2 \text{ in atmosphere}}$$

3. Structure of EGR Lead Valve

With turbocharged engines, the charging pressure can be higher than the exhaust pressure in the middle speed range, and it may cause the EGR gas to flow back into the exhaust side without flowing into intake side although the EGR valve is open. Because it will become difficult to reduce NOx in such cases, a lead valve (which works as a check valve) is installed in the downstream of the EGR valve to improve reduction of NOx (Fig.23-4). The EGR gas can be introduced into the cylinder with the air flow pulsation even in the area where the intake/exhaust pressure reverses.

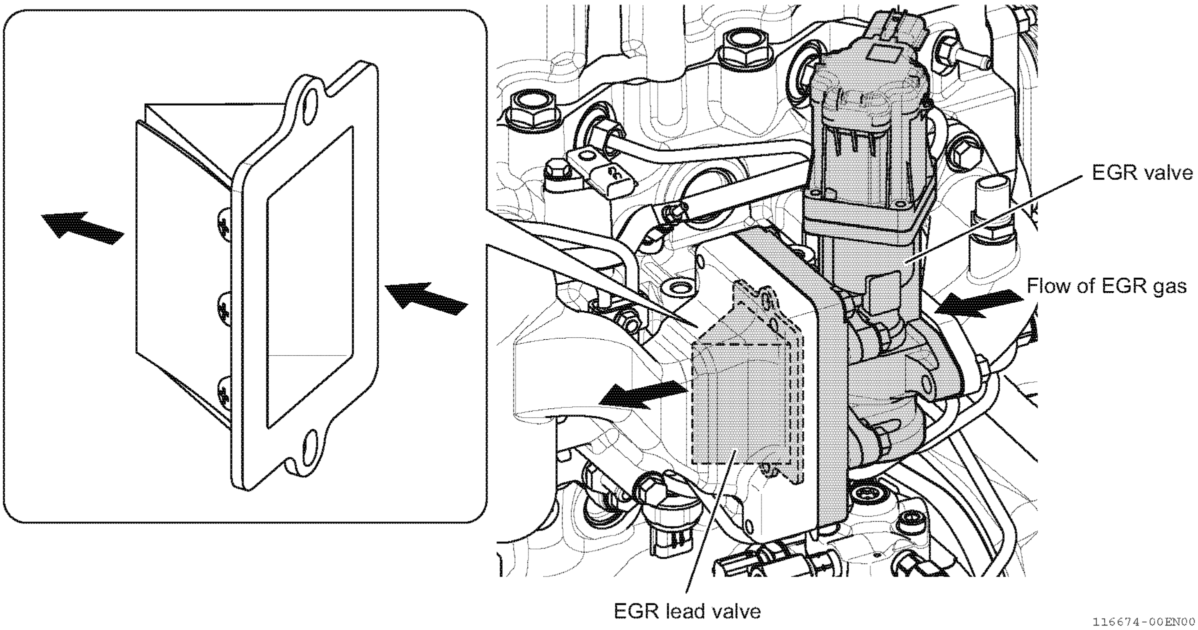


Fig.23-4

4. Structure of EGR Cooler

The EGR cooler cools the EGR gas with engine coolant before going to the intake side and the cooled EGR gas is mixed with the intake air to lower the intake air temperature leading to even lower combustion temperature, and the NOx is greatly reduced. The flows of EGR gas and engine coolant are as shown in Fig.23-5 below.

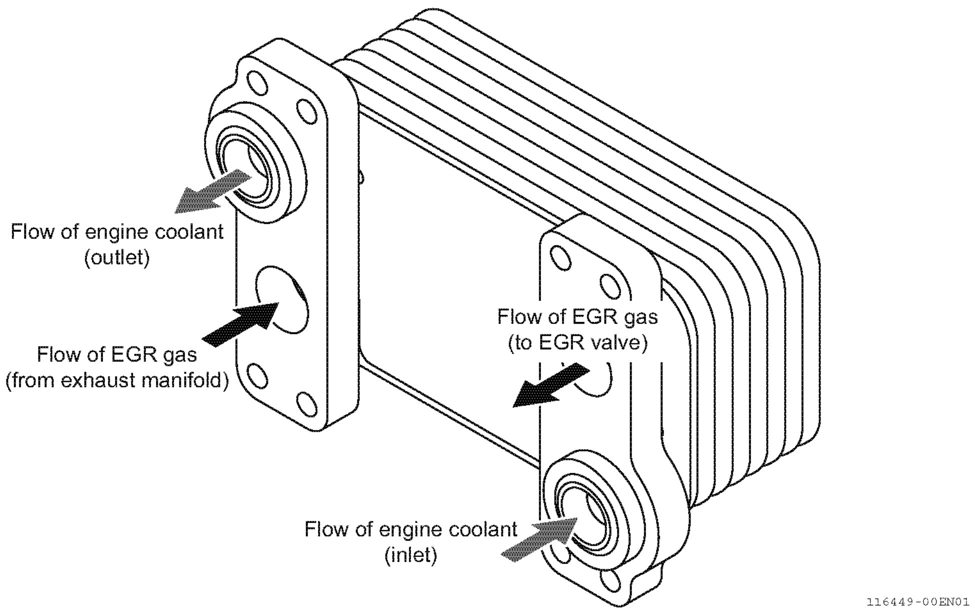


Fig.23-5

Disassembling procedure of each components will be described for maintenance and parts replacement of the EGR system.

1. Disassembling and Removing the EGR Valve System

1. Disconnect the harness connectors of the EGR valve (1, Fig.23-6) and EGR pipe (2, Fig.23-6) beforehand.
2. Loosen the cylinder head side mounting nut (3, Fig.23-6), and EGR valve-side mounting bolt on the EGR pipe, then remove the EGR pipe.and mounting bolt on the EGR valve side (4, Fig.23-6) on the EGR pipe, then remove the EGR pipe. Discard the EGR pipe gasket on the cylinder head side (5, Fig.23-6), and the EGR valve (IN) gasket on the EGR side (6, Fig.23-6).
3. Loosen the EGR mounting bolts (7, Fig.23-6) and remove the EGR valve. Discard the EGR valve (OUT) gasket (8, Fig.23-6).
4. Loosen the mounting bolt (10, Fig.23-6) of the EGR valve spacer (9, Fig.23-6) and remove the spacer. Discard the EGR valve spacer gasket (11, Fig.23-6).
5. Loosen the mounting bolt (13, Fig.23-6) of the EGR lead valve (12, Fig.23-6) and remove the lead valve.
6. Loosen the mounting bolt (15, Fig.23-6) and nut (16, Fig.23-6) of the intake collector (14, Fig.23-6), and remove the collector. Discard the intake pipe gasket (17, Fig.23-6). (If there is a harness clip bracket installed on the intake collector, remove it in advance.)

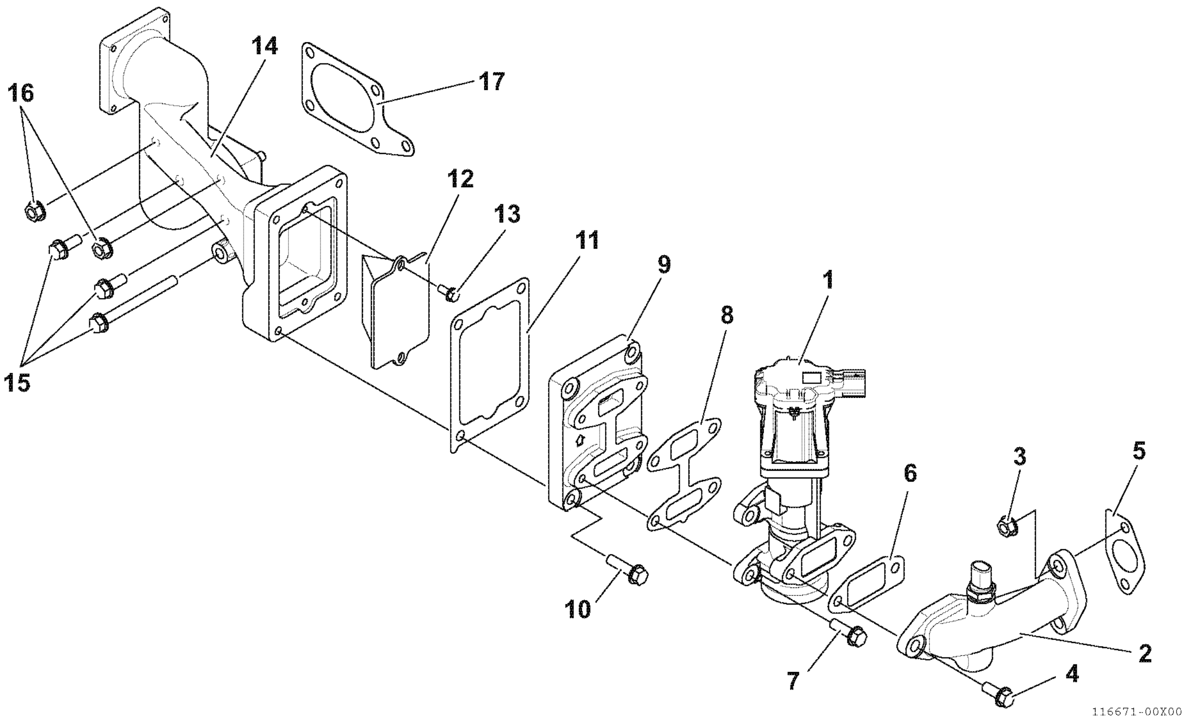


Fig.23-6

NOTICE

- When it is necessary to replace an EGR valve, be sure to replace the entire EGR valve assembly. Neither attempt to disassemble and repair the EGR valve, nor replace its individual components.
- The EGR system uses steel gaskets at the joints between its components/parts. These steel gaskets are specific to the respective joints. When you remove the system’s components/parts and reinstall them, replace the steel gaskets between them with new correct ones.

2. Removing the EGR Cooler

⚠ WARNING

Burn Hazard!

- **Keep your hands and other body parts away from hot engine surfaces such as the muffler, exhaust pipe, turbocharger (if equipped) and engine block during operation and shortly after you shut the engine down.**
  These surfaces are extremely hot while the engine is operating and could seriously burn you.
- **Failure to comply could result in death or serious injury.**

---

1. Drain the engine coolant. See 4000-02-04-01 “Draining Engine Coolant”.

⚠ CAUTION

Coolant Hazard!

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

---

2. Loosen the mounting nut (2, Fig.23-7) and mounting bolt (3, Fig.23-7) of the EGR cooler (1, Fig.23-7) installed on the cylinder head flywheel side, then remove the EGR cooler.
3. Remove the 2 EGR cooler gaskets (4, Fig.23-7) and two coolant gaskets (5, Fig.23-7) together with the EGR cooler. Discard the EGR cooler gaskets and coolant gaskets.

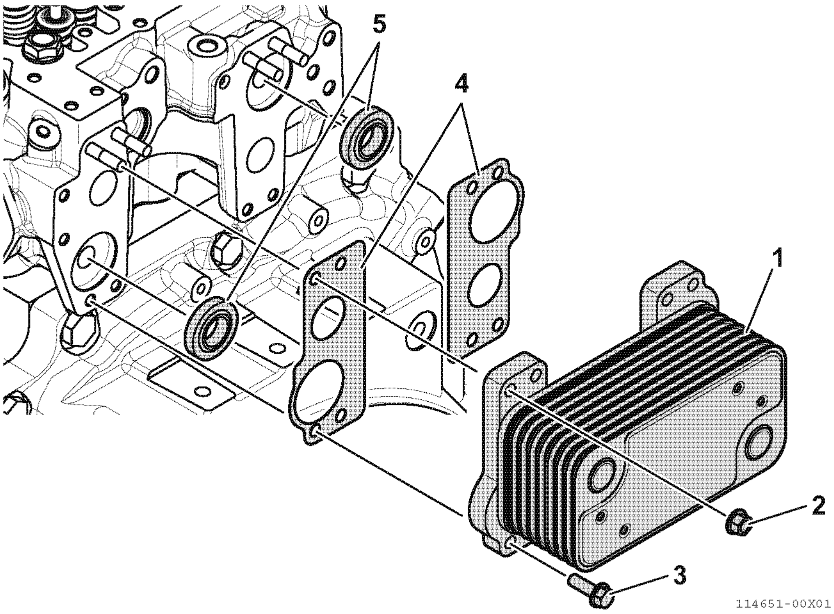


Fig.23-7

This section explains the assembly procedure for each component after EGR system maintenance, inspection, or part replacement was performed.

1. Assembling the EGR Valve System

When assembling the EGR valve system parts, follow the procedure in 2300-02-01-01 “Disassembling and Removing the EGR Valve System” which is the opposite of the disassembling order described earlier, and install the intake collector, lead valve, EGR valve spacer, EGR valve, and EGR pipe in sequence.

2. Attaching the EGR Cooler

When assembling the EGR cooler, follow the reverse procedure of 2300-02-01-02 “Removing the EGR cooler”. Tighten the mounting bolts and nuts to the specified torque. See 0000-07-03-01 “Standard torque”.

Note: Connecting part for each component uses a steel gasket. Replace them with new ones when reassembling. Parts numbers and usage positions of each gasket are shown in Fig.23-8.

1	Intake pipe gasket	129G01-12850
2	EGR valve spacer gasket	129G01-13720
3	EGR valve (OUT) gasket	129G01-13920
4	EGR valve (IN) gasket	129G01-13910
5	EGR pipe gasket	129G01-13810
6	EGR cooler gasket	129G01-13410
7	EGR CW cooler gasket	129G01-13420
8	Exhaust manifold gasket	129G01-13111

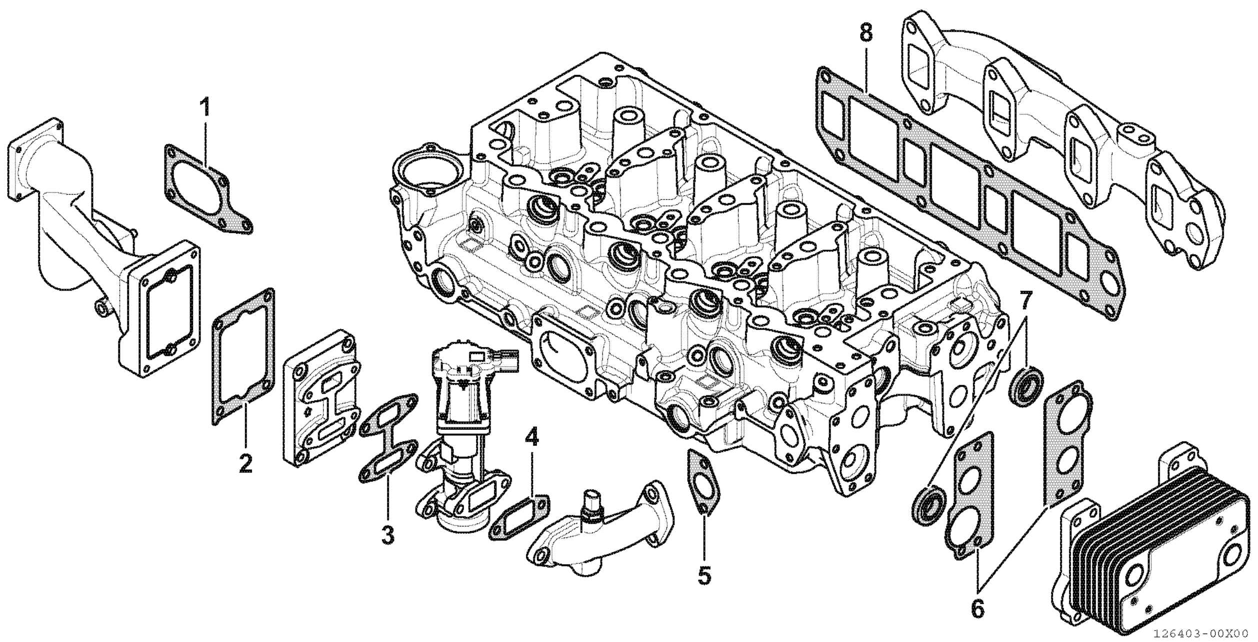


Fig.23-8

3. Attaching the Exhaust Manifold

Using the two stud bolts on the cylinder head side as a guide, attach a new gasket and an exhaust manifold. Install 2 M10 nuts and 8 M10 bolts via the bolt spacer, and tighten with a predetermined torque.

Tightening torque	Exhaust manifold attaching bolts (M10 × 1.5)	49 ± 4.9 N·m

Install the exhaust pressure pipe assembly to the cylinder head side and exhaust manifold side with M12 pipe joint bolts, and tighten with a specified torque.

Tightening torque	Pipe joint bolts for attaching exhaust pressure pipes (M12 × 1.25)	29.4 ± 4.9 N·m

1. Cleaning the EGR Valves

Cleaning the EGR valve is not included in Periodic Maintenance. However, if you are using it for a long time as a circulation passage of exhaust gas, and find accumulation of carbon causing the EGR rate to drop, clean the valve.

Because the EGR valve is in a closed state when the engine key switch is off, in order to clean the valve, connect the interface box to forcibly send a signal from the ECU to fully open the EGR valve by using SMARTASSIST DIRECT (SA-D) as shown in Fig.23-9. Therefore when removing the EGR valve from the engine for cleaning, either remove it with the wire harness connected, or if it is difficult to remove with the harness connected, disconnect the harness and then reconnect it after removing the EGR valve.

1.1 EGR active control procedure

First connect the interface box to the engine harness via the connector cable, then turn on SMARTASSIST DIRECT (SA-D) on the PC. Force open the EGR valve, and clean the vale.

Note: Before forcibly activating the EGR, check for errors that affect the fully closing process of the EGR.

How to check: Press “Defect Display” and “Current Defect”. If the error is displayed, go to (1). If no error is displayed, go to (2).

(1)	Select “Diagnostic Codes” and select “Defect History”.
	Press “All Clear” button. Error information is cleared from the “Defect History”.
(2)	Select “Diagnosis Tests” and select “Active Control”.
	Press “Execute” button from “EGR Valve Opening Control”.
	Enter the user ID and password.
	When “EGR Valve Opening Control” is displayed, enter “106” in “Desired” and press “Set”.

Active control starts if no error is found.

Note: Check that the desired value on the screen indicates the set target value. EGR valve opening control lamp comes on.

NOTICE

Do not end the SA-D while cleaning the EGR.

For details on how to operate the EGR Active Control, refer to the SMARTASSIST-DIRECT (SA-D) Operation Manual.

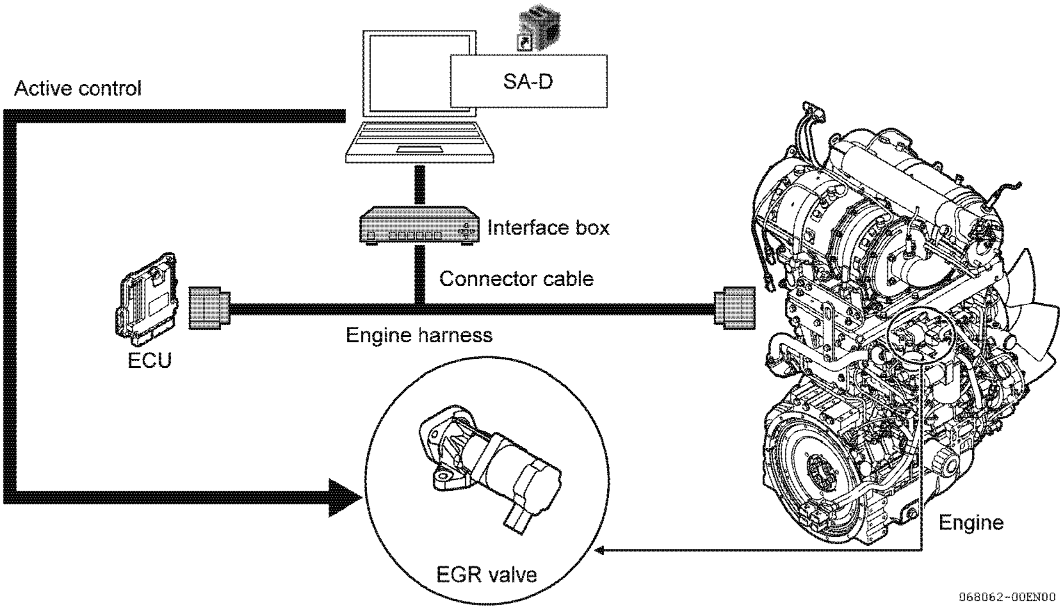

SA-D
Active control
Interface box
Connector cable
ECU
Engine harness
Engine
EGR valve
068062-00EN00

Fig.23-9

1.2 Cleaning the EGR valves

To remove deposited carbon, use compressed air (28 psi (0.19 MPa; 2 kg/cm^2) or lower). If the valves are heavily fouled, use carbon cleaner, kerosene, or some other liquid capable of removing carbon as well as a soft brush to clean the valves, taking care not to damage their parts.

When cleaning the valves, take extreme care to prevent water, solvent, cleaner, and other liquid from entering into the motor and coupler terminals; otherwise, failure may result. If the carbon deposits can not be removed by a brush, be sure to replace the entire EGR valve assembly. Remove the remaining carbon deposits by blowing the compressed air (Fig.23-10).

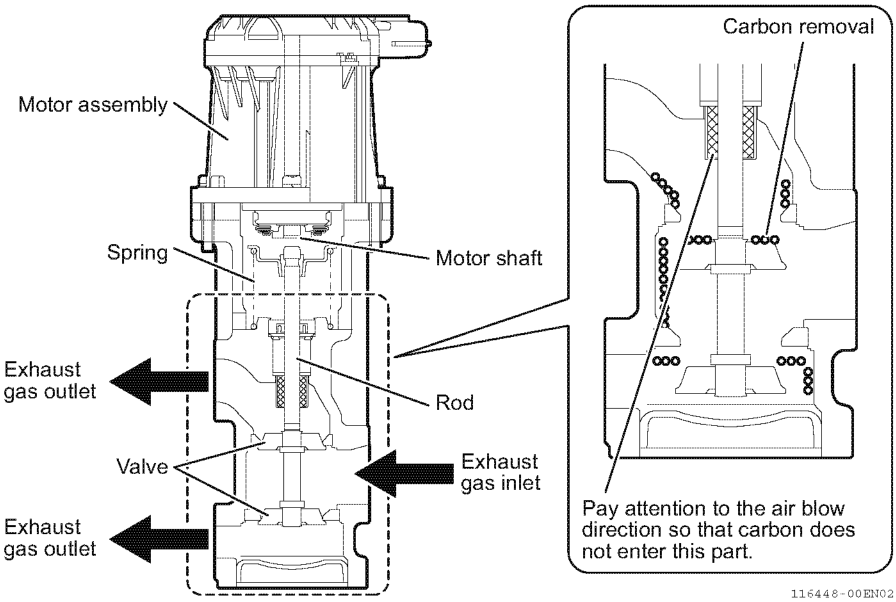


Fig.23-10

⚠ CAUTION

Flying Object Hazard!

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

1.3 Precautions for cleaning

- Do not disassemble the EGR valve.
- Do not use cleaning fluid.
- Do not use a hard brush made of metal.
- Clean entire circumference of the valve and the valve seat, and blow with the compressed air.
- Do not put your fingers into the valve portion.

1.4 Exit the EGR active control

You can exit the EGR Active Control from the SMARTASSIST-DIRECT screen.

- Press the “Stop” button from “EGR Valve Opening Control”.
- EGR valve opening control lamp goes off and EGR Active Control exits.

2. Cleaning the EGR Lead Valve

Cleaning the EGR lead valve is not included in Periodic Maintenance. However, if you are using it for a long time as a circulation passage of exhaust gas, and find accumulation of carbon causing the EGR rate to drop, clean the valve.

2.1 Disassembling the EGR lead valve

Loosen the small screws on both sides of the case, then remove the stopper and valve (Fig.23-11).

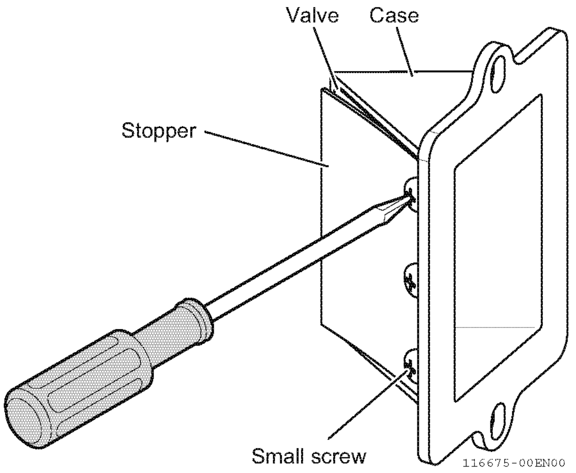


Fig.23-11

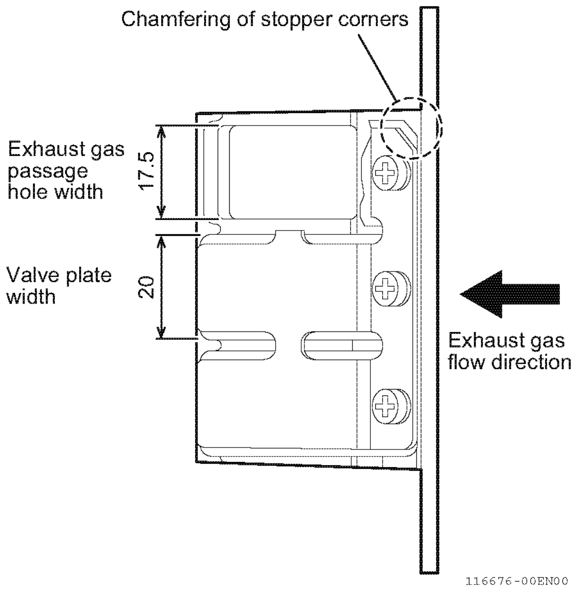


Fig.23-12

2.2 Cleaning the EGR lead valve

To remove deposited carbon, use carbon cleaner, kerosene, or some other liquid capable of removing carbon as well as a soft brush or cloth to clean the valves, taking care not to damage their parts. Upon completion of carbon removal, wipe off water and liquid, make sure that the case, valve, and stopper are free of foreign matter, and then reinstall the valve and related parts.

2.3 Assembling the EGR lead valve

- The valve and stopper must be installed in their specific orientations. As shown in the figure above, install the valve and stopper so that chamfering of stopper corners are located on the left-hand side of the lead valve Fig.23-12.
- Install the valve by tightening the machine screw while ensuring that it is evenly positioned inside the case window.The machine screw must be tightened with torque of 1.37 ± 0.2 N·m (14 ± 2 kgf·cm).
- After tightening the machine screw, mark it with a marker to indicate that it has already been tightened.

3. Cleaning the EGR Cooler

The EGR cooler must be periodically cleaned every 4500 hours because the exhaust gas passage is subject to carbon deposition and the cooling water transit portion to scale deposition and these depositions gradually deteriorate the cooling of recirculated gas, thus resulting in higher gas temperatures and lower effective circulation amounts (EGR rate).

1. To remove deposited carbon from the gas passage, use compressed air (28 psi (0.19 MPa; 2 kg/cm^2) or lower). Then dip the gas passage in carbon cleaner, kerosene, or some other liquid capable of removing carbon; leave it dry and blow it with compressed air again.
2. To clean the engine coolant transit portion, soak it in a solution of descaling detergent diluted with water.

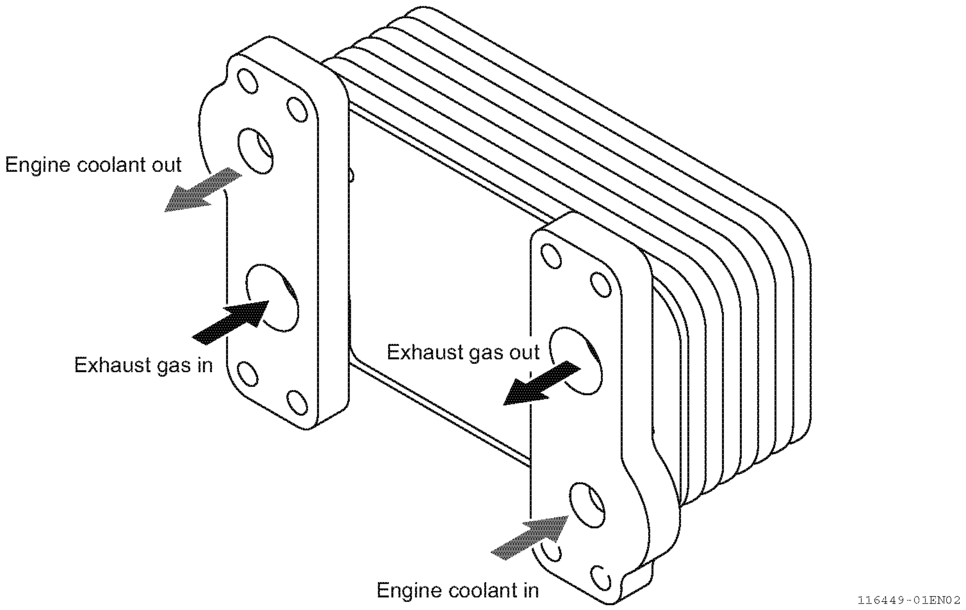


Fig.23-13

4. Cleaning the EGR Pipe and Other Connecting Elbows

The exhaust gas passage is subject to carbon deposition when used over time. These passages consist of the exhaust gas passage inside the cylinder head from the exhaust manifold (1, Fig.23-14) to the EGR cooler (2, Fig.23-14), the exhaust gas passage inside the cylinder head between the EGR cooler (1, Fig.23-15) and the EGR pipe (2, Fig.23-15). Cleaning these passages is not included in Periodic Maintenance. However if you find accumulation of carbon that reduces the EGR rate, perform cleaning. To remove deposited carbon from the gas passage, use compressed air (28 psi (0.19 MPa; 2 kg/cm^2) 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.

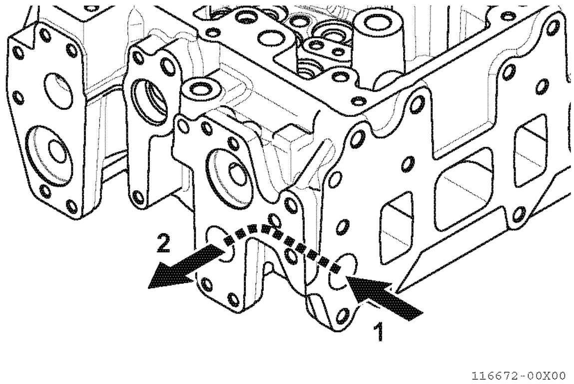


Fig.23-14

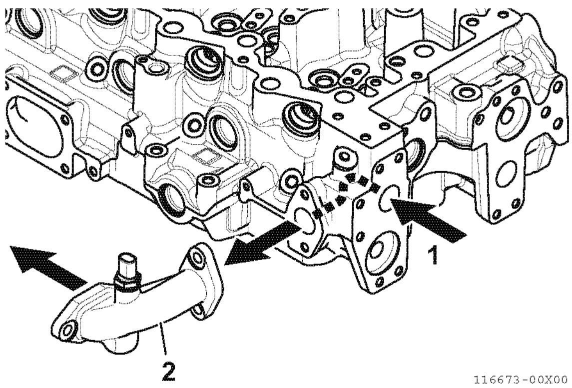


Fig.23-15

⚠ CAUTION

Flying Object Hazard!

- **Be sure to wear eye protection when inspecting the engine and when using compressed air or pressurized water. Dust, flying debris, compressed air, pressurized water or steam may injure your eyes.**
- **Failure to comply may result in injury.**

Turbocharger Components and Functions

There are two types of turbochargers for the 4TN107 engine: single-stage turbocharger for the 4TN107HT and 4TN107FHT types, and 2-stage turbocharger for the 4TN107TT and 4TN107FTT types. The single-stage turbocharger for the 4TN107HT and 4TN107FHT types is the same as past systems. However the 2-stage turbocharger for the 4TN107TT and 4TN107FTT types has a configuration in which two turbochargers are connected in series.

1. 2-stage Turbocharger

1.1 Configuration of the 2-stage turbocharger

Fig.24-1 shows the configuration of the 2-stage turbocharger and the intake air and exhaust gas flows. After passing through the exhaust manifold, the exhaust gas rotates the turbine and drives the compressor of the first-stage (high-pressure stage) turbocharger. The intake air pressurized by the second-stage (low-pressure stage) turbocharger is further pressurized and sent to the combustion chambers via the intake throttle.

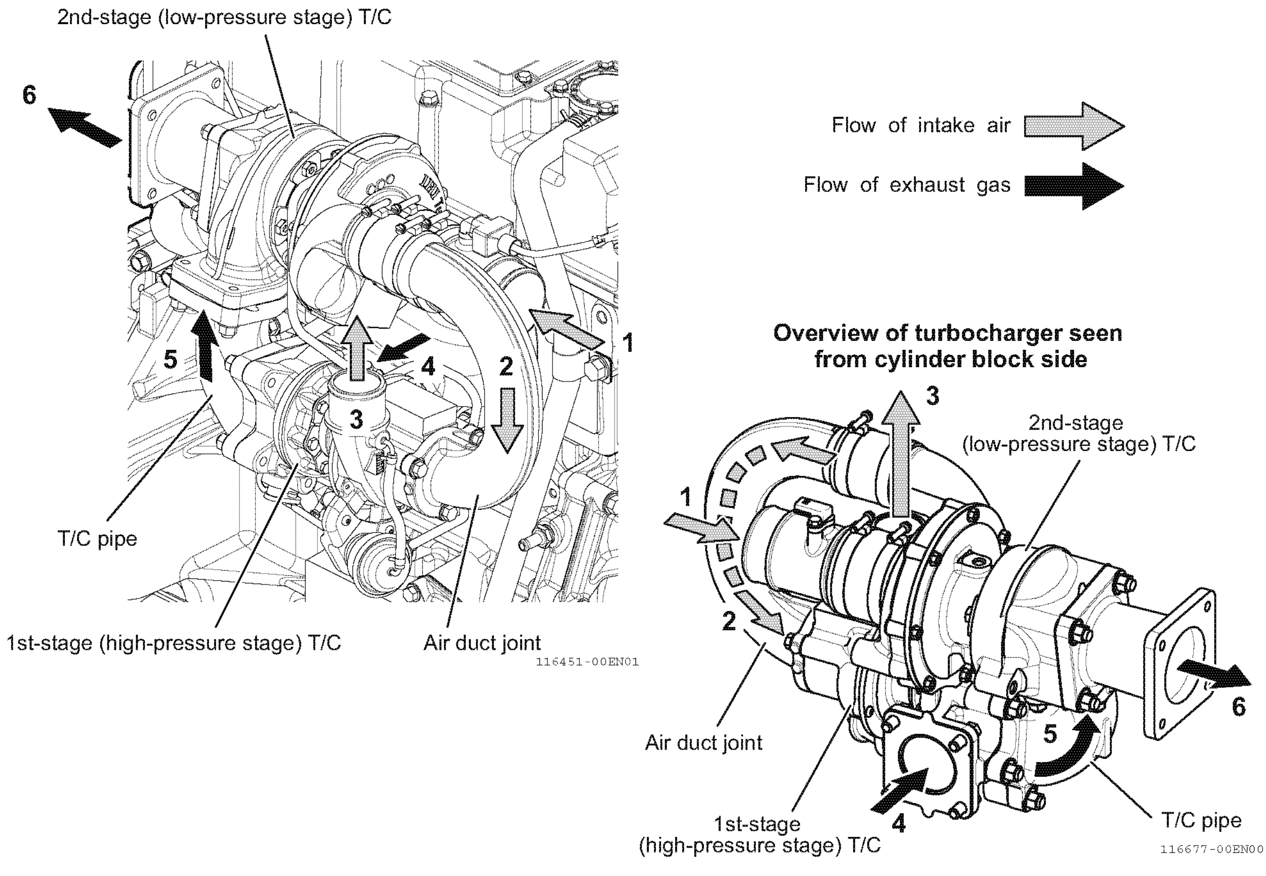


Fig.24-1

Flow of intake air

1 - From air cleaner to second-stage (low-pressure stage) T/C

2 - From second-stage (low-pressure stage) T/C to 1st-stage (high-pressure stage) T/C

3 - From first-stage (high-pressure stage) T/C to intake throttle

Flow of exhaust gas

4 - From exhaust manifold to first stage (high-pressure stage) T/C

5 - From first-stage (high-pressure stage) T/C to second-stage (low-pressure stage) T/C

6 - From second-stage (low-pressure stage) T/C to after-treatment system

1.2 Layout diagram for intake and exhaust flow of the 2-stage turbocharger

Fig.24-2 is a schematic showing the intake and exhaust system of the 2-stage turbocharger.
The layout connects the two turbochargers - the first-stage (high-pressure stage) turbocharger and second-stage (low-pressure stage) turbocharger - in series.

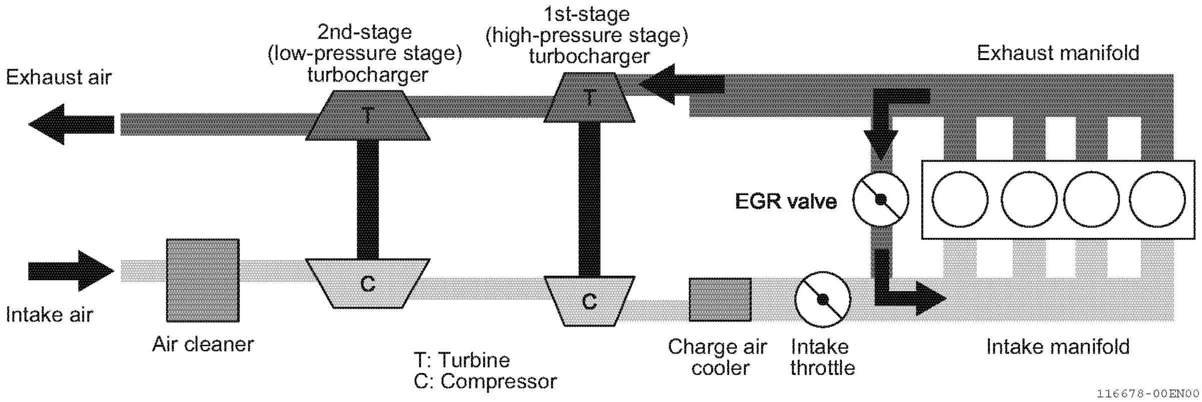


Fig.24-2

1.3 Functions of the 2-stage turbocharger

Compared to a single-stage turbocharger, the use of a 2-stage turbocharger produces higher torque at low speeds as a result of the first-stage (high-pressure stage) turbocharging. The second-stage (low-pressure stage) turbocharging ensures rated power and improves rated fuel economy. These conditions are shown in Fig.24-3.

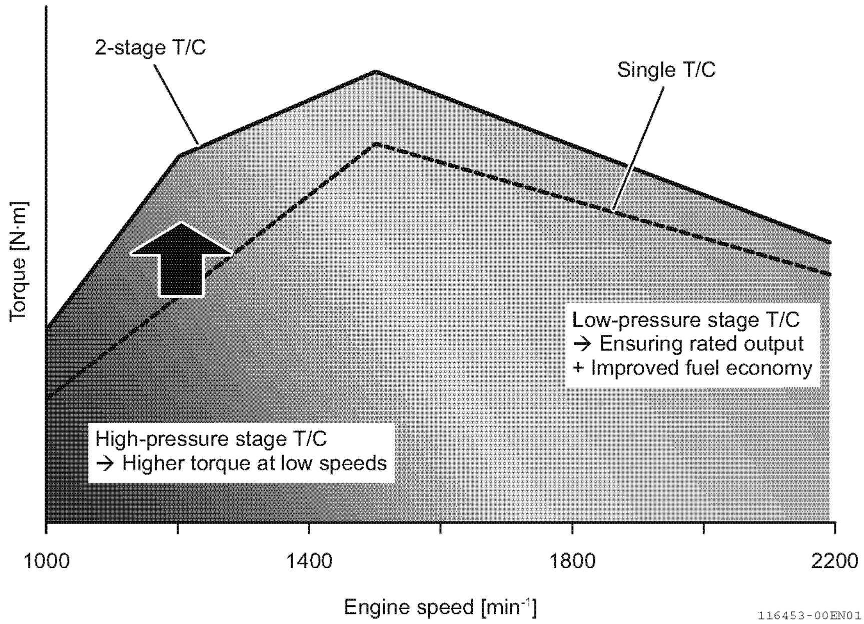


Fig.24-3

2. Single-stage Turbocharger

2.1 Configuration of the single-stage turbocharger

Fig.24-4 shows an overview of the single-stage turbocharger. The configuration of the single-stage turbocharger is the same as past systems.

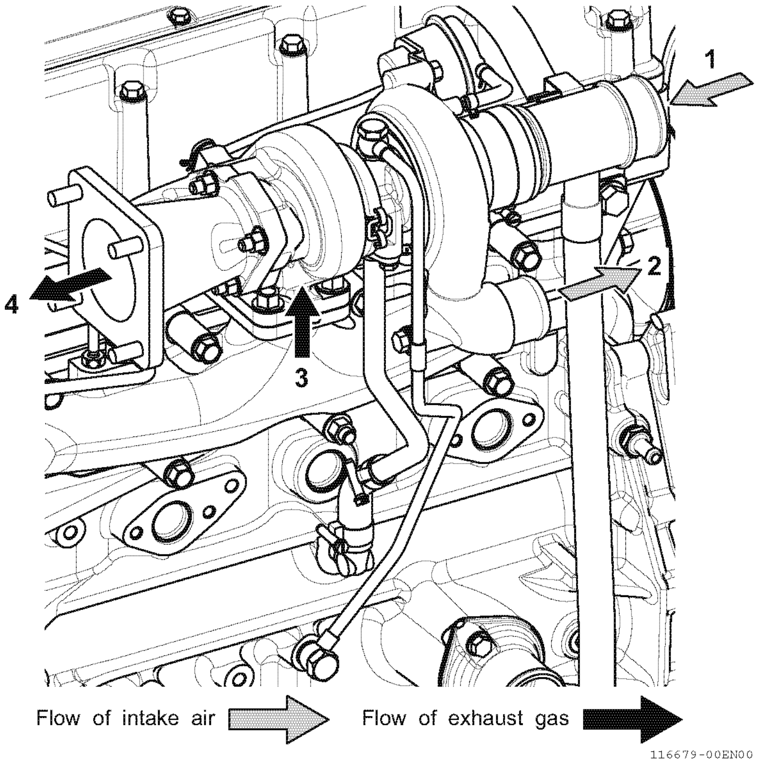


Fig.24-4

Flow of intake air

1 - From air cleaner to turbocharger (compressor)

2 - From turbocharger (compressor) to intake throttle

Flow of exhaust gas

3 - From exhaust manifold to turbocharger (turbine)

4 - From turbocharger (turbine) to after-treatment system

3. Turbocharger Specifications

The specifications of the turbocharger installed in the 4TN107HT, 4TN107FHT (single-stage turbocharger) type and 4TN107TT, 4TN107FTT (2-stage turbocharger) type are as follows.

Applicable engine model	4TN107HT 4TN107FHT	4TN107TT 4TN107FTT	
Turbocharger model	TD04R (MHI product)	First-stage (high-pressure stage)	Second-stage (low-pressure stage)
		RHF4 (IHI product)	RHF55 (IHI product)
Turbocharger specifications	Standard (with waste gate)	Standard (with waste gate)	No waste gate
Turbine type	Radial flow		
Blower (compressor) type	Centrifugal		
Lubrication	External lubrication		
Turbocharger mass (dry)	4.5 kg	6.2 kg	9.4 kg

4. Structure of Turbocharger

Engines achieve the most efficient combustion at a certain air-fuel ratio. Although the amount of fuel injection can be increased, the amount of air that can be introduced into the cylinder is limited. The turbocharger rotates the turbine using the pressure from engine exhaust gas, drives the compressor, and pressurize the intake air. Therefore the pressure inside the combustion chamber increases, thereby substantially increasing the amount of fuel that can be injected into the combustion chambers, while maintaining the proper air-fuel ratio to improve engine output property.

Structure of the turbocharger is shown in Fig.24-5. The turbocharger consists of two main components: Turbine, and compressor.

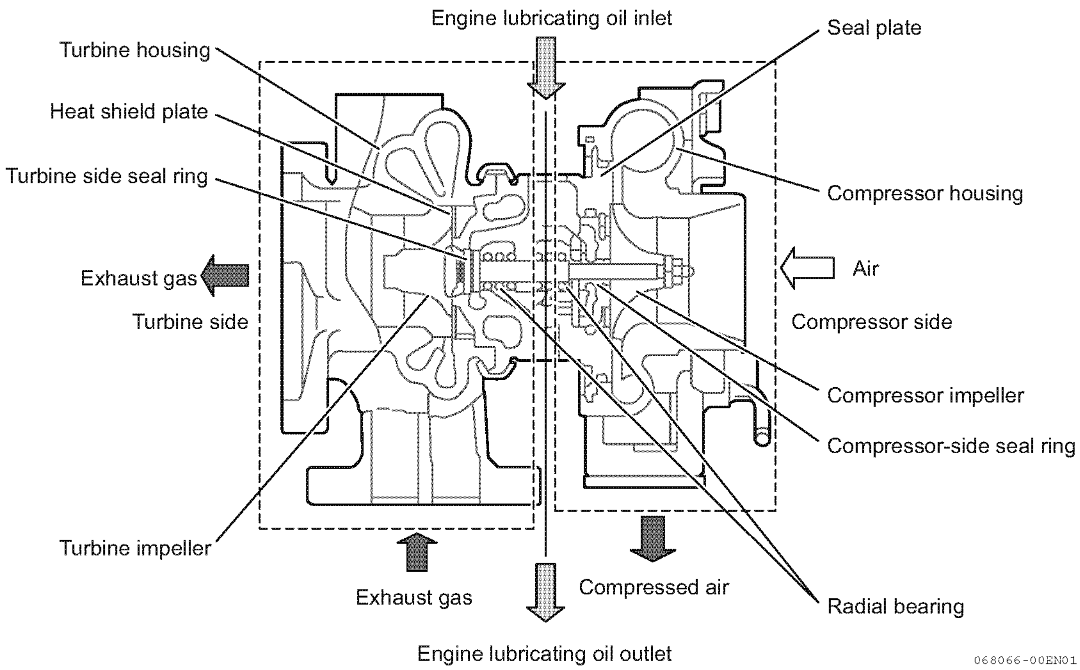


Fig.24-5

4.1 Turbine

The turbine is driven by exhaust gas pressure from the engine and is coupled to a shaft on the compressor side of the turbocharger. Exhaust gas velocity is accelerated at the nozzle portion in the turbine housing where the cross-sectional area is reduced. As exhaust passes over the turbine impeller at high linear velocity, the turbine shaft is rotated at proportionally high rpm.

4.2 Compressor

The compressor is driven by a shaft on the turbine side of the turbocharger and increases the induction air pressure at the intake manifold. The compressor impeller draws induction air into the turbocharger, compresses it and directs it into the engine at high-pressure. A seal ring and heat insulating plate thermally isolate heat energy, at the turbine side, from the bearings and the induction air, at the compressor side.

4.3 Bearings

1. Thrust bearing: A thrust force is continuously imposed on the turbine shaft during engine operation. A thrust bearing prevents the shaft from moving laterally under this thrust force.
2. Radial bearing: A floating radial bearing moves with the turbine shaft as oil films form on the inside and outside bearing surfaces. The bearing slipping speed is slower than the turbine shaft speed, resulting in higher dynamic stability and reduced mechanical noise.

4.4 Lubrication

The oil pump delivers oil from the engine to the turbocharger for cooling and lubrication of the bearings. As oil leaves the turbocharger, it is returned to the engine.

4.5 Compressor side sealing mechanism

A seal ring and a seal plate form a double wall structure at the rear of the compressor impeller. The seal ring and seal plate prevent Intake air and oil leakage.

5. Function of the Waste Gate

Excessive boost pressure that cannot be accommodated by the engine can damage the turbocharger. The waste gate is a component that monitors intake boost pressure on the compressor side and diverts exhaust gases around the turbocharger turbine. The amount of exhaust gas diverted is varied to limit turbine rpm and maintain the intake pressure equal to, or less than the specified maximum level. This improves the response to load variation in the low to medium rpm range and minimizes black smoke. A mechanical pressure sensor (1, Fig.24-6) in the outlet of the compressor side of the turbocharger actuates the actuator (2, Fig.24-6), and it opens and closes the waste gate to maintain the specified intake pressure at the intake manifold.

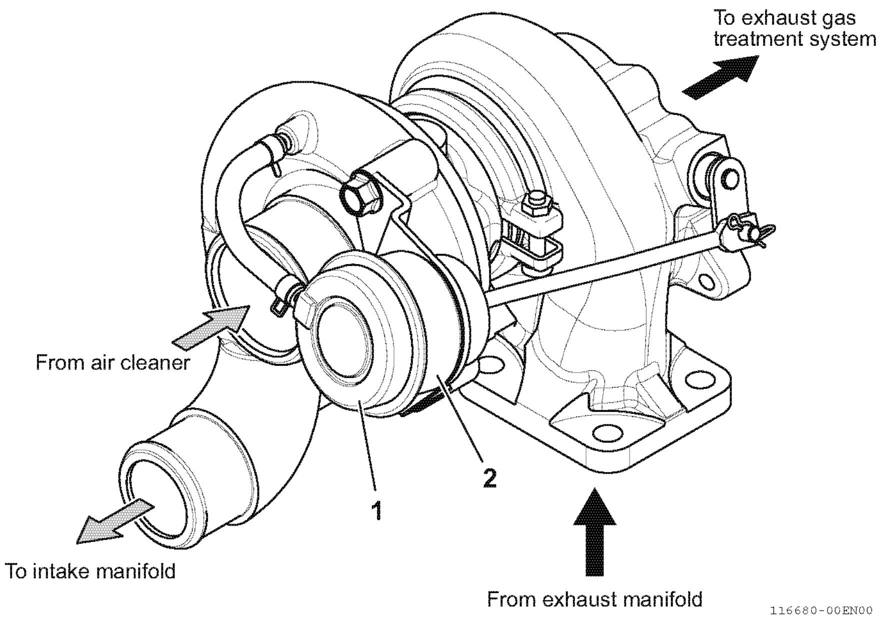


Fig.24-6

A waist gate is installed in the single-turbo of 4TN107HT and 4TN107FHT, and to the 1st stage (high pressure stage) turbocharger of 4TN107TT and 4TN107FTT.

1. Disassembling the 2-stage Turbocharger (4TN107TT, 4TN107FTT)

1.1 Disassembling the low-pressure stage turbocharger (upper side) of the 2-stage turbocharger

1 - Disconnect the air inlet and outlet connection of the low-pressure stage turbocharger (1, Fig.24-7).

2 - From the low-pressure stage turbocharger (1, Fig.24-7) and high-pressure stage turbocharger (2, Fig.24-7), loosen the pipe joint bolts (5, 6, and 7, Fig.24-7) on the lubricating oil supply pipes (3 and 4, Fig.24-7) and remove the lubricating oil supply pipes. Block the pipe joint hole and oil pipe with tape so that dust and other foreign matter do not enter.

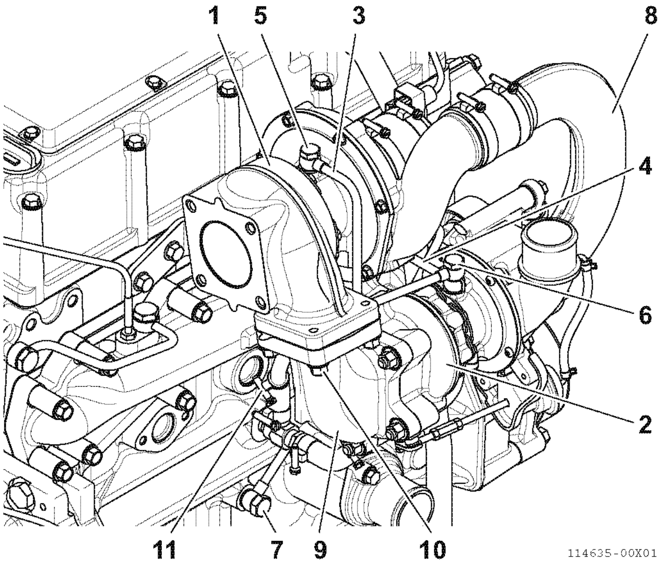


Fig.24-7

3 - Remove the turbocharger-side mounting bolts (2, Fig.24-8) from the two stays (1, Fig.24-8) which are fastening the low-pressure stage turbocharger and cylinder head.

4 - Remove the intake air duct joint (8, Fig.24-7) which connects to the high-pressure stage turbocharger.

5 - Remove the mounting nuts (10, Fig.24-7) from the flange of the exhaust pipe (9, Fig.24-7) that connects from the high-pressure stage turbocharger.

6 - Loosen the hose clips (11, Fig.24-7) of the lubricating oil return hose and remove the low-pressure stage turbocharger (upper side) (Fig.24-9).

7 - Remove the two stays (1, Fig.24-9) which are fastening the low-pressure stage turbocharger and cylinder head from the cylinder head.

8 - Discard the packing of the lubricating oil supply pipe joint and the turbocharger exhaust pipe gasket.

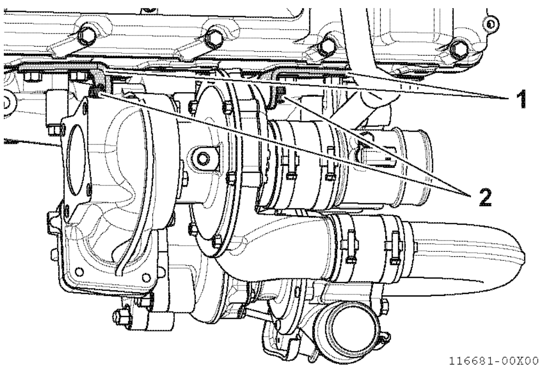


Fig.24-8

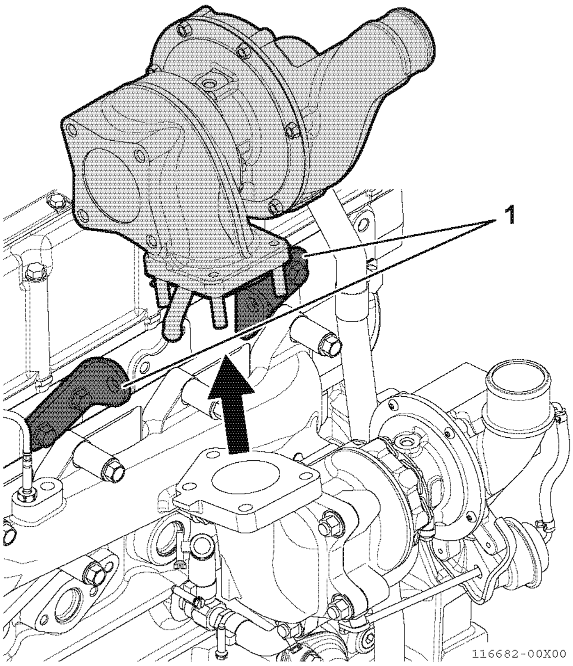


Fig.24-9

1.2 Disassembling the high-pressure stage turbocharger (lower side) of the 2-stage turbocharger

1 - Disconnect the air outlet (2, Fig.24-10) connection of the high-pressure stage turbocharger (lower side) (1, Fig.24-10).

2 - Remove the snap pin (4, Fig.24-10) from the heat shield cover (3, Fig.24-10) for the lubricating oil return hose of the high-pressure stage turbocharger (lower side).

3 - Loosen the hose clips (1, Fig.24-11) that fasten the lubricating oil return hose of the high-pressure stage turbocharger (lower side).

4 - Loosen the mounting nut (2, Fig.24-11) of the turbocharger and exhaust manifold, and remove the turbocharger (lower side) together with the exhaust pipe (3, Fig.24-11).

5 - Discard the gasket attached between the turbocharger and exhaust manifold.

6 - Remove another heat shield cover (4, Fig.24-11) of the lubricating oil hose as necessary, and remove the lubricating oil hose (1, Fig.24-12). In this case, use tape or other means to block the joint (2, Fig.24-12) to prevent dust or other foreign matter from the cylinder block.

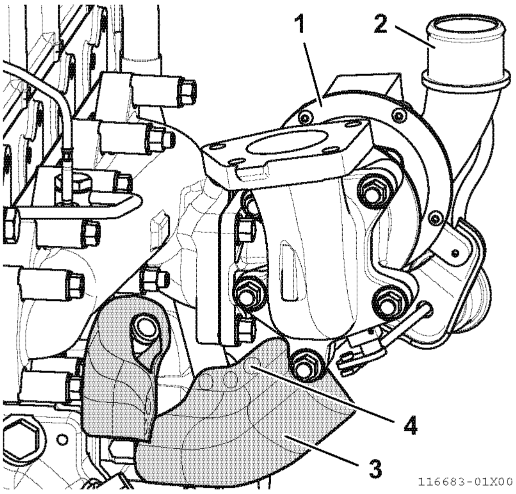


Fig.24-10

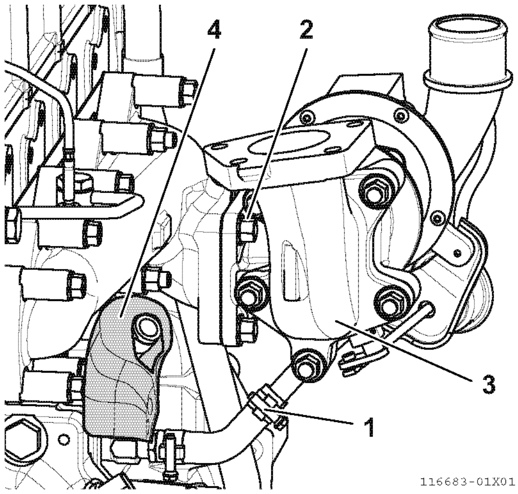


Fig.24-11

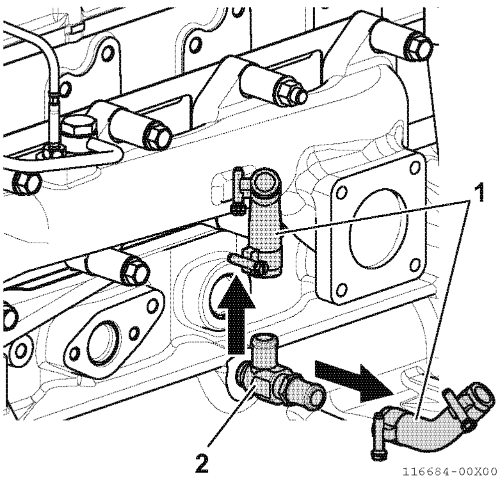


Fig.24-12

2. Disassembling the Single-stage Turbocharger (4TN107HT, 4TN107FHT)

1. Disconnect the air inlet and outlet connection of the single-stage turbocharger (1, Fig.24-13).
2. Loosen the pipe joint bolts (3 and 4, Fig.24-13) on the lubricating oil supply pipe (2, Fig.24-13) and remove the lubricating oil supply pipe. Block the pipe joint hole and oil pipe with tape so that dust and other foreign matter do not enter.
3. Discard the packing of the lubricating oil supply pipe joint bolts.
4. Loosen the mounting nuts (5, Fig.24-13) of the exhaust manifold flange.
5. Loosen the hose clips (6, Fig.24-13) of the lubricating oil return hose, and lift up and remove the turbocharger from the engine.
6. Discard the turbocharger exhaust manifold gasket.

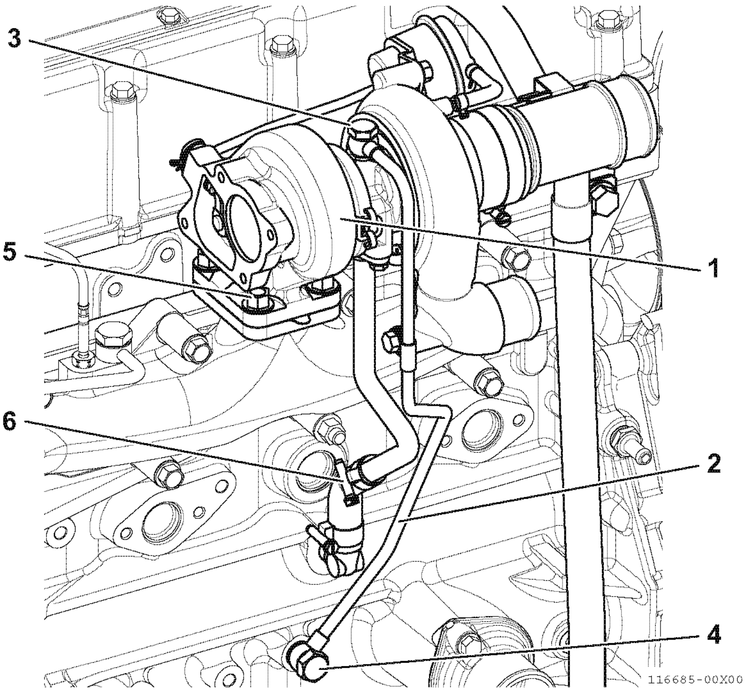


Fig.24-13

7. Remove the lubricating oil return hose (1, Fig.24-14) as necessary. In this case, use tape or other means to block the joint (2, Fig.24-14) from the cylinder block in order to prevent dust or other foreign matter from entering.

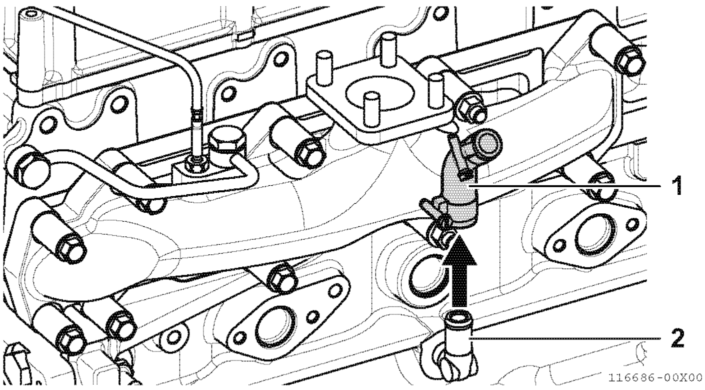


Fig.24-14

1. Inspecting the Turbocharger

1.1 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.

1.2 Inspecting the rotor rotation

1 - With the turbocharger removed and in unit condition, or with the turbocharger installed on the engine, remove the connection on the turbocharger air intake side or the connection on the turbocharger exhaust side and manually rotate the rotor (turbine shaft). 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 - Assemble the turbocharger in the correct manner, and start the engine. After the engine reaches normal operating temperature, place a stethoscope firmly against the turbocharger case. Increase the rpm gradually. A high-pitched sound, occurring at intervals of two or three seconds, is an indication of abnormal operation.

1.3 Checking rotor play

To inspect the play (end play, run-out) of the rotor, the turbocharger must be removed. See 2400-02-01-01 "Disassembling the 2-stage Turbocharger" or 2400-02-01-02 "Disassembling the Single-stage Turbocharger" for removing the turbocharger.

1 - To check rotor end play

1 - Set up a dial indicator as shown in (1, Fig.24-15) to the turbocharger housing, and place the gauge against the end of the rotor (turbine shaft) (2, Fig.24-15) in the axial direction (3, Fig.24-15).

2 - Manually move the rotor end-to-end while observing indicated readings.

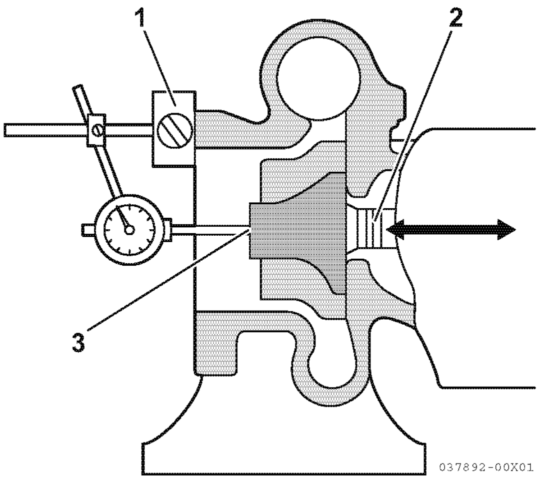


Fig.24-15

2 - To check rotor run-out

1 - Set up a dial indicator as shown in (1, Fig.24-16) to the turbocharger housing, and insert the gauge into the lubricating oil supply hole and place it against the shaft of the rotor (turbine shaft) (2, Fig.24-16).

2 - Manually rotate the rotor while observing indicated limits.

Note: Depending on the turbocharger model, run-out may not be measured.

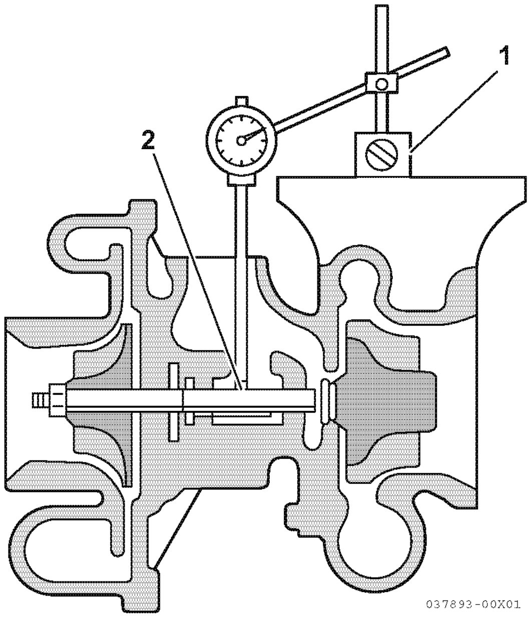


Fig.24-16

Replace the turbocharger or have it repaired if measurements are outside specified limits in the table below.

	Engine model	4TN107TT 4TN107FTT (2-stage turbocharger)		4TN107HT 4TN107FHT (single-stage turbocharger)
	Turbocharger model	Low-pressure stage turbocharger	High-pressure stage turbocharger	TD04
		RHF55	RHF4	
Play standard dimensions (mm)	End play	0.03 - 0.10	0.026 - 0.084	0.027 - 0.073
	Run-out	–	0.08 - 0.13	–

2. Inspecting the Waste Gate Valve

⚠ WARNING

Never apply over 40 psi (2.8 kgf/cm^2) to the waste gate actuator.

2.1 Operation check

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

NOTICE

If the waste gate valve does not meet specifications, replace the turbocharger or have it repaired by a qualified repair facility.

1 - Connect a hand-operated air pump to the waste gate actuator pipe (1, Fig.24-17).
The pump should be equipped with a 30 psi (0.21 MPa; 2.21 kgf/cm^2) pressure gauge (2, Fig.24-17) and a pressure relief valve to release any pressure pumped into the system.

2 - Apply 17 psi (0.12 MPa; 1.2 kgf/ cm^2) to the waste gate actuator (3, Fig.24-17) circuit. Observe if the waste gate valve fully opens. If the waste gate valve does not fully open, replace the turbocharger or have it repaired by a qualified repair facility.

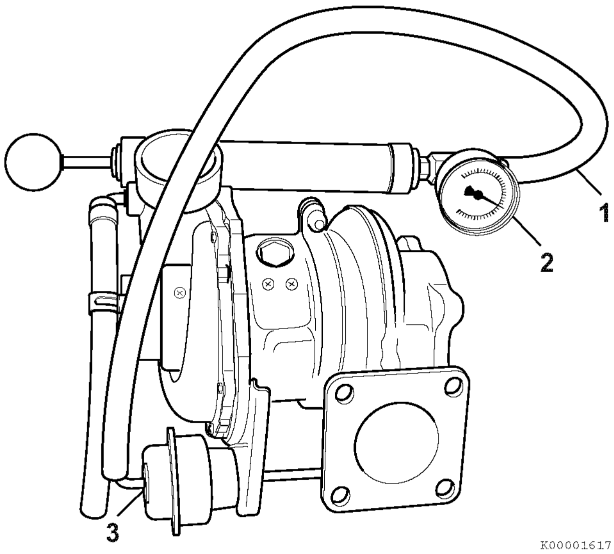


Fig.24-17

2.2 Waste gate actuator leak test

Allow the pressure, 17 psi (0.12 MPa; 1.2 kgf/cm^2) to remain in the circuit for one minute. After one minute, observe the pressure reading.

1 - If the pressure reading is equal to or greater than 15.9 psi (0.11 MPa; 1.1 kgf/cm^2), the waste gate actuator is not leaking and is operating properly.

2 - If the pressure gauge shows less than 15.9 psi (0.11 MPa; 1.1 kgf/cm^2), air is leaking at the waste gate actuator. Replace the turbocharger or have it repaired by a qualified repair facility.

1. Installing the 2-stage Turbocharger (4TN107TT, 4TN107FTT)

1.1 Installing the high-pressure stage (lower side) of the 2-stage turbocharger

1 - Before installing the high-pressure stage turbocharger (lower side) (1, Fig.24-18), pour 60 cc (2 oz) of clean lubricating oil in the oil inlet port at the top of the turbocharger. Rotate the compressor wheel to ensure the shaft bearings are lubricated.

2 - Install the new gasket (2, Fig.24-18) on the exhaust manifold side, then insert the lubricating oil return pipe (3, Fig.24-18) into the hose (4, Fig.24-18) and install the high-pressure stage turbocharger to the exhaust manifold (5, Fig.24-18).

3 - Apply anti-seize compound to the turbocharger mounting studs.

4 - Install the mounting nuts (M10) and tighten to the specified torque. See 0000-07-03-01 “Standard Torque”.

5 - Tighten the lubricating oil return hose bands to the specified torque.

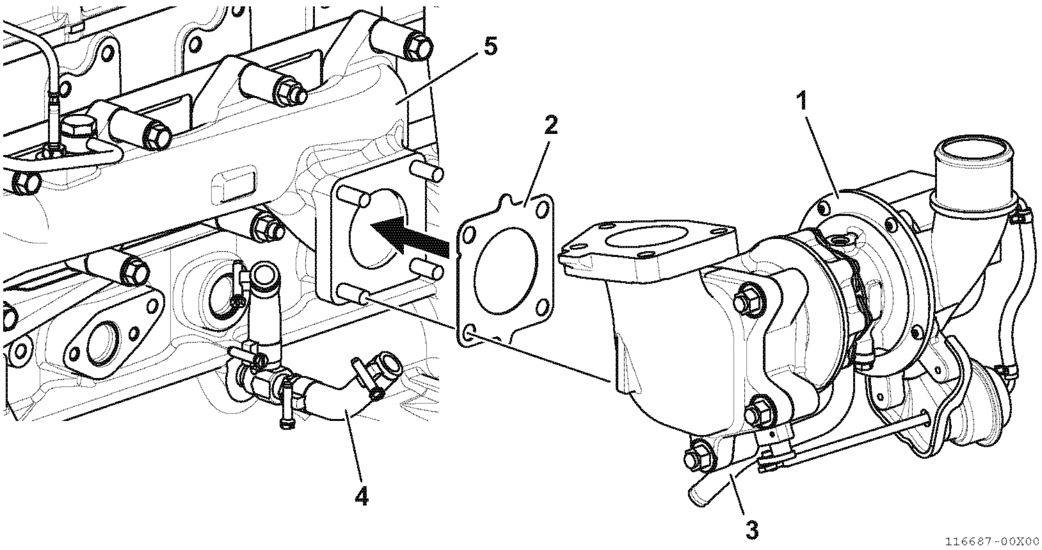


Fig.24-18

NOTICE

- Do not allow any material to fall into the oil lines or the oil inlet and outlet ports of the turbocharger.
- If the exhaust manifold was also removed during removal, attach the high-pressure turbocharger (lower side) to the exhaust manifold first, and then attach the exhaust manifold to the cylinder head.

1.2 Installing the low-pressure stage (upper side) of the 2-stage turbocharger

1 - Temporarily install the two stays (1, Fig.24-19), which fasten the low-pressure stage turbocharger (upper side) and cylinder head, to the cylinder head using the M10 bolts.

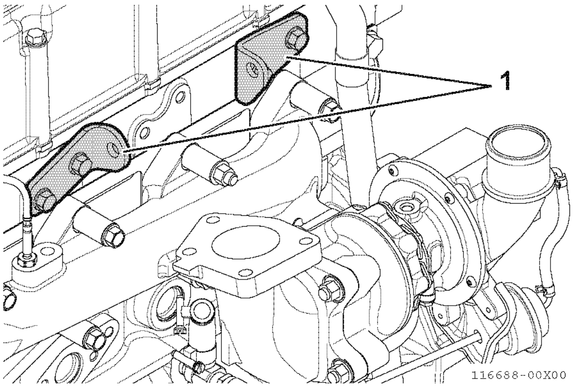


Fig.24-19

2 - Before installing the low-pressure stage turbocharger (upper side) (1, Fig.24-20), pour 60 cc (2 oz) of clean lubricating oil in the oil inlet port at the top of the turbocharger. Rotate the compressor wheel to ensure the shaft bearings are lubricated.

3 - Install the new turbocharger exhaust pipe gasket (2, Fig.24-20), then insert the lubricating oil return pipe (3, Fig.24-20) into the hose (4, Fig.24-20) and install the low-pressure stage turbocharger to the exhaust pipe (5, Fig.24-20).

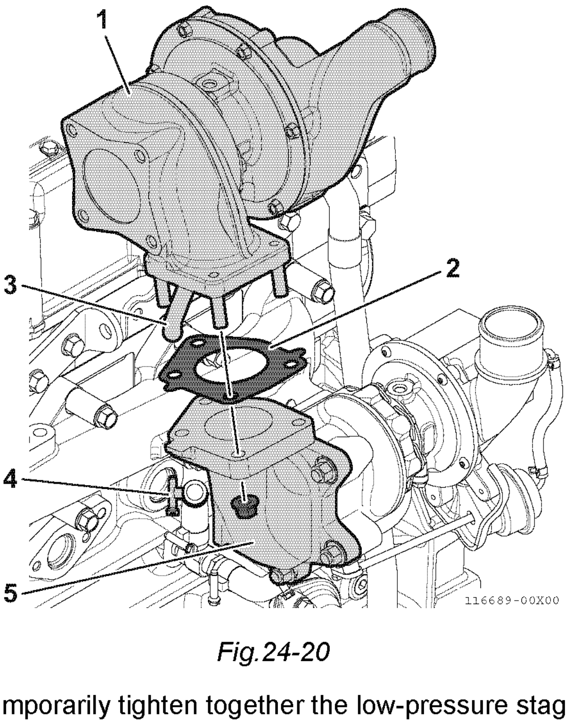


Fig.24-20

4 - Using M10 bolts, temporarily tighten together the low-pressure stage turbocharger and the two stays that were installed on the cylinder head in “1-”.

5 - Apply anti-seize compound to the turbocharger mounting studs.

6 - Install the mounting nuts (M10) and tighten to the specified torque. See 0000-07-03-01 “Standard Torque.

7 - Tighten the mounting bolts of the two stays which fasten the low-pressure stage turbocharger (upper side) and cylinder head to the specified torque. See 0000-07-03-01 “Standard Torque”.

8 - Tighten the lubricating oil return hose bands (1, Fig.24-21) to the specified torque.

9 - Install the intake air duct joint (2, Fig.24-21) which connects the airflow path of the low-pressure stage turbocharger and high-pressure stage turbocharger.

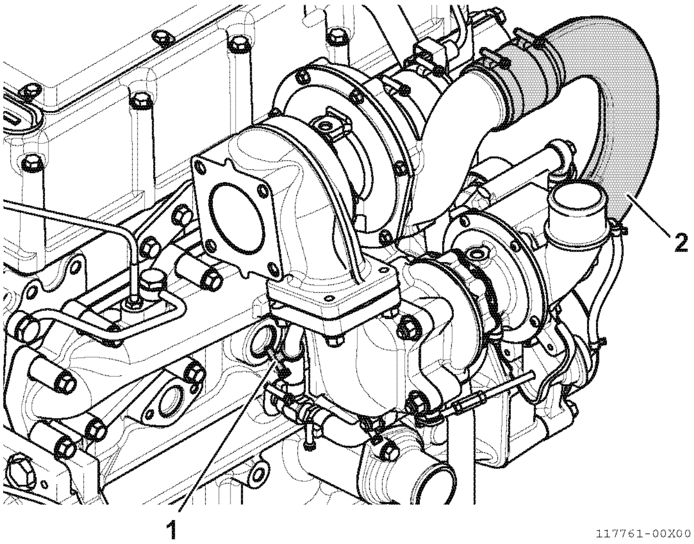


Fig.24-21

10 - Install the lubricating oil supply pipe (4 and 5, Fig.24-22) onto the low-pressure stage turbocharger (1, Fig.24-22), high-pressure stage turbocharger (2, Fig.24-22), and cylinder block (3, Fig.24-22). Replace the packing of the lubricating oil supply pipe joint with new one.

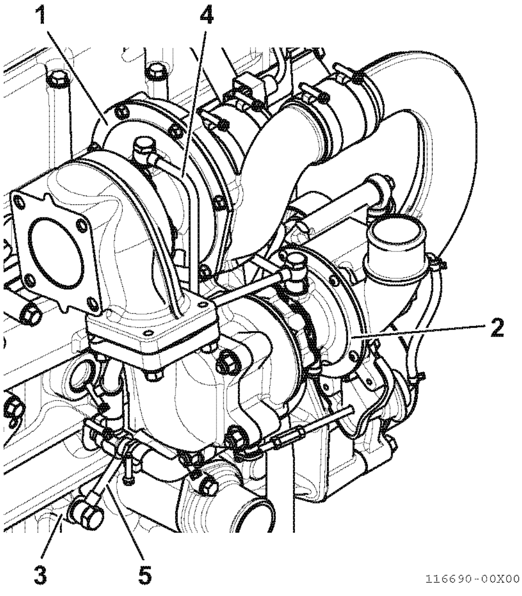


Fig.24-22

11 - Install the air inlet and outlet connections of the low-pressure stage turbocharger, and the exhaust exit connection of the high-pressure stage turbocharger.

NOTICE

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

2. Installing the Single-stage Turbocharger (4TN107HT, 4TN107FHT)

1. Before installing the turbocharger (1, Fig.24-23), pour 60 cc (2 oz) of clean lubricating oil in the oil inlet port at the top of the turbocharger. Rotate the compressor wheel to ensure the shaft bearings are lubricated.
2. Install the new gasket (2, Fig.24-23) on the exhaust manifold side, then insert the lubricating oil return pipe (3, Fig.24-23) into the hose (4, Fig.24-23) and install the turbocharger onto the exhaust manifold (5, Fig.24-23).
3. Apply anti-seize compound to the turbocharger mounting studs.
4. Install the mounting nuts (6, Fig.24-23) and tighten to the specified torque. See 0000-07-03-01 “Standard Torque”.
5. Tighten the lubricating oil return hose bands (7, Fig.24-23) to the specified torque.
6. Install the lubricating oil supply pipe (1, Fig.24-24) to the turbocharger (2, Fig.24-24) and cylinder block (3, Fig.24-24). Replace the packing of the lubricating oil supply pipe joint with new one.

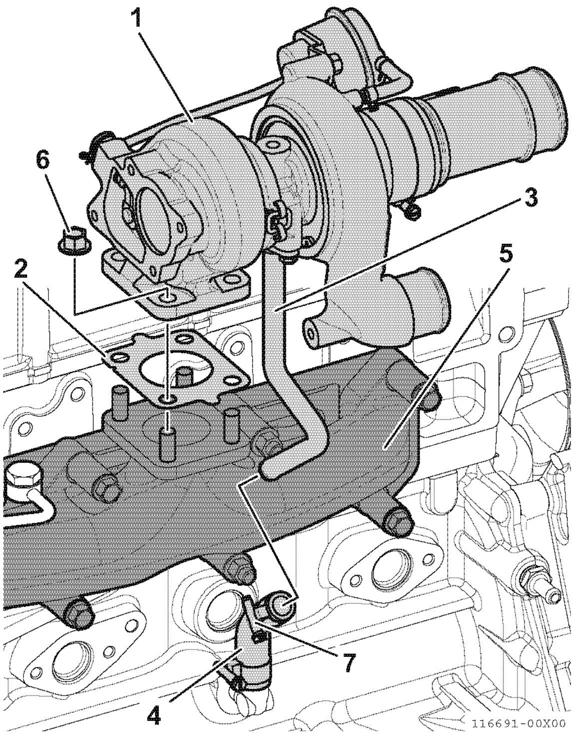


Fig.24-23

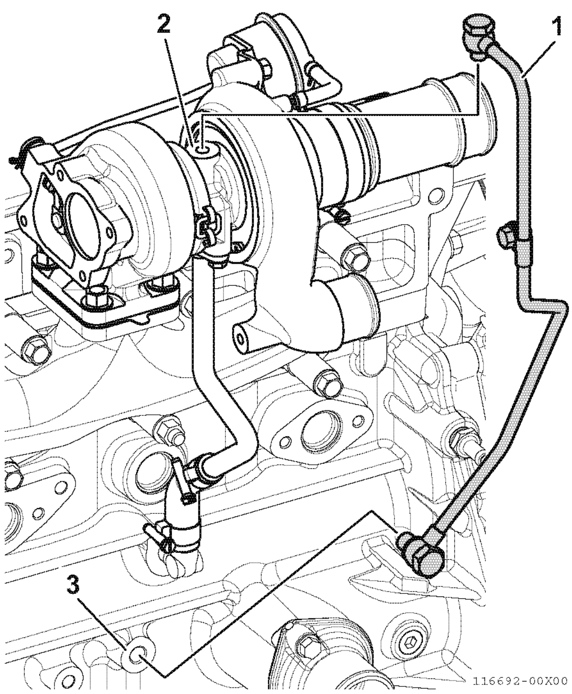


Fig.24-24

7. Install the turbocharger air inlet and outlet connection.

NOTICE

- Do not allow any material to fall into the oil lines or the oil inlet and outlet ports of the turbocharger.
- If the exhaust manifold was also removed during removal, attach the turbocharger to the exhaust manifold first, and then attach the exhaust manifold to the cylinder head.

1. Turbocharger Cleaning Procedure

The cleaning procedure described in this section is intended to clean the impeller on the compressor only if the engine loses rpm, seems sluggish or has insufficient boost pressure. The process does not require disassembling any portion of the turbocharger. Since cleaning is quick and easy, perform this procedure before considering replacement.

Note: Inspection, cleaning and repair of the internal turbocharger components must be performed by a qualified repair facility.

1. Start the engine and allow it to reach the normal operating temperature.
2. Remove the connection on the air inlet side.
3. While the engine is operating at normal load (75 - 80 % of maximum load), slowly and evenly spray 60 - 90 cc (2 - 3 oz) of blow clean fluid over a period of ten to fifteen seconds into the air inlet. Fig.24-25 shows 4TN107FTT.

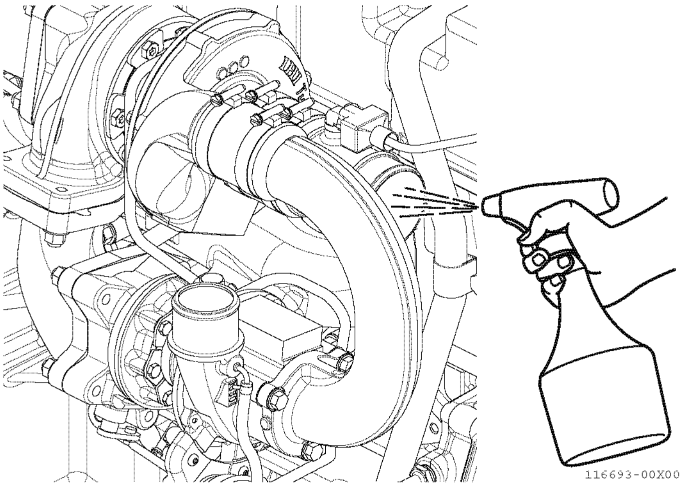


Fig.24-25

4. When spray is completed, continue to operate the engine under the same load for three to four minutes.
5. While the engine is still operating at normal load (75 - 80 % of maximum load), slowly and evenly spray 60 - 90 cc (2 - 3 oz) of clean water over a period of ten to fifteen seconds into the air inlet.
6. When spray is completed, continue to operate the engine under the same load for at least ten minutes to completely dry the air intake system and turbocharger.
7. Test the engine performance. If engine performance has not improved, repeat steps 2 through 6.
   If the engine performance does not improve after executing the cleaning process three times, replace the turbocharger or have it repaired by a qualified repair facility.

NOTICE

Avoid damage to the turbocharger or the engine. Do not spray blow clean fluid or water too quickly. Use short strokes from a spray bottle to inject blow clean fluid or water into the turbocharger. Spraying too much blow clean fluid or water, or spraying too quickly will damage the turbocharger.

1. Components of the After-treatment Device (ATD Unit) (Applicable only to EU Stage V certified models)

ATD unit: An after-treatment device combining the diesel particulate filter (DPF) and urea SCR (hereinafter, SCR). The ATD is an integrated unit, and the precision is correctly adjusted before shipment from the factory. Therefore, do not disassemble the unit.

An overview of the ATD unit is shown in Fig.25-1. The ATD unit is composed of the DPF and SCR, and they are connected with the SCR pipe. The ATD unit and the pipe are supported on the DPF-SCR bracket. The flow of exhaust gas is indicated by the arrow. For details of structures and components for DPF and SCR, see 2502-01-01-01 “DPF system” and 2503-01-01-01 “Urea SCR system”.

Note: The ATD unit (DPF + SCR) for 4TN107 engines is normally installed separately from the engine.

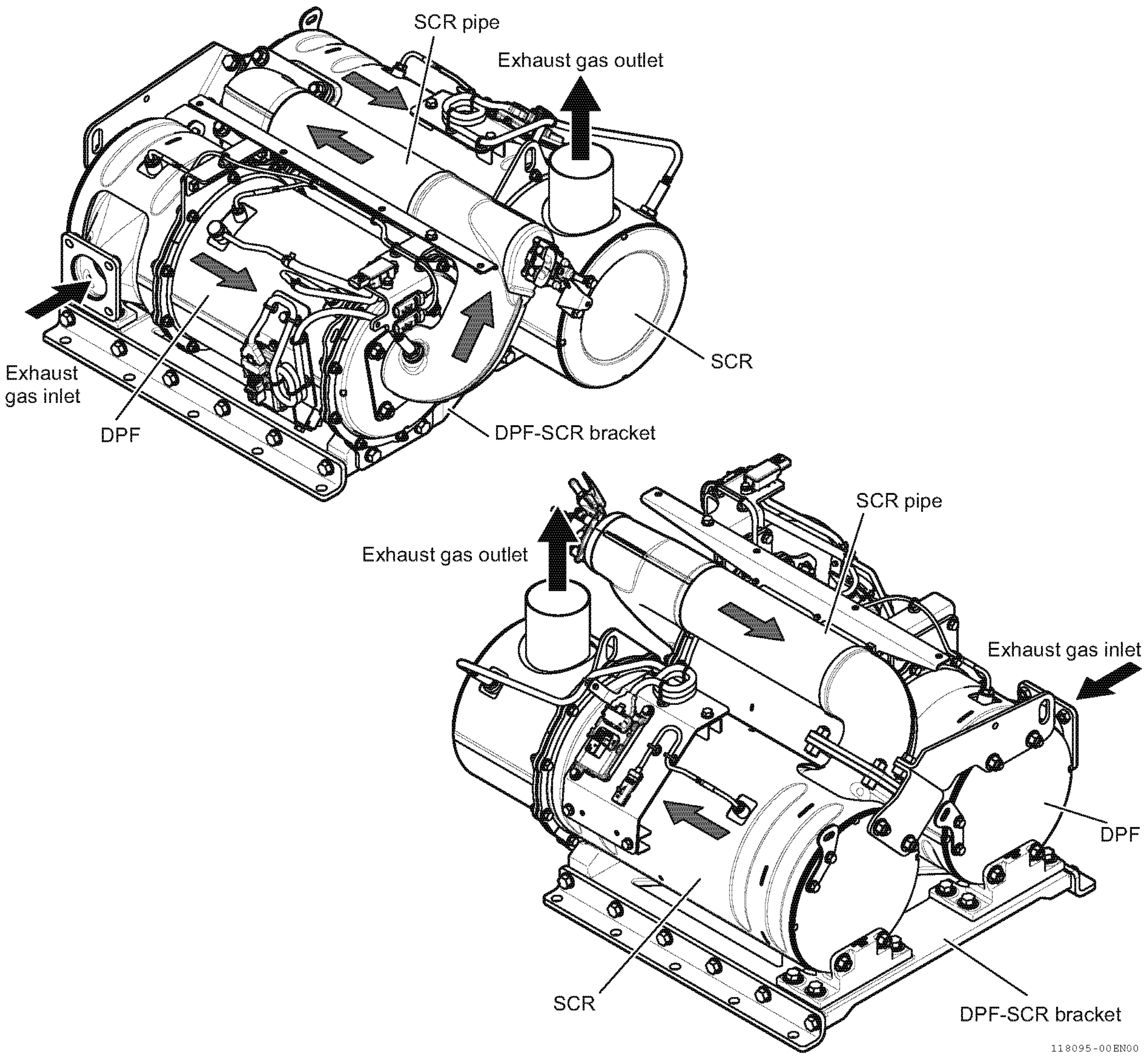


Fig.25-1

NOTICE

The ATD unit (DPF + SCR) is subject to emission control regulations. It is prohibited for users to disassemble it without prior consultation. If the ATD unit needs to be replaced, consult with your authorized YANMAR industrial engine dealer or distributor.

2. DPF System (Applicable only to EU Stage V certified models)

2.1 Structure and components of the DPF

The DPF consists of the Diesel Oxidation Catalyst (DOC) and the Soot Filter (SF), held by a case that sends the exhaust gas to the DOC and SF. (See Fig.25-2)

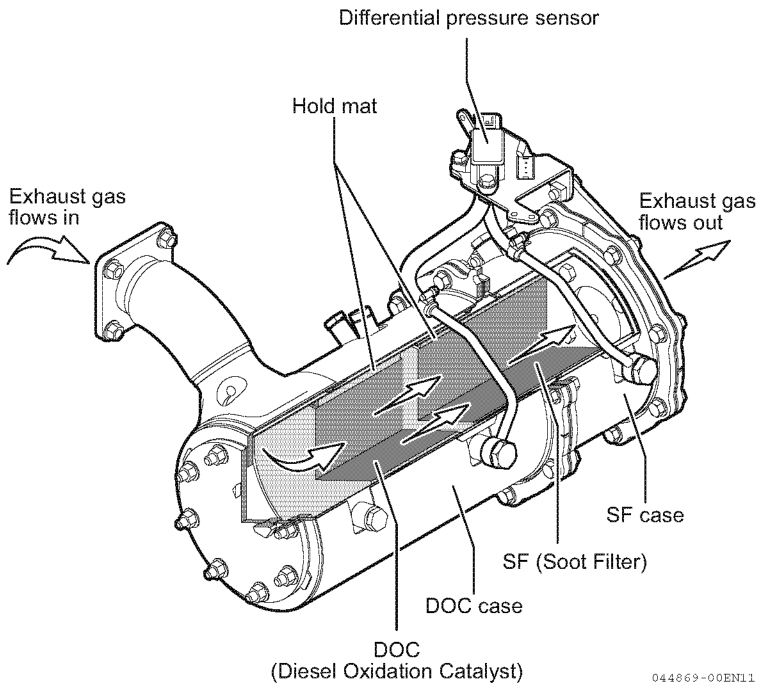


Fig.25-2

2.2 Function of the DPF

A DPF is a device that oxidizes hazardous components contained in exhaust gas using a DOC, and collects Particulate Matter (PM) with an SF in order to prevent them from discharged into the atmosphere. The PM collected by the SF will cause clogging if left as is. Because clogging decreases the engine performance, the accumulated PM needs to be treated by burning it. The means of treatment are called regeneration. There are several regeneration methods available. 2502-01-02-01 “DPF regeneration control” in the next page explains the details.

2.3 Cautions for use

Be sure to use the specified fuel and lubricating oil so that the DPF can fulfill its function.

■ Fuel to use

Use diesel fuel (ultra-low sulfur) with a sulfur content of 15 ppm or lower. If you use a fuel other than the specified oil, performance of the catalyst contained in the DOC deteriorates rapidly due to sulfur. This leads to decreased engine performance, increased fuel consumption, and a deterioration of general engine receptiveness caused by frequent switching to the regeneration mode.

■ Engine lubricating oil to use

Use a low-ash oil. If you use anything other than the specified lubricating oil, a large amount of ash will be discharged, and the DPF will get clogged quickly. This will not only reduce engine power and impair fuel efficiency, but will also make it necessary to perform SF maintenance at shorter intervals.

3. DPF Regeneration Control (Applicable only to EU Stage V certified models)

The differential pressure sensor and temperature sensors are attached to the DPF while the intake throttle valve is attached on the combustion chamber inlet side. If the DPF cannot regenerate continuously due to low-load operation or low-speed operation, the ECU performs automatic control to assist the DPF regeneration (hereinafter, “DPF regeneration control”) based on the valve operation and sensor information in order to prevent excessive accumulation of PM.

3.1 Self-regeneration

Regeneration (normal) without the use of regeneration assistance devices. During the operation at high speed and high load, the exhaust temperature rises and PM is continuously burned and removed.

3.2 Assist regeneration

Regeneration with the use of regeneration assistance devices (e.g. Intake throttle). When the differential pressure in the SF inlet/outlet in the DPF rises, the ECU commands the intake throttle to adjust the intake air volume according to the detected differential pressure. The ECU also controls to increase the exhaust temperature by performing after-injection*1 to burn and remove the PM. At this time, the EGR valve is closed.

3.3 Reset regeneration

Regeneration with the combined use of assisted regeneration and post-injection*1. 50 hours after the initial operation, and every 100 hours of operation thereafter, the assisted regeneration and post-injection*1 are automatically performed together to control regeneration by increasing the exhaust temperature to burn and remove the PM.

The above-mentioned automatic regeneration can be performed during operation. No special operation is required for the operator. The following conditions may occur due to the characteristics of the DPF system, but they are not abnormalities

- When starting and completing the DPF regeneration control, the opening of the intake throttle valve and EGR valve are adjusted. Therefore, the engine sound may change.
- Immediately after starting the engine or during acceleration in a cold state, white smoke may sometimes be discharged from the exhaust pipe. This is due to discharge of water vapor. As the exhaust temperature increases, the white smoke disappears. Always perform the DPF regeneration in a well-ventilated and safe location.
- The exhaust gas is purified through a catalyst built into the DPF. This makes it smell different from that of the conventional diesel engines.

**1: After-injection and post-injection*
Both of these are functions to inject fuel with a delay following the main injection. However, the post-injection is slightly more delayed than the after-injection. That allows the exhaust temperature to increase to assist DPF regeneration.

⚠ CAUTION

- **During reset regeneration, post-injection is performed and fuel is directly burned inside the DPF by producing chemical reaction inside the DOC. Through this heat, the PM inside the SF is burned, but this burning increases the exhaust gas temperature to close to 600 °C (1112 °F). Do not touch the DPF, and stay away from the exhaust gas. Extremely hot exhaust gas may burn you. Be careful that either people nor flammable materials are near the exhaust gas outlet.**
- **Post-injection can cause the fuel consumption to increase slightly.**
- **Through this unique YANMAR regeneration method, the dilution of the lubricating oil with fuel caused by the post-injection is minimized. However, some dilution may be expected during low-load operations (exhaust temperature is low) such as working with forklifts or other machines. Be sure to check the oil level everyday.**

3.4 Stationary regeneration

Even if the ECU is performing assist regeneration or reset regeneration, there are cases in which PM cannot be burned (the DPF cannot be regenerated) if operating conditions such as idling with no load or low-speed, low-load operation are repeated frequently. When this happens, if the ECU determines that the stationary regeneration is required, the DPF regeneration request lamp comes on. If the DPF regeneration request lamp comes one, immediately perform the stationary regeneration according to the following operations. If the operation is continued with the DPF regeneration request lamp left on, PM will accumulate excessively, which may cause it to burn abnormally. This may lead to breakage of the DPF, or fire.

■ Operation procedures of stationary regeneration

NOTICE

- Do not perform the operation in a place with poor air ventilation. Doing so may cause carbon monoxide poisoning.
- In order to avoid fire, make sure that there are no flammable things around the exhaust outlet.
- In order to avoid injury, do not touch the exhaust pipe during stationary regeneration. Also, ensure that no one gets close to the area around the exhaust outlet.
- The white smoke may be discharged from the exhaust pipe after you start stationary regeneration, but this is not abnormal. It is caused by water vapor, which is discharged when the exhaust temperature is low. The white smoke will disappear as the exhaust temperature increases.
- Only perform stationary regeneration after the engine has warmed up, as it may not operate if the engine is cold.
- The exhaust gas may smell different from that from a conventional diesel engine, but this is not abnormal. It is cleaned by passing through the catalysts built into the DPF and SCR, and this gives it a different smell.

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1. Move to a well-ventilated and safe place.
2. Move the acceleration lever to the lowest position and operate the engine in idling.
   Note: If the DPF regeneration prohibition switch is equipped, turn the 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 flashing.
4. Press the DPF regeneration request switch for at least 3 seconds (standard), and stationary regeneration will start. The time required to press the switch to start the stationary regeneration can be changed as optional. For details, follow the operation manual of the driven machine.
   - When stationary regeneration starts, the engine speed will slowly increase to the high idle speed, and stationary regeneration will be performed in that operating state.
   - When stationary regeneration starts, the DPF regeneration request lamp turns off. The DPF regeneration approval lamp changes from flashing to lit, and the exhaust temperature warning lamp comes on.
   - The stationary regeneration will be complete in about 25 to 30 minutes.
   - If you want to interrupt the stationary regeneration part way through, do either of the operations below.
     - Turn the interlock switch to "Regeneration Disabled".
     - Turn the DPF regeneration prohibition switch to "Regeneration Prohibited".
     - Turn the accelerator to a position other than the lowest position.
     - Turn off the key switch.
5. When the period of time stated above elapses, the engine speed slowly decreases to low idle speed. The regeneration approval lamp and exhaust temperature warning lamp turn off, and stationary regeneration ends.

■ Precautions for stationary regeneration

1. Stationary regeneration may be done using the SMARTASSIST DIRECT (SA-D), do not disconnect the SA-D (computer) during stationary regeneration. Check the remaining battery level to avoid the computer from shutting down. Prepare the sufficient battery that can perform the stationary regeneration for at 30 minutes to 1 hour.
2. Be sure to check the remaining fuel level to avoid the engine from running out of fuel while performing the stationary regeneration. Stationary regeneration normally takes 25 to 30 minutes to complete. Prepare sufficient fuel that can run the engine for at least 1 hour.
3. Check that no other failures other than excessive deposits are observed.

3.5 Recovery regeneration (optional)

■ Recovery regeneration

If the excessive PM accumulates, the DPF cannot be regenerated by the reset regeneration or stationary regeneration. Therefore, optional recovery regeneration function is available. The recovery regeneration required longer time than that of the reset regeneration or stationary regeneration. For details, see the operation manual provided by the driven machine manufacturer for the availability of recovery regeneration.

■ Precautions for recovery regeneration

1. Do not disconnect SMARTASSIST DIRECT (SA-D) or the computer during stationary regeneration. Check the remaining battery level to avoid the computer from shutting down. Recovery regeneration takes about 4 hours to complete.
2. Be sure to check the remaining fuel level to avoid the engine from running out of fuel while performing the recovery regeneration. Prepare sufficient fuel that can run the engine for at least 4 hours.
3. Check that no other failures other than excessive deposits are observed.

4. Urea SCR System (Applicable only to EU Stage V certified models)

SCR (Selective Catalytic Reduction) system is a technology that reduce and purify NOx included in exhaust gas into non toxic nitrogen (N_2) and water (H_2O) by using ammonia generated from urea water. Installation of the urea SCR System enables compliance with the Tier 4 final emission control regulations in each country, including the Tier 4 final emission control regulation set by the Environmental Protection Agency (EPA).

4.1 System overview

The overview of the SCR system is shown in Fig.25-3.

The system includes urea water tank for storing urea water, DM (Dosing Module) for injecting urea water as a high pressure mist, SM (Supply Module) for pumping urea water to the DM, DCU for controlling the injection volume of urea water, catalyst main body, and sensors (NOx and temperature). The urea SCR system calculates the NOx level of the engine exhaust gas by itself, and detects NOx using a NOx sensor. Then, it calculates the amount of ammonia required. The DCU comprehensively controls the amount of urea water injected so that it is the ideal amount.

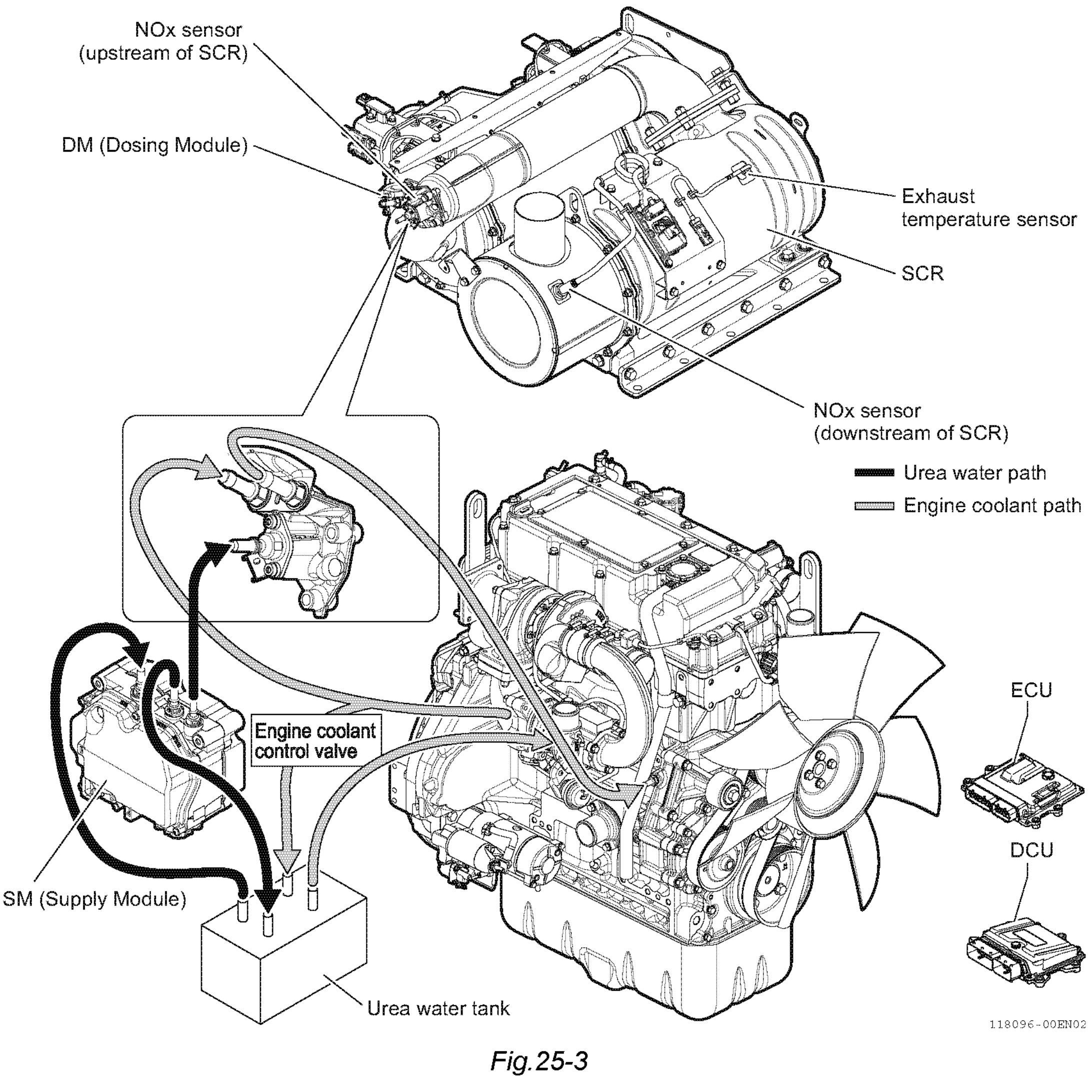

Fig.25-3

NOTICE

Use the specified urea water for the SCR system. If you use any kind of urea water other than the specified one, the system will not be covered by the warranty. Therefore, never use any kind of urea water other than the specified one.

4.2 System structure

The structure of the SCR system is shown in Fig.25-4.

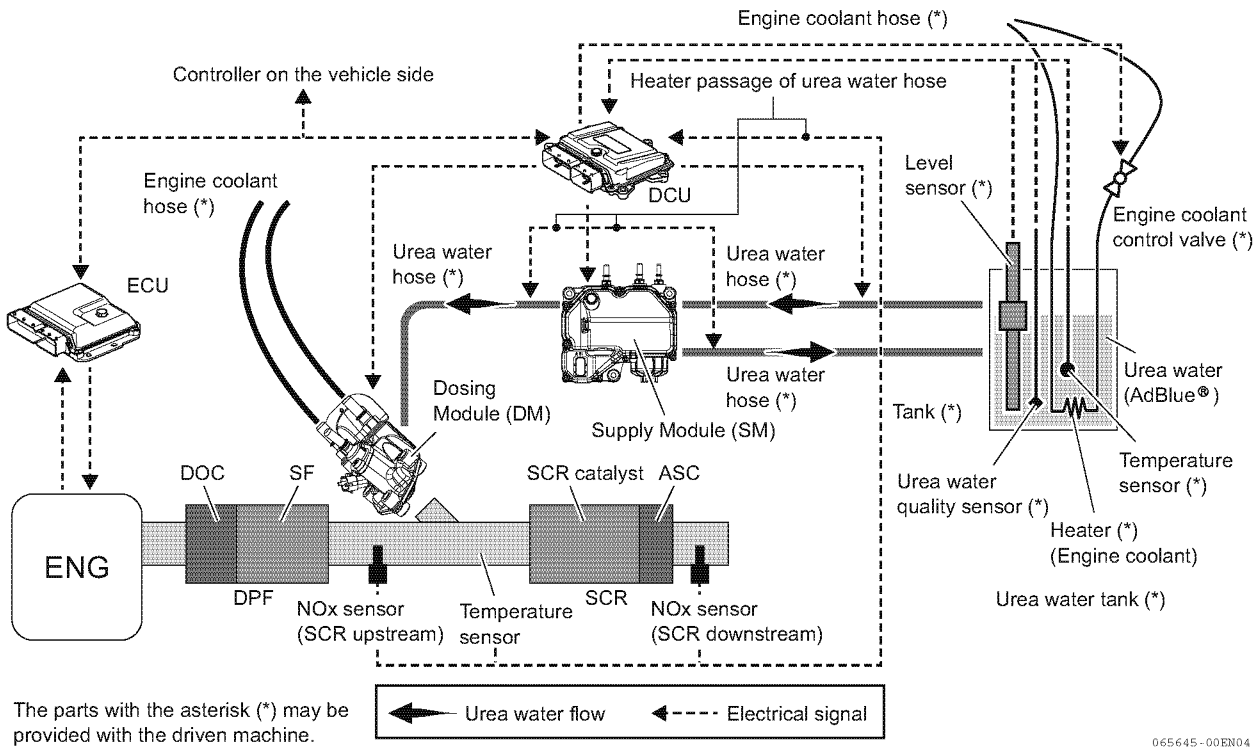

Fig.25-4

Urea water system diagram is shown in Fig.25-5.

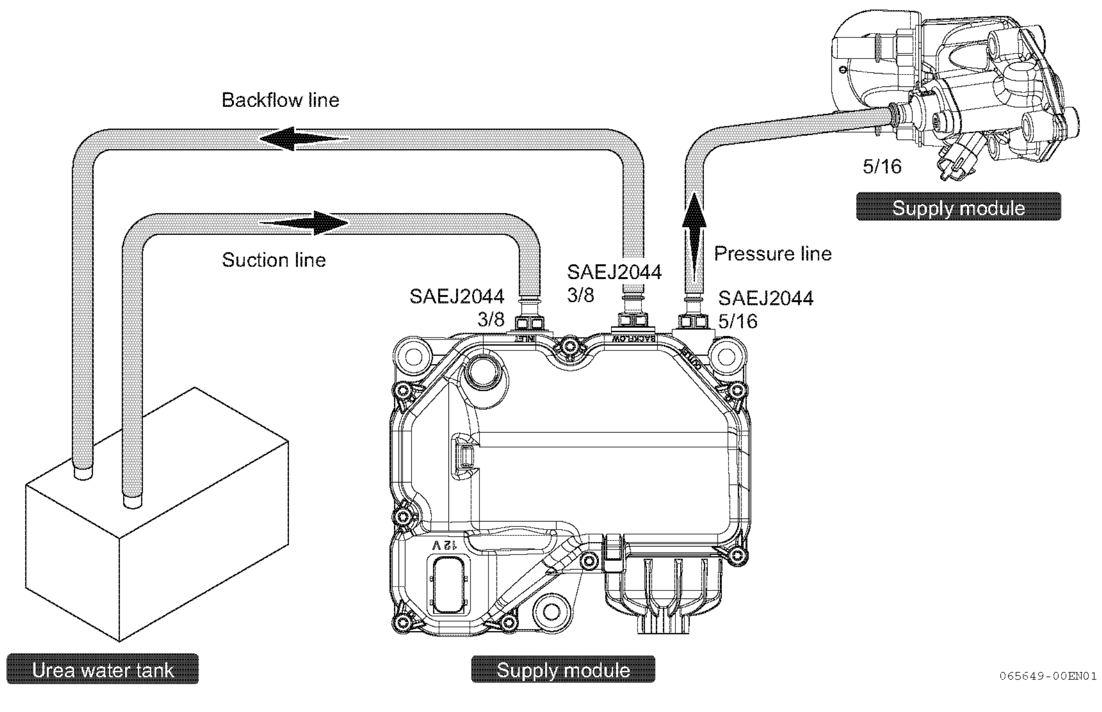

Fig.25-5

5. Components of the Urea SCR System (Applicable only to EU Stage V certified models)

5.1 SCR

The components of the SCR system is shown in Fig.25-6, and the function is shown in Table 25-1. SCR includes SCR catalyst for reducing and purifying NOx by absorbing ammonia generated by urea water being hydrolyzed, ASC (Ammonia Slip Catalyst) for oxidizing and purifying ammonia that could not be absorbed at SCR catalyst, and the SCR case for housing thereof. Further, DM (Dosing Module) for injecting urea water and an upstream NOx sensor are installed to the piping before entering the SCR case, exhaust temperature sensor on the upstream of the SCR catalyst, and downstream NOx sensor on the downstream of the SCR catalyst.

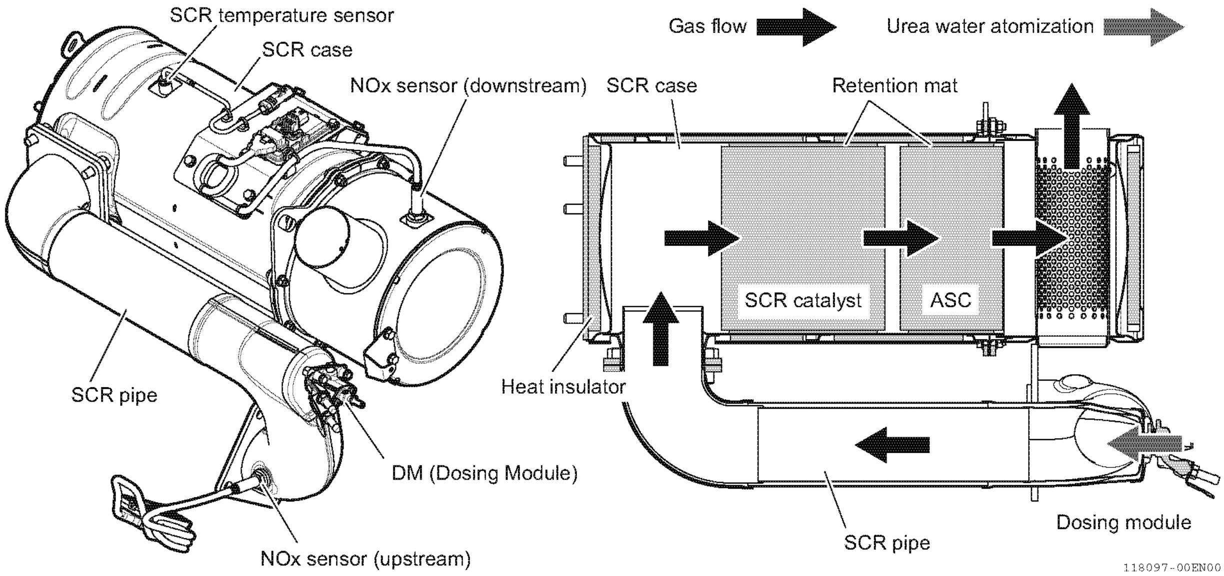

Fig.25-6

Table 25-1

SCR catalyst	A ceramic carrier coated by a catalyst. Ammonia that is adsorbed into the catalyst reacts with NOx contained in the exhaust gas and purifies it.
ASC (Ammonia Slip Catalyst)	A ceramic carrier coated by a catalyst. It purifies any excess ammonia so that no ammonia is discharged.
SCR case	A case made of stainless steel, and holds the SCR catalyst and ASC. The main body has the heat retaining property, and has a double-layered structure.
Retention mat	A mat for holding the catalyst, and the same as for the DPF.
SCR pipe	To make it resistant to urea water, the material used is stainless steel. It has a double-layered structure to ensure the gas heat retaining property. It has the boss to which the DM, which is an urea water injector, is attached.

5.2 SM (Supply module)

The SM (Supply Module) applies a pressure of 9 bars to the urea water sucked out from the urea water tank, and pumps it to the DM (Dosing Module). (Fig.25-7)

The SM (Supply Module) number is different depending on the voltage, 24 V or 12 V.

Voltage	Part number
24 V	129G01-19501
12 V	129G01-19521

- When the engine key is turned off, if any urea water remains in the path of the urea water, then the urea water inside the system freezes, causing expansion in volume, or urea water dries, causing deposits. As a result, it will damage the devices. In order to prevent damages, the SM controls to suck back any urea water remaining in the path to the tank (after-run). After the engine key is turned off and a waiting time of a few minutes has passed, the urea water is sucked back. The operation is complete in a maximum of about 10 minutes.

NOTICE

Do not shut down the power (for example by removing the wiring from the battery) until the suction is complete and the DCU (Dosing Control Unit) power turns off.

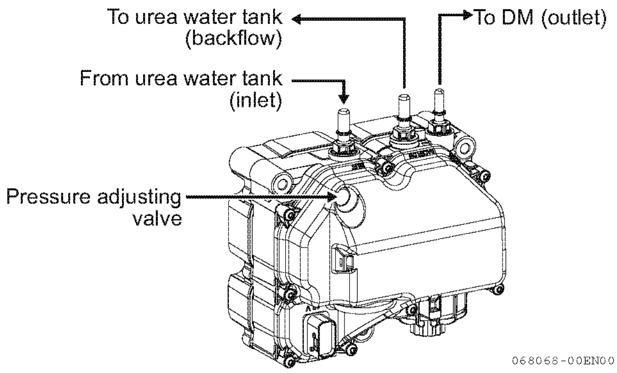

Fig.25-7

- The SM has an electric heater, and the temperature of urea water in the SM is controlled when the temperature is low.
- A main filter is installed to the SM, and the filter needs to be replaces every 4500 hours or 3 years. (See 2503-02-02-01 “Maintaining the SM (Supply Module)”)
- The SM is equipped with the pressure adjusting valve (Fig.25-7). Make sure that there are no paints or dirt on the valve that will cause clogging.

NOTICE

When storing the machine for a long period of time, if the SM membrane dries, the sealing property deteriorates, and the SM cannot suck urea water. As a result, the engine may not be started. In this case, fill urea water from the SM inlet (Inlet, **Fig.25-7**), then the engine may be started.

5.3 DM (Dosing module)

The DM (Dosing Module) (Fig.25-8) injects urea water into the exhaust gas in the form of a high pressure mist. The DCU (Dosing Control Unit) calculates the “required number of injection per unit time” based on the NOx concentration in the exhaust gas, and sends the signal. Then, the injection valve of the DM is actuated based on the signal, and injects urea water. Because the injection pressure and the injection signal stays the same, the injection volume per injection does not change.

NOTICE

The DM becomes hot due to valve operation. Therefore, it is cooled using the engine coolant. Only use the specified coolant (see 0000-10-03-01 “Engine Coolant”).
When you need inspection or repair work, do not touch it until the temperature decreases.

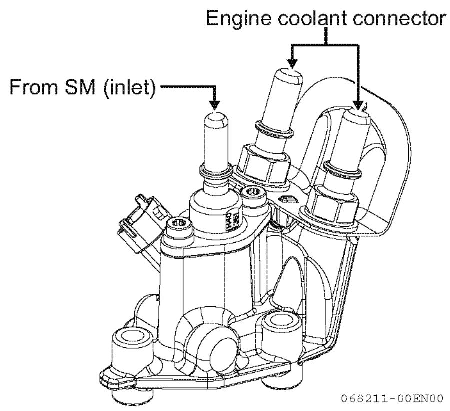

Fig.25-8

5.4 NOx sensor

The NOx sensor measure the NOx concentration at two locations, upstream and downstream of the SCR catalyst, and the DCU controls the urea water injection volume based on the detected values. The sensor and the controller of the NOx sensor are connected with a harness. Since the sensor adjustment values are recorded in the controller, the combination cannot be changed. Never remove the harness. If either of them fails, the controller and sensor must be replaced as a set. (Fig.25-9)

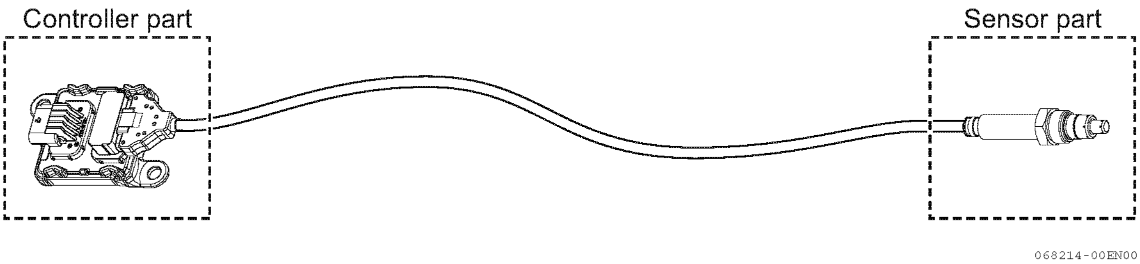

Fig.25-9

NOTICE

- A heater is built into the sensor, and performs self-heating. While measuring NOx concentration the temperature of the sensor will increase to approximately 150 °C. When you need inspection or repair work, do not touch it until the temperature decreases.
- Do not remove/insert a connector of the controller when the power supply is ON.
- Do not use a NOx sensor that has been dropped or has fallen.
- Do not touch the NOx sensor with your hands or dissemble it.
- When reattaching the removed NOx sensor, throughly apply a seizure prevention agent to the sensor thread. For the seizure prevention, we recommend Anti-Seize “High-Tech” Assembly Spray (GB) by WEICON, or an equivalent agent. Make sure you use an agent that does not contain magnesium.
- When carrying NOx sensors, take them one by one, and do not bundle multiple NOx sensors together.

5.5 Urea water tank

The urea water tank stores urea water, and the capacity and the shape are determined depending on the following conditions: urea water consumption, urea water supply intervals of the driven machine, and space available for installation. The flange on top of the urea water tank has a header assembly which has 3 sensors: level sensor, urea water quality sensor, and temperature sensor. There is also a tank heater pipe which allows heated engine coolant to pass through. The header assembly also includes a line which feeds urea water to the supply pump, and a pre-filter is attached at the bottom of the line. (Fig.25-10)

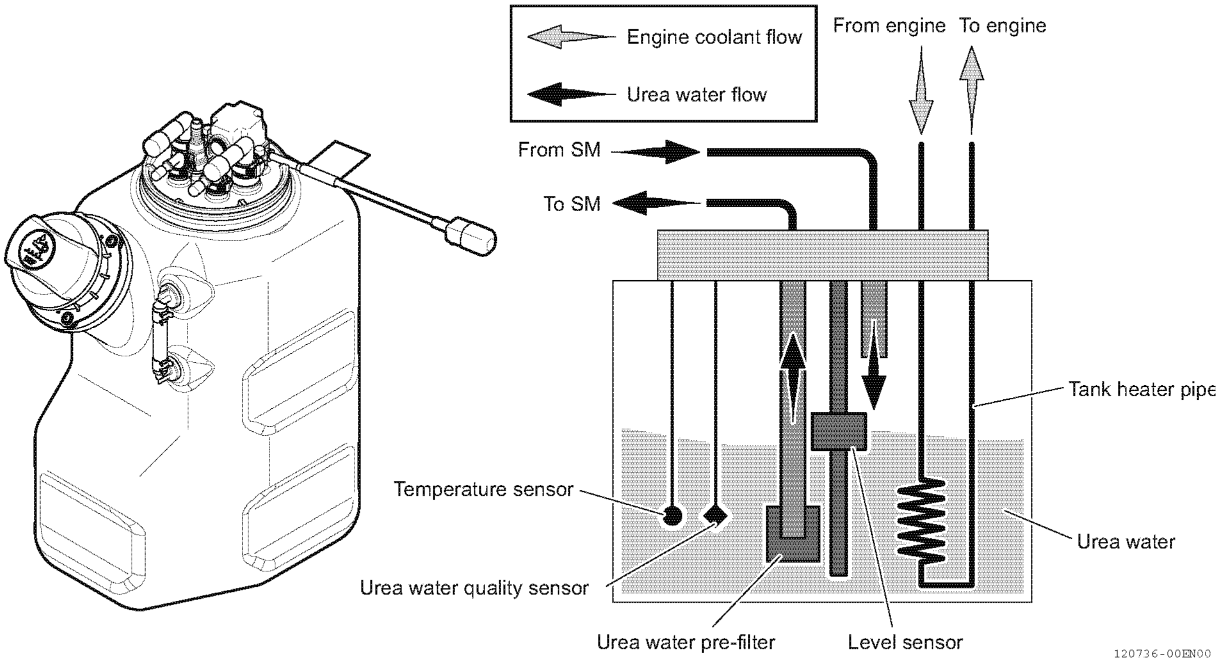

Fig.25-10

Urea water tank level sensor	Detects the remaining amount of urea water in the urea water tank.
Urea water quality sensor	Detects the concentration, and judges whether the appropriate urea water is in the tank.
Urea water temperature sensor	Detects urea water temperature in the urea water tank. This sensor is built-into the quality sensor.
Urea water tank heater	Circulates engine coolant to the tank, and when the urea water freezes, it thaws the urea water or keeps it warm using the heat from the engine coolant.
Urea water pre-filter	Prevents contamination in the urea water hose from the urea water tank to the SM.

NOTICE

- When urea water freezes, its volume expands by 7 %. In order to prevent the urea water tank from bursting, you need to ensure that the tank has a certain amount of spare capacity even when it is full.
- When filling the tank with urea water, stop filling before urea water reaches the pipe of the filler port. Make sure that the driven machine is level.
- When shipping or replacing the tank, do not start the engine without urea water in the tank.

5.6 Engine coolant control valve

To thaw and retain heat in the urea water tank, warmed engine coolant circulates in the heater pipe inside the urea water tank. This circulation is controlled by the engine coolant control valve. (Fig.25-11)

The engine coolant control valve is controlled by the DCU. When urea water in the tank needs to be thawed/heated, open the engine coolant control valve (ON) (Fig.25-12) and circulate engine coolant. When the urea water temperature rises and it does not need to be thawed/heated, close the coolant control valve (energization OFF) (Fig.25-13) to stop the engine coolant circulation. The flowing direction of the coolant of the coolant control valve is fixed. Therefore, when removing or reinstalling the engine coolant hose, make sure you insert the hose in the correct direction of IN (from engine) / OUT (to urea water tank).

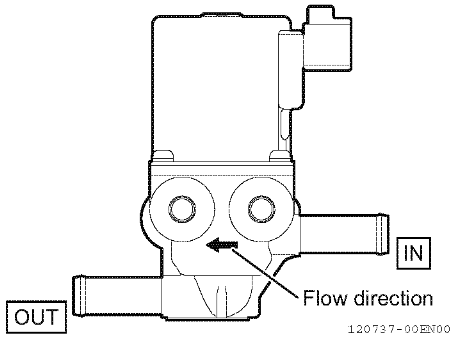

Fig.25-11

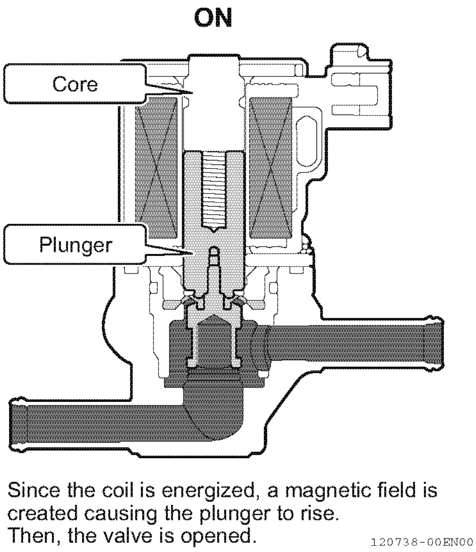

Fig.25-12

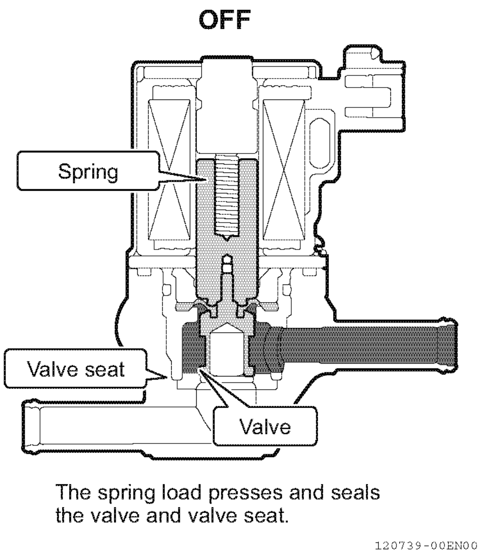

Fig.25-13

5.7 Urea water hoses

For the urea water hoses between the tank and SM, and SM and DM, a hose equipped with an electric heater has to be used. The DCU controls to turn on and off the electric current to the hoses, and it will thaw the urea water inside the hose and keep it warm at a low temperature. (Fig.25-14)

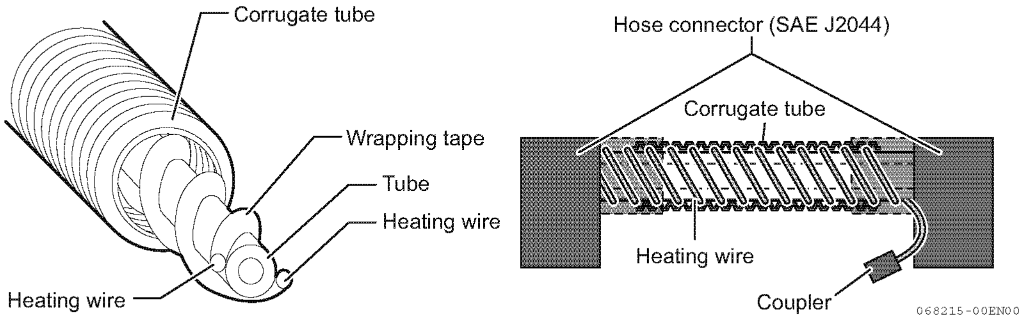

Fig.25-14

Disassembling the After-treatment Device (ATD Unit) (Applicable only to EU Stage V certified models)

1. Replacing (Removing) the ATD Unit

The usage limit for the DPF and SCR that compose the ATD unit is 9000 operating hours. When it reaches 9000 hours, or when you need to replace the unit for some reason before reaching 9000 hours, replace the ATD unit. The service (spare) parts for the ATD unit are not provided as a kit. Therefore, prepare both DPF and SCR as service (spare) parts. For the sensors of the ATD unit, they can be replaced or continuously be used depending on the operating hours at the time of ATD replacement.

When removing the ATD unit, you can either remove the DPF and SCR separately, or as a unit. When removing the DPF and SCR separately from the engine, see 2502-02-01-01 “Replacing (Removing) the DPF”, and 2503-02-01-01 “Replacing (Removing) the SCR. Procedures when removing the ATD as a unit are described below. The following procedures describes removal of the ATD unit when attached horizontally. However, the same procedures apply to ATD units attached in any position.

1. Before removing the ATD unit, remove the exhaust gas inlet and outlet pipes, DM (dosing module) pipes and wires, and wiring couplers for the NOx sensor, temperature sensor, and differential pressure sensor.
2. Remove the DPF-SCR bracket (1, Fig.25-15) that retains the ATD unit, and bolts and nuts that mount the both ends of the DPF (2, Fig.25-15) and SCR (3, Fig.25-15). The removal procedures are described blow sections, 3. and 4.
3. On the DM side (4, Fig.25-15), remove the fixing bolts (6, Fig.25-15) of the SF stiffener plate (5, Fig.25-15) of the DPF and remove the fixing bolts (8, Fig.25-15) of the flange (7, Fig.25-15) of the exhaust gas outlet pipe of the SCR.
4. On the opposite side of the DM, remove the fixing bolts (5 and 7) which fix the DPF bracket (4, Fig.25-16) Fig.25-16 and SCR bracket (6) respectively to the Fig.25-16 DPF-SCR bracket (3, Fig.25-16).

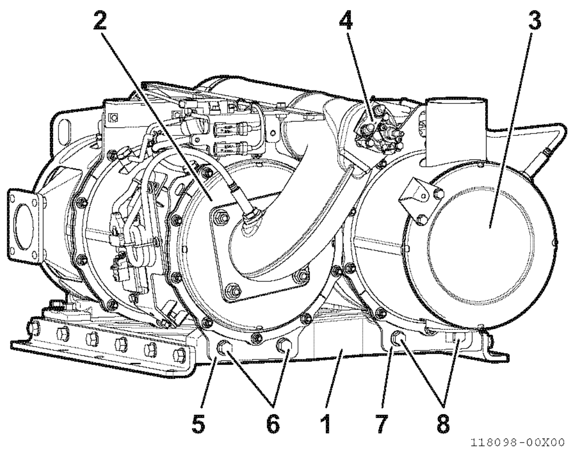

Fig.25-15 DM side

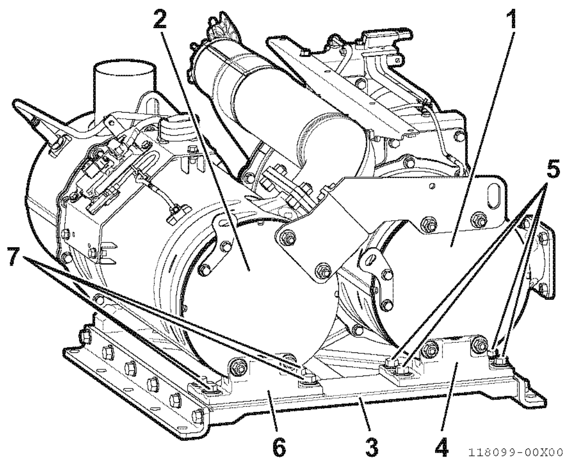

Fig.25-16 Opposite side of DM

5. Remove the ATD unit (1, Fig.25-17) from the DPF-SCR bracket (2, Fig.25-17).
   When lifting the ATD unit, use the lifting eyes (3, Fig.25-17) on the SCR and DPF.

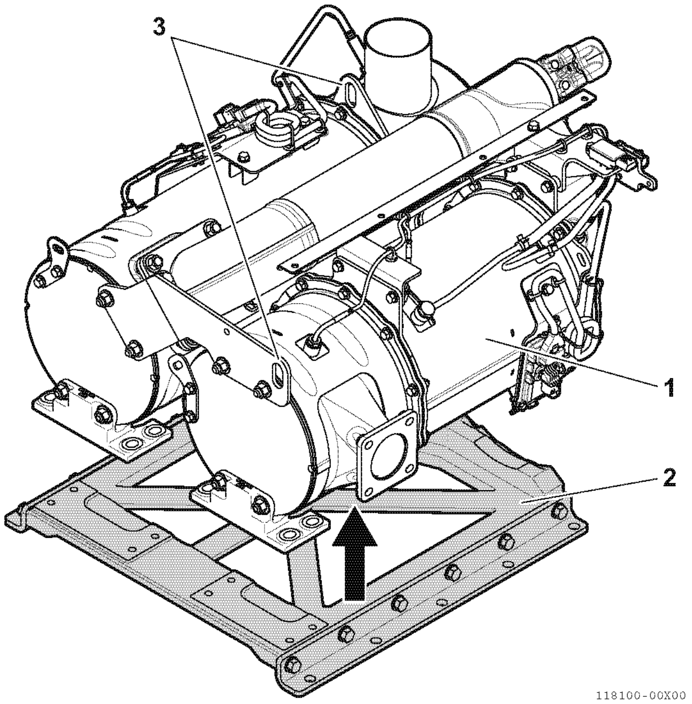

Fig.25-17

NOTICE

The ATD unit is extremely heavy. Use a crane or similar means to remove it.

6. With the ATD unit removed from the DPF-SCR bracket, loosen the nuts (4 pcs.) (3, Fig.25-18), and then remove the DPF stay (1, Fig.25-18) and SCR stay (2, Fig.25-18) as a unit. Remove the NOx sensor (4, Fig.25-18) controller (5, Fig.25-18) from the DPF together with the bracket (6, Fig.25-18) without removing it from the bracket.

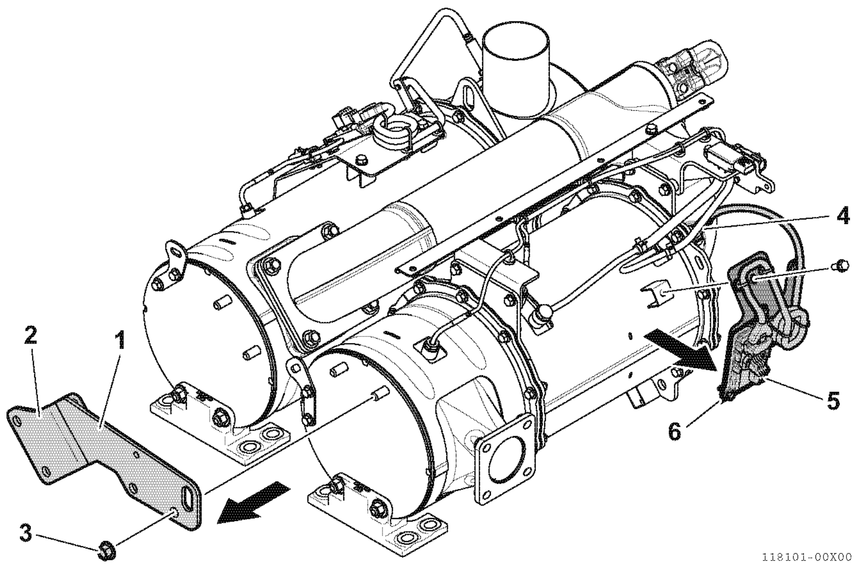

Fig.25-18

7. Loosen the nuts (4 pcs.) (3, Fig.25-19) that mount the DPF (1, Fig.25-19) and SCR pipe (2, Fig.25-19), and move the DPF in the direction of the arrow to remove it.

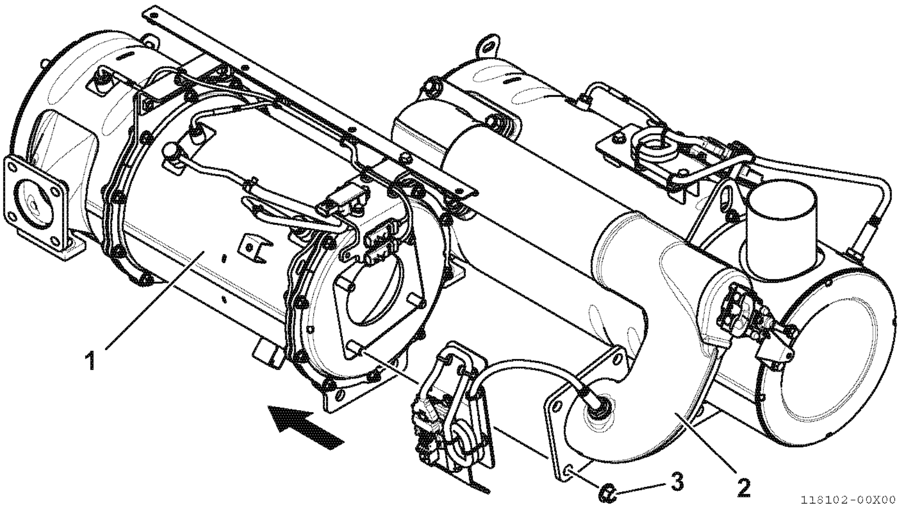

Fig.25-19

8. Loosen the nuts (4 pcs.) (3, Fig.25-20) that mount the SCR (1, Fig.25-20) and SCR pipe (2, Fig.25-20), and remove the SCR pipe together with the NOx sensor without removing it from the pipe.

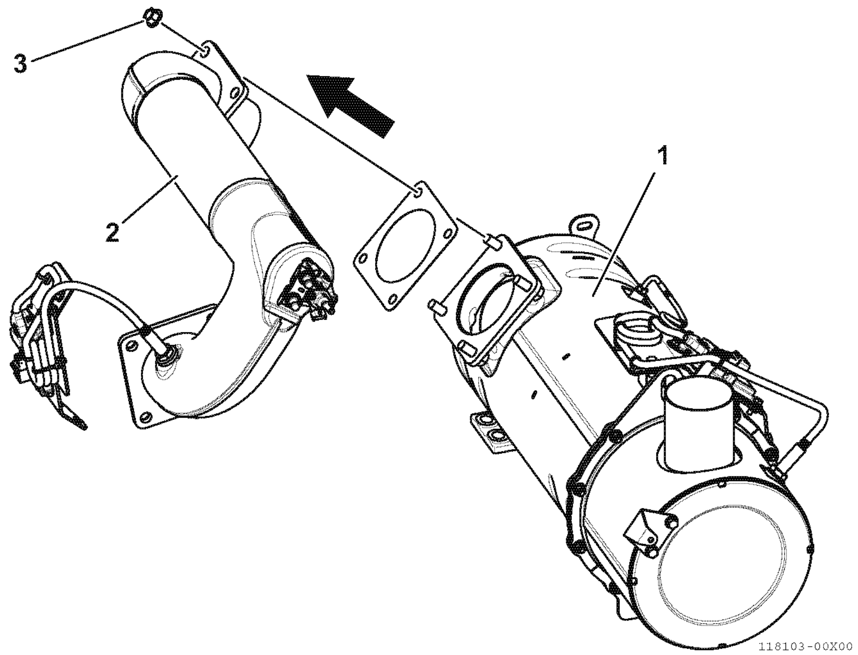

Fig.25-20

Inspection and maintenance

9. After removing the DPF and SCR, remove sensors and brackets from them.
   Remove the exhaust temperature sensor assembly (2, Fig.25-21) of the DPF (1, Fig.25-21), and exhaust differential pressure sensor unit (3, Fig.25-21) together with the sensor bracket (4, Fig.25-21) as a unit. Remove the DPF bracket (5, Fig.25-21). Remove the SCR exhaust temperature sensor assembly (7, Fig.25-21) and NOx sensor assembly (8, Fig.25-21) together with the sensor bracket (9, Fig.25-21) as a unit. Remove the SCR bracket (10, Fig.25-21). Discard the SCR pipe bracket (11, Fig.25-21).

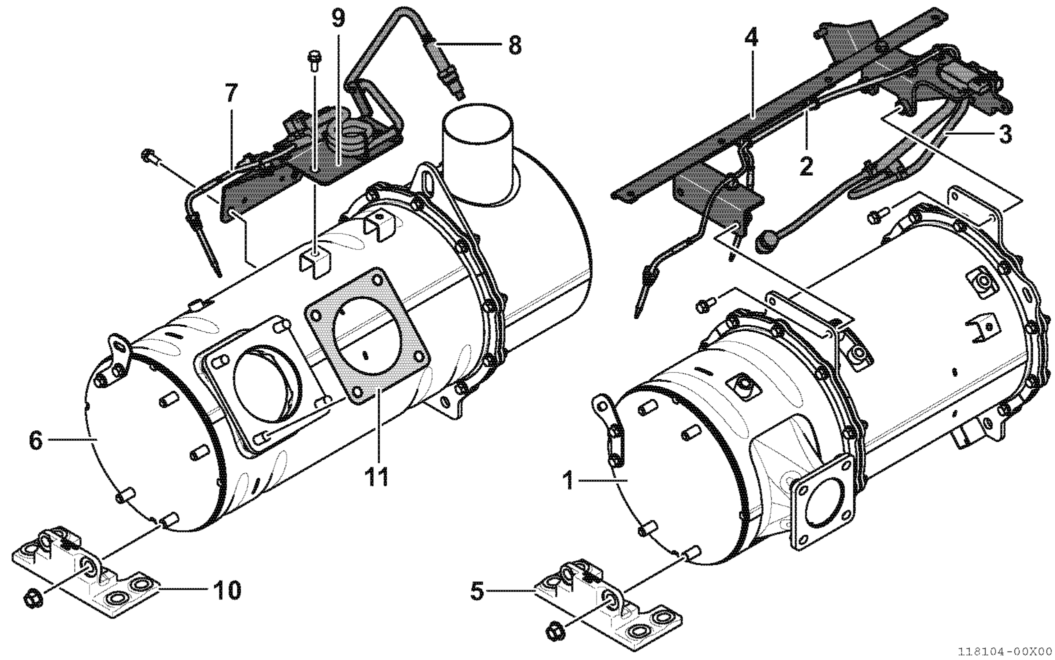

Fig.25-21

10. Replace the DPF and SCR with new ones.

2. Replacing (Removing) the DPF

The usage of DPF expires in 9000 operating hours. However, for some reason, if a damage or failure occurs during operation and it requires replacement of DPF, replace the DPF with a new one. For replacement, remove the DPF from the ATD unit. The procedure for removing is shown below. The installation location of the ATD varies depending on the driven machine. Refer to the manual provided by the driven machine manufacturer.

Sensors, brackets, stays, and related parts for replacement are not included in the spare (service) parts of DPF. Therefore, reuse the removed parts, or prepare new parts.

1. Removing the DPF inlet exhaust pipe

Remove the exhaust pipe on the driven machine side connected to the DPF(1, Fig.25-22) exhaust inlet (2, Fig.25-22).

2. Removing the sensor wires from the DPF

Remove the coupler of wirings from the driven machine side of the differential pressure sensor (Fig.25-22) and the temperature sensor (4, Fig.25-22).

3. Removing the pipes and wires of the DM (Dosing module)

The DPF is removed with the SCR pipe assembly (5, Fig.25-22). Therefore, remove the signal wires, engine coolant pipes, and urea water pipes of the DM (6, Fig.25-22).

4. Removing of the DPF

⚠ WARNING

When transporting a DPF unit with a soot filter for maintenance or cleaning, fix it firmly in the package to prevent soot ash scattering during transport.

On the SCR pipe side, remove fixing bolts (2 pcs.) (8, Fig.25-22) that mount the DPF and DPF-SCR bracket (7, Fig.25-22) retaining the ATD unit. Loosen and remove the nuts (4 pcs.) (3, Fig.25-23) that mount the SCR (1, Fig.25-23) and SCR pipe assembly (2, Fig.25-23). Also, loosen and remove the bolts (2 pcs.) (6, Fig.25-23) that mount the DPF stay (4, Fig.25-23) and SCR stay (5, Fig.25-23), then remove those stays. Remove the bolts (4 pcs.) (9, Fig.25-23) that mount the DPF-SCR bracket (7, Fig.25-23) and DPF bracket (8, Fig.25-23), and remove the DPF together with the SCR pipe. (Fig.25-24)

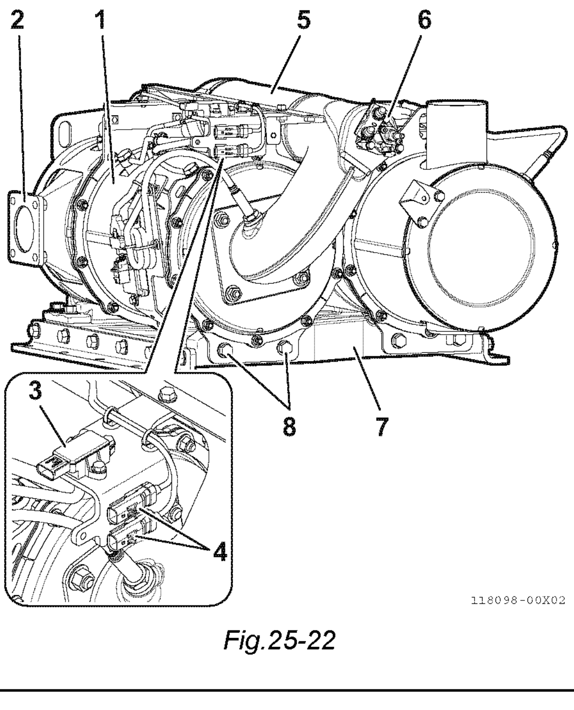

Fig.25-22

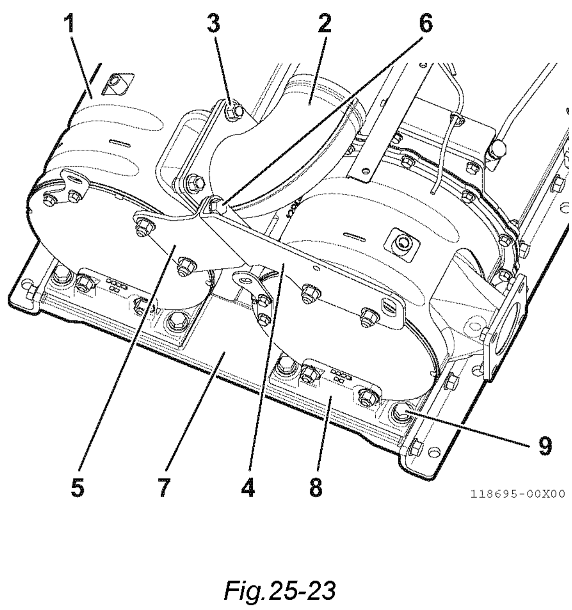

Fig.25-23

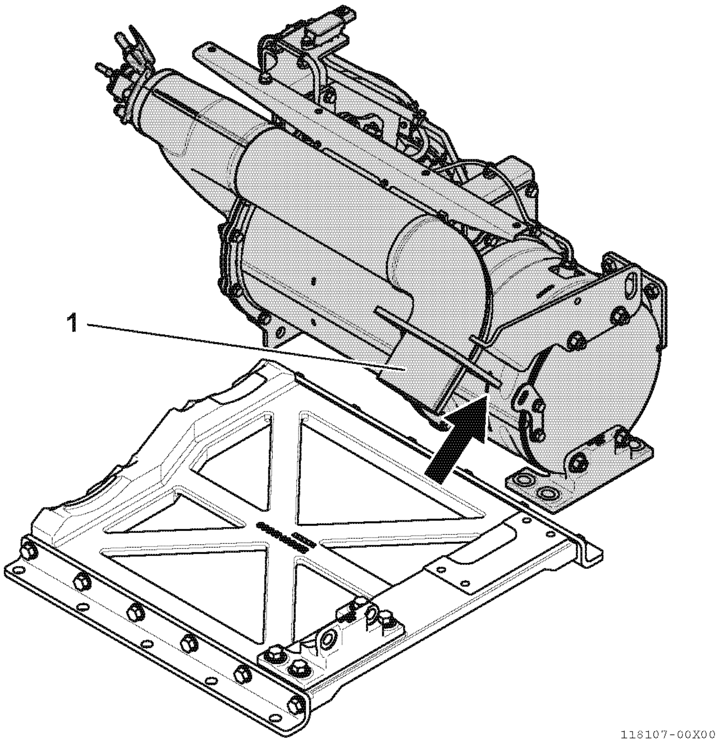

Fig.25-24

NOTICE

The connecting section (1, Fig.25-24) of the SCR pipe assembly is inserted about 70 mm to the SCR. Therefore, when removing the DPF with the SCR pipe assembly, do not pull the DPF straight upward. Pull up in the direction of the pipe insertion angle.

5. Removing the SCR pipe assembly

When replacing the DPF, or cleaning the SF, remove the SCR pipe assembly from the DPF.
When removing the SCR pipe, leave the upstream NOx sensor and controller attached to the SCR pipe. Do not remove the controller (2, Fig.25-25) of the NOx sensor (1, Fig.25-25) from the NOx sensor bracket (3, Fig.25-25). Loosen the bolts (2 pcs.) (4, Fig.25-25) that mount the bracket, and remove the bracket with the controller attached. Remove the nuts (4 pcs.) (5, Fig.25-25) that mount the SCR pipe assembly and DPF, then remove the SCR pipe assembly (1, Fig.25-26) from the DPF (2, Fig.25-26).

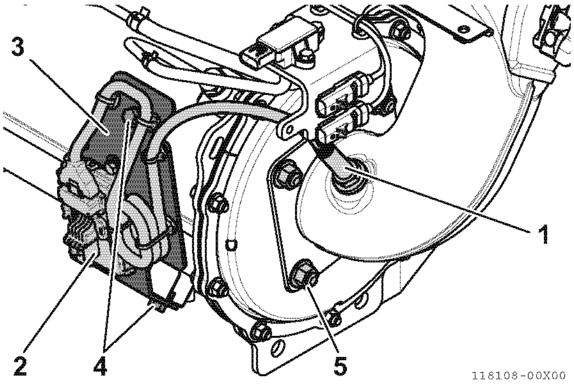

Fig.25-25

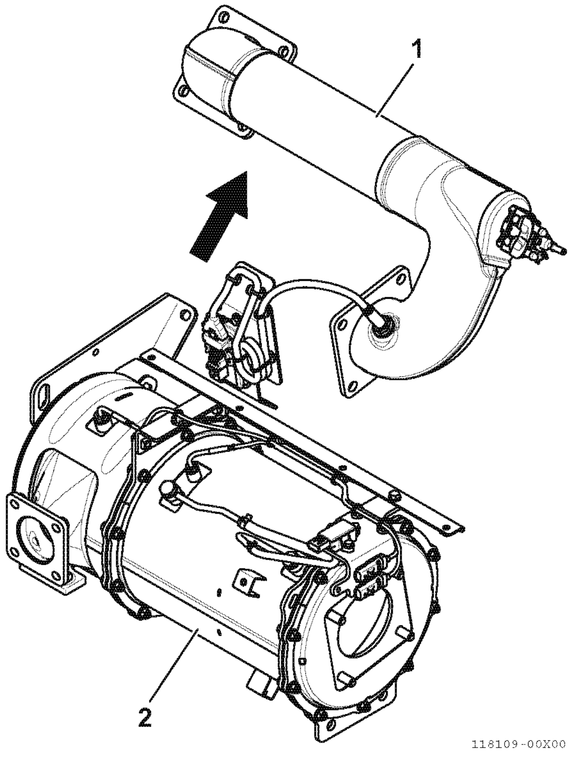

Fig.25-26

6. Removing the sensors from the DPF

1 - Loosen the hexagon nuts (width across flat 17 and 14) of the DOC inlet exhaust temperature sensor (1, Fig.25-27) and intermediate exhaust temperature sensor (2, Fig.25-27), and remove the sensor.

2 - Loosen and remove the pipe joint bolts (3, 4, Fig.25-27) for the exhaust pressure. Discard the gasket.

3 - Leave the sensor bracket (5, Fig.25-27), pressure sensor bracket (6, Fig.25-27), and CW hose bracket (7, Fig.25-27) of the DM assembled together. Loosen the fixing bolts of the flanges (8, 9, Fig.25-27) of the DPF, and remove the sensors and sensor bracket assembly (1, Fig.25-28) with the exhaust temperature sensor wires and connectors, and exhaust pressure pipes, hoses, and sensors still connected to the brackets.

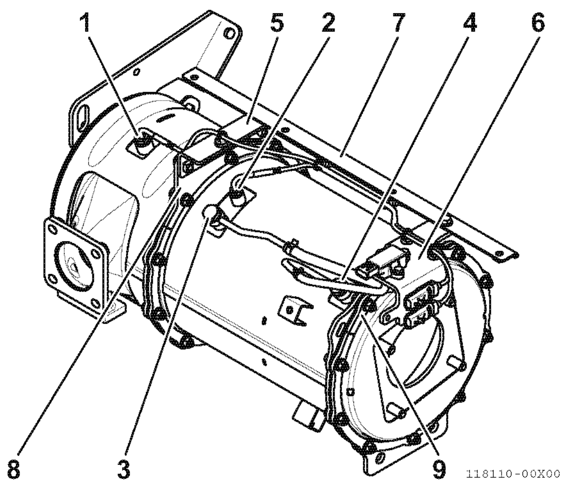

Fig.25-27

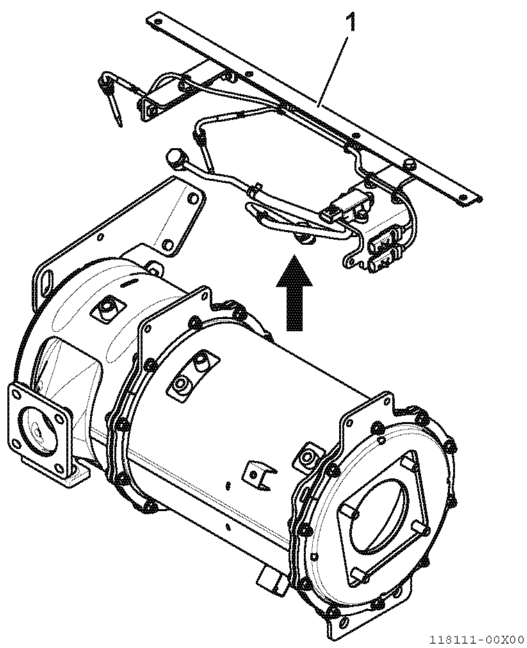

Fig.25-28

7. Removing the DPF stay and bracket

Loosen the nuts (2, Fig.25-29) of the DPF-SCR bracket that retains the DPF and DPF stay (1, Fig.25-29) that connect to the SCR.

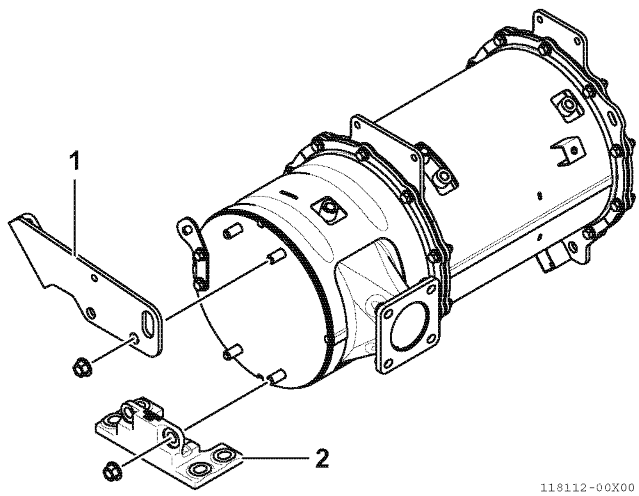

Fig.25-29

3. Removing the SF

In order to clean the SF, remove the SF case from the DPF while the DPF is as a single unit.
See 2502-02-01-01 “Replacing (Removing) the DPF” for details on removing the DPF from the ATD unit.

⚠ WARNING

When removing the soot filter from the DPF assembly, the soot ash in the filter may scatter. Be sure to wear protective equipment such as gloves, anti-dust masks, and eye protection.

1. Removing the SF case

1 - When removing the SF case (1, Fig.25-30) from the DPF as a single unit (2, Fig.25-30), remove all sensors beforehand as shown in Fig.25-30. You can leave the DPF stay (3, Fig.25-30) and DPF-SCR bracket (4, Fig.25-30) attached to the DPF.

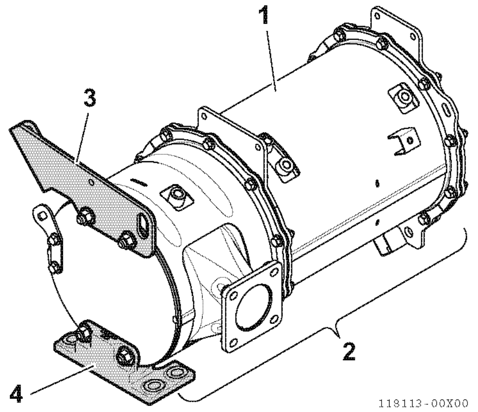

Fig.25-30

2 - Loosen the bolts (10 pcs.) (8, Fig.25-31) of the stiffener (4 pcs.) (4, 5, 6, 7, Fig.25-31) that retain the stiffener plates (3, Fig.25-31), and remove the stiffeners of the DOC case (1, Fig.25-31), and SF case (2, Fig.25-31). Mark the stiffeners so that they can be reassembled in the original position. Discard the gasket (9, Fig.25-31). Slowly separate the SF case from the DOC case.

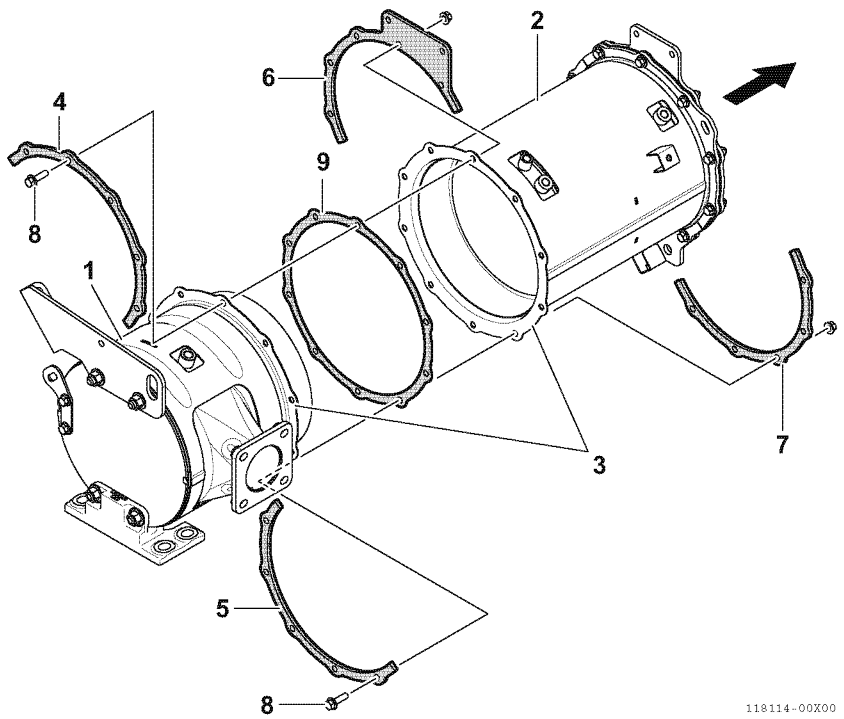

Fig.25-31

4. Replacing (Removing) the SCR

The usage of SCR expires in 9000 operating hours. However, for some reason, if a damage or failure occurs during operation and it requires replacement of SCR, replace the SCR with a new one. For replacement, remove the SCR from the ATD unit. The procedure for removing is shown below. The installation location of the ATD varies depending on the driven machine. Refer to the manual provided by the driven machine manufacturer. Sensors, brackets, stays, and related parts for replacement are not included in the spare (service) parts of SCR. Therefore, reuse the removed parts, or prepare new parts.

1. Removing the exhaust pipe on the SCR outlet side

Remove the exhaust pipe on the driven machine side connected to the SCR (1, Fig.25-32) exhaust outlet (2, Fig.25-32).

2. Removing the pipes and wires of the DM (Dosing module)

The SCR is removed with the SCR pipe assembly (3, Fig.25-32). Therefore, remove the signal wires, engine coolant pipes, and urea water pipes of the DM (4, Fig.25-32).

3. Removing the NOx sensor controller

Remove the NOx sensor controller (6, Fig.25-32) from the DPF (7, Fig.25-32) without removing the upstream NOx sensor (5, Fig.25-32) from the SCR pipe assembly. Loosen the bolts (2 pcs.) (9, Fig.25-32) that mount the NOX sensor bracket (8, Fig.25-32) to the DPF, and remove the NOx sensor bracket with the controller attached.

4. Removing the sensor wires from the SCR

Remove the wiring couplers from the exhaust temperature sensor (1, Fig.25-33) and NOx sensor (2, Fig.25-33) of the SCR.

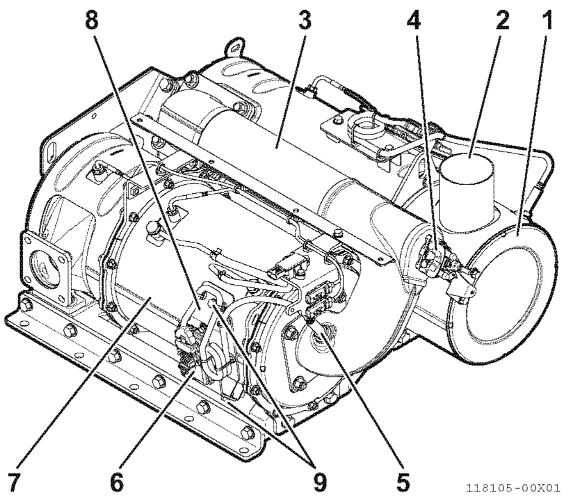

Fig.25-32

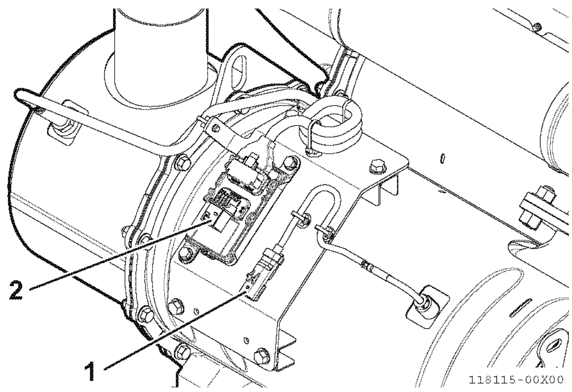

Fig.25-33

5. Removing the retaining nut of the SCR pipe assembly

Loosen the nuts (4 pcs.) (3, Fig.25-34) that mount the DPF (1, Fig.25-34) and SCR pipe flange (2, Fig.25-34).

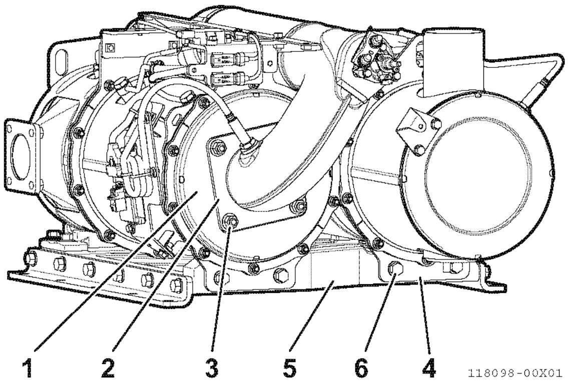

Fig.25-34

6. Removing the SCR fixing bolt

Remove the fixing bolts (2 pcs.) (6, Fig.25-34) that mount the SCR flange (4, Fig.25-34) and the DPF-SCR bracket (5, Fig.25-34). Remove the retaining nuts (2 pcs.) (2, Fig.25-35) of the DPF-SCR bracket (1, Fig.25-35), and the retaining nuts (2 pcs.) (4, Fig.25-35) of the SCR stay (3, Fig.25-35).

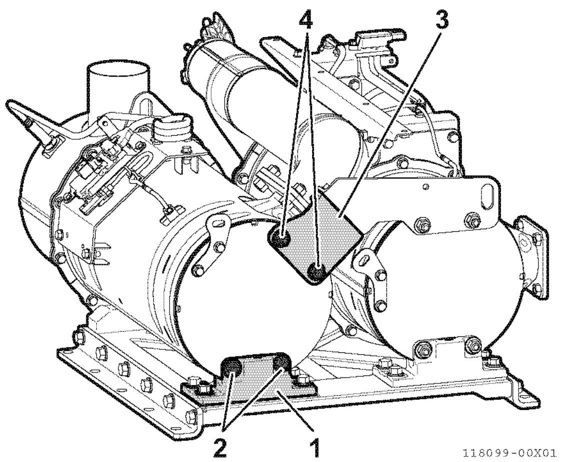

Fig.25-35

7. Removing the SCR and SCR pipe assembly

Slowly remove the SCR (1, Fig.25-36) together with the SCR pipe assembly (2, Fig.25-36) in the direction of the arrow (3, Fig.25-36), then lift it up. When removing, be aware of the weight because the SCR and SCR pipe assembly are heavy.

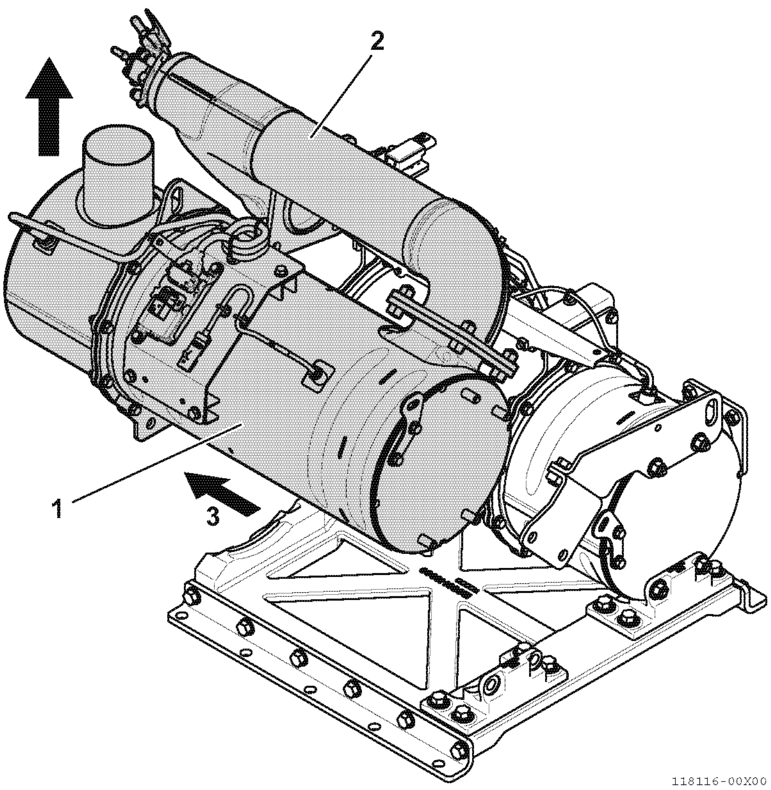

Fig.25-36

8. Removing the SCR pipe assembly

Remove the SCR pipe assembly (1, Fig.25-37) to separate it from the SCR. Remove the nuts (4 pcs.) (3, Fig.25-37) that mount the SCR pipe flange (2, Fig.25-37) to the SCR, and slowly pull out the SCR pipe assembly. Discard the gasket (4, Fig.25-37). The SCR pipe is inserted about 70 mm (5, Fig.25-37) to the SCR. Be careful no to damage the parts when removing.

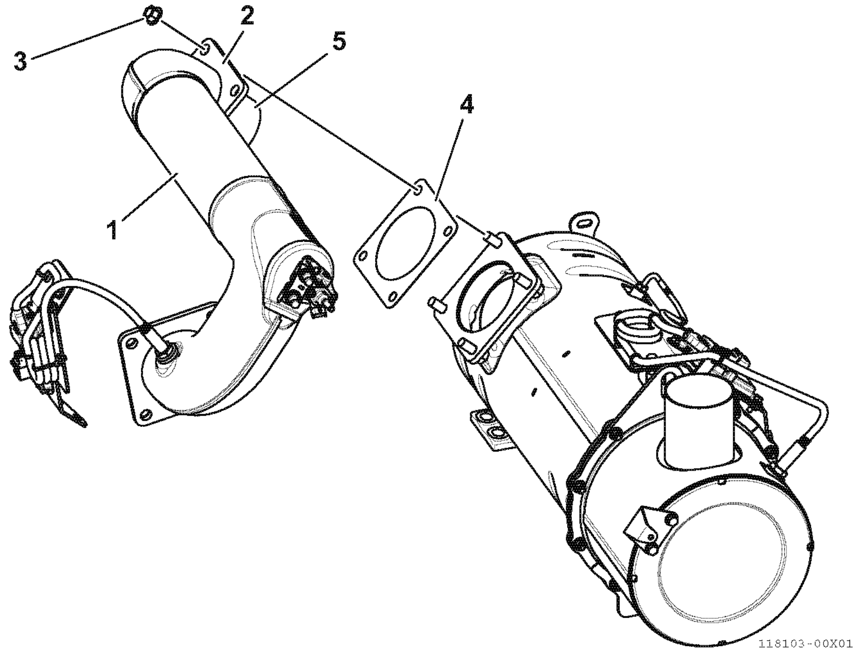

Fig.25-37

9. Removing the sensors and sensor bracket

Loosen the hexagon nuts (width across flat 22) of the downstream NOx sensor (1, Fig.25-38) and the hexagon nuts (width across flat 14) of the exhaust temperature sensor (2, Fig.25-38), and remove the sensors together with the sensor bracket (3, Fig.25-38). Replace the SCR with a new one. If you will reuse the sensors, store them in a safe place.

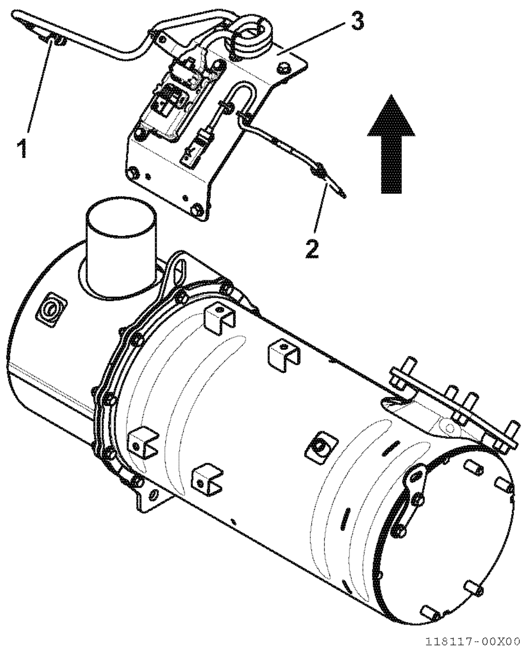

Fig.25-38

Maintenance on After-treatment Related Units and Parts (Applicable only to EU Stage V certified models)

1. Periodic Maintenance Interval for ATD Unit

The following table shows the maintenance intervals for the units and parts of the ATD unit.

Always replace the DOC (Diesel Oxidation Catalyst) and the urea SCR at the same time to satisfy the emission control regulations.

For details of replacement or removal procedures during maintenance of each device, see 2502-02-01-01 “Replacing (Removing) the DPF”, 2502-02-01-02 “Removing the SF”, and 2503-02-01-01 “Replacing (Removing) the SCR”.

Device	Part	Periodic maintenance interval		
		Usage limit	Cleaning	Check
DPF	DOC	9000 operating hours	Not required	Check the appearance and wiring of the DOC/SCR catalyst and related sensors, and check the occurrence status and error history of the engine failure lamp and warning lamps on the control panel every 4500 hours of operation.
	SF		If the DPF cleaning alarm is equipped, clean it when alarm is indicated. Otherwise, clan every 6000 hours of operation.	
Urea SCR	SCR	9000 operating hours	Not required	

Note: The SF is built into the SF case. The SF is cleaned at YANMAR’s service center with cleaning ability. Therefore, send the SF without removing it from the case.

NOTICE

The ATD unit (DPF + SCR) is subject to emission control regulations. It is prohibited for users to disassemble it without prior consultation. If the ATD unit needs to be replaced, consult with your authorized YANMAR industrial engine dealer or distributor.

2. Maintaining the SM (Supply Module)

2.1 Inspecting and replacing the SM main filter

The SM is a unit to boost and feed pressure to inject pressurized urea water to the SCR, and it is mounted on the driven machine. The main filter of the SM needs to be replaced every 4500 hours or 3 years, whichever comes first. When replacing the filter, replace the equalizing element inserted inside the main filter at the same time. Do not reuse the main filter after cleaning.

2.2 Replacement procedure of the SM main filter

1 - The SM is equipped on the driven machine side as shown in Fig.25-39. For the equipped placed, refer to the manual provided by the driven machine manufacturer. The main filter is equipped on the bottom of the SM.

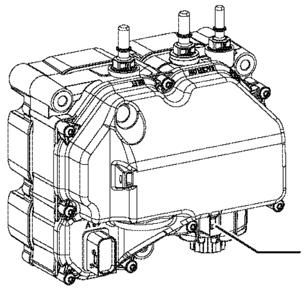

Fig.25-39

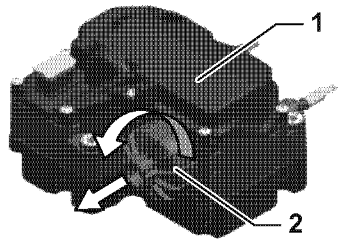

Fig.25-40

2 - Remove the main filter cover (2, Fig.25-40) of the SM (1, Fig.25-40) using a specified tool (27 mm 12-point socket wrench: DIN 3124/ISO 2725-1). When removing the cover, put a waste cloth or the like beneath the filter cover in case urea water spills on the floor.

3 - Pull out the equalizing element (2, Fig.25-41) inserted inside the filter element (1, Fig.25-41). At this time, make sure that the identification color at the center of the equalizing element is black.

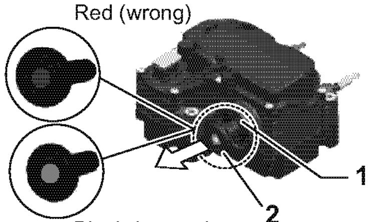

Fig.25-41

NOTICE

- For the maintenance of the main filter, wait for 10 minutes after turning off the engine key (after complete shutoff).
- Before replacing, make sure that all parts are sufficiently cooled. Do not work in high temperature or high pressure environment
- Be sure to replace it when the remaining urea water is low after finishing the after-run. Be careful of the urea water flowing out when removing the filter cover.
- Do not replace when the urea water is frozen.
- When replacing, because there may be pressure remaining in the system, wear appropriate protection gears (such as goggles).
- When replacing, do not apply excessive pressure to the parts, or break by stepping on them.
- When replacing, do not wear gloves that can create contamination such as fiber dust.

4 - Bend the filter element drawing-out tool (1, Fig.25-42) until both sides of the hinge contact, and insert it into the insertion position in the shape shown in Fig.25-42.

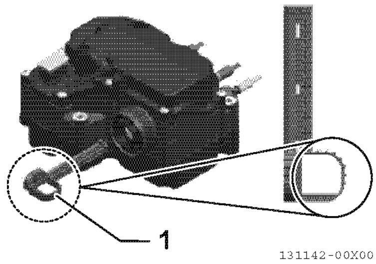

Fig.25-42

5 - Push the filter element drawing-out tool (1, Fig.25-43) to the position where it can be inserted.

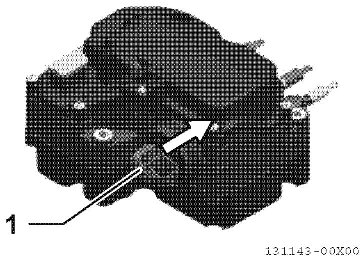

Fig.25-43

6 - Open the hinge part of the bent filter element drawing-out tool (1, Fig.25-44) to the shape and position shown in Fig.25-44.

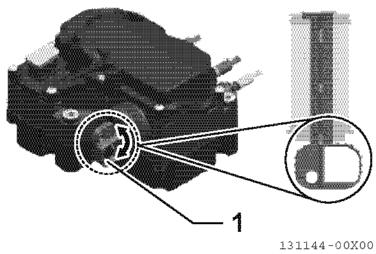

Fig.25-44

7 - Pull out the filter element tool (2, Fig.25-45) together with the filter element drawing-out tool (1, Fig.25-45). Do not use the SM housing as a support when pulling out the filter element. It may cause damage to the housing surface.

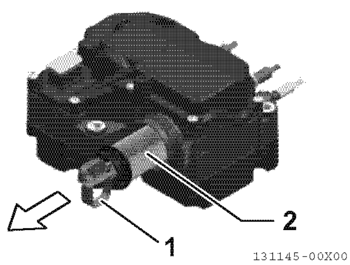

Fig.25-45

8 - Clean the main filter cover mounting threads (1, Fig.25-46) with freshwater before installing a new filter element.

NOTICE

Make sure you do not damage the thread part of the O-ring of the filter element, and thread and seal part of the filter element while replacing. If you try to attach the filter when the urea water is crystallized, the O-ring may be damaged. Rinse the crystal with water.

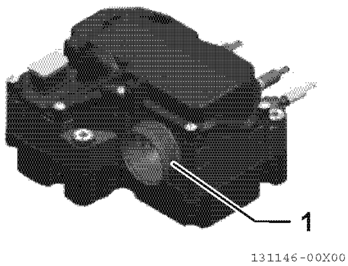

Fig.25-46

9 - For new filter elements (1, Fig.25-47), use the main filter kit shown on the next page. Apply bearing oil (Mobil Velocite # 6 is recommended) to the O-ring (2, Fig.25-47) and attach it. Insert the filter element all the way in and be careful not to damage the O-ring when replacing it.

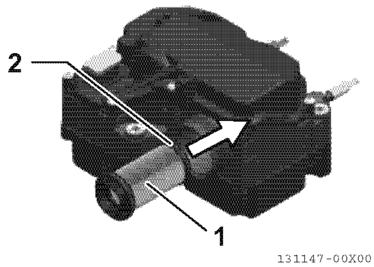

Fig.25-47

10 - Insert a new equalizing element (1, Fig.25-48).

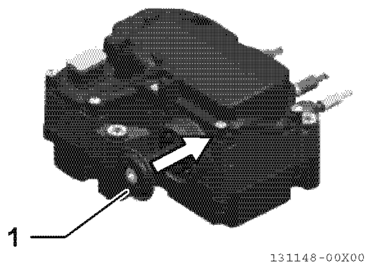

Fig.25-48

11 - Tighten the main filter cover (1, Fig.25-49) to the specified torque using the specified tool (27 mm wrench: DIN 3124 / ISO 2725-1).

Tightening torque	Equalizing element	20 - 25 N·m

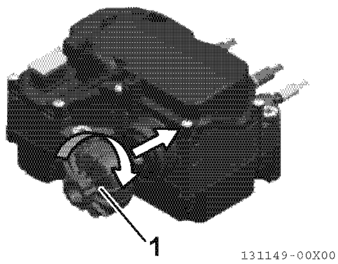

Fig.25-49

Main filter kit	Part No.	129F01-19510
	Contents	Filter element, equalizing element

NOTICE

- Do not install when the filter paper of the filter element is wet. Deformation of the filter makes it difficult to insert.
- Do not reuse the filter element. Deformation of the filter makes it difficult to insert.
- When replacing the main filter element, make sure to replace the equalizing element with the new one included in the kit.
- When tightening the filter cover, use a specified tool (27 mm 12-point socket wrench: DIN 3124/ ISO 2725-1).
- When installing, make sure that there are no contaminants such as foreign matter and dust. When replacing, do not wear gloves that can create contamination such as fiber dust.

12 - After replacement, start the engine and boost the system to check for urea water leaks.

2.3 Caution on replacing the filter cover

Although you do not need to replace the filter cover when you replace the main filter, if the filter cover is damaged and needs to be replaced, replace not only the cover but the entire filter kit (including the equalizing element).

2.4 Replacement procedures of the SM (Supply module)

1 - When replacing the SM, remove the hoses from the urea water piping connectors (3 places) (1, Fig.25-50). Be careful of the urea water flowing out when removing the hoses. Remove the couplers of the electric wiring connectors (2, Fig.25-50), and loosen the mounting bolts (3 pcs.) (3, Fig.25-50) of the SM, and then remove the SM.

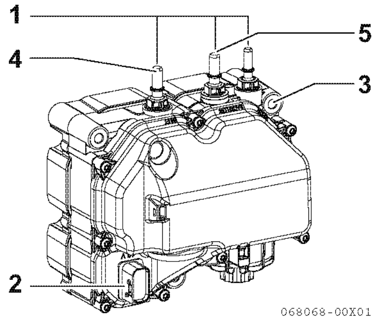

Fig.25-50

NOTICE

- Before replacing, make sure that all parts are sufficiently cooled. Do not work in high temperature or high pressure environment.
- Be sure to replace it when the remaining urea water is low after finishing the after-run. Be careful of the urea water flowing out when removing the filter cover.
- Do not replace when the urea water is frozen.
- When replacing, because there may be pressure remaining in the system, wear appropriate protection gears.
- When replacing, do not apply excessive pressure to the parts, or break by stepping on them.
- When replacing, do not wear gloves that can create contamination such as fiber dust.
- When removing pipes and wires, before removing the wiring couplers, remove the urea water hoses first to prevent urea water from spilling over the electric wiring terminal.
- When replacing, do not touch the plug pin of the electric wiring connector.
- When replacing, make sure there is no stain on connecting parts and attaching parts of the connectors and the components.
- When you store with the SM removed, cover the electric wiring connectors and urea water pipes with protective caps to make sure no foreign matter comes from those inlet and outlet. Keep the protective caps attached immediately before installation.

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2 - Tighten the new SM using specified bolts to the specified torque (13.7 ± 2.9 ft·lb (19.0 ± 3.8 N·m; 1.9 ± 0.4 kgf·m)). When installing, make sure that the mounting surface is not damaged.

3 - Attach the electric wiring couplers, attach the urea water piping hoses. Be careful not to connect correct connectors, back-flow connector (4, Fig.25-50) and inlet connector (5, Fig.25-50).

4 - Lightly pull the electric wiring coupler to make sure that it does not come off. In addition, make sure that no error occurs due to mis-connection.

5 - After replacement, start the engine and boost the system to check for urea water leaks.

NOTICE

- When attaching pipes and wires, before attaching the urea water hoses, attach the electric wiring couplers first to prevent urea water from spilling over the electric wiring terminal.
- When installing, make sure that there are no contaminants such as foreign matter and dust. When replacing, do not wear gloves that can create contamination such as fiber dust.
- If he urea water piping connectors are replaced, do not reuse the O-ring of the connector.
- Do not paint the components.

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3. Maintaining the DM (Dosing Module)

3.1 Inspecting the DM and replacing the sealing plate

Although you do not need to replace the sealing plate for the attaching part of the DM exhaust pipe periodically, if there is leakage, replace it with a new one. Follow the replacement procedure shown below.

3.2 Replacement procedure of the DM sealing plate

1 - Before removing the DM (Fig.25-51) from the SCR pipe, remove the engine coolant hose from the engine coolant connector (1, Fig.25-51), then remove the urea water hose from the urea water inlet connector (2, Fig.25-51). Be careful of the coolant and urea water flowing out when removing the hoses. Remove the coupler from the DM electric wiring connector (3, Fig.25-51).

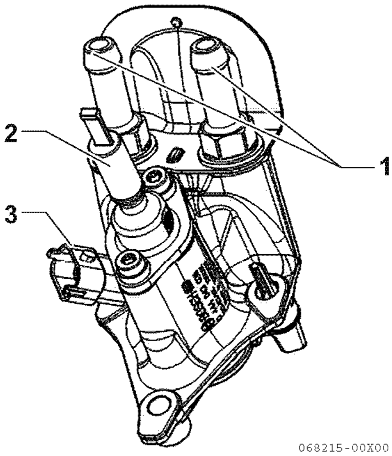


Fig.25-51

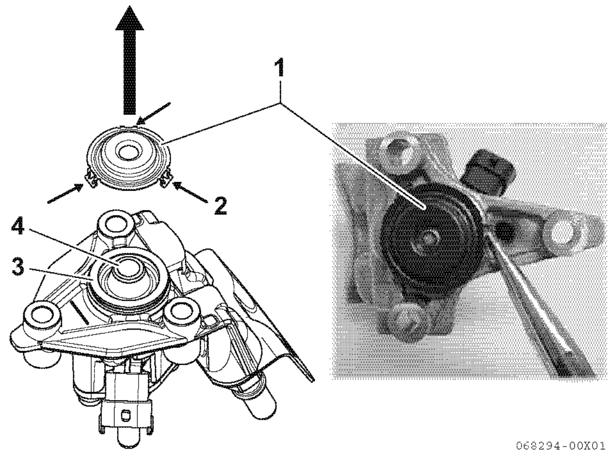


Fig.25-52

NOTICE

- Replacement should be done after making sure that all parts are sufficiently cooled. Do not work in high temperature or high pressure environment.
- Replacement should be done when the remaining urea water is low after finishing the after-run. Be careful of the urea water flowing out when removing the filter cover.
- Do not replace when the urea water is frozen.
- When replacing, because there may be pressure remaining in the system, wear appropriate protection gears.
- When replacing, do not apply excessive pressure to the parts, or break by stepping on them.
- When replacing, do not wear gloves that can create contamination such as fiber dust.
- When removing pipes and wires, before removing the wiring couplers, remove the urea water hoses first to prevent urea water from spilling over the electric wiring terminal.
- When replacing, do not touch the plug pin of the electric wiring connector.

2 - Loosen the DM mounting bolts to remove the DM. Remove the sealing plate (1, Fig.25-52) on the urea water injection nozzle. Use the notches (2, Fig.25-52) at three places of the circumference of the plate. Be careful not to damage the sealing surface with a sharp tool.
Before attaching a new sealing plate, clean the sealing surface (3, Fig.25-52) if necessary. When cleaning, be careful not to damage the sealing surface, and do not touch the orifice plate (4, Fig.25-52) in the middle.

3 - Attach the new sealing plate (1, Fig.25-53) to the sealing surface, and push it in the direction of the arrow (2, Fig.25-53). Be careful not to damage the sealing plate. Do not reuse the sealing plate.

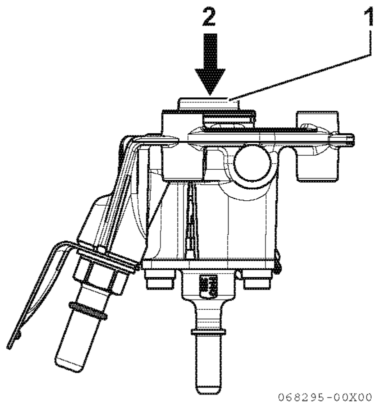


Fig.25-53

4 - For attaching the sealing plate to the SCR pipe, follow the reverse procedure to the removal procedure. Tightening torque for DM mounting bolt (M6 × 30) is 8.0 ± 0.7 ft·lb (10.8 ± 1 N·m; 1.1 ± 0.1 kgf·m).

5 - Attach the electric wiring couplers, and attach the urea water piping hose and engine coolant hose. When attaching the engine coolant hose, make sure the hose is not twisted, and no excess force is applied to the hose. If bundling the hoses together, make sure no excess force is applied to the bundled section.

6 - Lightly pull the electric wiring coupler to make sure that it does not come off. In addition, make sure that no error occurs due to mis-connection.

7 - After installation, start the engine and boost the system to check for urea water leaks. Check the engine coolant system for leakage.

NOTICE

- When replacing, make sure there is no stain on connecting parts and attaching parts of the connectors and the components.
- When you store with the SM removed, cover the electric wiring connectors and urea water pipes with protective caps to make sure no foreign matter comes from those inlet and outlet. Keep the protective caps attached immediately before installation.
- When attaching pipes and wires, before attaching the urea water hoses, attach the electric wiring couplers first to prevent urea water from spilling over the electric wiring terminal.
- When installing, make sure that there are no contaminants such as foreign matter and dust. When replacing, do not wear gloves that can create contamination such as fiber dust.
- If he urea water piping connectors are replaced, do not reuse the O-ring of the connector.
- Do not paint the components.

Assembling the After-treatment Device (ATD Unit) (Applicable only to EU Stage V certified models)

1. Replacing (Assembling) the ATD Unit

Following is the procedure for installing new DPF and SCR as a unit. If installing the DPF/SCR while either of DPF or SCR is being attached to the DPF-SCR bracket, see 2502-02-03-01 “Replacing (Assembling) the DPF” for installing the DPF, and 2503-02-03-01 “Replacing (Assembling) the SCR” for installing the SCR.

1. Attaching the sensors and brackets to the DPF

- Using studs bolts and nuts (5, Fig.25-54), (6, Fig.25-54), attach the DPF bracket (1, Fig.25-54), and PDF stay (2, Fig.25-54) and SCR stay (3, Fig.25-54), that have been removed as a unit, to the end face (4, Fig.25-54) of the DPF exhaust gas inlet.
- Reattach the removed sensors and brackets. Attach the DOC inlet exhaust temperature sensor (7, Fig.25-54), intermediate exhaust temperature sensor (8, Fig.25-54), and exhaust differential pressure sensor unit (9, Fig.25-54) together with the sensor bracket assembly(10, Fig.25-54) as a unit. Here, from the exhaust differential pressure sensor, replace the pipe joint bolt (11, Fig.25-54), gasket (12, Fig.25-54), and pressure hose (13, Fig.25-54) with new ones (2 places).
- When attaching the exhaust temperature sensor and the pipe joint bolt of the differential pressure sensor to the new DPF, apply seizure prevention agent to each thread part, and tighten them.

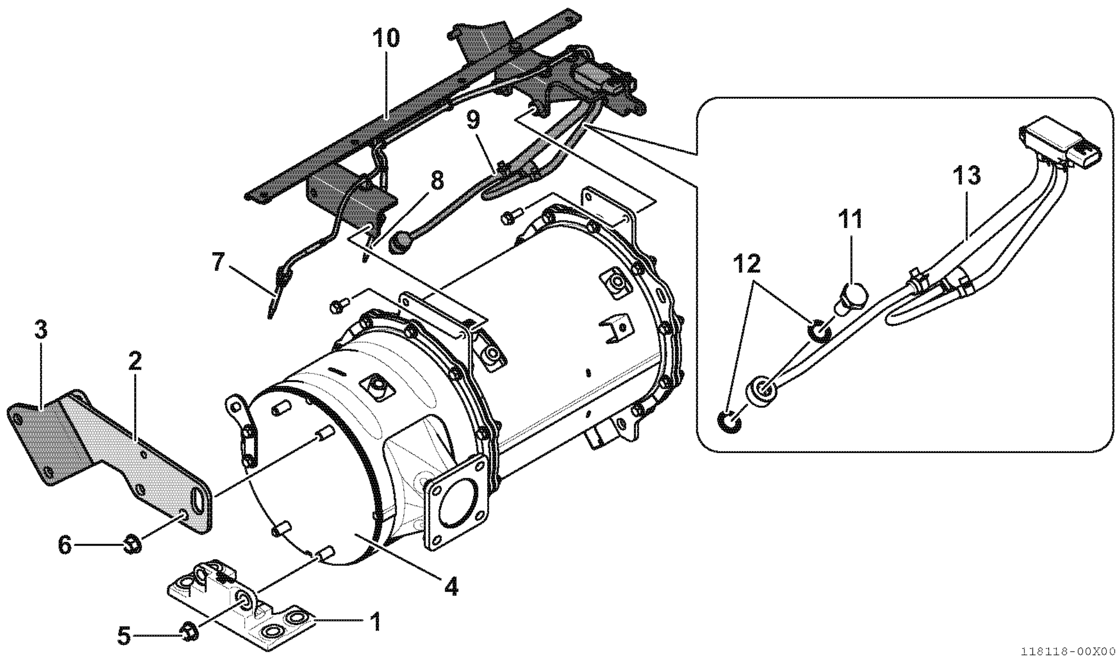


Fig.25-54

2. Fig.25-55 shows the condition when the DPF is installed alone.

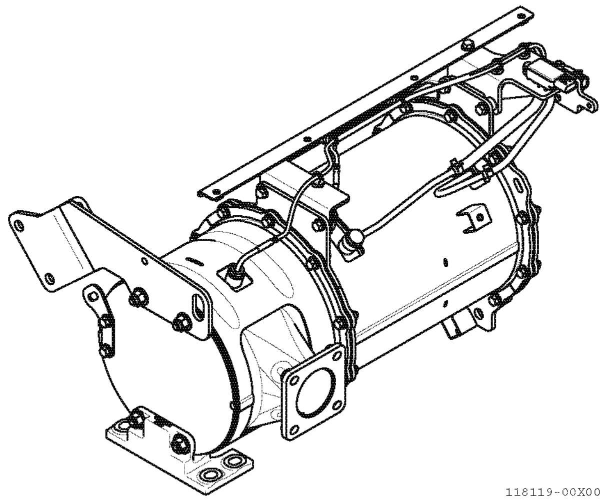


Fig.25-55

3. Attaching the sensors and brackets to the SCR
   - Using studs bolts and nuts (3, Fig.25-56), attach the SCR bracket (1, Fig.25-56) to the end face (1, Fig.25-56) of the new SCR exhaust gas inlet.
   - Reattach the removed SCR temperature sensor (4, Fig.25-56) and NOx sensor (5, Fig.25-56) together with the sensor bracket (6, Fig.25-56). Apply seizure prevention agent to each thread part, and tighten them.

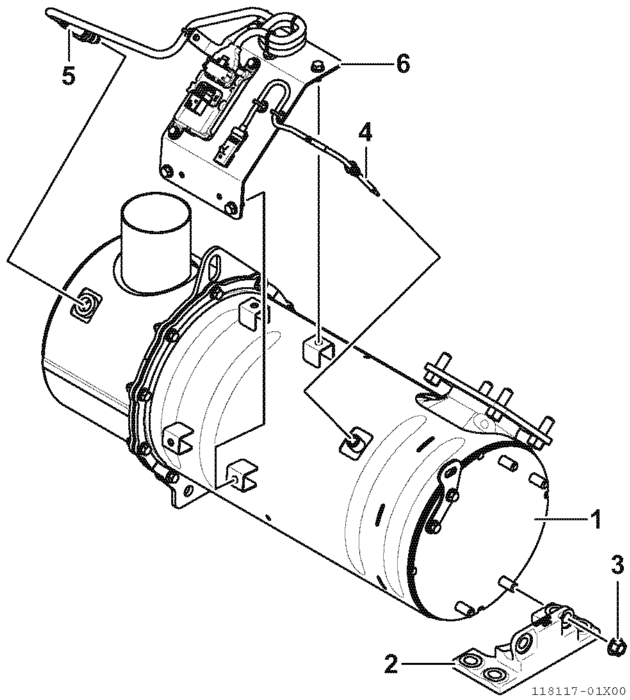


Fig.25-56

4. Installing the DPF, SCR, and SCR pipe

Installation can be done in the reserve procedure to the removal procedure.

- Insert the SCR pipe (2, Fig.25-57) with the upstream NOx sensor assembly (1, Fig.25-57) attached to the exhaust gas inlet flange (4, Fig.25-57) of the SCR (3, Fig.25-57) together with the new gasket (5, Fig.25-57). Loosely tighten it using the nuts (6, Fig.25-57).
- Install the DPF (1, Fig.25-58) with sensors attached to the SCR pipe (2, Fig.25-58), and firmly tighten them together. Align and insert the stud bolts (3, Fig.25-58) on the DPF exhaust gas outlet side to the SCR pipe flange (4, Fig.25-58), and loosely tighten it using the flange side nuts (7, Fig.25-58). Also, align the SCR stay (5, Fig.25-58) to the stud bolts (6, Fig.25-58), and loosely tighten it using stay side nuts (8, Fig.25-58) Replace the gasket (9, Fig.25-58) between the DPF and SCR pipe with a new one. Attach the upstream NOx sensor bracket (10, Fig.25-58) to the DPF.

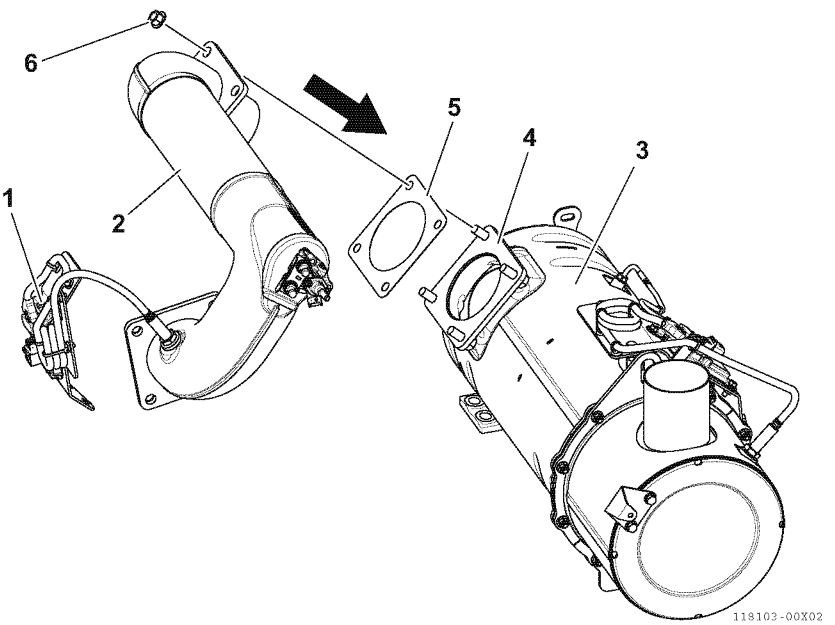


Fig.25-57

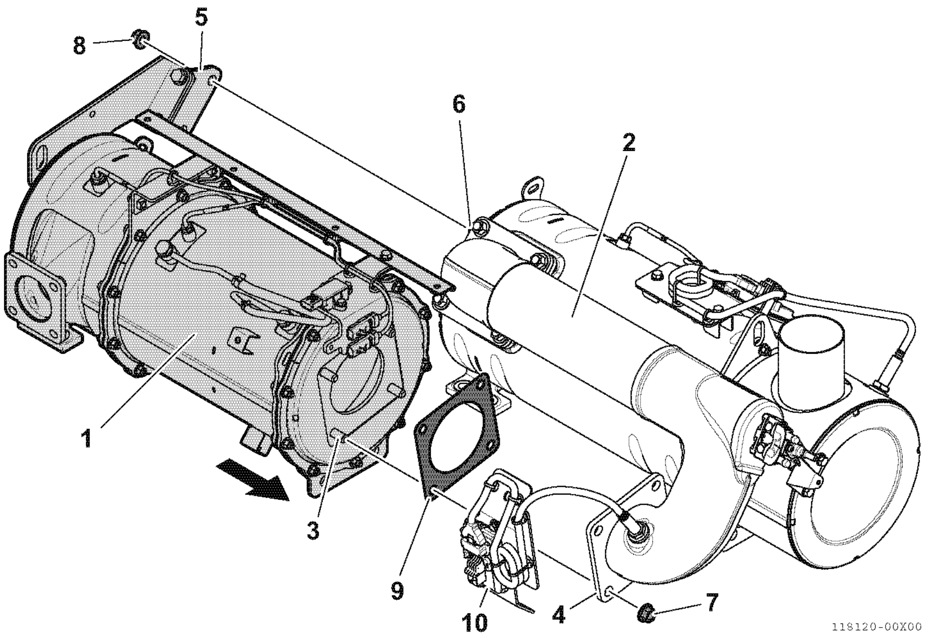


Fig.25-58

5. Fixing the DPF, SCR, and SCR pipe to the base
    - Mount the DPF and SCR unit (1, Fig.25-59) to the DPF-SCR bracket (2, Fig.25-59), then loosely tighten the DPF bracket (3, Fig.25-59) and SCR bracket (4, Fig.25-59) to the DPF-SCR bracket using the bolts (5, Fig.25-59).
    - On the opposite side, loosely tighten the SF stiffener plate (1, Fig.25-60) of the DPF and SCR exhaust gas outlet pipe flange (2, Fig.25-60) to the DPF-SCR bracket (3, Fig.25-60) using the bolts (4, Fig.25-60).

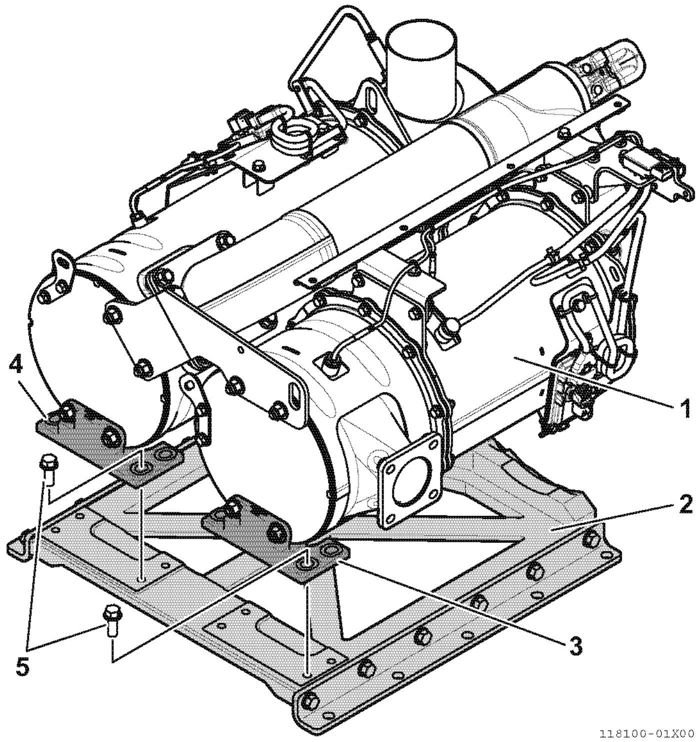


Fig.25-59

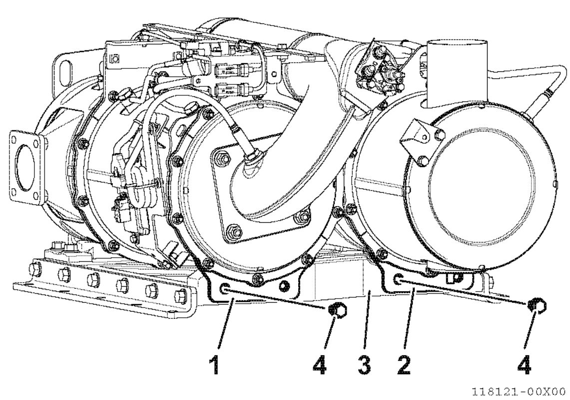


Fig.25-60

6. Check the each connecting section of DPF and SCR pipe, SCR pipe and SCR, and DPF-SCR bracket and DPF/SCR, and make sure they are not twisted. Fully tighten all bolts and nuts to the specified torque.

2. Replacing (Assembling) the DPF

The procedure for installing a new DPF to the ATD unit is shown below. The following procedures are applied when the SCR is attached to the DPF-SCR bracket.

2.1 Attaching the DPF stay and bracket

Attach the removed DPF stay (2, Fig.25-61) and DPF bracket (3, Fig.25-61) to the new DPF (1, Fig.25-61), and loosely tighten them with nuts.

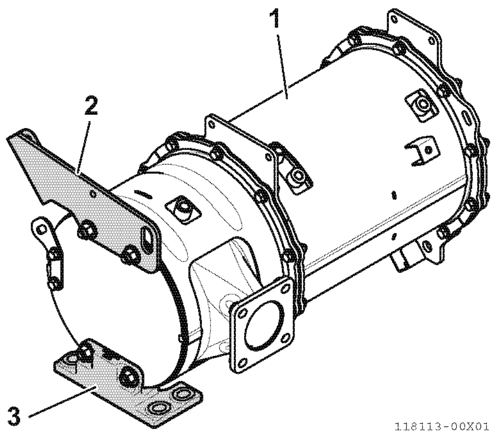


Fig.25-61

2.2 Attaching the DPF sensors and brackets

Reattach the removed sensors and brackets. Attach the DOC inlet exhaust temperature sensor (1, Fig.25-62), intermediate exhaust temperature sensor (2, Fig.25-62), and exhaust differential pressure sensor unit (3, Fig.25-62) together with the sensor bracket assembly(4, Fig.25-62) as a unit. Here, from the exhaust differential pressure sensor, replace the pipe joint bolt (5, Fig.25-62), gasket (6, Fig.25-62), and pressure hose (7, Fig.25-62) with new ones. When attaching the pipe joint bolt and the temperature sensor of the differential pressure sensor to the new DPF, apply seizure prevention agent to each thread part, and tighten them.

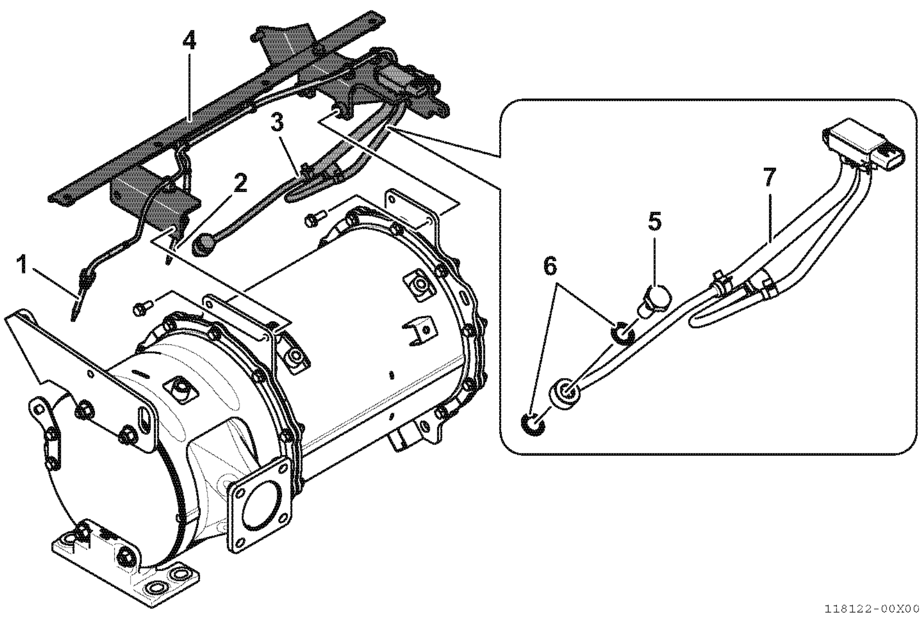


Fig.25-62

DPF assembly (CMP)	129F01-16000
Pipe joint bolt of differential pressure sensor	129A00-13350
Pipe joint bolt gasket	129A00-17311
Pressure hose of differential pressure sensor (INLET)	129E26-17600
Pressure hose of differential pressure sensor (OUTLET)	129C23-17550

Tightening torque	Exhaust temperature sensor (Both M12 and M14)	29.5 ± 3.7 ft·lb (40 ± 5 N·m; 4.1 ± 0.5 kgf·m)
	Exhaust differential pressure sensor (M12 Pipe joint bolt)	21.7 ± 3.7 ft·lb (29.4 ± 5 N·m; 3.0 ± 0.5 kgf·m)

2.3 Installing the SCR pipe

Reinstall the removed SCR pipe assembly to the DPF (Fig.25-63). Align and insert the new gasket (2, Fig.25-63) to the stud bolts (4 pcs.) (1, Fig.25-63) on the DPF exhaust gas outlet, and install the SCR pipe assembly (3, Fig.25-63). Loosely tighten it using nuts (4, Fig.25-63). Using the bolts (3, Fig.25-64), attach the NOx sensor bracket (2, Fig.25-64) to the DPF with the controller of the upstream NOx sensor (1, Fig.25-64) attached to the bracket.

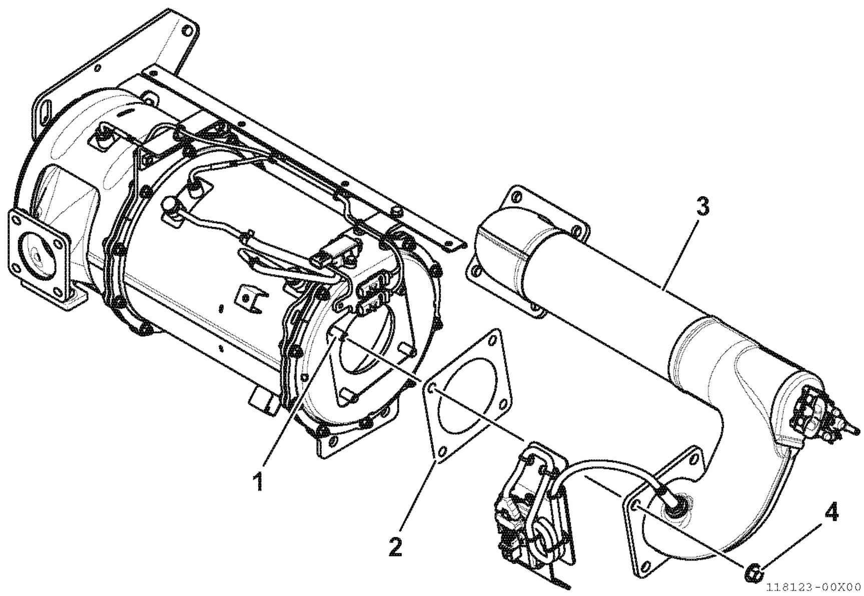


Fig.25-63

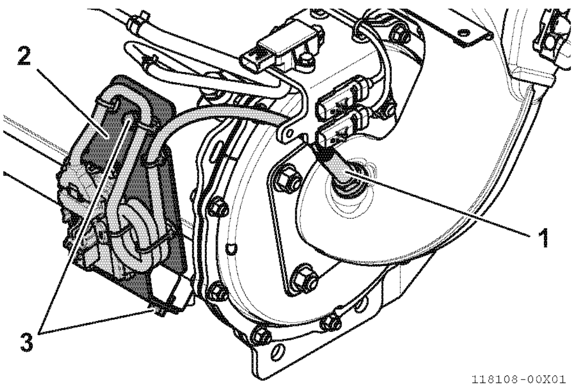


Fig.25-64

2.4 Installing the DPF to SCR

1 - After installing the SCR pipe assembly to the DPF (1, Fig.25-65), install the DPF to the SCR (2, Fig.25-65). Attach the new SCR pipe gasket (3, Fig.25-65) between the DPF and SCR. While inserting the connecting section (4, Fig.25-65) of the SCR pipe to the SCR, align the stud bolts (5, Fig.25-65) on the SCR to the flange (6, Fig.25-65) on the SCR pipe assembly, and loosely tighten it using nuts (4 pcs.) (7, Fig.25-65). Align the mounting holes (10, Fig.25-65) of the DPF bracket (8, Fig.25-65) and the DPF-SCR bracket base (9, Fig.25-65), and then loosely tighten it using bolts (4 pcs.) (11, Fig.25-65).

2 - Loosely tighten the fixing bolt (2 pcs.) (3, Fig.25-66) that mount the DPF stay (1, Fig.25-66) and SCR stay (2, Fig.25-66).

3 - Loosely tighten the fixing bolts (2 pcs.) (3, Fig.25-67) that mount the exhaust gas outlet flange (1, Fig.25-67) of the DPF and the DPF-SCR bracket (2, Fig.25-67).

4 - Check each part, and make sure that they are not twisted. Fully tighten the bolts and nuts to the specified torque.

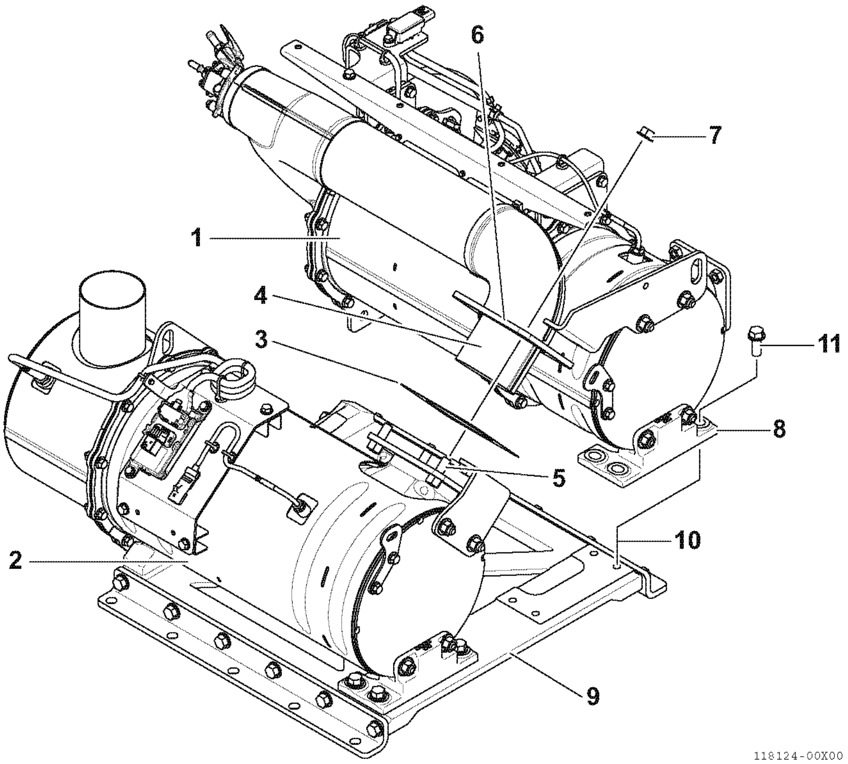


Fig.25-65

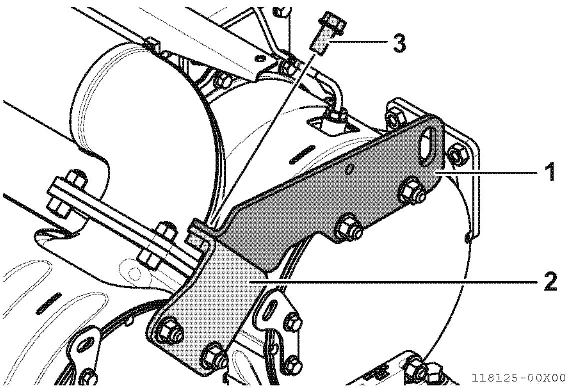


Fig.25-66

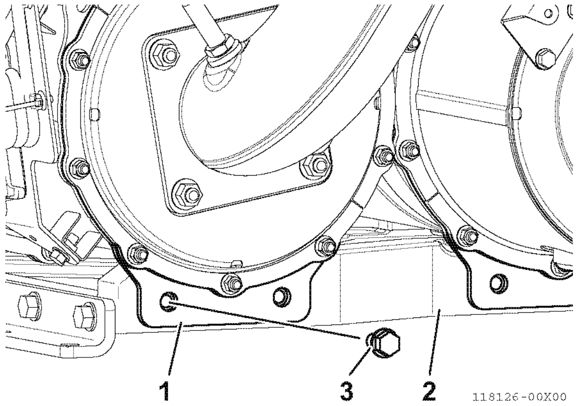


Fig.25-67

3. Assembling the SF

The procedure for installing the SF case to the DPF is shown below after SF cleaning.

1. Install the cleaned SF case (1, Fig.25-68) with the built-in SF to the DOC case (2, Fig.25-68). Replace the gasket (3, Fig.25-68) with a new one. Retain the stiffener plates (4, Fig.25-68) of the DOC and SF case using the stiffeners × 4 (5, 6, 7, 8, Fig.25-68) from the both ends, then temporarily install them using the bolts (9, Fig.25-68). Replace the bolts with new ones. At this time, be sure to reinstall each stiffener in its original position according to the mark at the time of disassembly. After temporary installation, remove the bolt 10 and 11 as described in the below diagram, and diagonally insert the positioning pins for servicing (129G01-17950) (12, Fig.25-68). Tighten the remaining bolts × 8 to the specified torque. Pull out the positioning pins × 2, and insert the bolts, and then tighten them to the specified torque.

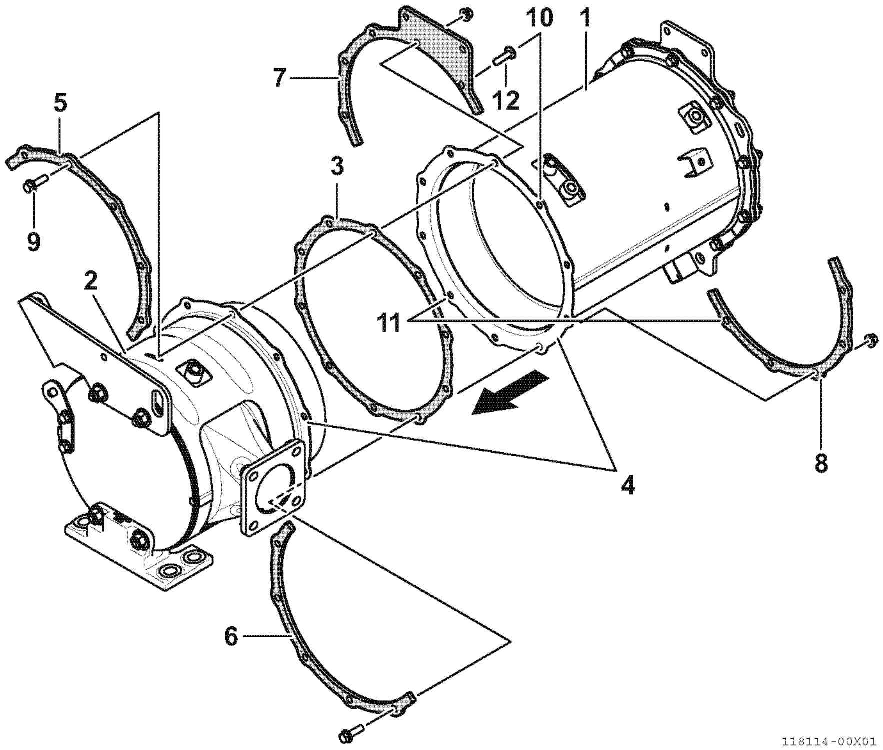


Fig.25-68

2. Fully tighten the bolts to the specified torque, and reinstall the removed sensors and SCR pipe assembly to the SCR. For details, see 2502-02-03-01 “Replacing (Assembling) the DPF”.

4. Replacing (Assembling) the SCR

The procedure for installing a new SCR to the ATD unit is shown below. The following procedures are applied when the DPF is attached to the DPF-SCR bracket.

4.1 Attaching the SCR sensors and sensor bracket

Reattach the removed NOx sensor (2, Fig.25-69) and exhaust temperature sensor (3, Fig.25-69) to the sensor bracket (4, Fig.25-69), and install them to the new SCR (1, Fig.25-69). When attaching the NOx sensor and exhaust temperature sensor, apply seizure prevention solution to the thread part.

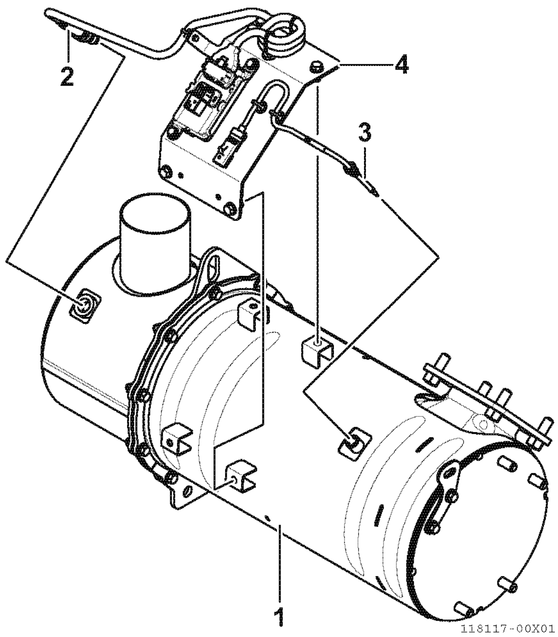


Fig.25-69

4.2 Installing the SCR pipe

Reinstall the removed SCR pipe assembly (1, Fig.25-70) to the SCR (2, Fig.25-70).
Attach the new SCR pipe gasket (3, Fig.25-70) between the DPF and SCR. While inserting the connecting section (4, Fig.25-70) of the SCR pipe to the SCR, align the stud bolts (5, Fig.25-70) on the SCR to the flange (6, Fig.25-70) on the SCR pipe assembly, and loosely tighten it using the nuts (4 pcs.) (7, Fig.25-70).

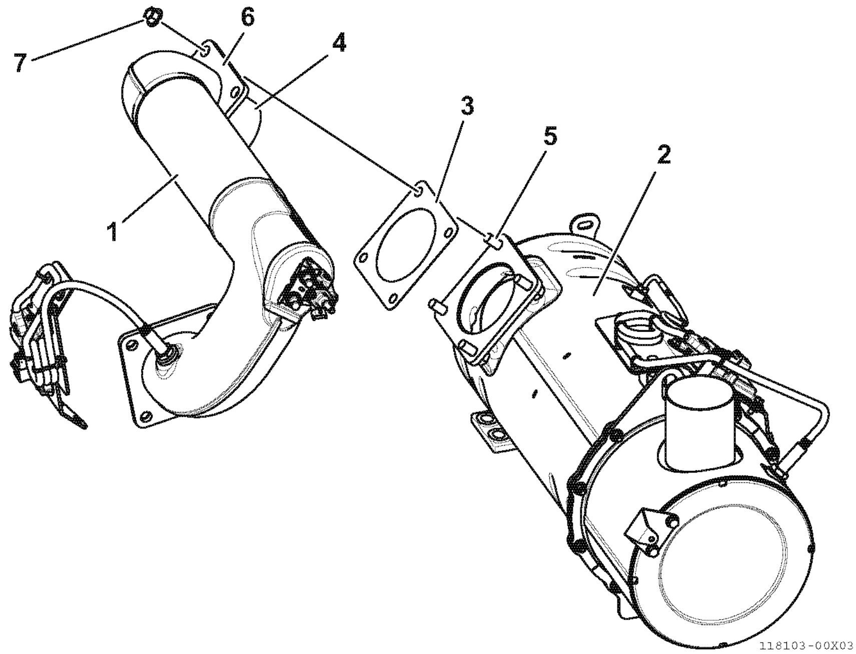


Fig.25-70

4.3 Installing the SCR to DPF

1 - After installing the SCR pipe assembly (1, Fig.25-71) to the SCR (2, Fig.25-71), install the SCR to the DPF (3, Fig.25-71). Align the stud bolts (2 pcs.) (5, Fig.25-71) at the bottom of the opposite end (4, Fig.25-71) of the SCR exhaust gas outlet with the mounting holes of the SCR bracket (6, Fig.25-71). Also, align the stud bolts (7, Fig.25-71) at the top with the mounting holes of the SCR stay (8, Fig.25-71), and move the SCR in the direction of the arrow (9, Fig.25-71).

2 - At the same time, align the stud bolts (2, Fig.25-72) of the DPF with the flange holes (1, Fig.25-72) Replace the gasket (3, Fig.25-72) between the DPF and SCR pipe flange with a new one. Align the mounting holes of the SCR exhaust gas outlet flange (4, Fig.25-72) and the mounting holes of the DPF-SCR stay (5, Fig.25-72), and loosely tighten with the bolts (6, Fig.25-72)

3 - Using nuts (10, Fig.25-71), (11, Fig.25-71), loosely tighten top and bottom of the stud bolts on the opposite end (4, Fig.25-71) of the SCR exhaust gas outlet.

4 - Using nuts (7, Fig.25-72), loosely tighten the stud bolts on the DPF exhaust gas outlet.

5 - Check each part, and make sure that they are not misaligned. Fully tighten the bolts and nuts to the specified torque.

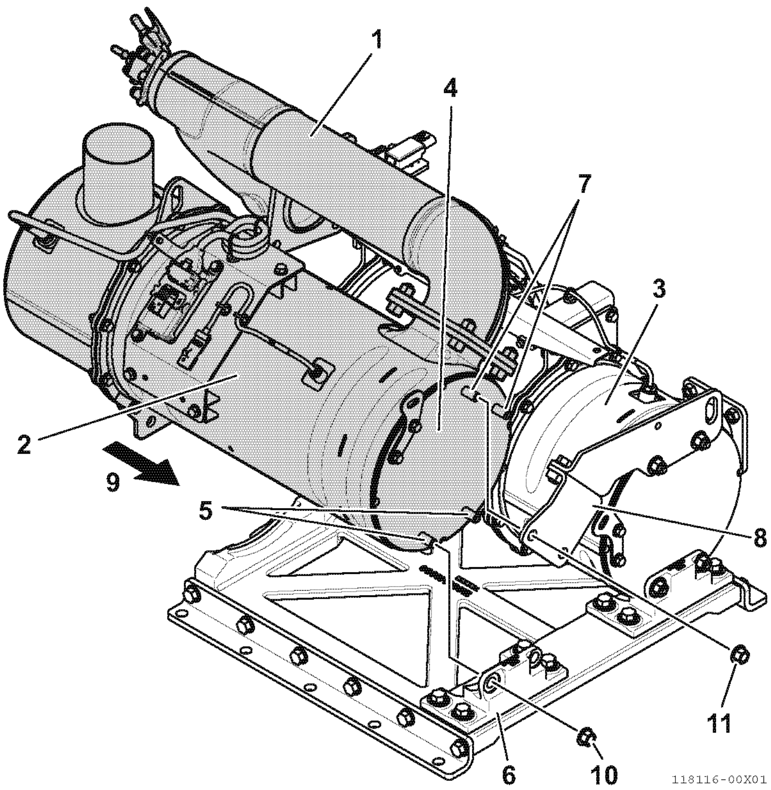


Fig.25-71

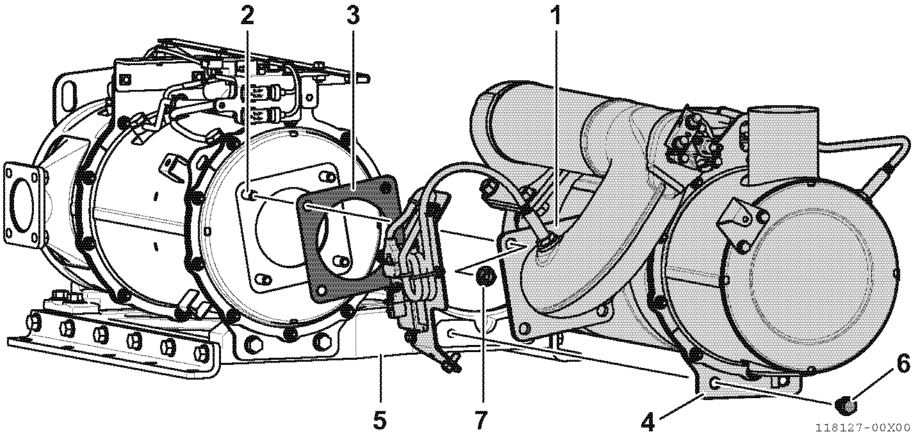


Fig.25-72

4.4 Attaching the upstream NOx sensor bracket

Attach the upstream NOx sensor bracket (1, Fig.25-73) to the DPF bracket base (2, Fig.25-73), and fully tighten using the bolts (2 pcs.) (3, Fig.25-73).

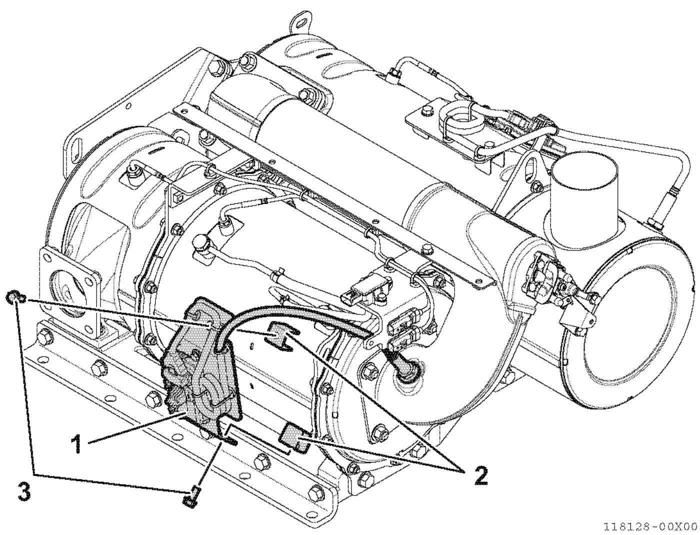


Fig.25-73

1. Cleaning the SF

SF is built-into the SF case. Clean the SF as it is. SF is cleaned at a specific YANMAR service center with cleaning facility. Therefore, after removing from DPF, send the SF with the SF case on.

WARNING

- **When removing the soot filter from the DPF assembly, the soot ash in the filter may scatter. Be sure to wear protective equipment such as gloves, anti-dust masks, and eye protection.**
- **When transporting soot filter (SF), fix it firmly in the package to prevent soot ash from scattering during transport.**
- **Soot Ash removed from the soot filter may be considered as industrial waste. Please handle in accordance with local laws and regulations.**
  Adequate provision must be assured for the containment of the material once it is removed. Disposal should be performed in accordance with local laws and regulations.

1. Lubrication System

This section describes an overview of the lubrication system structure for the 4TN107 engine and the procedures for disassembly, inspection, and reassembly of the lubricating oil pump.

1.1 Lubrication system components

Fig.30-1 shows an overview of the components of the lubrication system for the 4TN107 engine.
The lubricating oil pump for the 4TN107 engine is located on the flywheel side. The timing gear is located behind the flywheel, and the lubricating oil pump is driven together with the supply pump gear by the crank gear via the idle gear. The lubricating oil that is sucked up into the lubricating oil suction pipe passes from the lubricating oil pump through the lubricating oil cooler and is sent to the main moving parts and the turbocharger from the main gallery inside the cylinder block.

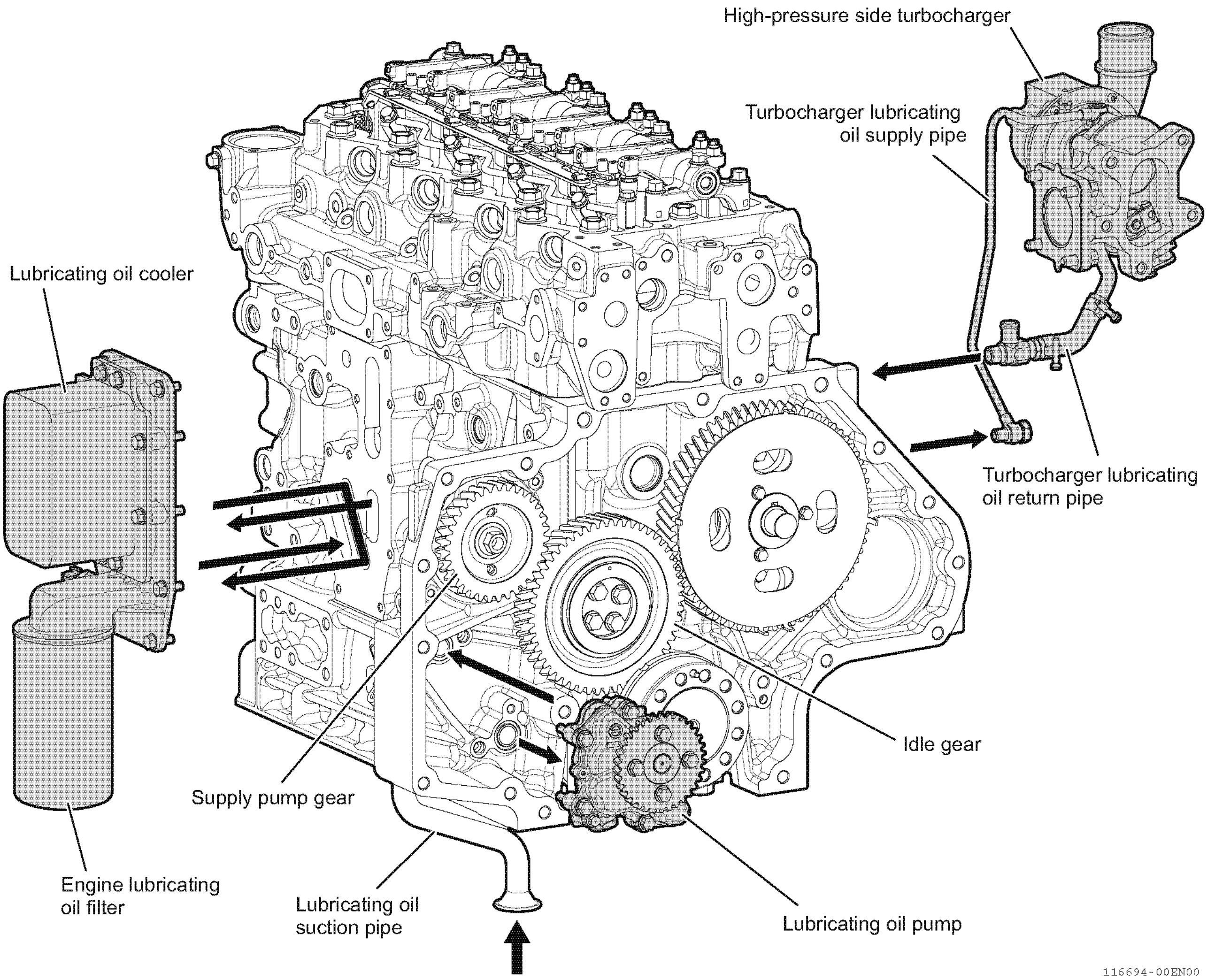


Fig.30-1

1.2 Components of the lubricating oil cooler

The components of the lubricating oil cooler for the 4TN107 engine are as follows.

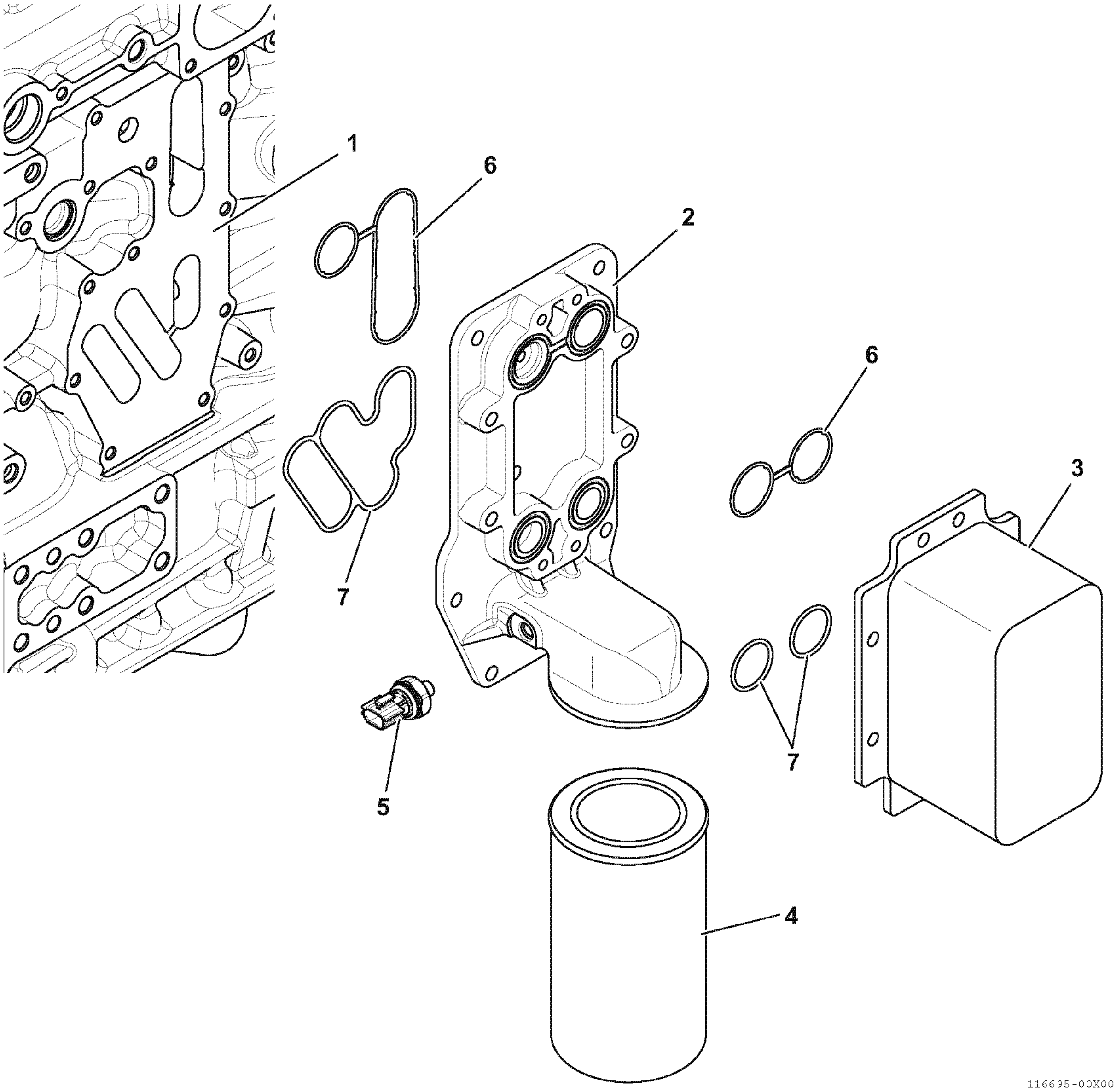


Fig.30-2

1 -	Cylinder block	5 -	Lubricating oil pressure sensor
2 -	Lubricating oil cooler bracket	6 -	Lubricating oil cooler gasket (CW)
3 -	Lubricating oil cooler	7 -	Lubricating oil cooler gasket (LO)
4 -	Lubricating oil filter		

2. Lubrication System Diagram

A system diagram showing the flow of lubricating oil in the entire lubrication system is shown in Fig.30-3.

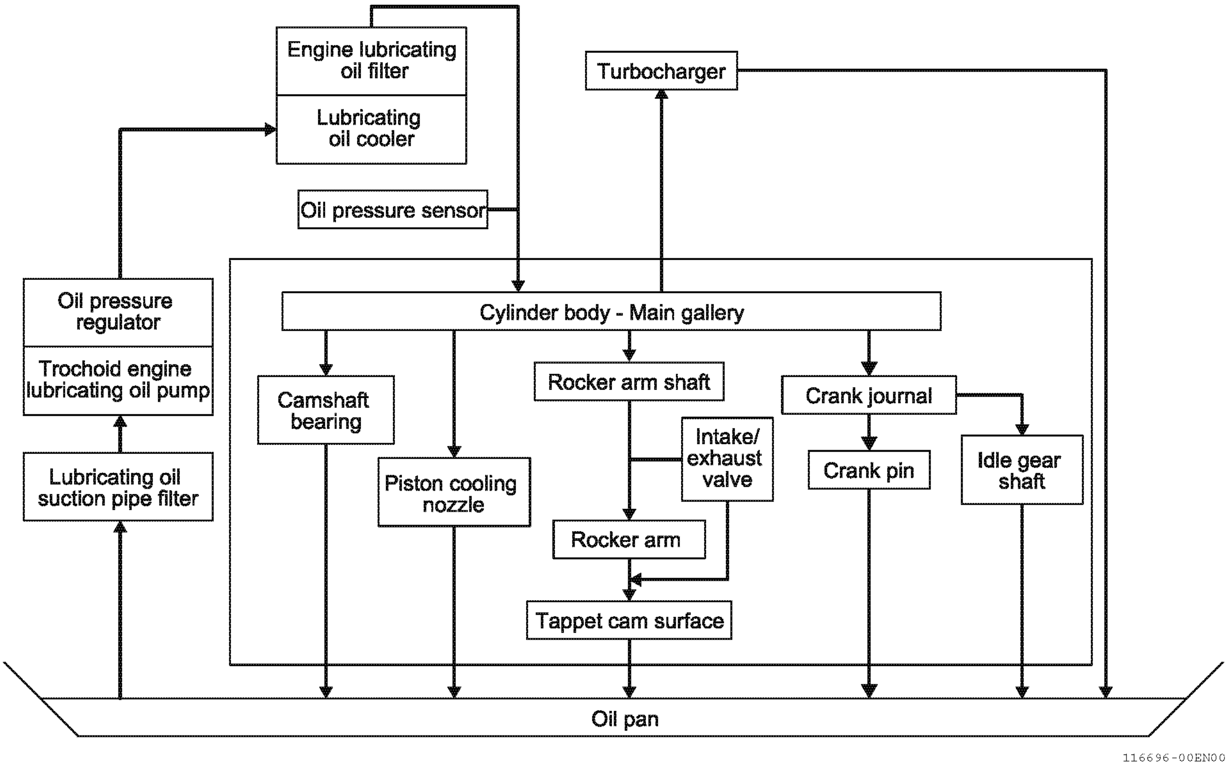


Fig.30-3

2.1 Flows of lubricating oil and coolant at the lubricating oil cooler

The flows of lubricating oil and coolant at the lubricating oil cooler are as shown below.

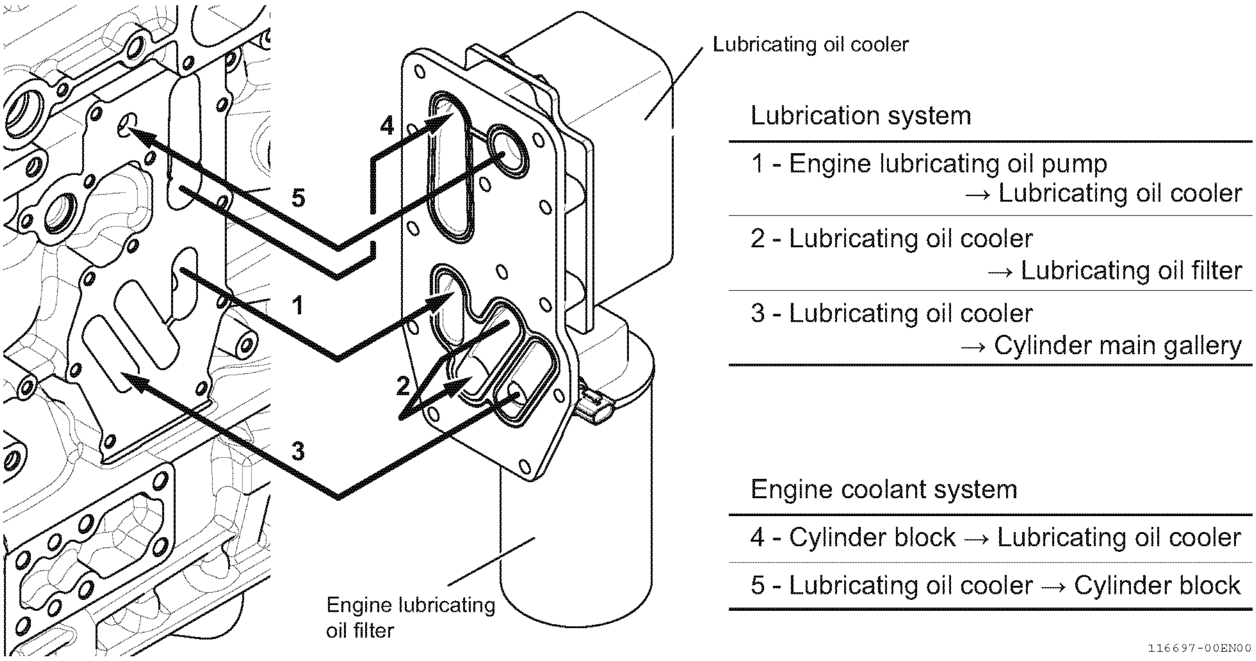


Fig.30-4

1. Removing the Lubricating Oil Pump

The lubricating oil pump (1, Fig.30-5) is installed to the cylinder block on the flywheel side, and the rotor inside the pump is driven by the drive gear (2, Fig.30-5).

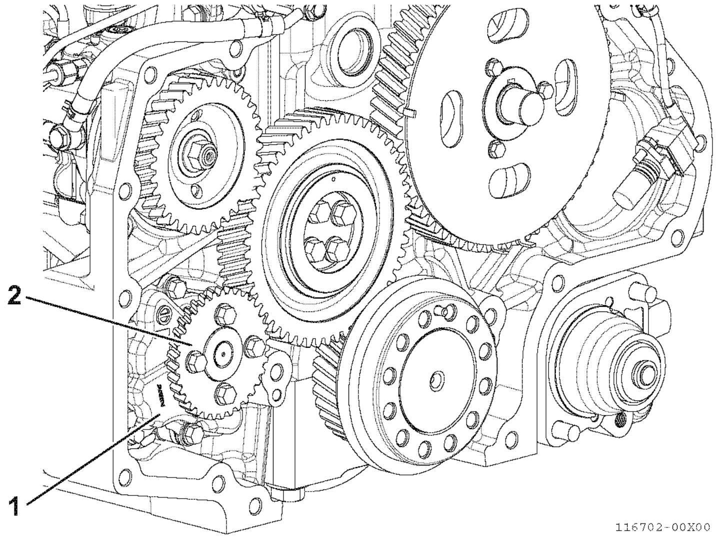


Fig.30-5

NOTICE

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

1. When replacing the lubricating oil pump, it is necessary to remove the flywheel (1, Fig.30-6) and flywheel housing (2, Fig.30-6). The flywheel and flywheel housing are heavy. Use a crane or similar means to remove them.
2. Loosen the flywheel mounting bolts (3, Fig.30-6) and remove the flywheel from the crankshaft.

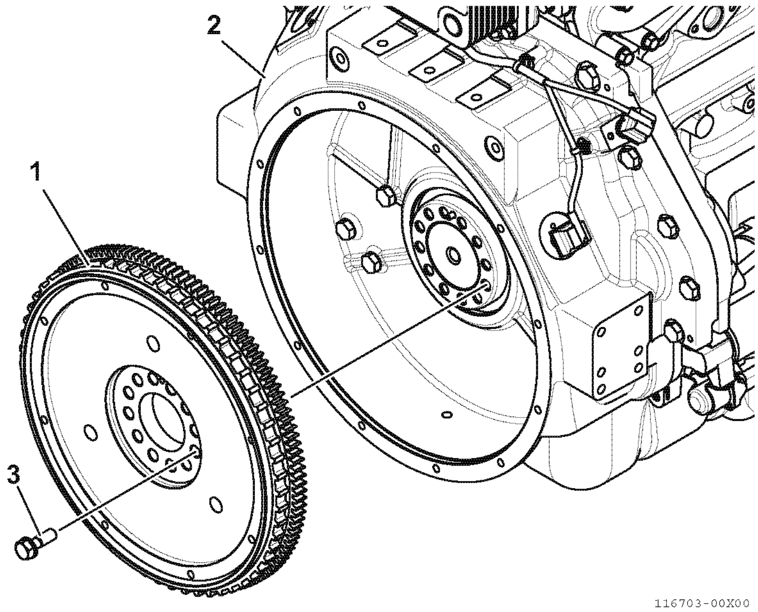


Fig.30-6

3. Before removing the flywheel housing (1, Fig.30-7), remove the crankshaft speed sensor (2, Fig.30-7) from the housing, and disconnect the coupler of the camshaft speed sensor (3, Fig.30-7).
   The flywheel housing is tightened to the cylinder block and oil pan (4, Fig.30-7).
   First remove the oil pan tightening bolts (6 bolts) (see Fig.30-8), then loosen the bolts that tighten the housing to the cylinder block, and remove the flywheel housing together with the oil seal (5, Fig.30-7).

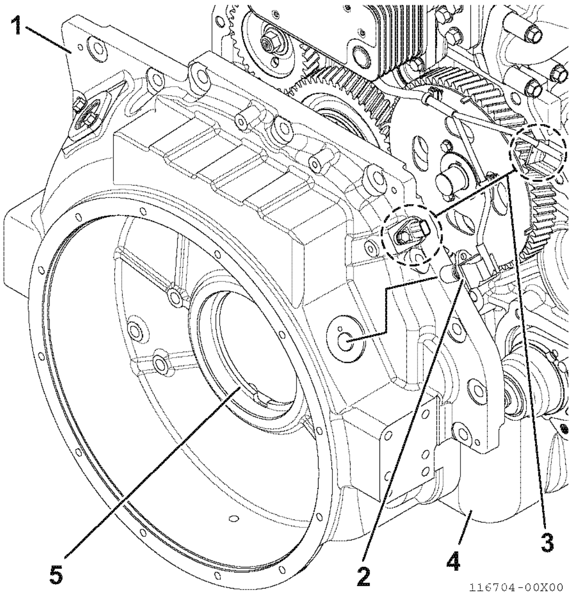


Fig.30-7

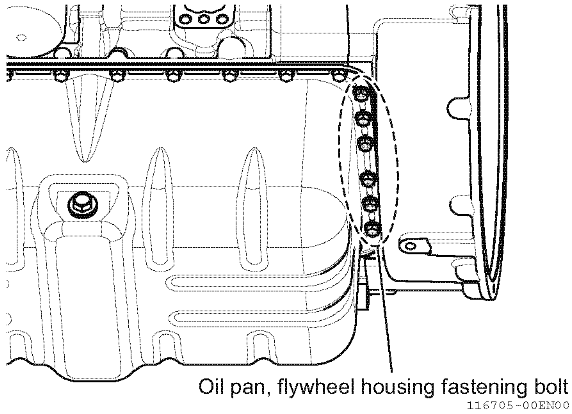


Fig.30-8

4. Remove the lubricating oil pump drive gear (1, Fig.30-9), then remove the lubricating oil pump assembly (2, Fig.30-9) from the cylinder block. Discard the O-rings (3, Fig.30-9) that are installed at two locations on the lubricating oil pump.

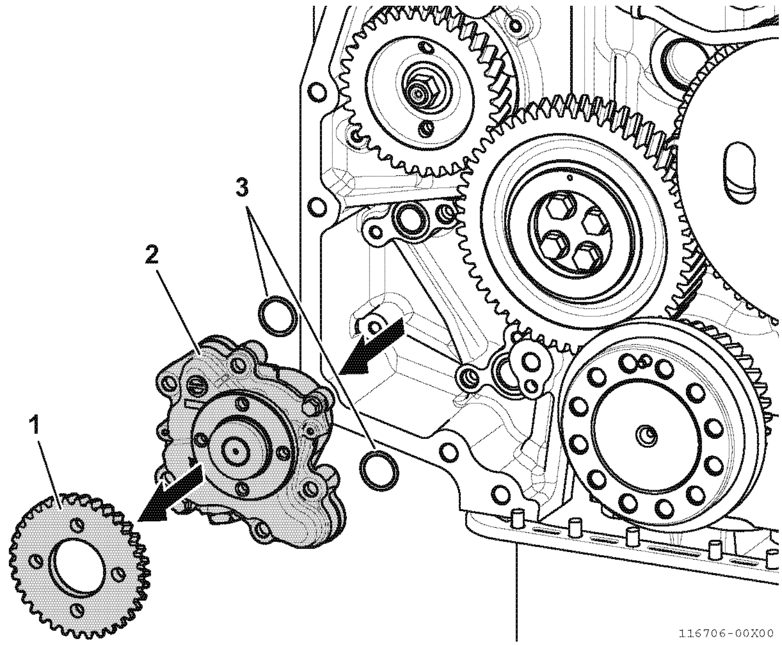


Fig.30-9

2. Removing the Lubricating Oil Filter

Follow the procedure below to remove the engine lubricating oil filter.

1. Drain the lubricating oil. See 3000-02-04-01 “Draining the Engine Lubricating Oil”.
2. Turn the lubricating oil filter (1, Fig.30-10) counterclockwise (2, Fig.30-10) using a filter wrench to re-move.

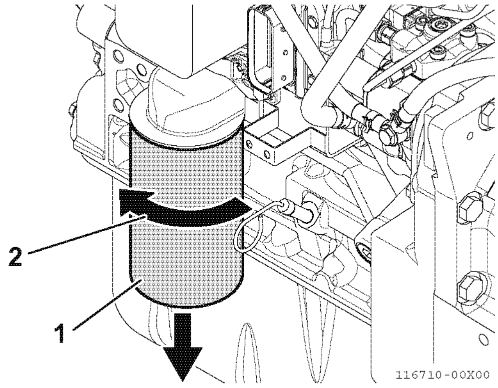


Fig.30-10

3. Removing the Lubricating Oil Cooler

Follow the procedure below to remove the lubricating oil cooler. Before removing the lubricating oil cooler, remove the lubricating oil filter beforehand. For removing the lubricating oil filter, see 3200-02-01-01 “Removal of lubricating oil filter”.

1. Loosen the M8 fixing bolts ×8 (3, Fig.30-11) of the lubricating oil cooler (2, Fig.30-11) attached to the lubricating oil cooler bracket (1, Fig.30-11). Remove the gaskets of the three lubricating oil coolers (4, Fig.30-11).
2. Loosen the M8 bolts ×8 (5, Fig.30-11) to attach the lubricating oil cooler bracket to the cylinder block, and remove the lubricating oil cooler bracket. Remove the gaskets of the two lubricating oil filter brackets (6, Fig.30-11).

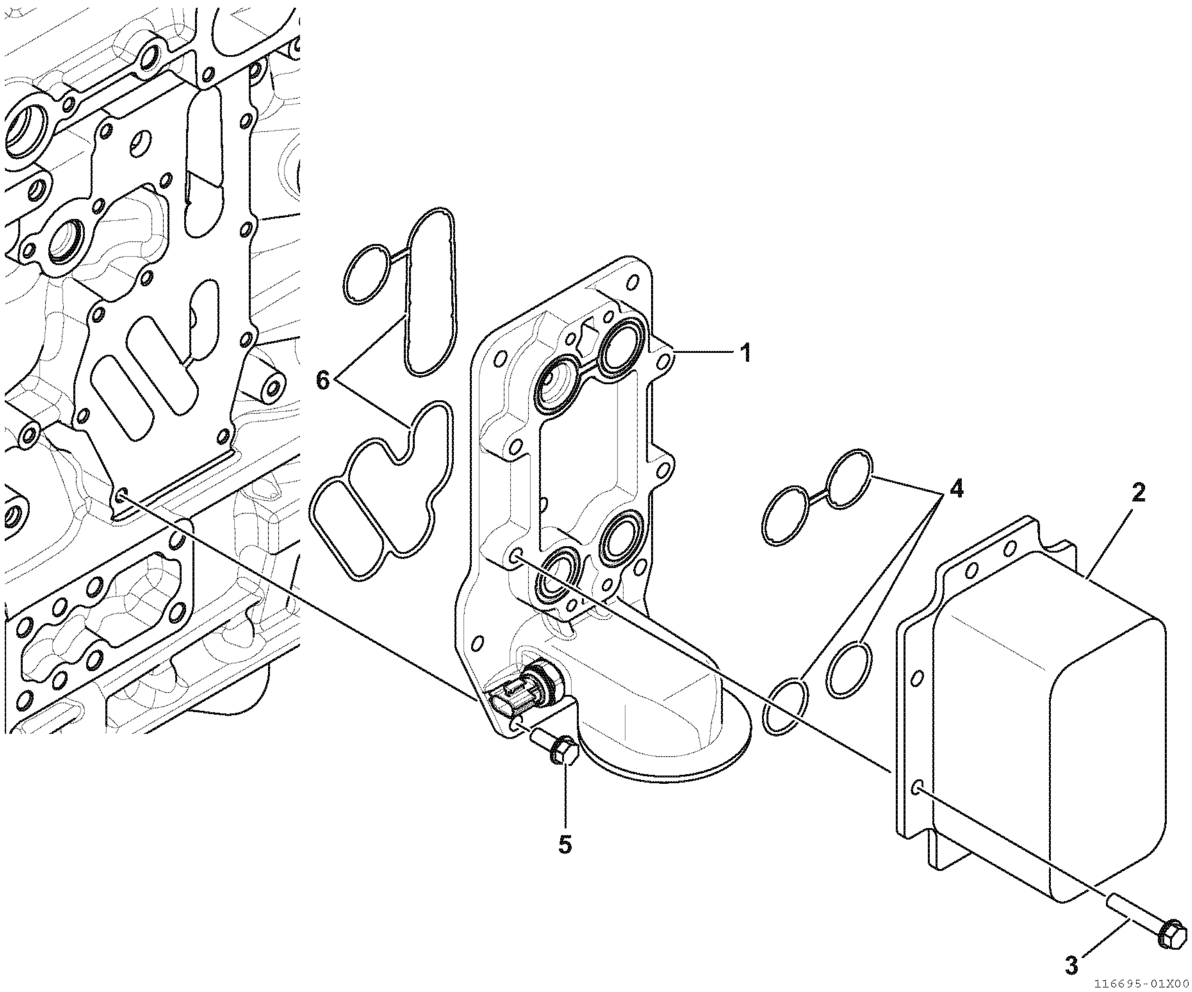


Fig.30-11

1. Reassembling the Lubricating Oil Pump

1. Apply clean lubricating oil to the two lubricating oil pump O-rings (1, Fig.30-12), then install the O-rings into the O-ring grooves in the cylinder block. Use a new O-ring.
2. Install the lubricating oil pump assembly (2, Fig.30-12) to the cylinder block, and tighten the bolts (3, Fig.30-12) to the specified torque.

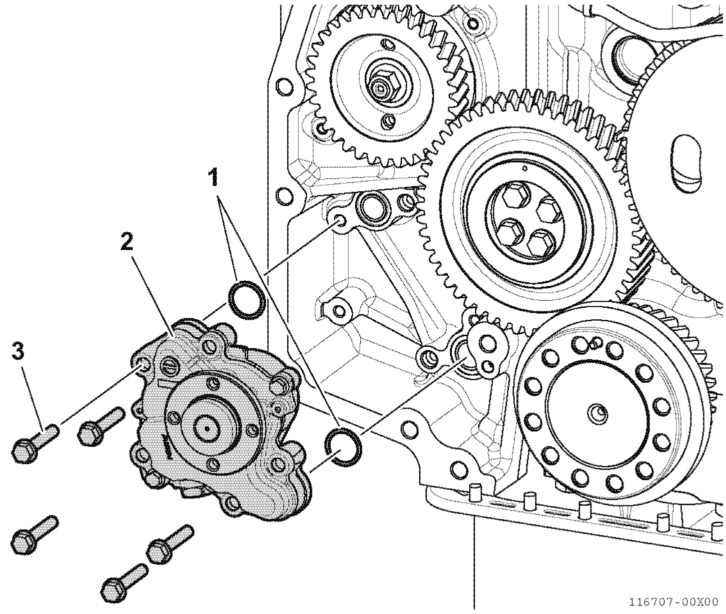


Fig.30-12

NOTICE

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

3. Install the lubricating oil pump drive gear (1, Fig.30-13) and tighten the bolts (2, Fig.30-13) to the specified torque.

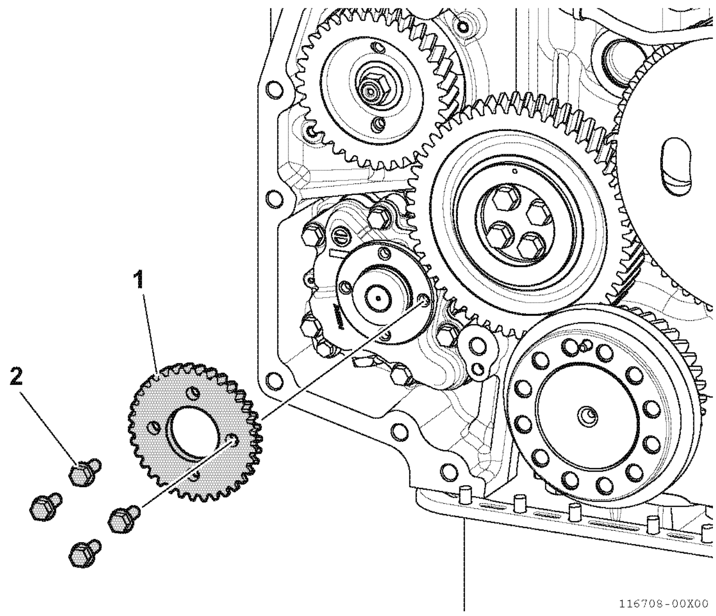


Fig.30-13

4. Wipe the crankshaft oil seal contact surface so it is clean, then install the flywheel housing (1, Fig.30-14) to the cylinder block and temporarily tighten the bolts. After temporarily tightening the bolts (2, Fig.30-14) that fasten the bottom of the flywheel housing and oil pan, tighten each of the bolts to the specified torque. The flywheel housing are heavy. Use a crane or similar means when installing them.

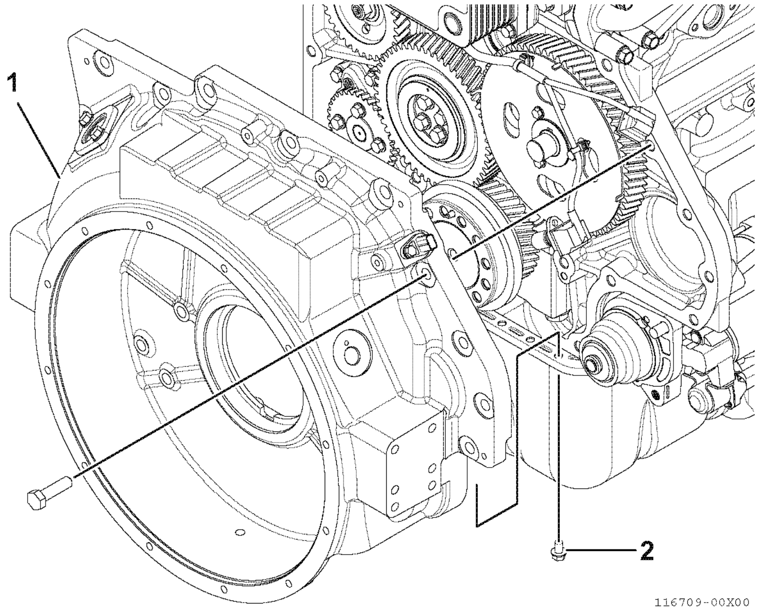


Fig.30-14

5. Install the flywheel (1, Fig.30-15) to the crankshaft, and tighten the mounting bolts (2, Fig.30-15) to the specified torque. Connect the wiring couplers of the removed crankshaft speed sensor (3, Fig.30-15) and camshaft speed sensor (4, Fig.30-15) to the flywheel housing.

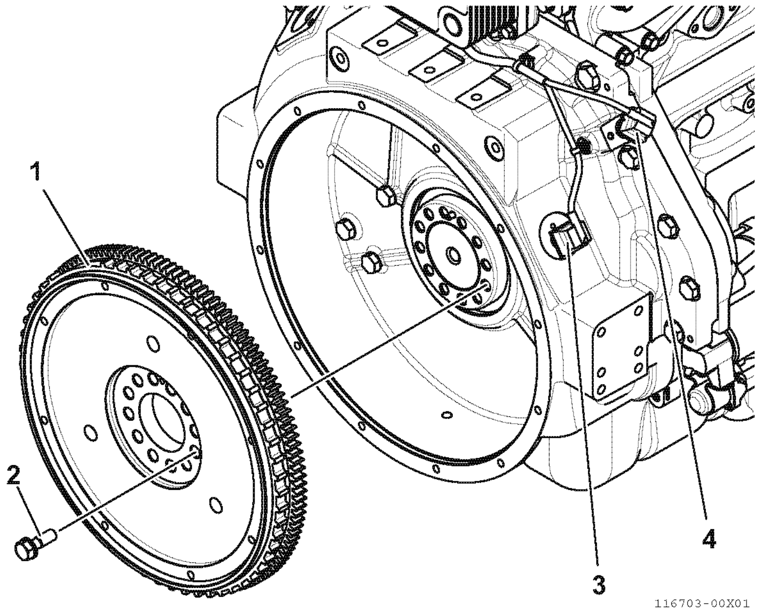


Fig.30-15

2. Installing the Lubricating Oil Filter

Follow the procedure below to install the new engine lubricating oil filter.

1. Clean the engine lubricating oil filter mounting face of the lubricating oil cooler bracket (1, Fig.30-16).
2. Lightly apply clean engine lubricating oil to the gasket surface of the new lubricating oil filter (2, Fig.30-16). Install the new engine lubricating oil filter manually by turning it clockwise (3, Fig.30-16) until it contacts the mounting surface. Tighten to the specified torque or one additional turn using the filter wrench.

Tightening torque	Lubricating oil filter	23.0 ± 2.0 N·m

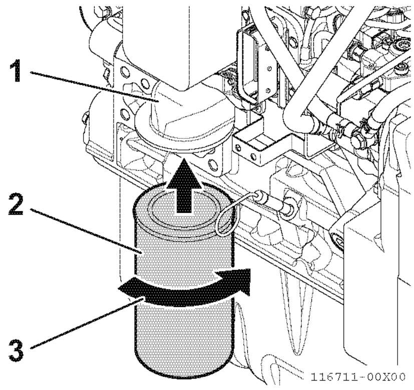


Fig.30-16

NOTICE

Be sure to use YANMAR genuine filter for replacing the engine lubricating oil filter.

3. Installing the Lubricating Oil Cooler

For installing the lubricating oil cooler, follow the reverse procedure to the removal procedure.

1. Clean the mounting face of the engine lubricating oil cooler bracket (1, Fig.30-17) and the mounting face of the cylinder block side.
2. Fit a new lubricating oil cooler gasket (2, Fig.30-17) to the groove of the lubricating oil cooler bracket. Attach the lubricating oil cooler bracket to the to the cylinder block, and tighten with the M8 bolts x8 (3, Fig.30-17) to the specified torque.
3. Clean the lubricating oil cooler mounting side of the lubricating oil cooler bracket, and the attaching face of the lubricating oil cooler (4, Fig.30-17).
4. Fit a brand new lubricating oil cooler gasket (5, Fig.30-17) to the lubricating oil cooler bracket groove. Attach the lubricating oil cooler to the lubricating oil cooler bracket, and tighten with the M8 bolts ×8 (6, Fig.30-17) to the specified torque.

Tightening torque	Lubricating oil cooler bracket bolt (M8 × 1.25)	25.5 ± 2.9 N·m
	Lubricating oil cooler bolt (M8 × 1.25)	

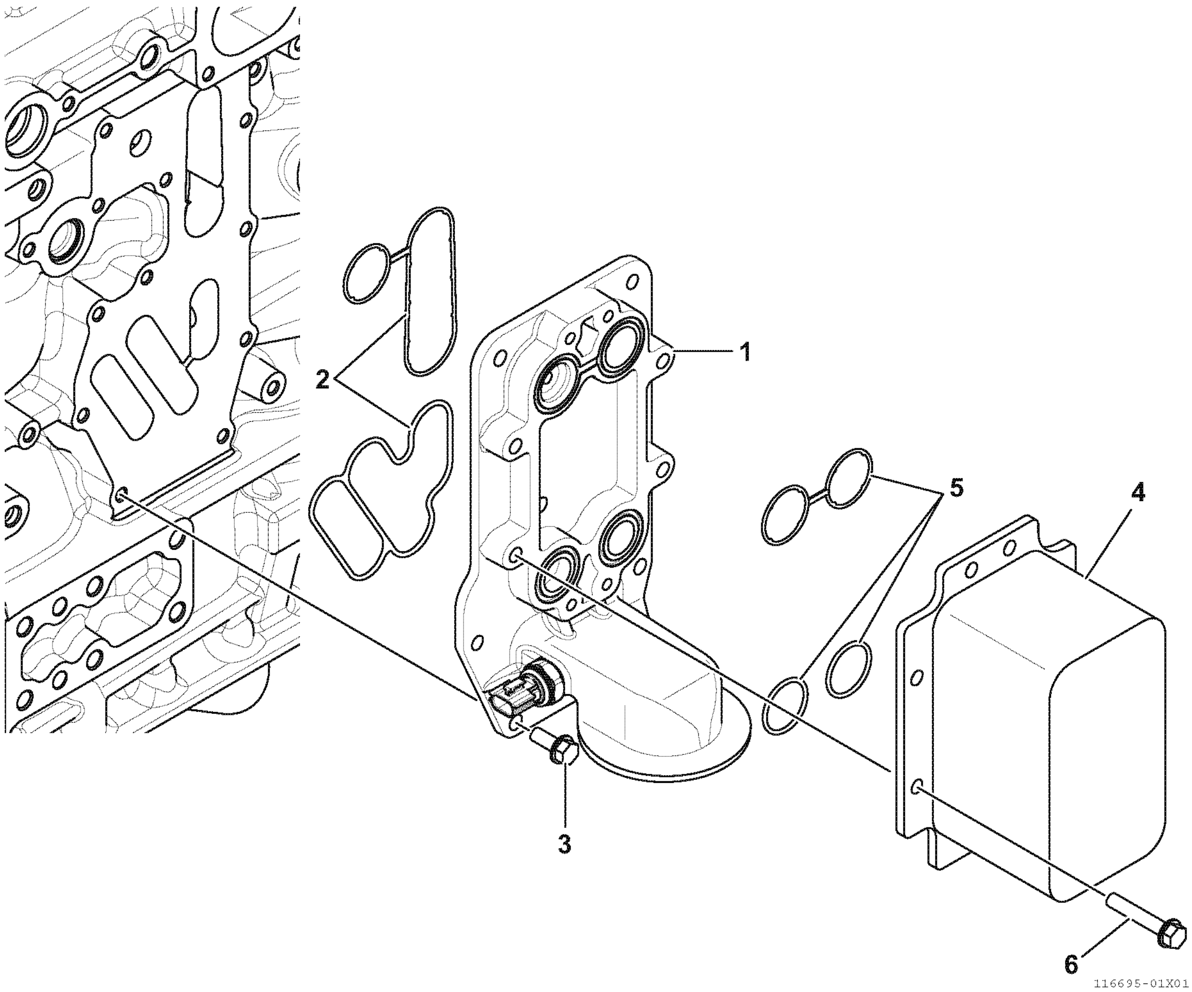


Fig.30-17

1. Draining the Engine Lubricating Oil

When changing the engine lubricating oil or replacing the lubricating oil filter, it is necessary to drain the lubricating oil.
Follow the procedure below to drain the lubricating oil.

WARNING

Burn Hazard!

- **If you must drain the engine lubricating oil while it is still hot, stay clear of the hot engine lubricating oil to avoid being burned.**
- **Always wear eye protection.**
- **Failure to comply could result in death or serious injury.**

1. When draining engine lubricating oil, check that the temperature of the engine and lubricating oil has dropped to a temperature that will not cause burns.
2. Make sure the engine is level.
3. Start the engine and bring it up to operating temperature.
4. Stop the engine.
5. Remove the oil filler port cap (1, Fig.30-18) to vent the engine crankcase and allow the engine lubricating oil to drain more easily.
6. Position a container under the engine to collect waste oil.
7. Remove the drain plug (1, Fig.30-19) from the oil pan. Allow lubricating oil to drain.

   Note: The oil drain plug may be in another location if an optional oil pan is used.
8. After all lubricating oil has been drained from the engine, reinstall the oil drain plug, and tighten it to the specified torque.

Tightening torque	Engine lubricating oil drain plug	58.8 ± 4.9 N·m

9. Dispose of used oil properly.

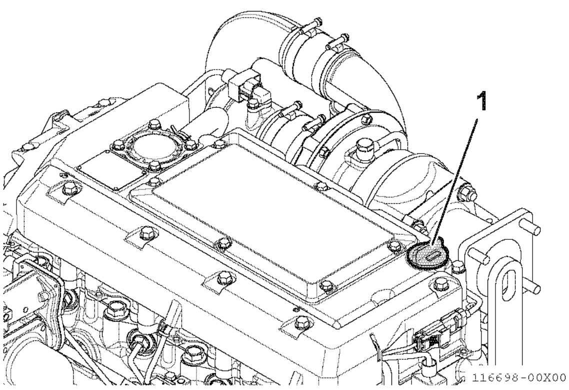


Fig.30-18

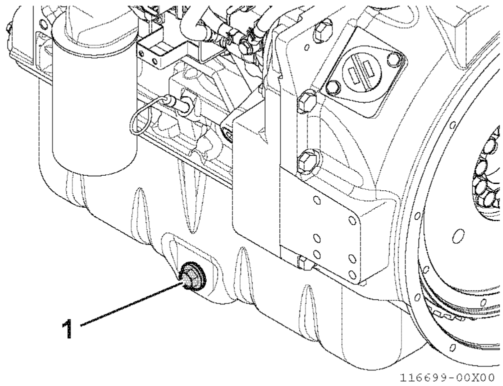


Fig.30-19

2. Filling Engine Lubricating Oil

1. Make sure engine is level.
2. Remove the engine lubricating oil filler port cap (1, Fig.30-20), and add indicated amount of engine lubricating oil at the top or side engine lubricating oil filler port. When filling oil from the top of the engine, add the lubricating oil gradually.
   As a guideline, add no more than 1.2 L of oil at a time, at intervals of 30 seconds or more. If the oil is added all at once, lubricating oil may enter the crank chamber and combustion chambers. If oil remains in the combustion chamber, there is the risk that oil hammer will occur, resulting in the engine damage.
3. Run the engine for five minutes to warm up the engine and check that there is no leakage of lubricating oil.
4. When the engine is sufficiently warm, stop the engine and leave for ten minutes.
5. Check the lubricating oil level.
6. As necessary, add more lubricating oil until the level is between the upper limit and lower lines on the dipstick (1, Fig.30-21).

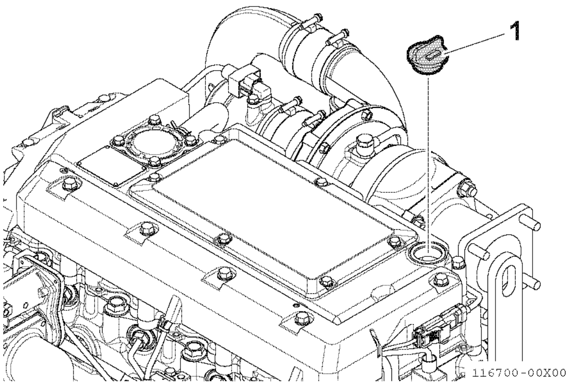


Fig.30-20

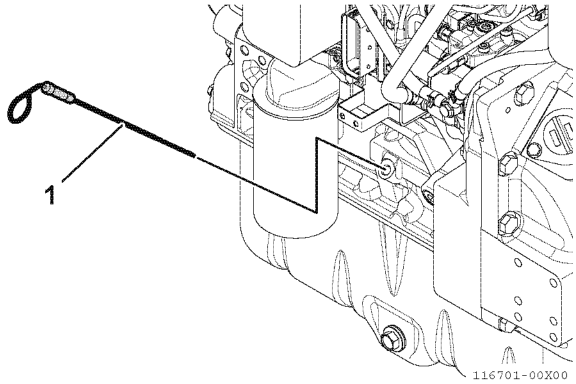


Fig.30-21

NOTICE

- Never overfill.
- Always make sure the engine lubricating oil level is between the upper and lower lines on the dipstick.

Engine lubricating oil capacity (Deep type)

The table below shows the engine lubricating oil capacity of the deep-type oil pan. The oil capacity of the engine lubricating oil differs depending on the type of oil pan used in each engine. To know the engine lubricating oil capacity of your machine, refer to the operation manual provided by the driven machine manufacturer.

Engine names (codes)	Engine lubricating oil pan capacity
4TN107	20.2 L

3. Check the Engine Lubricating Oil

Check the lubricating oil with the procedure below.

1. Make sure engine is level.
2. Remove the dipstick (1, Fig.30-22) and wipe it with a clean cloth.
3. Insert the dipstick deep down the dipstick hole.
4. Remove the dipstick again. The oil level should be between the upper (2, Fig.30-22) and lower (3, Fig.30-22) lines on the dipstick.
5. If the oil is lower than the minimum scale, add lubricating oil and make sure that it is between the maximum and minimum scale. If the lubricating oil decreases excessively, follow the troubleshooting table and find out the cause.
6. If the oil level is higher than the maximum scale, fuel oil may have mixed in. Follow the troubleshooting table and find out the cause.
7. Insert the dipstick deep down the dipstick hole.

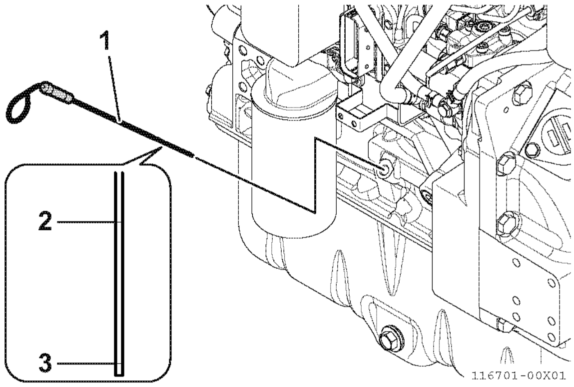


Fig.30-22

This section describes an overview of the cooling system structure for the 4TN107 engine and the procedures for disassembly, inspection, and reassembly of the coolant pump.

1. Overview of Cooling System Structure

1.1 Overview of cooling system

An overview of the 4TN107FTT cooling system is shown in Fig.40-1.
The coolant pump is installed at the approximate center of the cylinder block height, and is driven by the crank pulley via a V-ribbed belt. The crank pulley also drives the fan and alternator, and the fan belt tension is optimally adjusted using the tensioner.

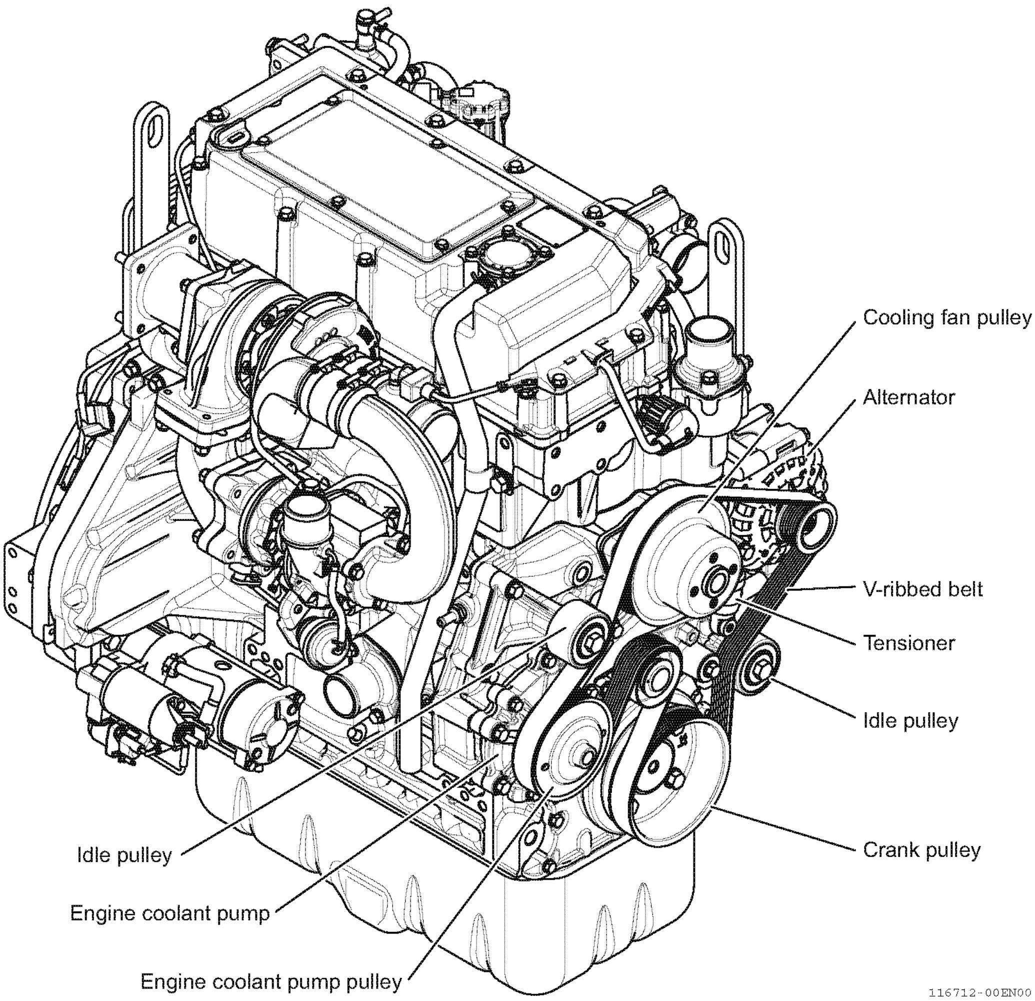


Fig.40-1

1.2 Coolant pump components

The figure below shows the installation of the coolant pump onto the cylinder block.

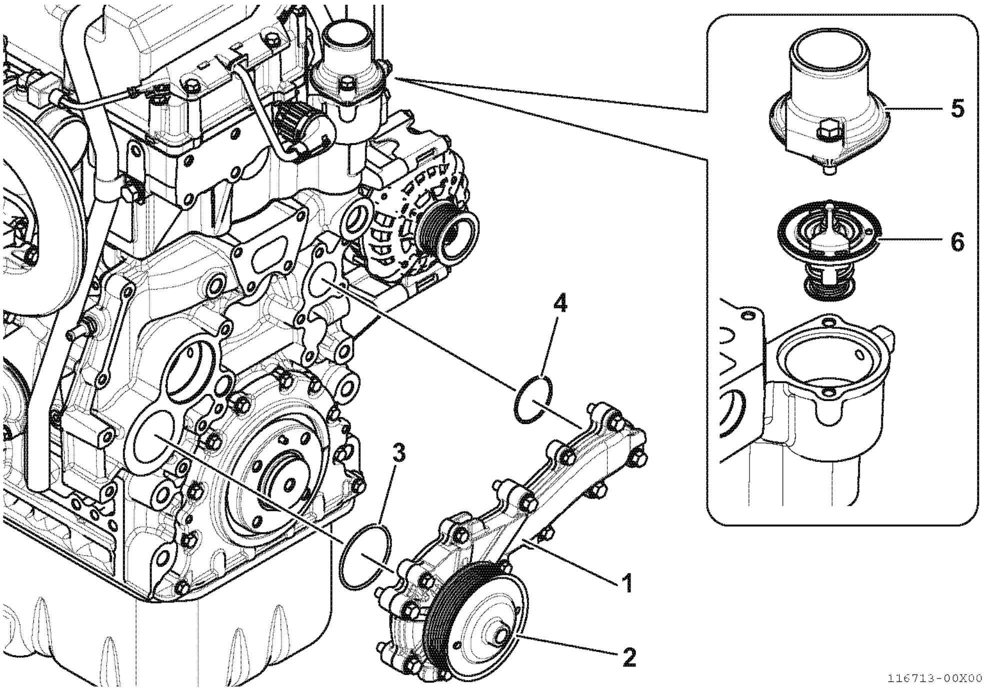


Fig.40-2

1 -	Engine coolant pump	4 -	Coolant pump outlet-side O-ring
2 -	Coolant pump pulley	5 -	Thermostat cover
3 -	Coolant pump inlet-side O-ring	6 -	Thermostat

1.3 Components of coolant pump drive system

The figure below shows the components of the system that drives the coolant pump and cooling fan.

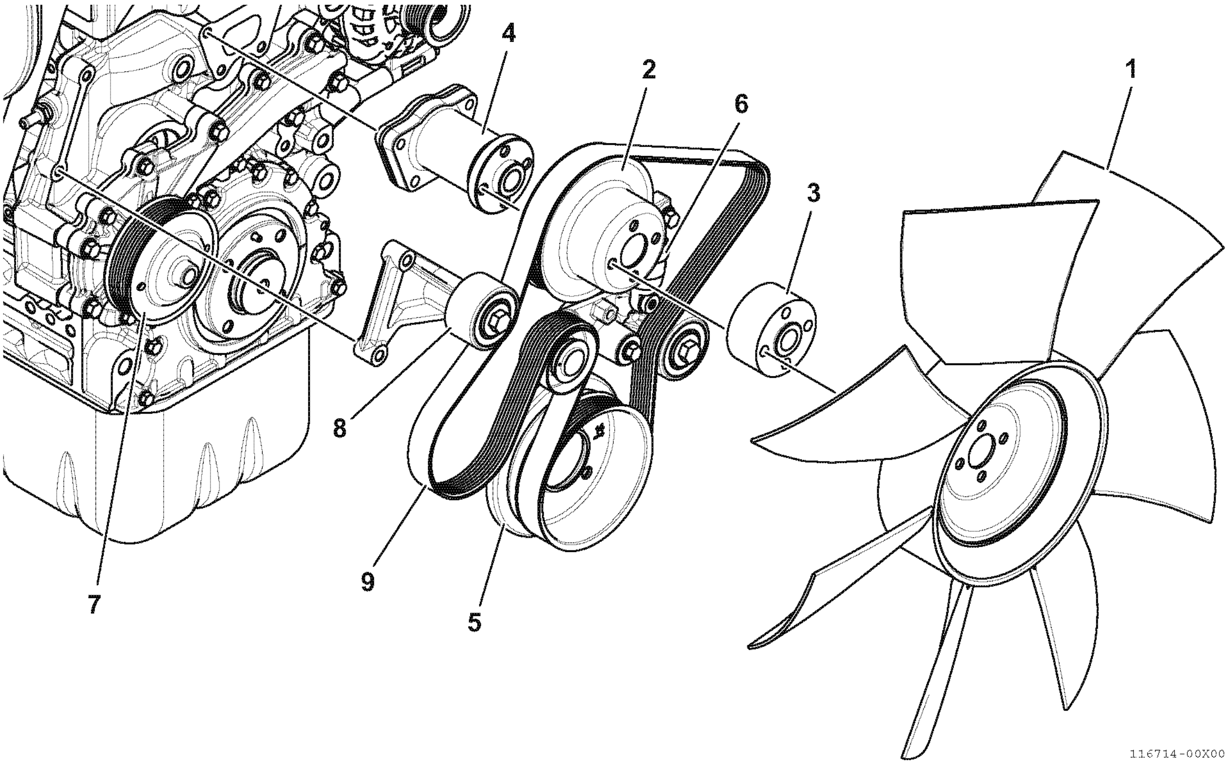


Fig.40-3

1 -	Engine cooling fan	6 -	Tensioner assembly
2 -	Cooling fan pulley	7 -	Coolant pump pulley
3 -	Fan pulley spacer	8 -	Idle pulley
4 -	Cooling fan bracket	9 -	V-ribbed belt
5 -	Crank pulley		

1.4 Tensioner components

The figure below shows the components of the tensioner for the belt that drives the coolant pump and cooling fan.

1. The tension pulley (1, Fig.40-4) is installed between the crank pulley (2, Fig.40-4) and coolant pump pulley (3, Fig.40-4), and optimally adjusts the spring load by means of the idle pulleys at two locations (4, 5, Fig.40-4) and the hydraulic tensioner (6, Fig.40-4).

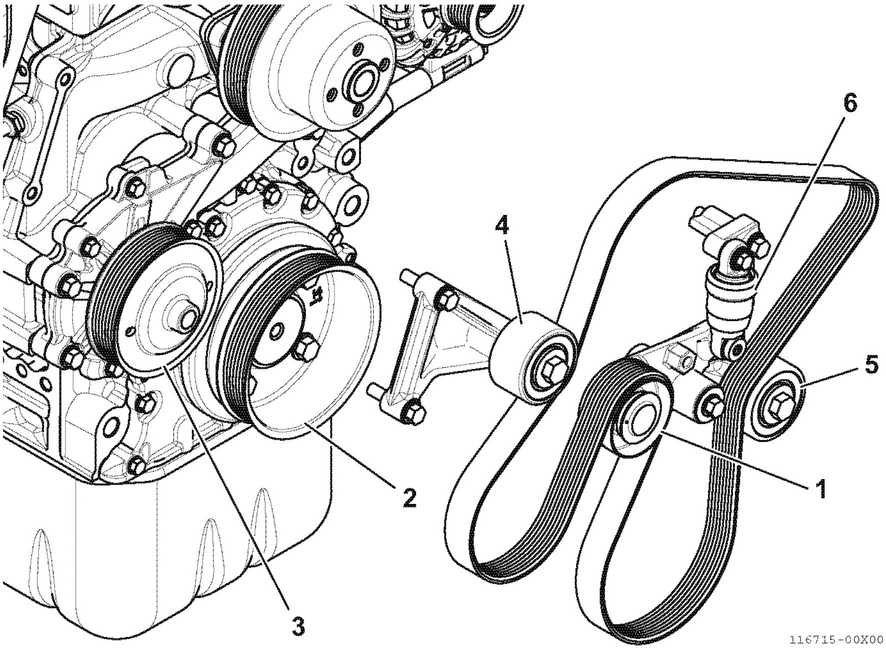


Fig.40-4

2. Tension mechanism
   The tensioner uses the A point of the tensioner arm (1, Fig.40-5) as the fulcrum. The hydraulic tensioner (2, Fig.40-5) is installed on one end and the tension pulley (3, Fig.40-5) is installed on the other end. To loosen the belt, use a wrench or the like on the nut (4, Fig.40-5) on the tensioner arm, apply torque in the counterclockwise direction, and move the tension pulley in the loosening direction.

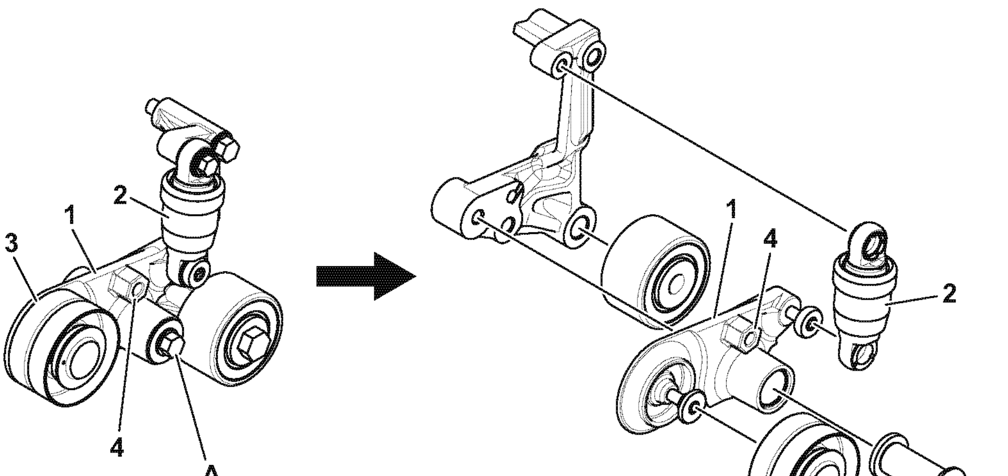


Fig.40-5

2. Cooling System Diagram

The cooling system diagram shows the coolant flow in Fig.40-6.

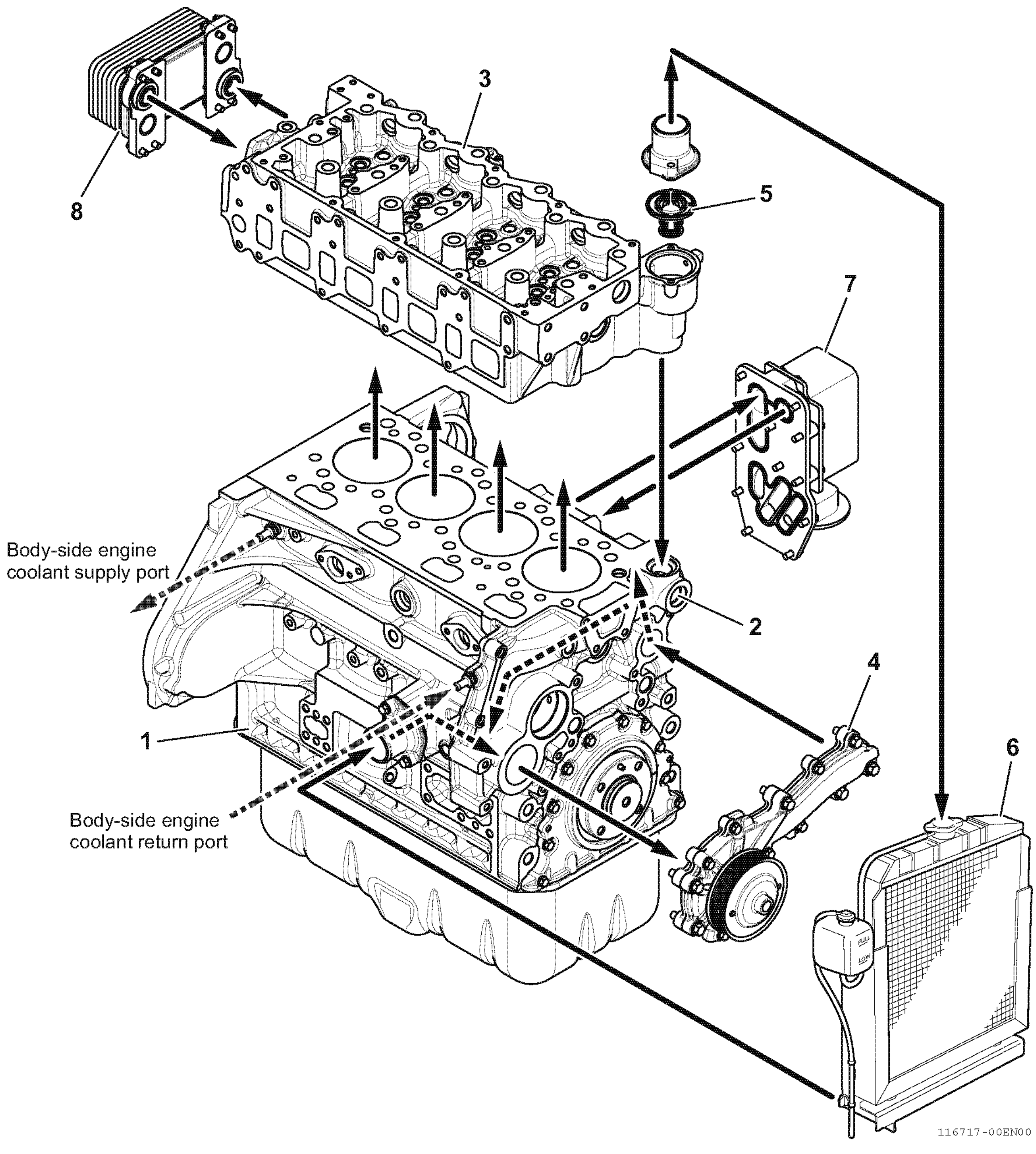


Fig.40-6

1 -	Cylinder block	5 -	Thermostat
2 -	Water rail	6 -	Radiator
3 -	Cylinder head	7 -	Lubricating oil cooler
4 -	Engine coolant pump	8 -	EGR cooler

For details of the lubricating oil cooler and EGR cooler, refer to the lubrication system (3000-01-01-01 “Lubrication System” and 3000-01-01-02 “Lubrication System Diagram”) and EGR system (2300-01-02-03 “Structure of EGR Cooler” and 2300-02-01-02 “Removing the EGR Cooler”).

1. Inspecting the Cooling System (Before Disassembly)

⚠ DANGER

Burn Hazard from Steam or Hot Water!

- **Do not open the radiator cap during the engine is hot. Wait until the engine cools before you drain the engine coolant. Hot engine coolant may splash and burn you.**
- **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 engine coolant level by observing the reserve tank.**
- **Failure to comply will result in death or serious injury.**

1.1 Checking for water leakage

Check the engine cooling system for leakage.

1 - With the radiator properly filled with coolant, install a cooling system tester (1, Fig.40-7).

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

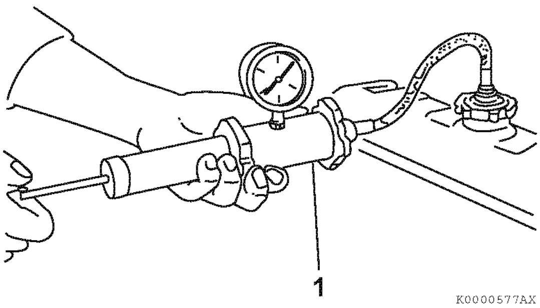


Fig.40-7

1.2 Engine coolant pump

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

NOTICE

- If the engine coolant pump must be replaced, replace the engine coolant pump as an assembly. Do not attempt to repair the engine coolant pump or replace individual components.
- Never reuse the used O-rings, washers, or hollow screws.

1. Removing the Cooling System

The procedure for removing each cooling system is shown below. Before removing the cooling system component including engine coolant pump, thermostat, lubricating oil cooler, EGR cooler etc., it is necessary to drain the engine coolant. See 4000-02-04-01 “Draining Engine Coolant”.

1.1 Removing the engine coolant pump

1 - Fan belt

Before removing the belt, loosen the cooling fan bolts (1, Fig.40-8) slightly.
Next use a ratchet wrench or similar tool on the nut (2, Fig.40-8) of the tensioner arm on the back side of the cooling fan or (1, Fig.40-9). Apply torque in the counterclockwise direction (2, Fig.40-9) and move the tension pulley (3, Fig.40-8) or (2, Fig.40-9) in the direction of the arrow. Insert the hexagonal bar wrench to the insertion hole on the back side of the tensioner arm (hole diameter: 5.9 mm) (1, Fig.40-10) to fasten the tensioner arm. When moving the tensioner arm in the direction of the arrow, take at least three seconds to do the task. Remove the loosened fan belt (4, Fig.40-8) from the coolant pump pulley (5, Fig.40-8) and crank pulley (6, Fig.40-8).

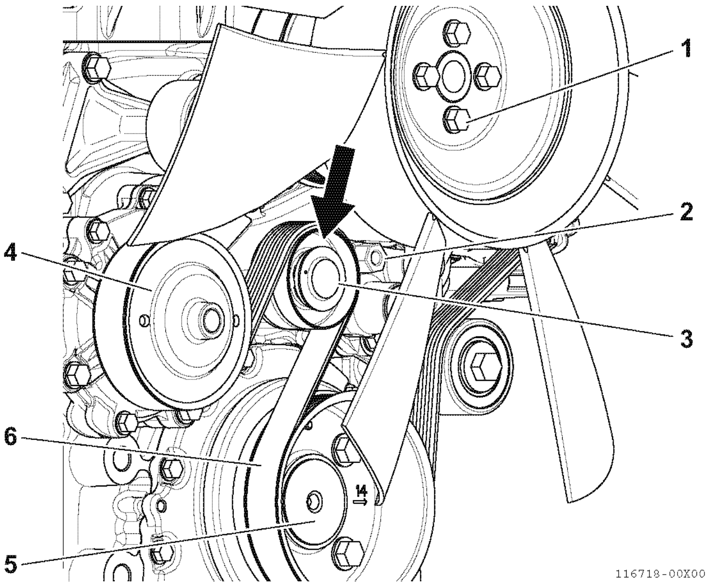


Fig.40-8

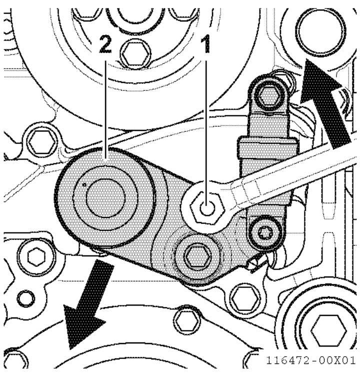


Fig.40-9

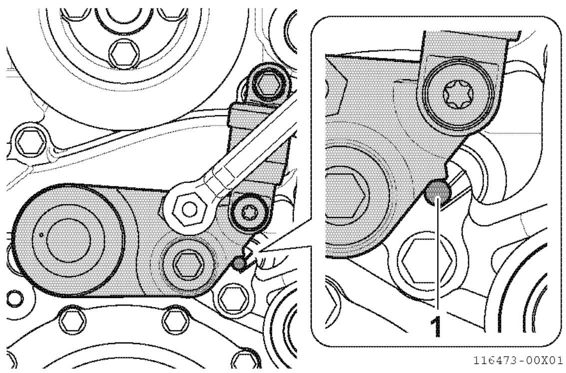


Fig.40-10

⚠ CAUTION

Pinch Hazard!

Securely hold the tensioner when loosening or removing the belt.
Failure to comply may result in injury.

2 - Cooling fan

If the cooling fan is equipped with a cooling fan guard, remove the guard. Then loosen the cooling fan mounting bolts (1, Fig.40-11), and remove the fan plate (2, Fig.40-11), cooling fan (3, Fig.40-11), fan spacer (4, Fig.40-11), and cooling fan pulley (5, Fig.40-11).

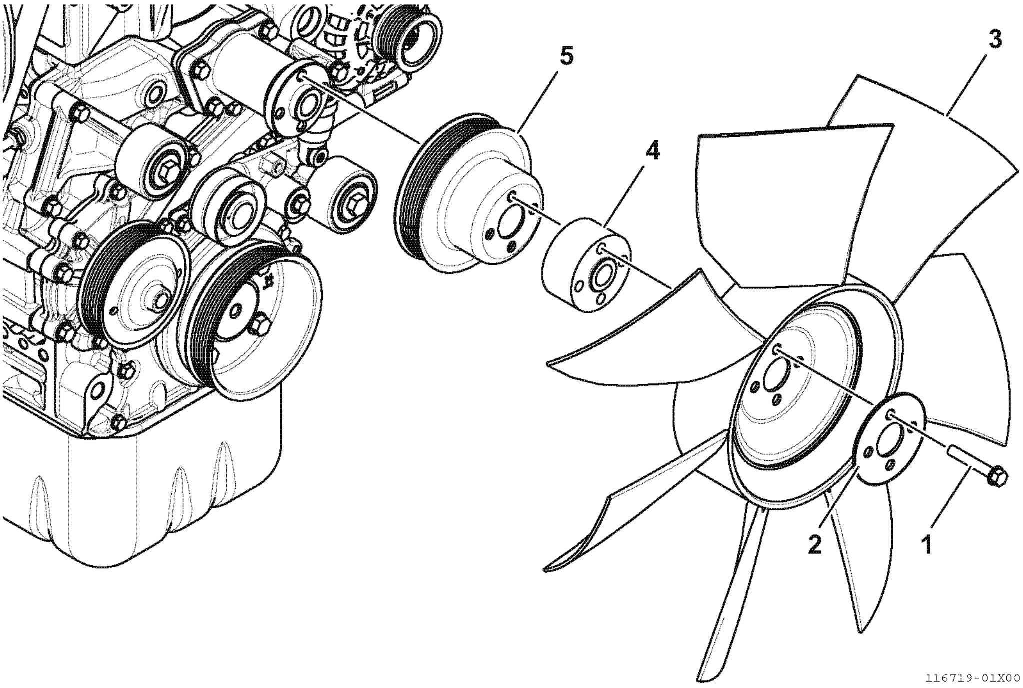


Fig.40-11

3 - Tensioner assembly

In order to remove the coolant pump (1, Fig.40-12), it is necessary to remove the tensioner assembly (2, Fig.40-12). Loosen the two bolts (1, Fig.40-13) that fastens the tensioner assembly to the cylinder block, then remove the tensioner assembly.

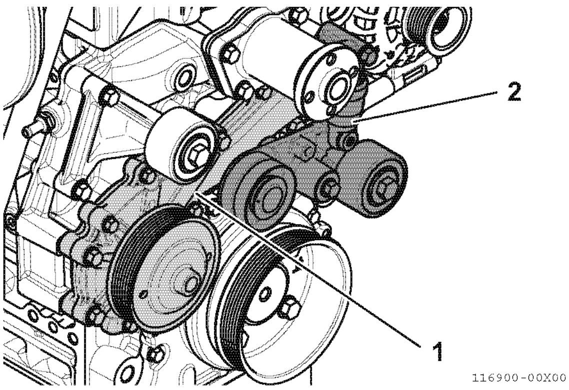


Fig.40-12

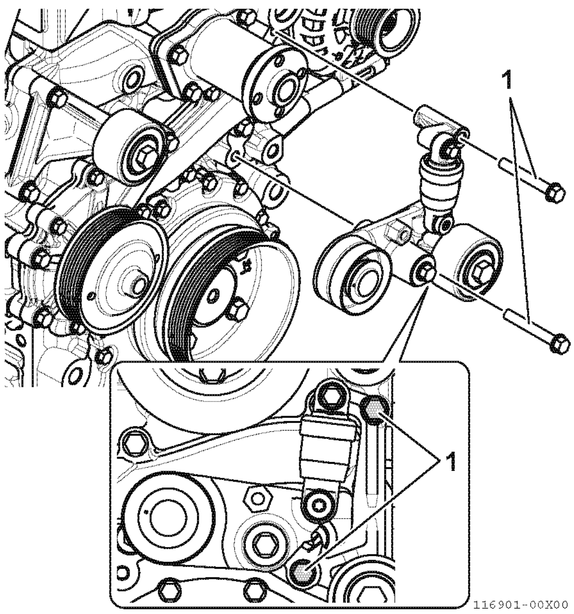


Fig.40-13

4 - Engine coolant pump

Loosen the coolant pump (1, Fig.40-14) mounting bolts, then remove the pump. Discard the two O-rings (2, Fig.40-14).

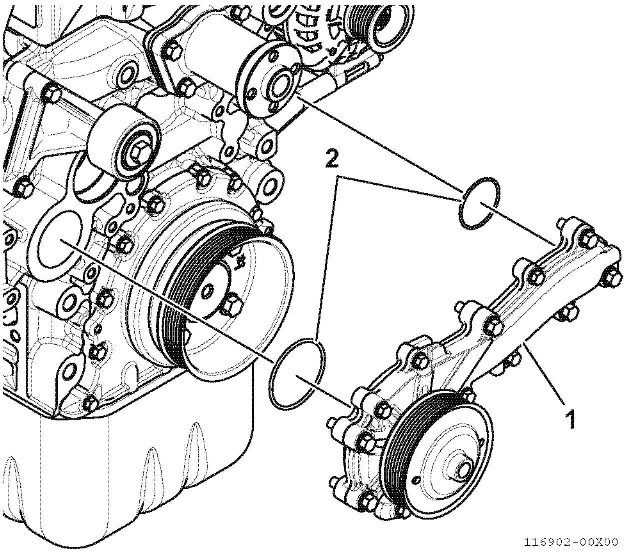


Fig.40-14

1.2 Removing the thermostat

Loosen the thermostat cover (1, Fig.40-15) mounting bolts, then remove the thermostat cover and thermostat (2, Fig.40-15).

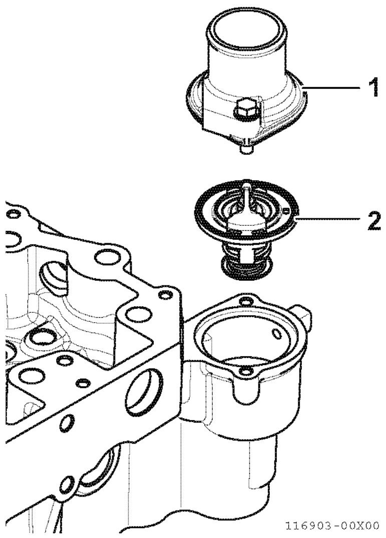


Fig.40-15

1.3 Removing the coolant temperature sensor

The coolant temperature sensor is installed below the No. 4 injector on the intake side (see Fig.40-16). Disconnect the coolant temperature sensor coupler (1, Fig.40-16), then remove the coolant temperature sensor (1, Fig.40-17) from the cylinder block. Discard the gasket.

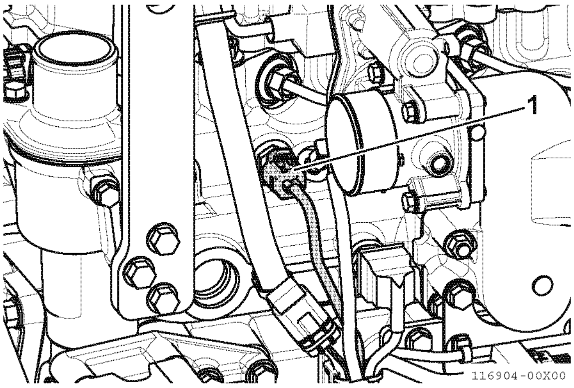


Fig.40-16

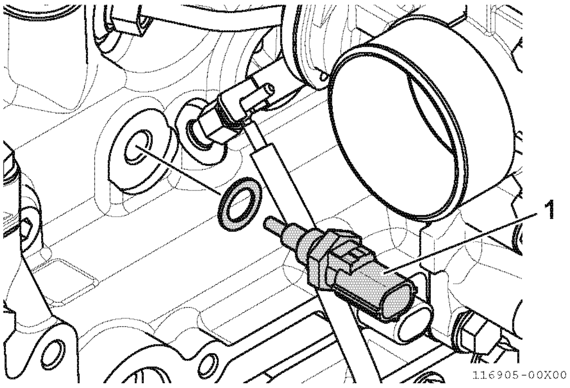


Fig.40-17

2. Inspecting the Cooling System (After Disassembly)

2.1 Thermostat

1 - Check for proper operation of the thermostat. Place the thermostat (1, Fig.40-18) and an accurate thermometer (2, Fig.40-18) into warm water.

2 - Slowly increase the water temperature using an external heat source.

3 - The thermostat is operating properly if it starts to open at the temperature value stamped on the flange of the thermostat, and fully opens as the temperature of the water is increased.

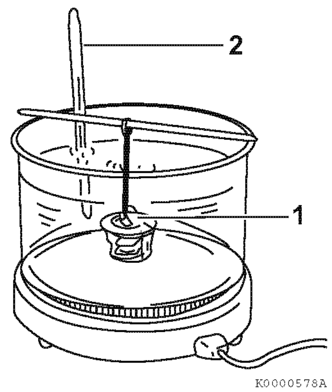


Fig.40-18

Customer product number	Valve opening temperature
129G01-48600	71 ± 2 °C
129G01-48610	82 ± 2 °C

2.2 Coolant temperature sensor

1 - Check for proper operation of the coolant temperature sensor. As shown in the following figure, connect an electric resistor to the coupler of the coolant temperature sensor (1, Fig.40-19).

2 - Dip the coolant temperature sensor and an accurate thermometer (2, Fig.40-19) into the engine coolant.

3 - Measure the electrical resistance while slowly raising the cooling water temperature using an external heat source.

4 - The resistance value at each of the following temperatures is within the permissible range specified, the water temperature sensor is correctly operating. If not within specifications, replace the coolant temperature sensor.

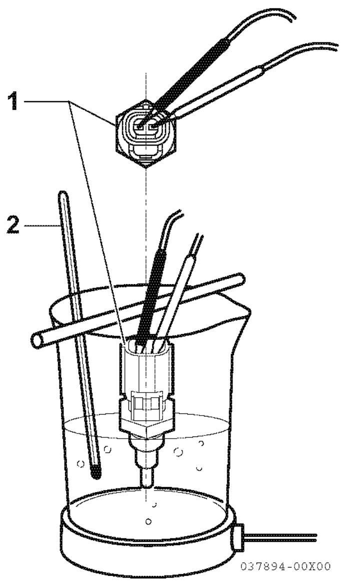


Fig.40-19

Engine coolant temperature (°C)	Resistance (kΩ)
20	$2.45^{+0.14}_{-0.13}$
80	0.318 ± 0.008
100	(0.1836)

2.3 Radiator cap

1 - Check for proper operation of the radiator cap. Install the radiator cap (1, Fig.40-20) on a cooling system tester.

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

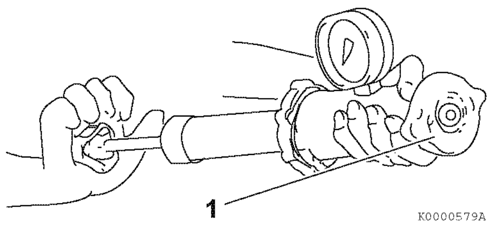


Fig.40-20

1. Installing the Cooling System

1.1 Coolant temperature sensor

1 - Install the coolant temperature sensor (1, Fig.40-21) and new copper gasket (2, Fig.40-21).

2 - Connect the temperature sensor wire coupler.

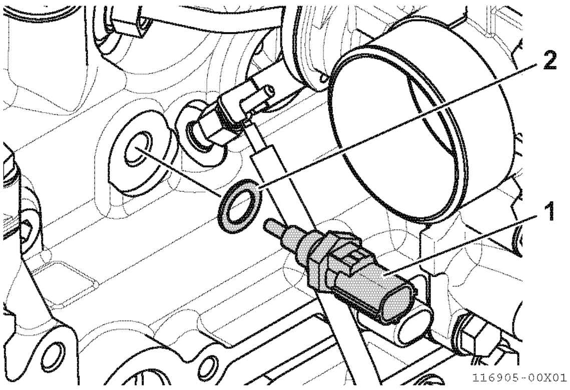


Fig.40-21

1.2 Thermostat

1 - Install the thermostat (1, Fig.40-22) to the cylinder head.

2 - Install the thermostat cover (2, Fig.40-22) and tighten it with the cover mounting bolts.

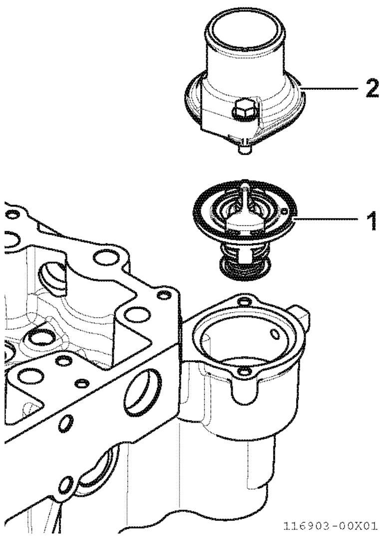


Fig.40-22

1.3 Coolant pump

Install the coolant pump (1, Fig.40-23) to the cylinder block. Use two new O-rings (2, Fig.40-23). Tighten the coolant pump mounting bolts to the specified torque.

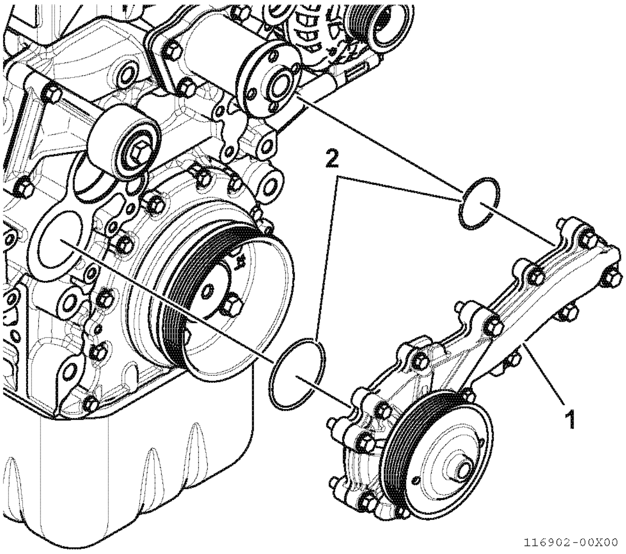


Fig.40-23

1.4 Tensioner assembly

Install the tensioner assembly (1, Fig.40-24) onto the cylinder block using two bolts (2, Fig.40-24) and tighten them to the specified torque.

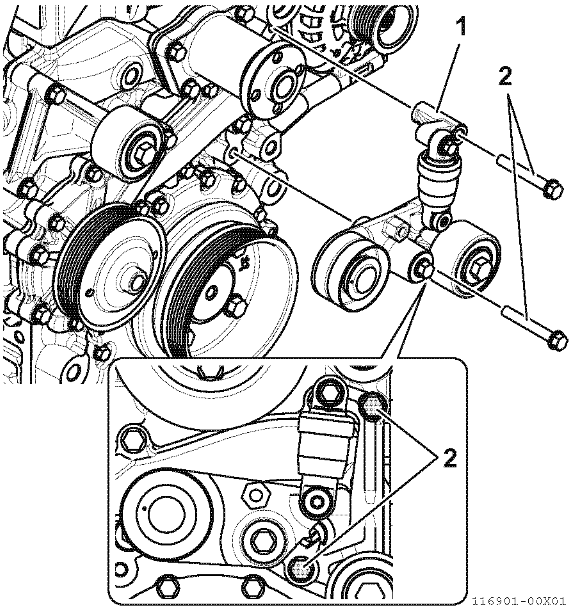


Fig.40-24

1.5 Fan and belt

1 - Install the cooling fan pulley (1, Fig.40-25), fan spacer (2, Fig.40-25), and cooling fan plate (3, Fig.40-25) in sequence, and tighten the cooling fan mounting bolts (5, Fig.40-25).

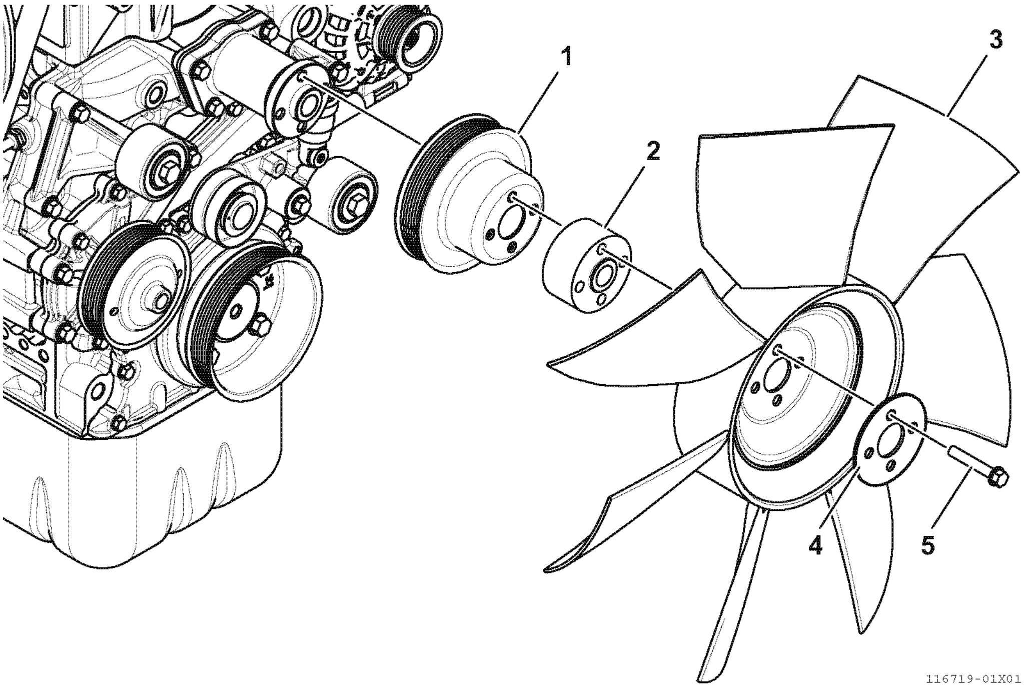


Fig.40-25

2 - Inspect the condition of the fan belt. If the belt is scratched or worn unevenly, replace the belt.

3 - Before installing the fan belt, use a ratchet wrench or similar tool on the nut (2, Fig.40-26) of the tensioner arm or (1, Fig.40-28). Apply torque in the counterclockwise direction and move the tension pulley (2, Fig.40-26) or (2, Fig.40-28) in the direction of the arrow. Insert the hexagonal bar wrench to the insertion hole on the back side of the tensioner arm (hole diameter: 5.9 mm) (1, Fig.40-27) to fasten the tensioner arm. When moving the tensioner arm in the direction of the arrow, take at least three seconds to do the task. Install the fan belt as described in Fig.40-28. Apply torque to the ratchet wrench to pull put the insertion tool that fastened the tensioner arm. Slowly put the tension pulley back to the original position to apply tension to the belt.

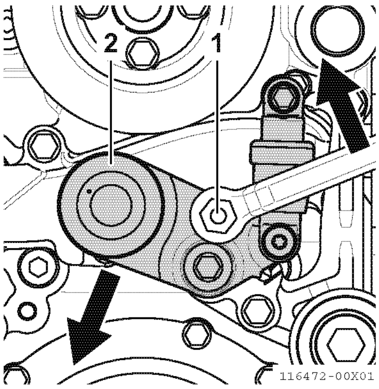


Fig.40-26

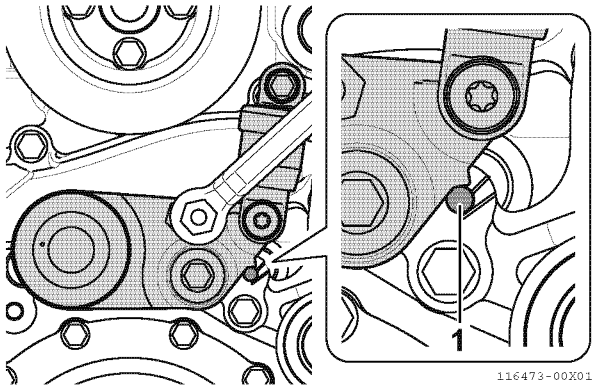


Fig.40-27

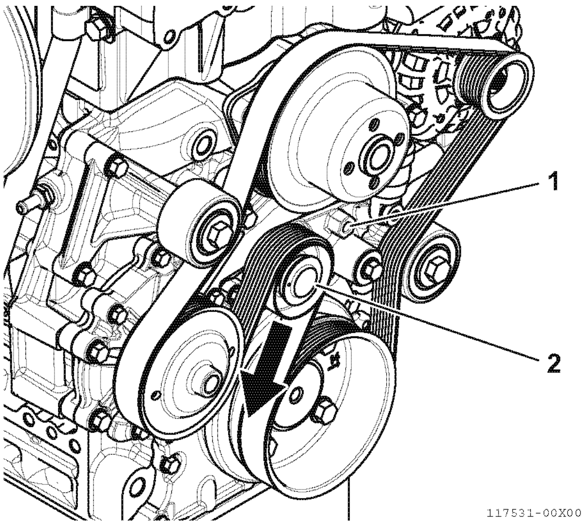


Fig.40-28

1.6 Filling engine coolant

1 - Tighten the drain plug (1, Fig.40-30) on the cylinder block.

2 - Fill the radiator with engine coolant. For details, see 4000-02-04-02 “Filling Radiator with Engine Coolant”.

1. Draining Engine Coolant

Prior to removing the cooling system components including the engine coolant pump, thermostat, lubricating oil cooler, EGR cooler etc., it is necessary to drain the engine coolant.

⚠ 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.**

1. Before draining engine coolant, make sure the engine and engine coolant are not hot.
2. If the engine coolant is to be reused, drain the engine coolant into a clean container. Otherwise, properly dispose of the coolant.
3. Remove the radiator cap (1, Fig.40-29).
4. Remove the drain plug or open the drain valve (2, Fig.40-29), and at the lower portion of the radiator and drain the coolant.

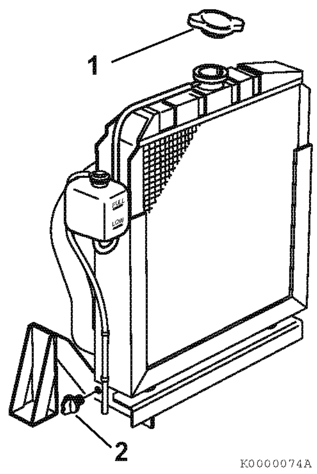


Fig.40-29

5. To drain the engine coolant from the cylinder block, loosen the drain plug (1, Fig.40-30) located below the alternator, and drain out the coolant.

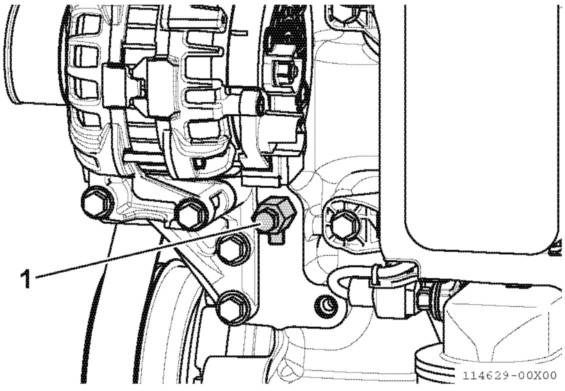


Fig.40-30

2. Filling Radiator with Engine Coolant

Fill the radiator and reserve tank as follows. This procedure is for filling the radiator for the first time or re-filling it after inspection or maintenance of the coolant system or cleaning of the radiator.
Note that a typical radiator is illustrated.

1. Check that the radiator drain plug (1, Fig.40-31) is closed.
2. Check that the cylinder block drain plug (1, Fig.40-32) is closed.
3. Remove the radiator cap (2, Fig.40-31) by turning it counterclockwise about 1/3 of a turn.
4. Pour the engine coolant slowly into the radiator until it is even with the lip of the engine coolant filler port. Make sure that air bubbles do not develop as you fill the radiator.
5. Tighten the radiator cap (2, Fig.40-31). Align the tabs on the back side of the radiator cap with the notches on the engine coolant filler port. Press down and turn the cap clockwise about 1/3 of a turn.
6. Remove the cap of the reserve tank (3, Fig.40-31), and fill it to the LOW mark (4, Fig.40-31), with engine coolant. Reinstall the cap.
7. Check the hose (5, Fig.40-31) that connects the reserve tank to the radiator. Be sure it is securely connected and there are no cracks or damage. If the hose is damaged, engine coolant will leak out instead of going into the reserve tank.
8. Run the engine until it reaches operating temperature. Check the level of engine coolant in the reserve tank. When the engine is running and the engine coolant is at normal temperature, the coolant level in the reserve tank should be at or neat the FULL mark (6, Fig.40-31). If the coolant is not at the FULL mark, add coolant to the reserve tank to bring the coolant level to the FULL mark.

NOTICE

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

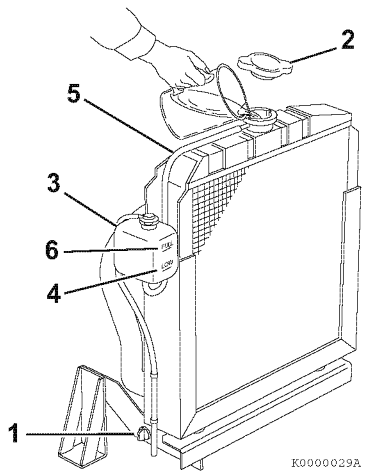


Fig.40-31

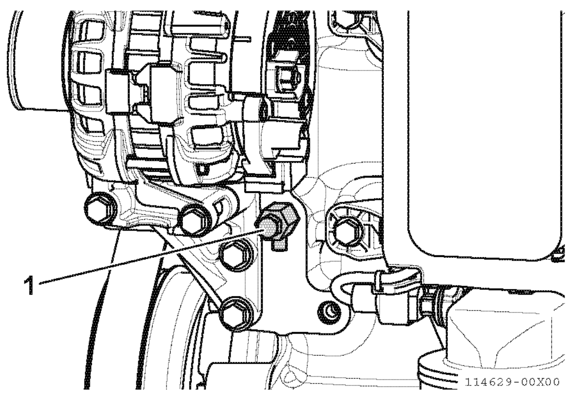


Fig.40-32

Engine coolant capacity (Standard)

Capacities listed are for the engine only without a radiator. Refer to the operation manual provided by the driven machine manufacturer for actual engine coolant capacity on your machine. The following are the engine coolant capacities for 4TN107 engines is the following.

Engine name	Engine coolant capacity
4TN107TT, 4TN107FTT	9.0 L
4TN107HT, 4TN107FHT	8.9 L

3. Inspecting the Engine Coolant System

1. Make sure that the water level in the sub tank is between LOW and FULL.
2. Add additional engine coolant to the reserve tank if necessary.
3. Make sure that there is no crack, wearing, or cut to the radiator hose. If there is any damage, replace the hose.

4. Replacing the Cooling Fan Belt

Replace the fan belt with a new one every 3000 hours or when the tensioner protrusion as described in Fig.40-33 reached the belt replacement timing position marked on the tensioner bracket “(2)”, whichever comes first.

For replacing the fan belt, see 0000-08-03-07 “Periodic maintenance: Every 3000 hours of operation”.

For details of removing and attaching the fan belt, refer to 4000-02-01-01 “Removing the Cooling System” and 4000-02-03-01 “Installing the Cooling System”.

Please store them as follows. Belts may deteriorate if not stored appropriately.

- Avoid direct sunlight.
- Store in a condition where temperature is 40 °C or lower, and humidity is 75 % or lower.
- Do not stack up or store in a folded state.
- Lean the belt on a shelf or wall. Do not place directly on the ground.

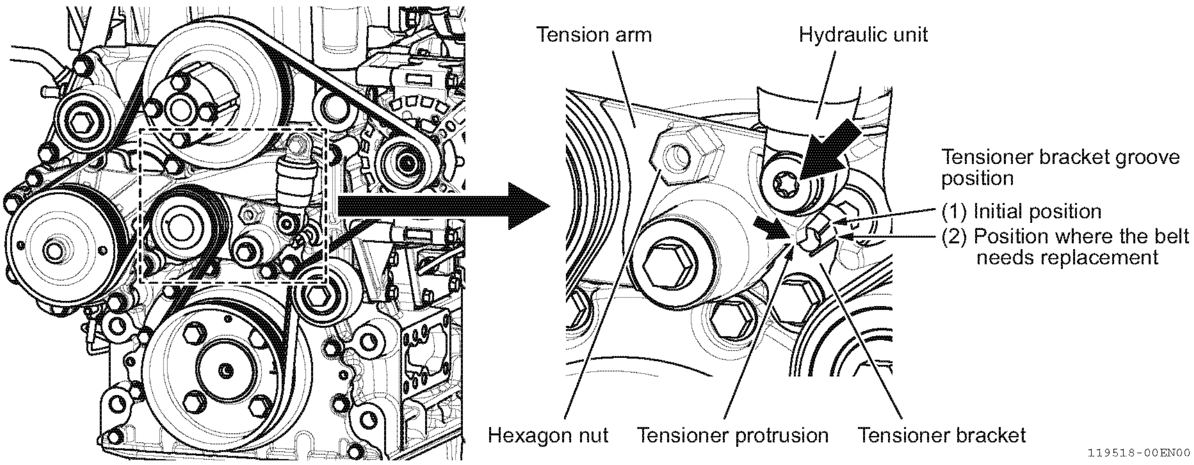


Fig.40-33

Overview of Fuel System Structure

The following is an explanation of the fuel system components and system diagram.

1. Fuel System Configuration

The configuration of the fuel system is shown in Fig.50-1.

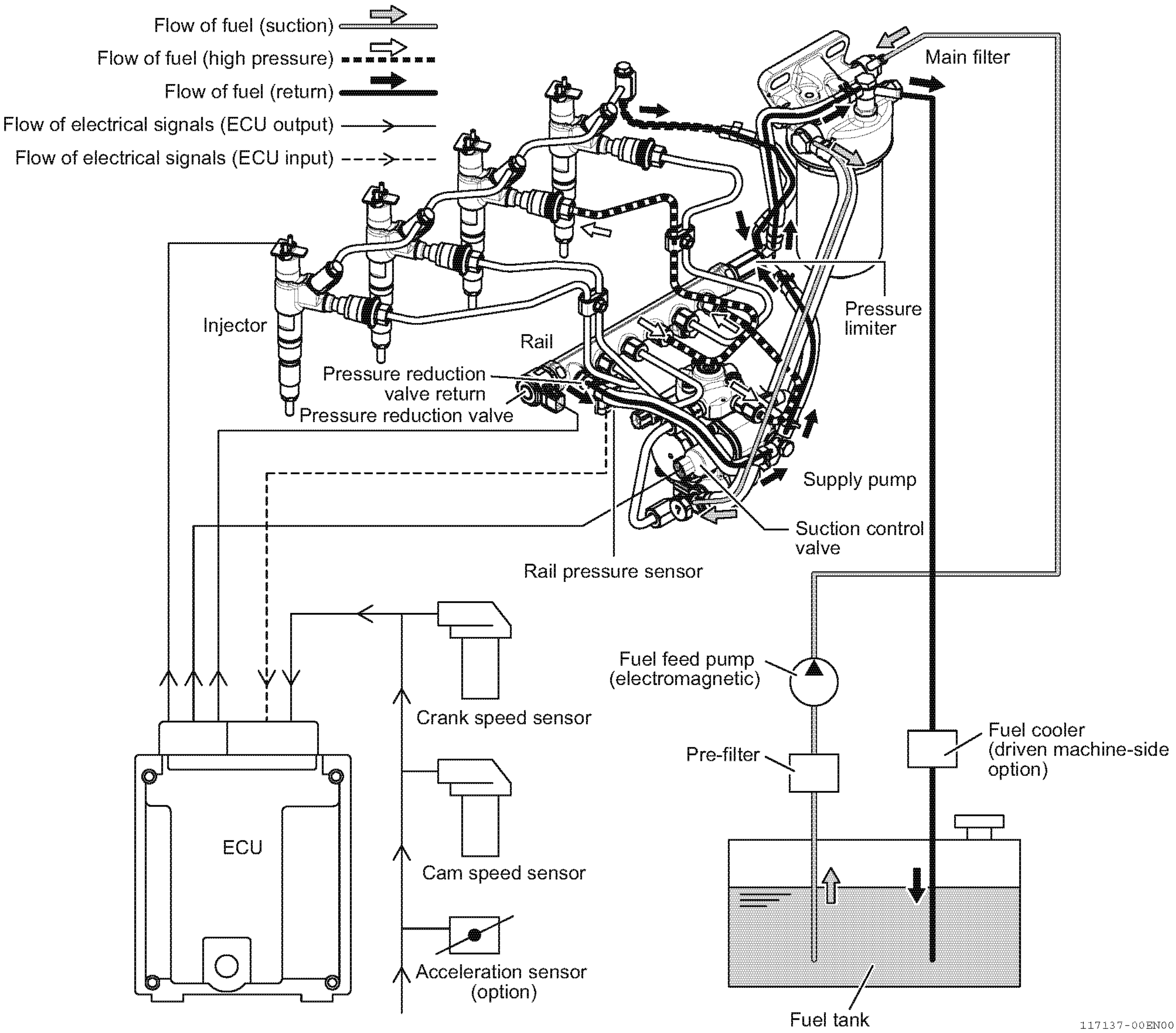


Fig.50-1

1.1 Supply pump

The fuel passes the pre-filter and is pressure-fed by a fuel feed pump to the main filter, then it arrives at the supply pump. The ECU controls the opening of the intake metering valve and adjusts the fuel intake volume so that the rail pressure is at the target value. The fuel pressurized in the supply pump is fed to the rail.

1.2 Rail

The maximum pressure of 200 MPa is accumulated in the rail. The rail is equipped with a rail pressure sensor and it sends information to the ECU. In the case of abnormal increase in the rail pressure, the pressure limiter (relief valve) opens to prevent the pressure increase.

1.3 Injector

The ECU controls the injector to maintain optimum injection volume and injection timing, and injects the high-pressure fuel accumulated in the rail into the cylinder. Each injector has its unique correction data to optimize the injection volume. The correction data can be found on the top of the injectors. The correction data is written to the ECU, and the ECU corrects the injection volume based on the correction data. Therefore, it is necessary to write the correction data to the ECU using the SMARTASSIST-DIRECT (SA-D) when the injector or ECU is replaced. For details, see the SMARTASSIST-DIRECT (SA-D) Operation Manual. Never touch the electric wiring with your hands when the key switch is in the “ON” position. High-voltage current flows in the injector.

1.4 Crank speed sensor, camshaft speed sensor

In the 4TN107 engines, the crank rotation sensor is equipped on the flywheel side and the gear speed sensor is equipped on the gear side. Based on these 2 sensor outputs, the ECU recognizes the engine speed and each piston position.

1.5 ECU

Based on the information from each sensor, ECU determines optimum injection volume, injection timing and rail pressure, and controls the intake metering valve of the supply pump and injector. It also monitors the occurrence of system abnormality at all times. If an abnormality is detected, it notifies the operator and controls the safe running condition of the system.

2. Fuel System Components

The components of the fuel system are shown in Fig.50-2.

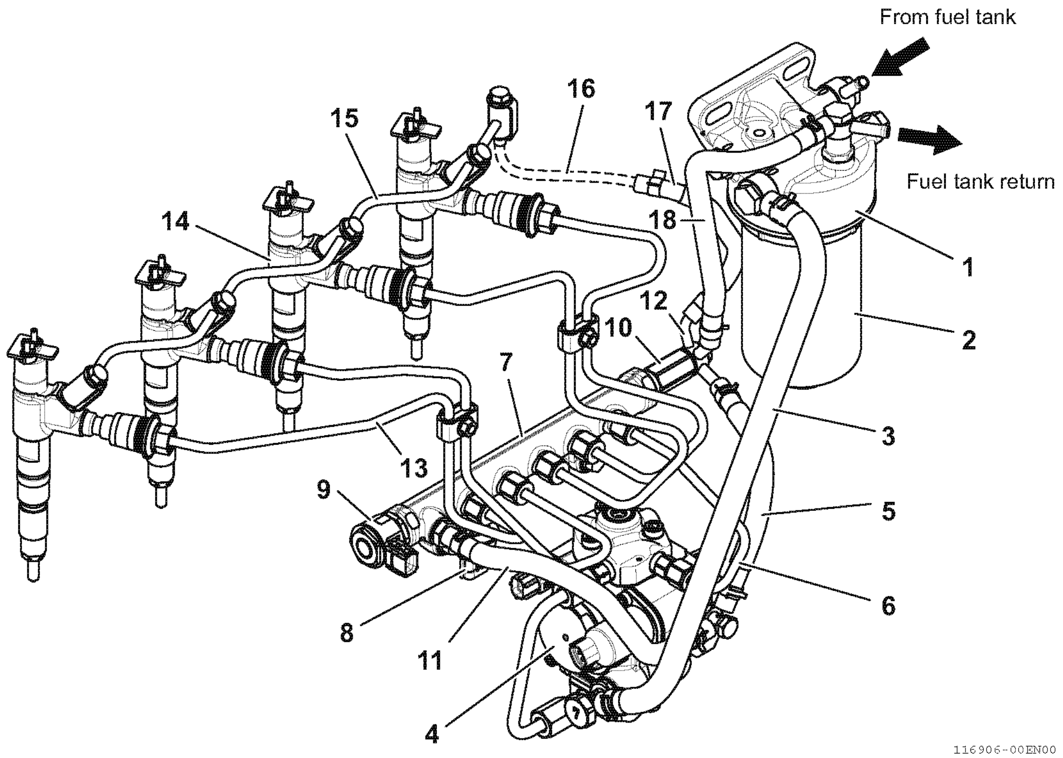


Fig.50-2

1 -	Fuel filter bracket	10 -	Pressure limiter
2 -	Fuel filter	11 -	Fuel return hose (Common rail → Supply pump)
3 -	Fuel hose (Fuel filter → Supply pump)	12 -	Fuel return 3-way hose joint
4 -	Supply pump	13 -	High-pressure fuel injection line (Common rail → Injector)
5 -	Fuel return hose (Supply pump → 3-way joint)	14 -	Injector
6 -	High-pressure fuel injection line (Supply pump → Common rail)	15 -	Injector fuel return line
7 -	Common rail	16 -	Fuel return channel in cylinder head
8 -	Pressure sensor	17 -	Fuel return hose (Injector → 3-way joint)
9 -	Pressure reduction valve	18 -	Fuel return hose (3-way joint → Fuel filter)

3. Supply Pump

The components of the supply pump are shown in Fig.50-3.

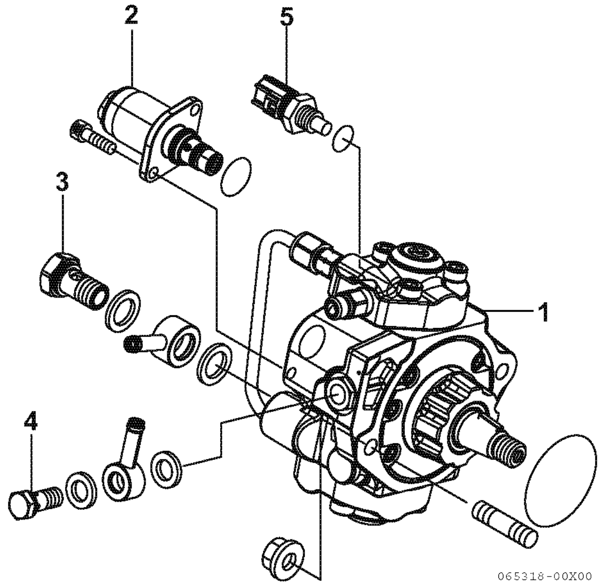


Fig.50-3

1 - Supply pump	4 - Hollow screw (pump fuel discharge port)
2 - SCV (suction control valve)	5 - Fuel temperature sensor
3 - Hollow screw (pump fuel inlet)	

Supply pump components 1 - 5 shown in Fig.50-3 can be replaced. However each component is prepared as a kit and the individual parts cannot be replaced. Be sure to replace the components as a kit. Be sure to follow the failure diagnosis process when deciding whether or not replacement is necessary.

4. Common Rail

The components of the common rail are shown in Fig.50-4.

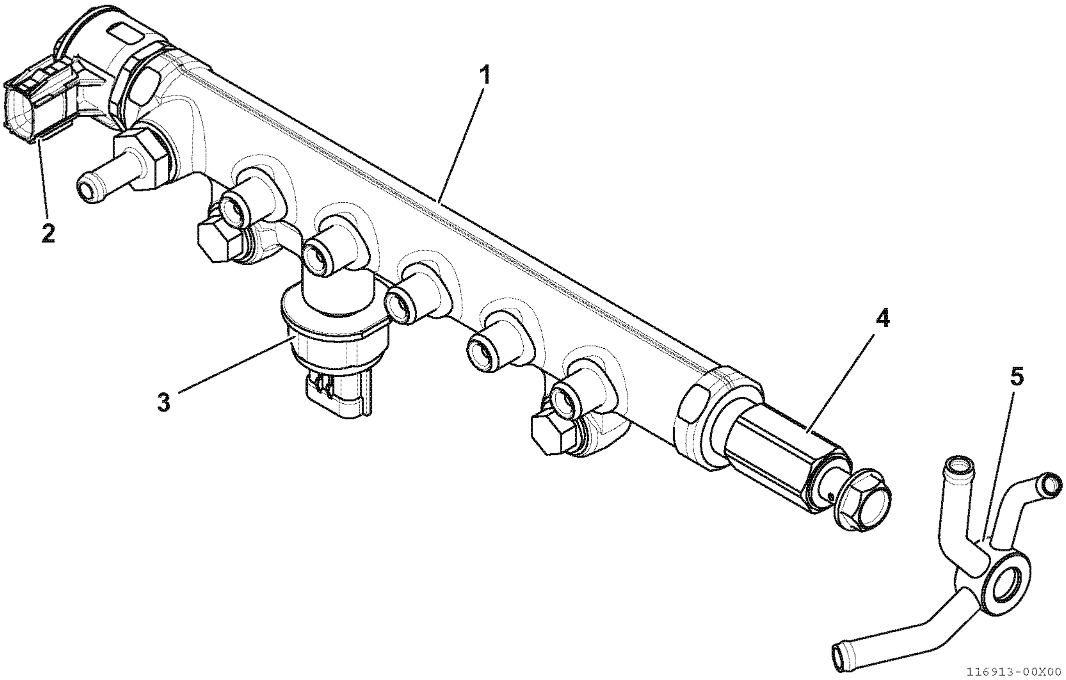


Fig.50-4

1 - Rail body	4 - Pressure limiter
2 - Pressure reduction valve	5 - Hose joint
3 - Pressure sensor	

Of the rail components shown in Fig.50-4, the pressure limiter can be replaced. However it is prepared as a kit and the individual parts cannot be replaced. Be sure to replace the components as a kit. Be sure to follow the failure diagnosis process when deciding whether or not replacement is necessary.

1. Removing the Supply Pump

The supply pump for the 4TN107 engine is installed on the cylinder block on the flywheel side. Following is the procedure for removing the supply pump.

1.1 Connectors

Remove the wiring couplers of the fuel temperature sensor (1, Fig.50-5) and SCV (suction control valve) (2, Fig.50-5) that are connected to the supply pump.

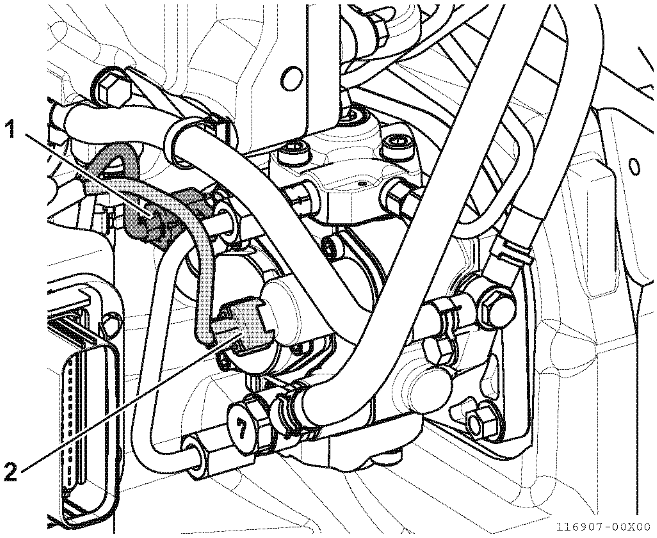


Fig.50-5

1.2 High-pressure fuel injection lines

1 - Clean around the cap nuts on both the pump and rail sides (1, Fig.50-6) using a brush or aspirator.

2 - While pressing and holding the pipes of the rail and pump sides respectively against the bearing surface by hand, loosen the cap nut using a tool. Loosen and remove the cap nut by hand, and remove the high-pressure pipe.

3 - Clean the removed seat portions of the rail inlet and pump outlet with an aspirator or the like and cover them with a vinyl bag.

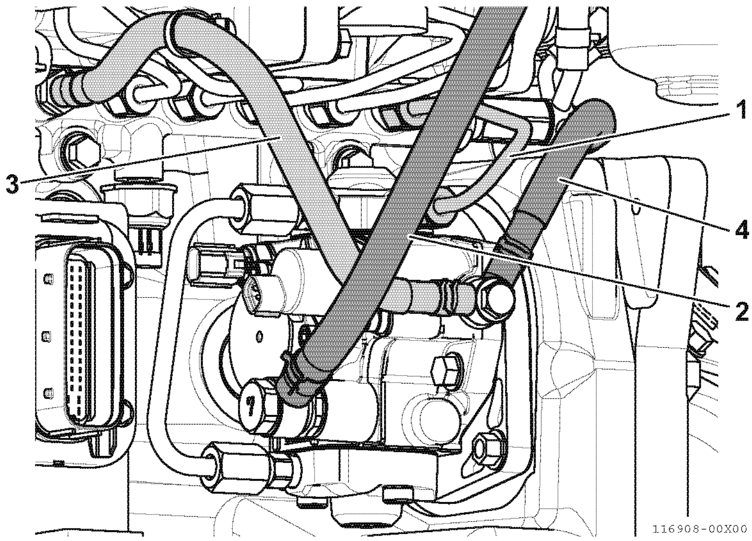


Fig.50-6

1.3 Fuel hose

Remove the fuel supply hose (supply pump fuel inlet side) (2, Fig.50-6) from the fuel filter, disconnect the fuel return hose (3, Fig.50-6) from the rail, and disconnect the fuel overflow hose (4, Fig.50-6) from the supply pump.

NOTICE

- The fuel in the pipe may possibly spill at this time. Prepare a fuel container before its removal.
- Prevent foreign matter from entering the pump.

1.4 Supply pump

When removing the supply pump, it is necessary to remove the flywheel and the flywheel housing, and then take out the supply pump drive gear beforehand.

1 - Remove the flywheel and flywheel housing. For removal of the flywheel housing, see 0300-02-01-01 “Removing the Flywheel” and 0300-02-01-03 “Removing the Flywheel Housing”.

2 - Remove the mounting nut (2, Fig.50-7) of the supply pump drive gear (1, Fig.50-7).

3 - Use a gear puller to remove the supply pump drive gear.

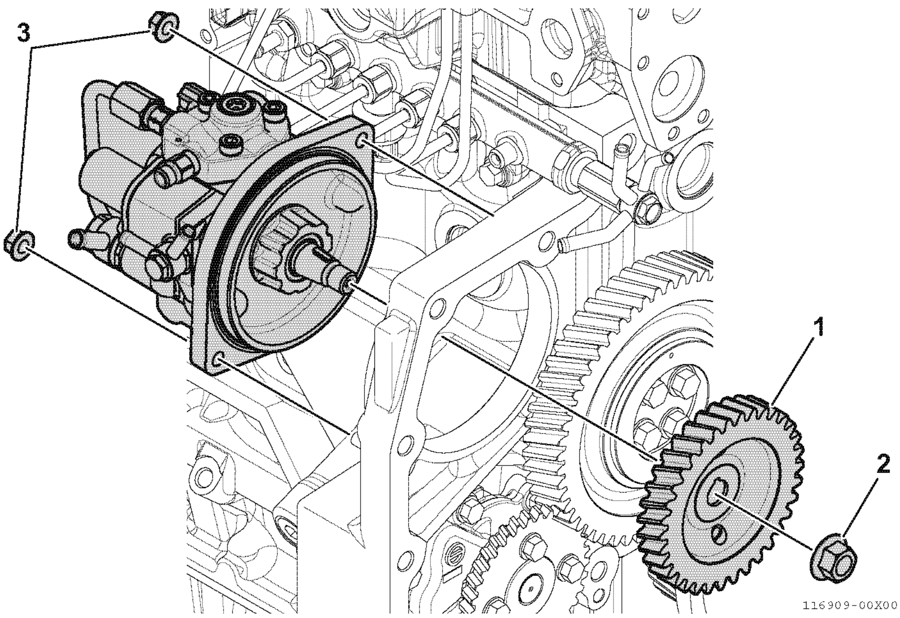


Fig.50-7

NOTICE

- Be sure to put an alignment mark between the supply pump drive gear and the idle gear. Do not rotate the crankshaft of the engine after putting the mark.
- Be sure to use a gear puller when removing the drive gear.

4 - Loosen the supply pump attaching nut (3, Fig.50-7), and remove the supply pump together with the supply pump spacer (4, Fig.50-7) and the pump gasket.

NOTICE

- Never disassemble the supply pump.
- When replacing the supply pump, it is necessary to replace the entire pump with a new one.

The supply pump can be removed without taking out the flywheel housing. However, before removing, open the supply port (1, Fig.50-8) and mark the meshing part with the idle gear. When removing the drive gear after removing the supply pump, insert a tool from the supply port and loosen the drive gear attaching nut (2, Fig.50-8) before removing the pump body. This enables easier removing of the pump drive gear after removing the supply pump.

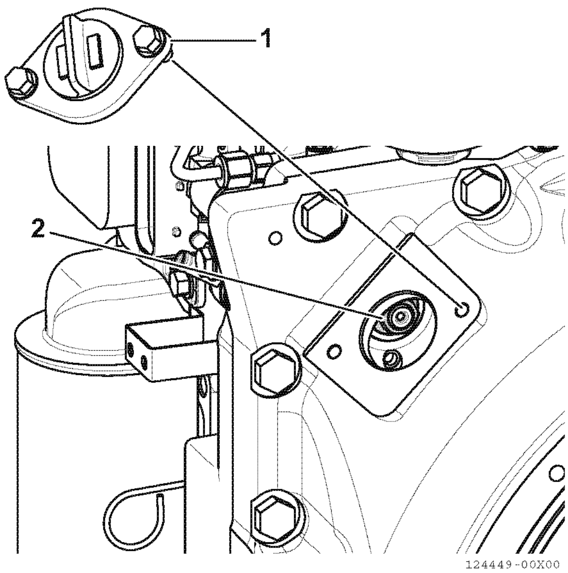


Fig.50-8

2. Removing the Common Rail

2.1 Removing the common rail related parts

When removing the common rail and the high-pressure lines which connect the common rail to the injectors, remove the EGR valve and intake collector first so that replacement work will be easier. Follow the procedure below to remove the related parts.

1 - Remove the harness connector (2, Fig.50-9) of the EGR valve (1, Fig.50-9).

2 - Remove the two bolts (5, Fig.50-9) which mount the harness clip bracket (3, Fig.50-9) to the intake collector (4, Fig.50-9), then pull the bracket together with the harness, and put them aside.

3 - Remove the four bolts (7, Fig.50-9) which mount the intake collector and intake air throttle valve (6, Fig.50-9). Leave the intake hose (8, Fig.50-9) from the turbocharger connected to the intake air throttle valve.

4 - Remove the four bolts (10, Fig.50-9) which mount the EGR valve and EGR pipe (9, Fig.50-9).

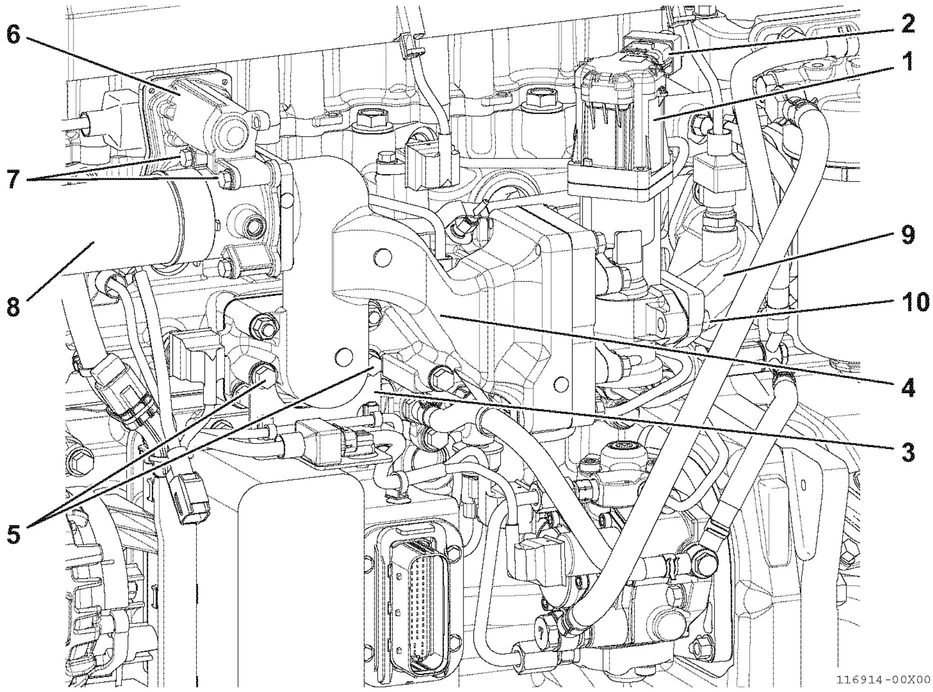


Fig.50-9

5 - Remove the three bolts (2, Fig.50-10) and two nuts (3, Fig.50-10) which mount the intake collector (1, Fig.50-10) and cylinder block, then remove the EGR valve together with the intake collector.

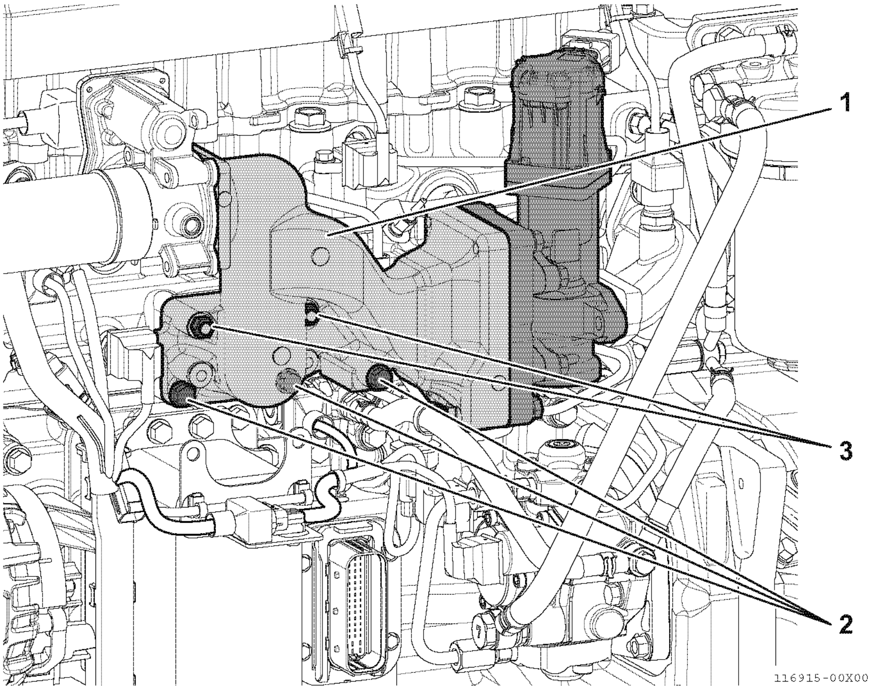


Fig.50-10

2.2 Removing the high-pressure fuel injection lines

Remove the high-pressure lines between the injectors and common rail (1, Fig.50-11) and between the common rail and supply pump (2, Fig.50-11).

1 - Clean around the cap nuts on both the pump and rail sides, using a brush or aspirator.

2 - While pressing and holding the pipes of the common rail and pump sides respectively against the bearing surface by hand, loosen the cap nut using a tool. Loosen and remove the cap nut by hand, and remove the high-pressure pipe.

3 - With the pipe pressed against the seat, loosen and remove the cap nut by hand, and remove the high-pressure pipe.

4 - Clean the removed seat portions of the rail inlet with an aspirator or the like and cover them with a vinyl bag.

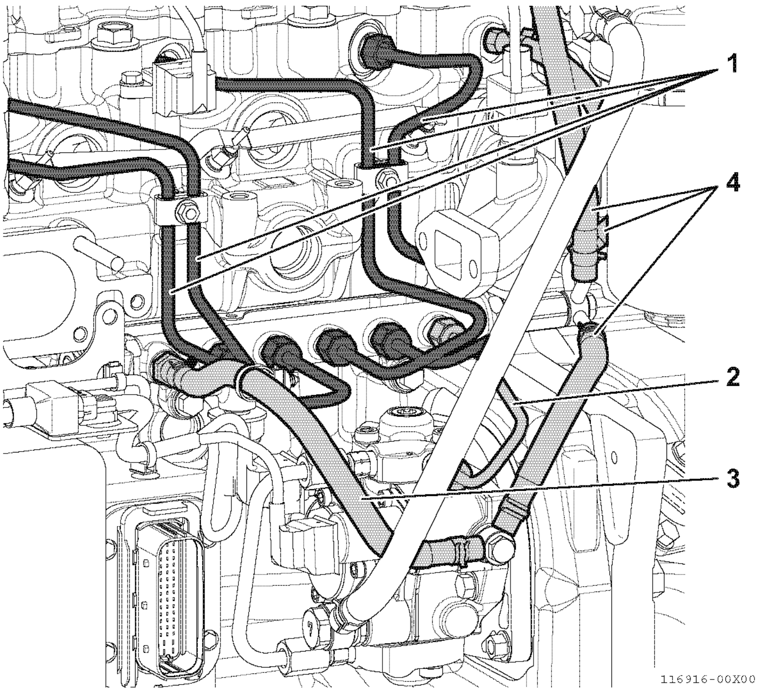


Fig.50-11

2.3 Removing the fuel hose

Remove the fuel return hose (3, Fig.50-11) of the rail pressure reduction valve, and the three fuel return hoses (4, Fig.50-11) connected to the pressure limiter hose joint.

2.4 Removing the common rail

1 - Remove the pressure reduction valve harness coupler (1, Fig.50-12), then remove the rail pressure sensor harness coupler (2, Fig.50-12).

2 - Remove the two bolts (3, Fig.50-12) which mount the common rail, then remove the rail body.

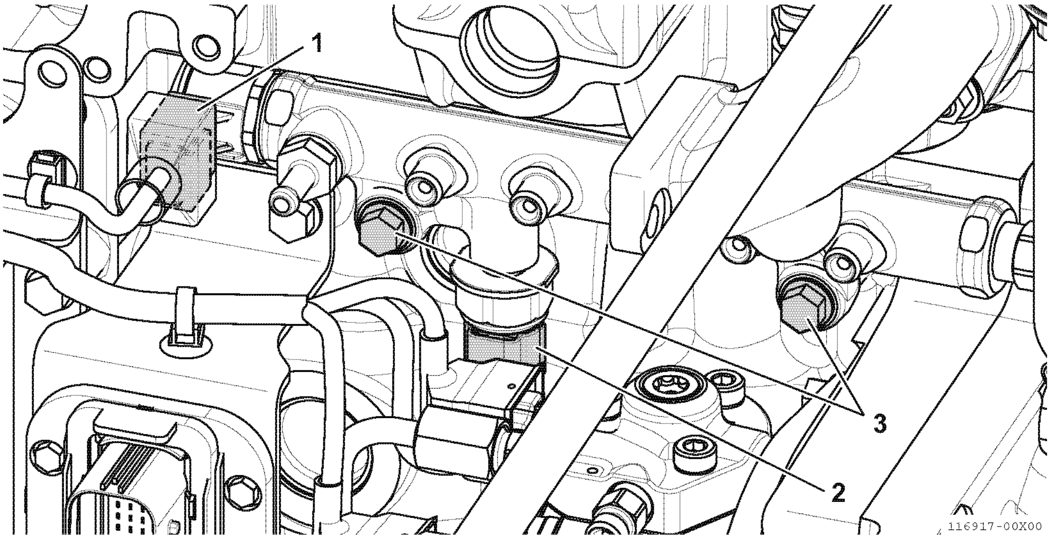


Fig.50-12

NOTICE

- Loosen the bolts while securely holding the rail body by hand not to drop it.
- Hold the rail body without touching the sensors.

3. Removing the Injectors

3.1 Removing the bonnet

In order to remove the injectors, it is necessary to remove the bonnet (1, Fig.50-13) and the harness cover (2, Fig.50-13) that is attached to the cover. For removal of the bonnet, see 1404-02-01-01 “Removing the bonnet”. For removal of the harness cover, see 7200-02-01-01 “Removing the Wire Harness Assembly”.

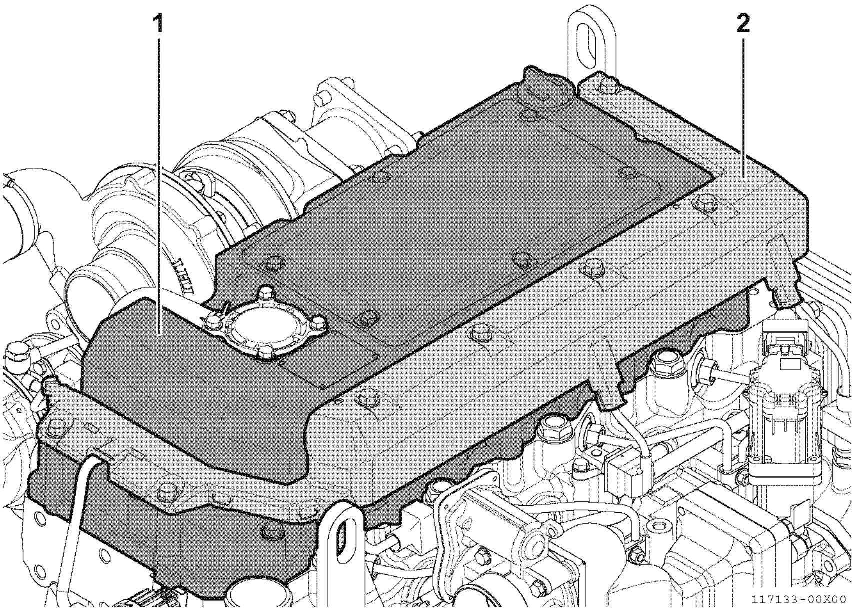


Fig.50-13

3.2 Removing the high-pressure fuel injection lines

Remove the high-pressure fuel injection lines (1, Fig.50-14) that connects between the injectors and the common rail. if it is difficult to remove the cap nuts on the common rail side, remove the rail related parts in advance. When removing the related parts, see 5200-02-01-01 “Removing the Common Rail: Removing the common rail related parts”.

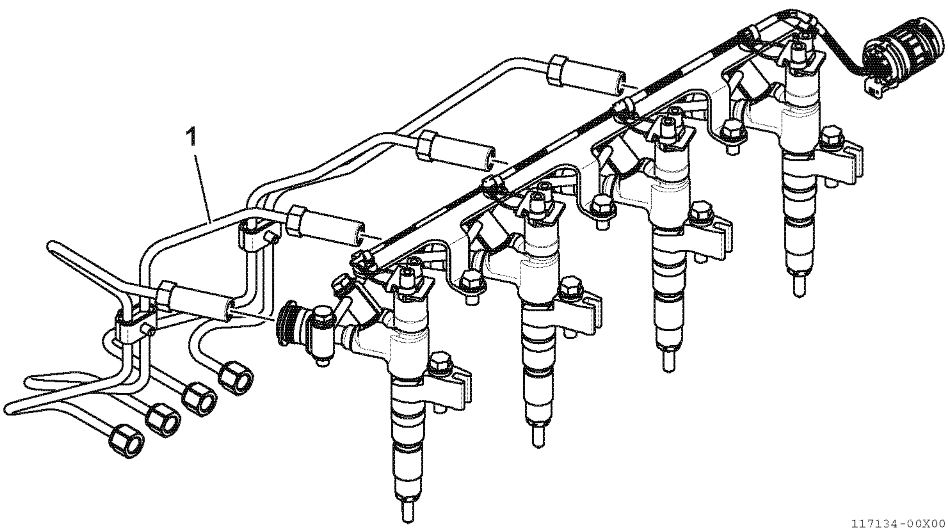


Fig.50-14

3.3 Removing the injectors

1 - Loosen the nut (2, Fig.50-15) of the injector terminal (1, Fig.50-15) using the hexagon wrench, and remove the harness coupler (3, Fig.50-15) from the injector.

2 - Loosen the M8 bolts × 3 (5, Fig.50-15) that fasten the injector harness bracket (4, Fig.50-15). Remove and put aside the injector harness (6, Fig.50-15) together with the bracket without uncoupling them. Leave the injector harness collective coupler (7, Fig.50-15) attached to the cylinder head.

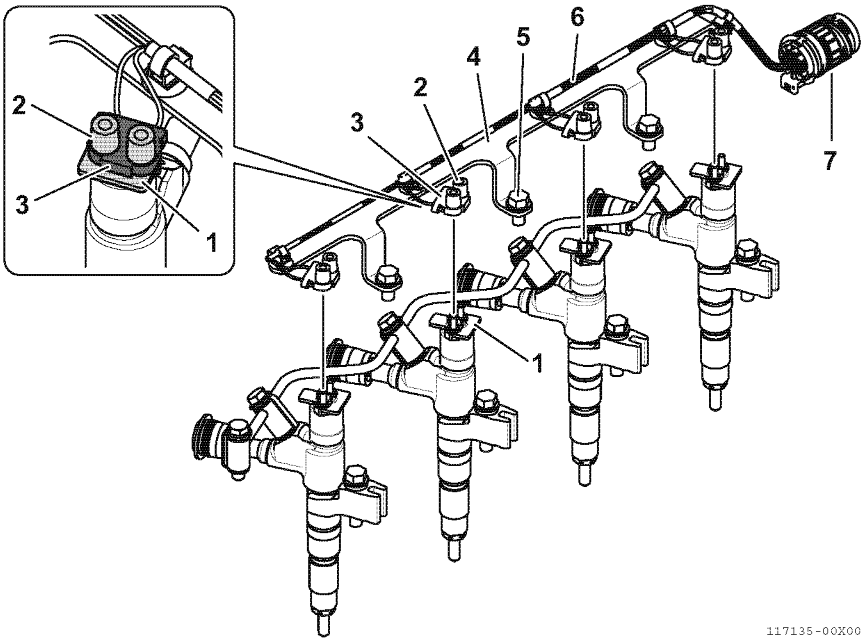


Fig.50-15

3 - Loosen the pipe joint bolts (2, Fig.50-16) of the fuel return hose (1, Fig.50-16) and remove the fuel return hose assembly.

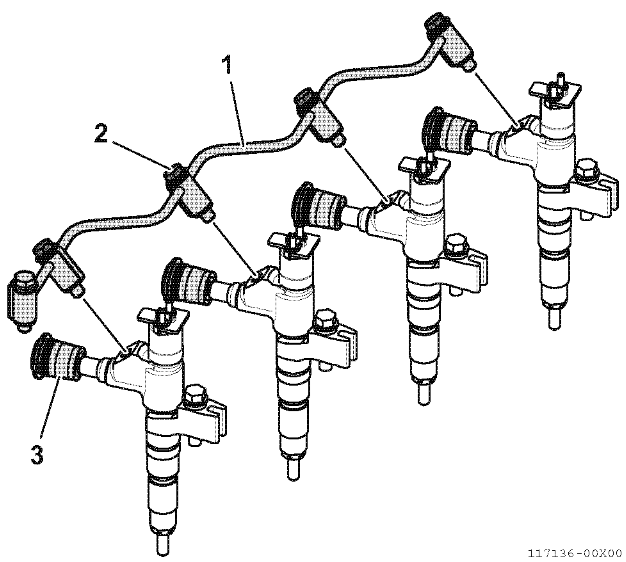


Fig.50-16

4 - Pull out and remove the pipe seal (3, Fig.50-16) that is inserted into the cylinder head.

5 - Loosen the bolt (2, Fig.50-17) of the injector fixture retainer (1, Fig.50-17), and remove the injector (3, Fig.50-17) together with the O-ring (4, Fig.50-17) and gasket (5, Fig.50-17).

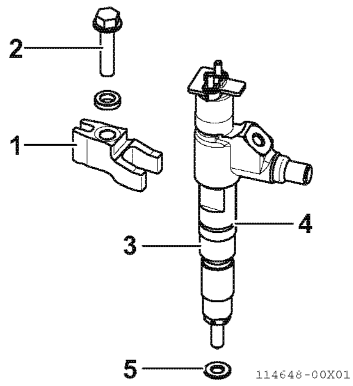


Fig.50-17

NOTICE

- Do not reuse the injector O-ring or gasket.
- Separate the injectors by each cylinder (mark them). Clean the removed injectors and cover them with a vinyl bag.
- Do not disassemble the injector.
- When replacing the injector with a new part, it is necessary to replace the entire injector.

4. Removing the High-pressure Pipes

Remove the high-pressure pipes between the injectors and common rail (1, Fig.50-18) and between the rail and supply pump (2, Fig.50-18).

1. Use a brush or a vacuum to clean each cap nut of the injector, rail, and supply pump.
2. Loosen each cap nut of the tight parts of the high-pressure pipes using a tool by pushing the pipe toward the seat by hand.
3. With the pipe pressed against the seat, loosen and remove the cap nut by hand, and remove the high-pressure pipe.

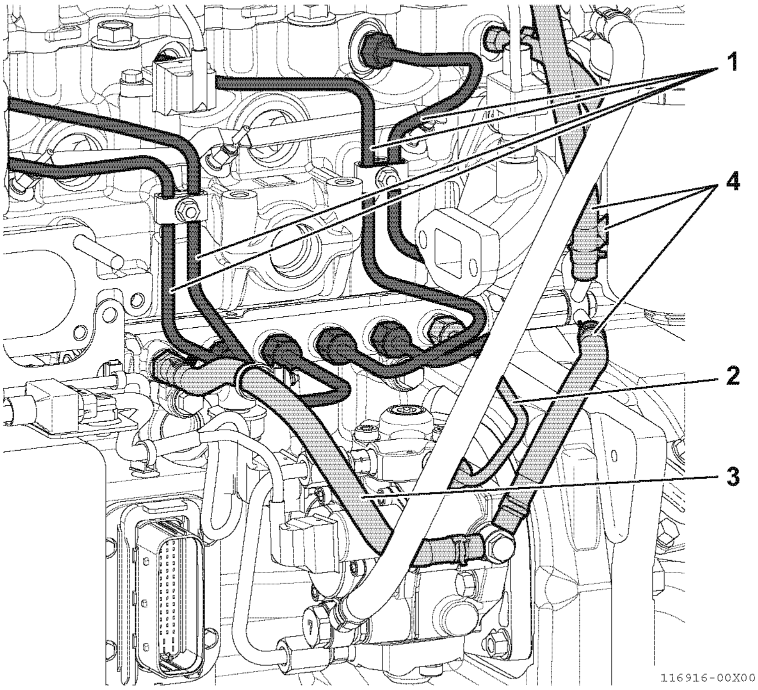


Fig.50-18

4. When removing the high-pressure pipe between the injector and common rail, if it is difficult to remove the cap nuts on the common rail side, remove the common rail related parts beforehand. When removing the related parts, see 5200-02-01-01 “Replacing the Common Rail”.
5. Clean the seat part of the removed injector with a vacuum (or the like) to remove dusts, and cover it with plastic bags.

1. Attaching the Supply Pump

1.1 Supply pump unit

Align the position of the supply pump drive shaft key (1, Fig.50-19) with the drive gear key groove (2, Fig.50-19), and install the supply pump body to the cylinder block. Then tighten the nuts (3, Fig.50-19).

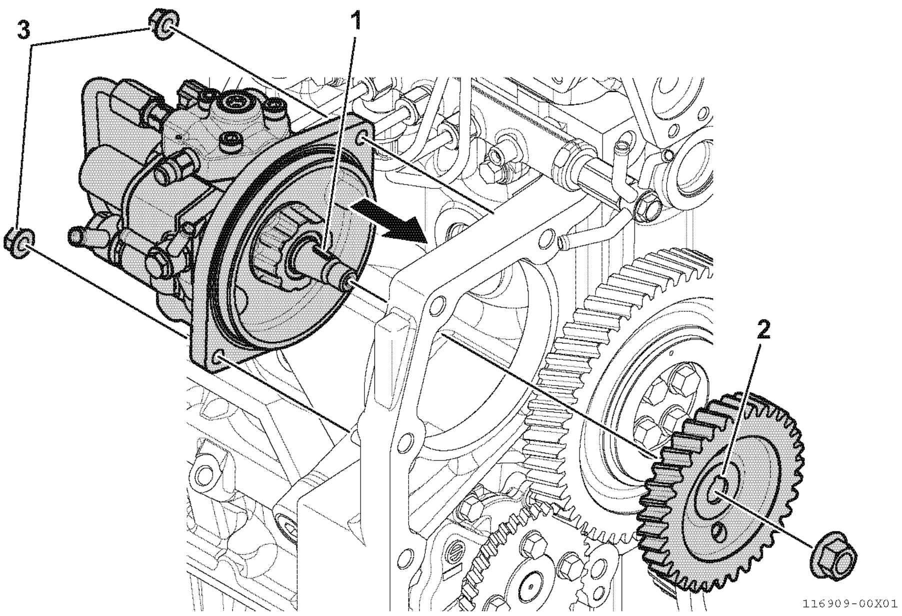


Fig.50-19

Tightening torque	Supply pump nut (M8 × 1.25)	25.5 ± 2.9 N·m

1.2 Supply pump drive gear

Make sure that the alignment mark with the idle gear is correctly aligned, then install the supply pump gear to the supply pump drive shaft using the special M14 nut.

Tightening torque	Supply pump drive gear nut (M14 × 2.0)	64.0 ± 4.0 N·m

1.3 Flywheel and flywheel housing

After installing the flywheel housing, attach the flywheel. For attaching the flywheel housing, see 0300-02-03-01 “Attaching the Flywheel Housing”. For attaching the flywheel, see 0300-02-03-03 “Attaching the Flywheel”.

If the supply pump is removed without removing the flywheel housing, make sure to attach the supply pump to the cylinder block while matching with the idle gear marking, and tighten with the specified torque using a nut. If the supply pump drive gear is removed, attach the supply pump to the block while the nut is temporarily tightened, and insert a tool from the supply port to tighten the attaching nut of the supply pump drive gear to the specified torque.

1.4 High-pressure fuel injection lines

Install the high-pressure fuel injection lines that connect the supply pump and common rail.

⚠ CAUTION

For high-pressure fuel injection line, use a new one. If you reuse it, the displacement of the working face may occur, causing the fuel to leak.

---

1 - Before connecting a high-pressure fuel injection line, apply fuel to the threads of the cap nut.

2 - Press the high-pressure line against the seat while provisionally tightening the cap nut by hand. (Both pump side and rail side)

3 - Tighten the cap nuts to the specified torque.

Tightening torque	High-pressure fuel injection line cap nut (M12 × 1.75)	35.0 ± 5.0 N·m

1.5 Fuel hose

Install the fuel overflow hose between the supply pump and the rail 3-way joint, the fuel return hose between the rail and the supply pump, and the fuel supply hose from the fuel filter (supply pump fuel inlet side).

1.6 Connectors

Install the wiring couplers for the fuel temperature sensor and SCV (suction control valve) that connect to the supply pump.

NOTICE

- If the supply pump is replaced with a new one, be sure to perform the pump self-learning operation. When the supply pump is operated with self-learning operation under certain conditions, the pump correction value is calculated and written to the SMARTASSIST DIRECT (SA-D). See SMARTASSIST DIRECT (SA-D).for details.
- Be sure to perform priming. If air is mixed to the fuel, seizure to the supply pump and the injector may result.

---

2. Attaching the Common Rail

2.1 Common rail body

Temporarily tighten the 2 pieces of M8 bolts by hand while securely holding the common rail body by hand. Then, tighten the bolts to specification.

Tightening torque	Rail bolt (M8 × 1.25)	25.5 ± 2.9 N·m

2.2 High-pressure fuel injection lines

Install the high-pressure fuel injection lines between the common rail and supply pump, and between the common rail and injectors.

⚠ CAUTION

For high-pressure fuel injection line, use a new one.If you reuse it, the displacement of the working face may occur, causing the fuel to leak.

1 - Before reinstalling the high-pressure pipe, apply fuel to the cap nut thread portion.

2 - Be sure to fit and fix the high-pressure pipe on each side e to the sheet part by hand, and temporarily tighten the cap nut by hand.

3 - Tighten the cap nuts to the specified torque.

Tightening torque	High-pressure fuel injection line cap nut (M12 × 1.75)	35.0 ± 5.0 N·m

2.3 Fuel hose and harness coupler

1 - Install the fuel return hose (3, Fig.50-11) of the rail pressure reduction valve, and the three fuel return hoses (4, Fig.50-11) that are connected to the pressure limiter hose joint.

2 - Install the pressure reduction valve harness coupler (1, Fig.50-12) and the rail pressure sensor harness coupler (2, Fig.50-12).

2.4 Common rail related parts

If the related parts were removed when the common rail was removed, reinstall them in their original positions.
For the installation procedure, follow the procedure of 5200-02-01-01 “Removing the Common Rail: Removing the common rail related parts” in the reverse order. When installing, discard the original gaskets and replace them with new ones.

Intake pipe gasket (between intake collector and cylinder block)	129G01-12850
Throttle gasket (between intake collector and intake air throttle valve)	129A00-12910
EGR-V intake-side gasket (between EGR valve and EGR pipe)	129G01-13910

After work is complete, check the replaced parts for correct operation using the failure diagnosis tool (SA-D).

3. Attaching the Injector

3.1 Installing the injectors - 1

1 - Insert the injector into the head by using the new injector gasket and O-ring. At this time, insert the pipe seal (3, Fig.50-16) into the cylinder head, and align it so that it covers the injector fuel inlet.

NOTICE

If you reuse the injector, be sure to reinstall it to the original cylinder.

2 - Align the injector fixture retainer with the dowel pin, and temporarily tighten the bolt by hand at this time.

3.2 Installing the high-pressure fuel injection lines - 1

Install the high-pressure fuel injection line that is in between the injector and the rail.

CAUTION

For high-pressure fuel injection line, use a new one. If you reuse it, the displacement of the working face may occur, causing the fuel to leak.

1 - Before reinstalling the high-pressure pipe, apply fuel to the cap nut thread portion.

2 - Hold the high-pressure line in a hand and fit and fix it to the seat. While holding it in place, temporarily tighten the cap nut by hand.

3.3 Installing the injectors - 2

Tighten the injector fixture retainer mounting bolt to the specified torque.

Tightening torque	Injector retainer bolt (M8 × 1.25)	25.5 ± 2.9 N·m

3.4 Installing the high-pressure fuel injection lines - 2

Tighten the cap nut of the high-pressure fuel injection line to the specified torque.

Tightening torque	High-pressure fuel injection line cap nut (M12 × 1.75)	35.0 ± 5.0 N·m

3.5 Installing the fuel return hose

Install the fuel return pipe assembly. Thoroughly apply fuel between the pipe joint bolt (1, Fig.50-20) of the fuel return pipe and the gasket (2, Fig.50-20). When tightening the bolt, make sure that the gasket does not interfere with the fuel pipe (3, Fig.50-20). Do not reuse the gasket.

Tightening torque	Fuel return pipe pipe joint bolt (M8 × 1.25)	14.7 ± 2.0 N·m

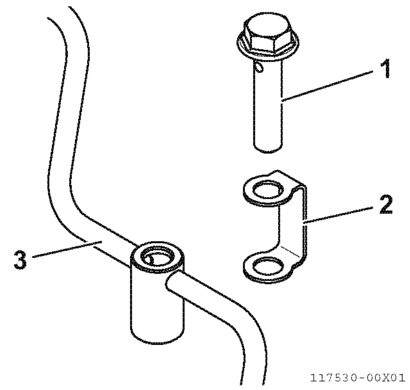


Fig.50-20

3.6 Installing the injector harness

1 - Tighten the injector bracket using bolts × 3.

2 - Fit the harness coupler to the injector terminal and tighten the nut.

Tightening torque	Injector harness coupler nut (M4 × 0.7)	2.0 ± 0.1 N·m

3.7 Installing the bonnet

Install the removed bonnet and harness cover. For installation of the bonnet, see 1404-02-03-01 “Installing the bonnet”. For removal of the harness cover, see 7200-02-03-01 “Installing the Wire Harness Assembly”. If related parts were removed in order to remove the rail-side cap nuts of the high-pressure lines, reinstall them back to the original positions.

When attaching the related parts, see 5200-02-03-01 “Attaching the Common Rail: Common rail related parts”.

NOTICE

- If you replace the injector, it is required to write the correction value of each injector to ECU.
- Rewrite the correction value using YANMAR Diagnostic Tool, SMARTASSIST-DIRECT (SA-D). The correction value is written on the injector QR tag.
- If the correction value of the injector is not correctly written, the engine performance cannot be guaranteed.

4. Attaching the High-pressure Pipes

Install the high-pressure fuel injection lines between the common rail and supply pump, and between the rail and injectors.

CAUTION

For high-pressure fuel injection line, use a new one. If you reuse it, the displacement of the working face may occur, causing the fuel to leak.

1. Before installing the high-pressure pipe, apply fuel to the cap nut thread.
2. For the fastening part of each high-pressure pipe (1 and 2, Fig.50-11), hold the high-pressure pipe by hand, and press toward the seat part by hand to temporarily tighten the cap nut by hand.
3. Tighten the cap nuts to the specified torque.

Tightening torque	High-pressure fuel injection line cap nut (M12 × 1.75)	35.0 ± 5.0 N·m

1. Replacing the SCV (Suction Control Valve)

Among the supply pump components, the SCV (suction control valve) is a service part which is prepared as a kit and can be replaced. Be sure to follow the failure diagnosis process when deciding whether or not replacement is necessary.

1.1 Precautions for replacement

- Be sure that foreign matter do not contact or enter the replacement parts or inside of the product, as they can cause fuel leakage or malfunction.
- In order to prevent malfunction, do not drop replacement parts or apply excessive impact.

NOTICE

- Be sure to observe the following in order to prevent the intrusion of foreign matter into the product.
  - Wear a clean work clothing and perform the work with clean bare hands. Do not wear gloves.
  - Perform the work in an environment where sand and dust cannot enter, and stop fans or other equipment while working.
  - Before starting work, clean the area around the work location and the work bench.
  - Do not leave the parts unattended during replacement.
- Disconnect the battery (-) terminal before starting work.

1.2 Checking the parts

Kit part number: 129G01-51100
Check that all kit parts are included.

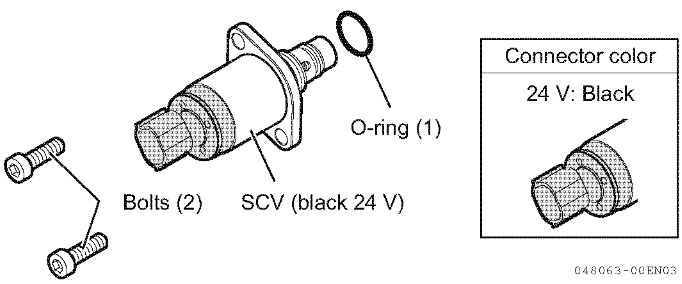


Fig.50-21

NOTICE

- Be sure to observe the following in order to prevent foreign matter from contacting the parts.
  - Do not place parts on a dirty work bench. Never touch parts with dirty hands.
  - Do not unseal the parts before the replacement work.
- Do not use any components have been dropped.
- Check the connector for colors (for correct voltage).

1.3 Removing the SCV

1 - Carefully clean around the SCV using cleaning fluid, nylon brush, air blow, or other means.

2 - Disconnect the connector and use a hex wrench (size: 5 mm) to loosen and remove the SCV mounting bolts (1, Fig.50-22). Do not perform this work with the hex wrench inserted at an angle or improperly inserted.

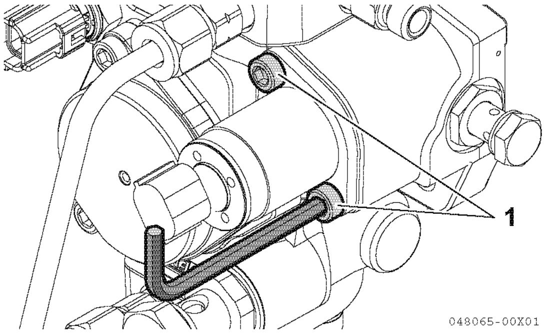


Fig.50-22

3 - Pull the SCV out straight. In order to prevent foreign matter from entering the pump body, install the new SCV immediately after removing the old SCV.

NOTICE

- When replacing the SCV, carefully operate so as to prevent any foreign matter or from entering matter do not enter the pump or contact the SCV mounting surface. Be sure to observe the following in order to prevent the intrusion of foreign parts into the pump.
  - When removing the SCV, carefully operate so as to prevent any foreign matter or from entering matter do not enter the pump.
  - After removing, wipe the part of the pump where the valve was removed with a cloth or similar item.
- Never reuse the used SCV or O-ring.
- Check that the O-ring is not remaining on the pump side. If the O-ring is still on the pump, remove it.

1.4 Installing the SCV

1 - Apply clean silicon grease to the O-ring, then install the O-ring into the O-ring groove of housing (1, Fig.50-23).

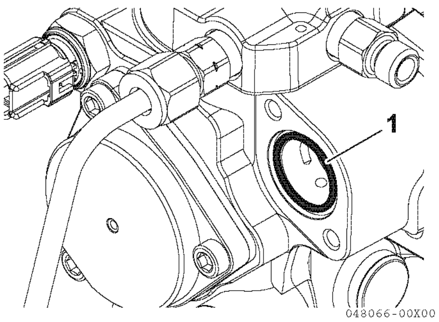


Fig.50-23

NOTICE

- Be sure to observe the following in order to prevent the intrusion of foreign matter into the pump.
  - Do not allow foreign matter contact the O-ring groove or SCV mounting surface.
  - Be sure to prevent foreign matter from entering matter do not contact the O-ring.
  - Never touch parts with dirty hands.

2 - Insert the guide pins (1, Fig.50-24) into the SCV mounting bolt hole and tighten them by hand.

Note: The guide pins are used so that the SCV is inserted straight, preventing the O-ring from being trapped or damaged when the SCV is inserted into the pump.

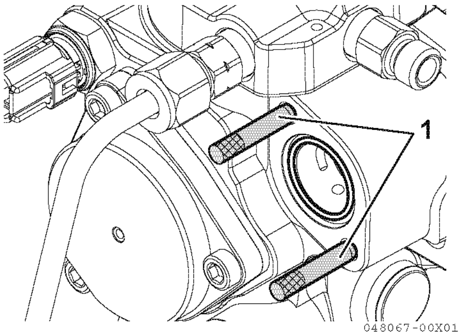


Fig.50-24

NOTICE

- Hand-tighten the guide pins. Over-tightening will make it difficult to remove.
- Prevent foreign matter from entering the pump.

3 - Apply clean silicon grease to the O-ring on the end of the SCV (Fig.50-25).

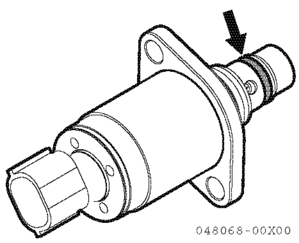


Fig.50-25

NOTICE

Be careful to prevent contact with foreign matter when applying the grease.

4 - Insert the SCV straight to the guide pins until it securely contacts the supply pump housing (Fig.50-26). Pay attention to the orientation when installing. Install so that the SCV connector is facing close to the pump center. Incorrect installation will result in serious malfunction.

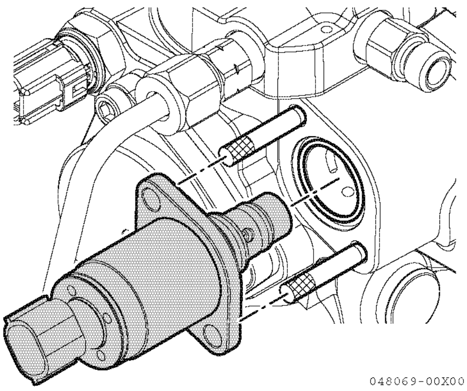


Fig.50-26

NOTICE

- Make sure that there are no foreign matter on the mounting surface.
- Insert the SCV straight without prying. This may cause fuel leakage due to O-ring torn or cut, or malfunction.

5 - After inserting the SCV, remove the guide pins while pressing on the SCV, then temporary tighten the bolts (Fig.50-27). Tighten the bolts alternately by hand so that both bolts contact the bearing surface evenly.

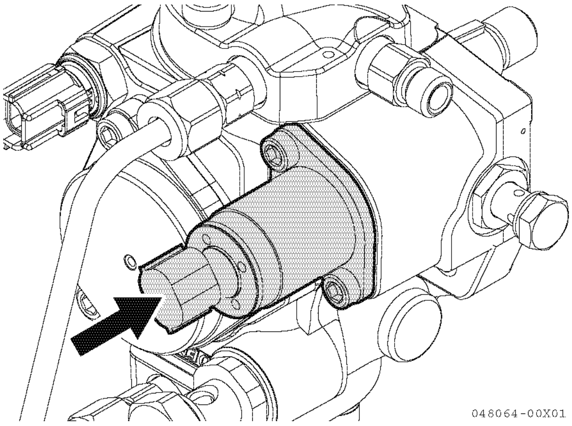


Fig.50-27

6 - Use a hex wrench (size: 5 mm) and torque wrench to tighten the bolts to the specified torque. Tighten the bolts alternately so that both bolts contact the bearing surface evenly.

Tightening torque	SCV bolt (M6 × 1.0)	8.85 ± 1.95 N·m

NOTICE

Do not over-tighten the bolts. It may damage the bolts.

7 - Connect the SCV connector.

NOTICE

- Make sure that there are no foreign matter inside the SCV connector. Foreign matter may cause malfunction or short circuit. If any matter is present, use an air blow or other means to fully remove it.
- Connect the SCV harness in the prescribed path, and make sure there is no excessive slack or tension in the harness. There is the risk of harness disconnection and malfunction.
- Do not apply excessive impact to the SCV. It may result in fuel leakage or malfunction. There is the risk of fuel leakage and malfunction.

After the work is complete, check that the parts, check the replaced parts for correct operation using the failure diagnosis tool (SA-D).

2. Replacing the Hollow Screws

Among the supply pump components, the hollow screws are service parts which are prepared as a kit and can be replaced. Be sure to follow the failure diagnosis process when deciding whether or not replacement is necessary.

2.1 Precautions for replacement

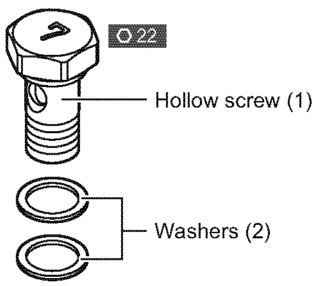
- Be sure that foreign matter do not contact or enter the replacement parts or inside of the product, as they can cause fuel leakage and malfunction.
- In order to prevent malfunction, do not drop replacement parts or apply excessive impact.

NOTICE

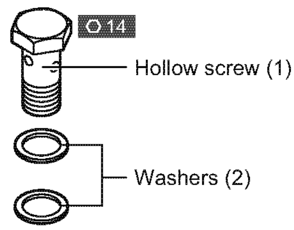
- Be sure to observe the following in order to prevent the intrusion of foreign matter into the product.
  - Wear a clean work clothing and perform the work with clean bare hands. Do not wear gloves.
  - Perform the work in an environment where sand and dust cannot enter, and stop fans or other equipment while working.
  - Before starting work, clean the area around the work location and the work bench.
  - Do not leave the parts unattended during replacement.

2.2 Checking the parts

There are hollow screws used at the fuel inlet and fuel outlet (Fig.50-28).
Check that all kit parts are included.



Fuel inlet kit part number: 129978-51300
048076-00EN00



Fuel outlet kit part number: 129978-51400
048077-00EN00

Fig.50-28

NOTICE

- Be sure to observe the following in order to prevent the foreign matter from contacting the parts.
  - Do not place parts on a dirty work bench. Never touch parts with dirty hands.
  - Do not unseal the parts before the replacement work.
- Do not use any components have been dropped.

2.3 Removing the hollow screws

1 - Carefully clean around the hollow screws using cleaning fluid, nylon brush, air blow, or other means.

2 - Slightly turn the hollow screws at the fuel inlet side (1, Fig.50-29) and fuel outlet side (2, Fig.50-29) counterclockwise to loosen them, then clean the fastening location again. (This is done to remove any paint chips or other foreign matter generated when the bolts were loosened.)

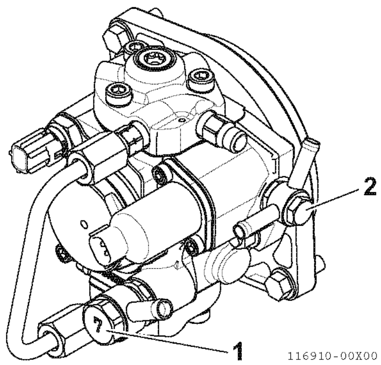


Fig.50-29

3 - Remove the hollow screws, taking care that the washers do not fall off. In order to prevent foreign matter from entering the pump body, install each new hollow screw immediately after removing the old hollow screw.

NOTICE

- Prevent foreign matter from entering the pump.
- Never reuse the used hollow screws or washers.

2.4 Installing the hollow screws

1 - Install the hollow screws and washers to the engine-side low-pressure line on the fuel inlet side and fuel outlet side.

NOTICE

- Be sure to observe the following in order to prevent contact with foreign matter.
  - Make sure that the mounting surface is free of foreign matter and scratches.
  - Do not touch with dirty hands.
- Do not use any components have been dropped.
- Install the washer one each to both ends of the pipe.

2 - Turn the hollow screws clockwise and tighten them into the pump threads by hand. Take care to avoid applying excessive stress to the piping at this time.

3 - Tighten the hollow screws to the specified torque using a 22 or 14 socket wrench.

Tightening torque	Fuel inlet-side hollow screw (M6 × 1.0)	17.2 ± 2.4 N·m
	Fuel outlet-side hollow screw (M6 × 1.0)	10.3 ± 2.4 N·m

NOTICE

Be sure to prevent foreign matter from entering matter do not enter the piping connections.

3. Replacing the Fuel Temperature Sensor

Among the supply pump components, the fuel temperature sensor is a service part which is prepared as a kit and can be replaced. Be sure to follow the failure diagnosis process when deciding whether or not replacement is necessary.

3.1 Precautions for replacement

- Be sure that foreign matter do not contact or enter the replacement parts or inside of the product, as they can cause fuel leakage and malfunction.
- In order to prevent malfunction, do not drop replacement parts or apply excessive impact.

NOTICE

- Be sure to observe the following in order to prevent the intrusion of foreign matter into the product.
  - Wear a clean work clothing and perform the work with clean bare hands. Do not wear gloves.
  - Perform the work in an environment where sand and dust cannot enter, and stop fans or other equipment while working.
  - Before starting work, clean the area around the work location and the work bench.
  - Do not leave the parts unattended during replacement.
- Disconnect the battery (-) terminal before starting work.

3.2 Checking the parts

Kit part number: 1299978-51200

Check that all kit parts are included.

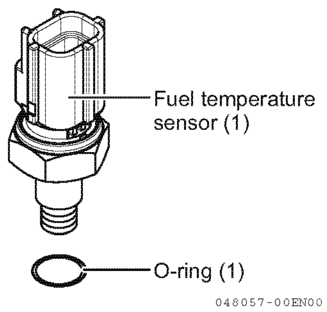


Fig.50-30

NOTICE

- Be sure to observe the following in order to prevent foreign matter from contacting the parts.
  - Do not place parts on a dirty work bench. Never touch parts with dirty hands.
  - Do not unseal the parts before the replacement work.
- Do not use any components have been dropped.

3.3 Removing the fuel temperature sensor

The fuel temperature sensor is installed on the inside of the supply pump therefore, it is necessary to remove the supply pump from the engine in order to remove the sensor. See 5100-02-01-01 “Removing the Supply Pump”.

1 - Prior to removing, carefully clean around the part where the fuel temperature sensor (1, Fig.50-31) is installed using cleaning fluid, nylon brush, air blow, or other means.

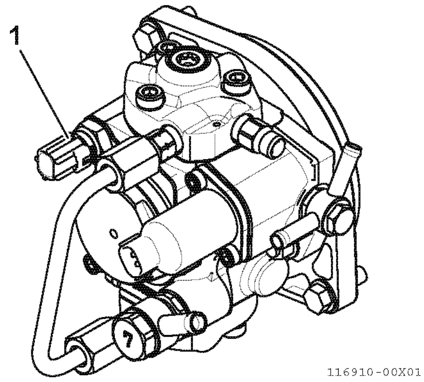


Fig.50-31

2 - Slightly turn the fuel temperature sensor counterclockwise to loosen it, loosen the fuel temperature sensor by turning it counterclockwise (Fig.50-32) then clean the fastening location again. (This is done to remove any paint chips or other foreign matter generated when the bolts were loosened.) When loosening the fuel temperature sensor, use a wrench or similar tool and place it securely on the hexagon nut.

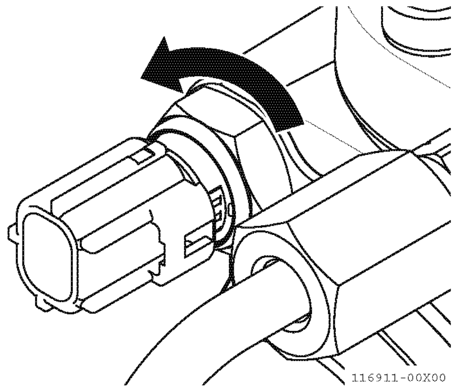


Fig.50-32

3 - Remove the fuel temperature sensor, taking care that the O-ring does not fall off. In order to prevent foreign matter from entering the pump body, install the new fuel temperature sensor immediately after removing the old fuel temperature sensor.

NOTICE

- Prevent foreign matter from entering the pump.
- Never reuse the used fuel temperature sensor or O-ring.

3.4 Installing the fuel temperature sensor

1 - Install the fuel temperature sensor (1, Fig.50-33) and O-ring (2, Fig.50-33) to the fuel temperature sensor mounting part on the supply pump.

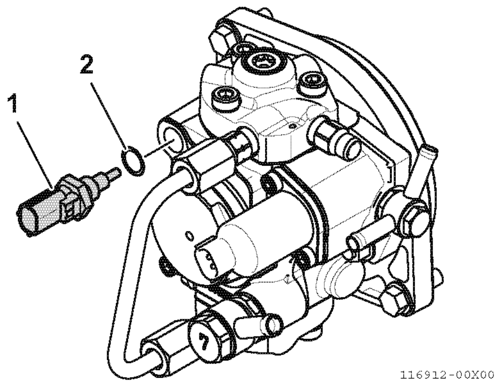


Fig.50-33

NOTICE

- Be sure to observe the following in order to prevent contact with foreign matter.
  - Make sure that the mounting surface is free of foreign matter and scratches.
  - Do not touch with dirty hands.
  - Be sure to prevent foreign matter from entering matter do not contact the O-ring.
- Do not use any components have been dropped.
- Check that the O-ring is correctly installed to the fuel temperature sensor.

2 - Turn the fuel temperature sensor clockwise and tighten it by hand. Do not grasp the connector when tightening.

3 - Tighten the fuel temperature sensor to the specified torque using a torque wrench.

Tightening torque	Fuel temperature sensor (M12 × 1.25)	22.0 ± 4.5 N·m

NOTICE

- Do not grasp the connector when tightening. Doing so may damage the connector and result in malfunction.
- Be sure to prevent foreign matter from entering matter do not enter the fastening part.

4 - Install the supply pump onto the engine. For the installation procedure, see 5100-02-03-01 “Attaching the Supply Pump”.

5 - Connect the fuel temperature sensor connector.

NOTICE

- Make sure that there are no foreign matter inside the connector. Foreign matter may cause malfunction or short circuit. If any matter is present, use an air blow or other means to fully remove it.
- Connect the fuel temperature sensor harness in the prescribed path, and make sure there is no excessive slack or tension in the harness. There is the risk of harness disconnection and malfunction.

After work is complete, check the replaced parts for correct operation using the failure diagnosis tool (SA-D).

4. Replacing the Pressure Limiter

Among the rail components, the pressure limiter is a service part which is prepared as a kit and can be replaced. Be sure to follow the failure diagnosis process when deciding whether or not replacement is necessary.

4.1 Precautions for replacement

- Be sure that foreign matter do not contact or enter the replacement parts or inside of the product, as they can cause fuel leakage and malfunction.
- In order to prevent malfunction, do not drop replacement parts or apply excessive impact.

NOTICE

- Be sure to observe the following in order to prevent the intrusion of foreign matter into the product.
  - Wear a clean work clothing and perform the work with clean bare hands. Do not wear gloves.
  - Perform the work in an environment where sand and dust cannot enter, and stop fans or other equipment while working.
  - Before starting work, clean the area around the work location and the work bench.
  - Do not leave the parts unattended during replacement.
- Disconnect the battery (-) terminal before starting work.

4.2 Checking the parts

Kit part number: 129G01-57200
Check that all kit parts are included.

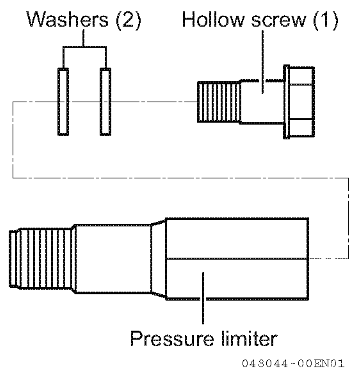


Fig.50-34

NOTICE

- Be sure to observe the following in order to prevent foreign matter from contacting the parts.
  - Do not place parts on a dirty work bench. Never touch parts with dirty hands.
  - Do not unseal the parts before the replacement work.
- Do not use any components have been dropped.

4.3 Removing the pressure limiter

When replacing the pressure limiter, it can be removed and installed with the common rail being installed to the engine. When removing, remove any peripheral parts as necessary before starting.

1 - Carefully clean around the SCV using cleaning fluid, nylon brush, air blow, or other means.

2 - Use a tool and slightly turn the hollow screw (1, Fig.50-35) counterclockwise to loosen it, then clean the fastening part again carefully to remove any paint chips or other foreign matter generated when the bolts were loosened. Then remove the hollow screw and hose joint (2, Fig.50-35), taking care that the washers do not fall off.

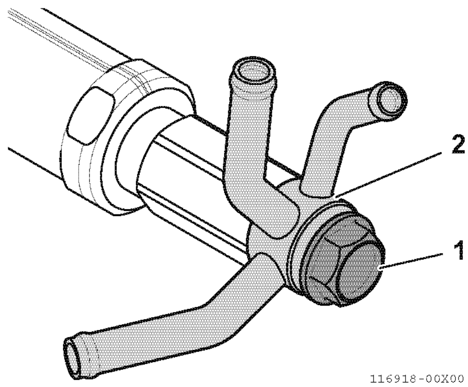


Fig.50-35

NOTICE

- Be sure to prevent foreign matter from entering matter do not enter the rail body fastening part.
- Never reuse the used hollow screws or washers.

3 - In the same way as the hollow screw, use a tool and slightly turn th pressure limiter (1, Fig.50-36) counterclockwise to loosen it, then clean the fastening part again carefully to remove any paint chips or other foreign matter generated when the bolts were loosened. Be sure to prevent foreign matter from entering matter do not enter the pressure limiter opening. Then remove the pressure limiter from the rail. In order to prevent foreign matter from entering the rail body, install the new pressure limiter immediately after removing the old pressure limiter.

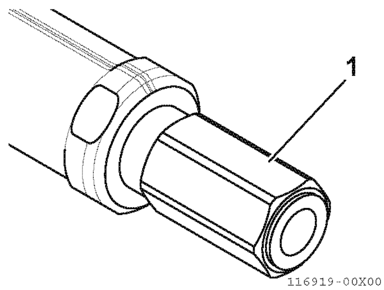


Fig.50-36

NOTICE

Never reuse the used pressure limiter.

4.4 Installing the pressure limiter

1 - Install the pressure limiter to the common rail, and temporarily tighten it.

NOTICE

- Be sure to prevent foreign matter from entering matter do not contact the seal surface.
- Be sure to prevent foreign matter from entering matter do not enter the rail body fastening part.
- Do not use any components have been dropped.

2 - Use a tool and torque wrench to fully tighten the pressure limiter. Follow the procedure below and perform angle tightening.

Tightening procedure by using angle control method

1 - Tighten the limiter to the snug torque (the torque necessary to ensure tight contact between the threads and seat) of 30 ± 3 N·m.

2 - Then tighten further at an angle of 24 ± 1°.

3 - Check that the tightening monitor torque is T ≤ 300 N·m.

Tightening torque	Pressure limiter	Refer to the above angle tightening procedure

NOTICE

- Both the tightening angle and monitor tightening torque must satisfy the standards.
  If they do not, there is the risk of fuel leakage and malfunction.
- Be sure to prevent foreign matter from entering matter do not enter the rail body fastening part.

3 - Install the hose joint (2, Fig.50-37), washers (3, Fig.50-37), and hollow screw (4, Fig.50-37) to the pressure limiter (1, Fig.50-37). Install the washer one each to both ends of the hose joint.

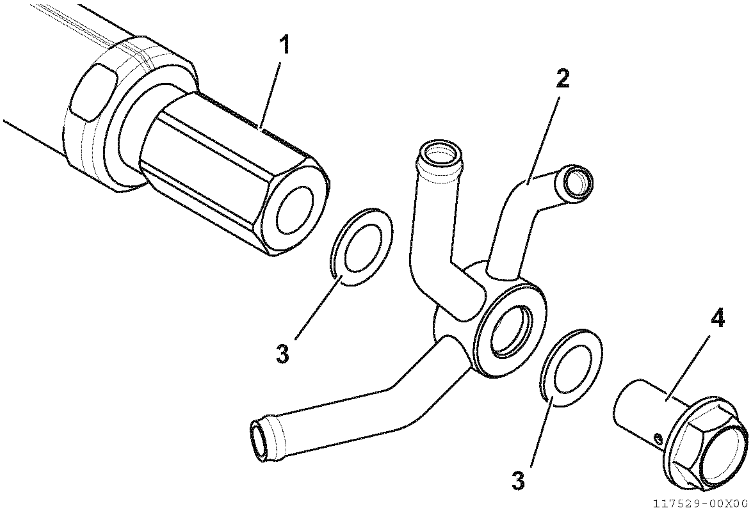


Fig.50-37

NOTICE

- Be sure to observe the following in order to prevent contact with foreign matter.
  - Make sure that the mounting surface is free of foreign matter and scratches.
  - Do not touch with dirty hands.
- Do not use any components have been dropped.

4 - After temporarily tightening the hollow screw by hand, fully tighten using a tool and torque wrench.

Tightening torque	Pressure limiter hollow screw (M10 × 1.0)	20.2 ± 2.4 N·m

NOTICE

- Take care to avoid applying excessive stress to the piping.
- Be sure to prevent foreign matter from entering matter do not enter the fastening part.

1. Starter Components

A conventional magnetic engaging starter is used on the 4TN107 series engines. The conventional starter has a pinion and armature shaft that are coaxial. With this type of starter, the pinion is pushed by the solenoid force via the drive lever for engagement with the flywheel ring gear.

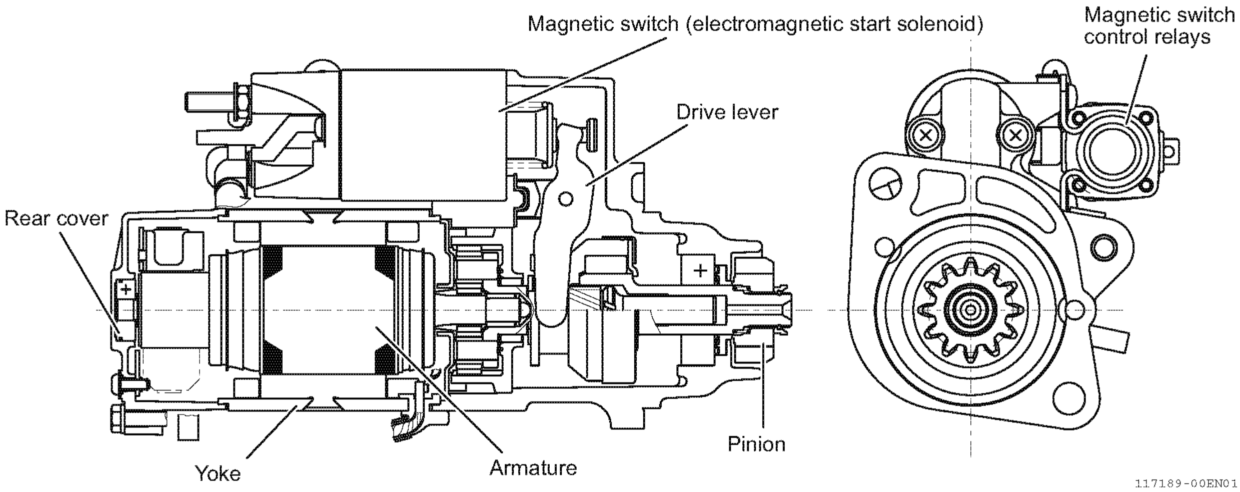


Fig.70-1

2. Function of the Magnetic Switch

Fig.70-2 shows the detailed view of the magnetic switch (electromagnetic starter solenoid).
When turning the key switch to START position, battery voltage is applied to the S terminal, and current flows through the pull-in coil and holding coil. These coils pull the plunger, and push out the pinion via the driver lever. At the same time, moving contact is closed, allowing battery current to flow through the armature.

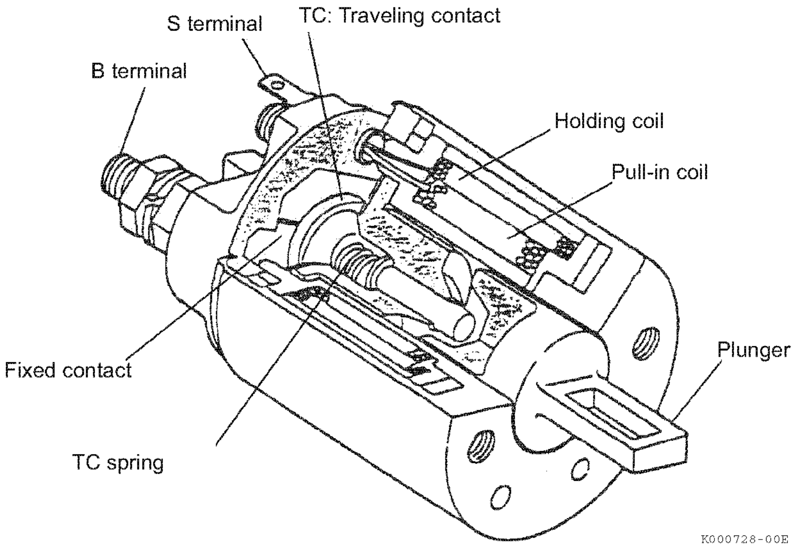


Fig.70-2

3. Main Specifications and Standard Value of the Starter

3.1 Main specifications

YANMAR Part No.	Mfg.	Manufacturer's part number	Specifications
129G01-77000	Mitsubishi	MT008T64971	24 V DC - 5.0 kW
129G01-77012	Mitsubishi	M-10081-70	12 V DC - 3.6 kW

3.2 Standard value

1	YANMAR Part No.			129G01-77000	129G01-77012
2	Nominal output			5.0 kW	3.6 kW
3	mass			7.5 kg	7.5 kg
4	Revolution direction (as viewed from pinion)			Clockwise	Clockwise
5	Engagement system			Electromagnetic engagement (auxiliary rotation)	Electromagnetic engagement (auxiliary rotation)
6	Guaranteed specifications	No load	Terminal voltage	23 V	11 V
			Current	85 A or less	170 A or less
			Rotation speed	3300 min^{-1} or more	3400 min^{-1} or more
		Loaded	Terminal voltage/current	18.5 V / 400 A	8.8 V / 550 A
			Torque	25.50 N·m or more	16.20 N·m or more
			Rotation speed	1250 min^{-1} or more	1400 min^{-1} or more
		Restraint	Terminal voltage	9 V	2.5 V
			Current	1400 A or less	1300 A or less
			Torque	88.26 N·m or more	37.3 N·m or more
7	Clutch system			Overrunning	Overrunning
8	Operating voltage of electromagnetic switch 20 °C)			16 V or lower	8 V or lower
9	Pinion diameter pitch or module/Number of teeth			M3 / 12	M3 / 12

1. Removing the Starter

⚠ WARNING

Shock Hazard!

- **Turn off the battery switch (if equipped) or disconnect the negative battery cable before servicing the electrical system.**
- **Check the electrical harnesses for cracks, abrasions, and damaged or corroded connectors. Always keep the connectors and terminals clean.**
- **Failure to comply could result in death or serious injury.**

1. Remove the battery cables from the battery. Remove the negative cable first.
2. Remove the cable from the terminal B (2, Fig.70-3) of the magnetic switch assembly (1, Fig.70-3), and remove the cable from the terminal (4, Fig.70-3) of the magnetic switch control relay (3, Fig.70-3).

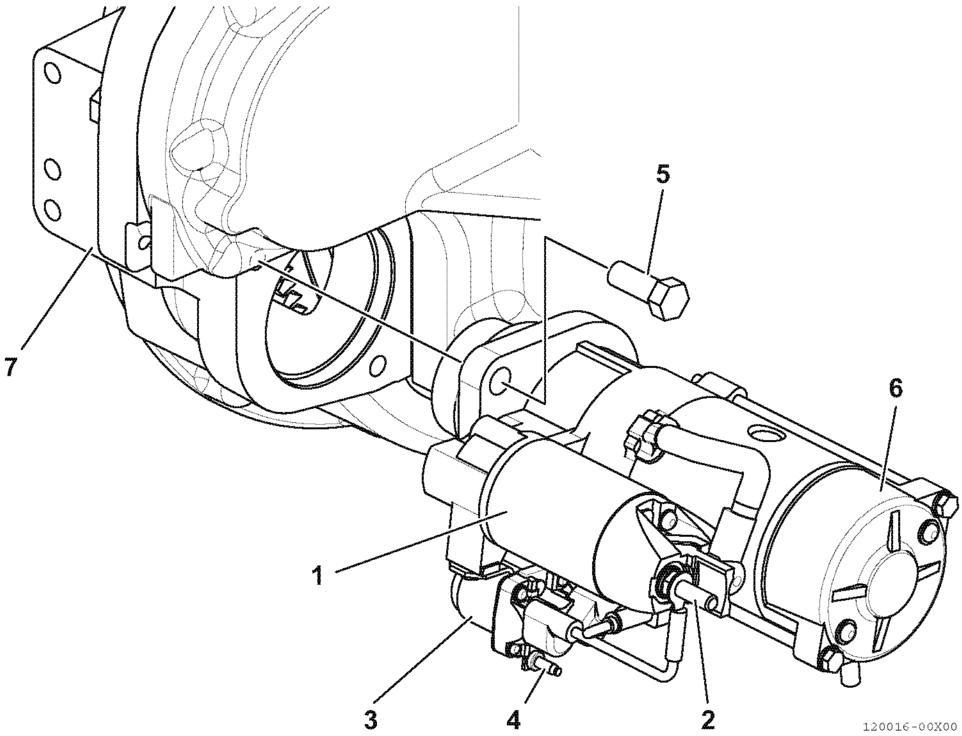


Fig.70-3

3. Remove the two starter bolts (5, Fig.70-3), and remove the starter (6, Fig.70-3) from the flywheel housing (7, Fig.70-3).

1. Installing the Starter

1. Install the starter to the flywheel housing.
2. Install the starter (1, Fig.70-4) to the flywheel housing (2, Fig.70-4), and tighten the mounting bolts (3, Fig.70-4) to the specified torque. See 0000-07-03-01 “Standard Torque”.

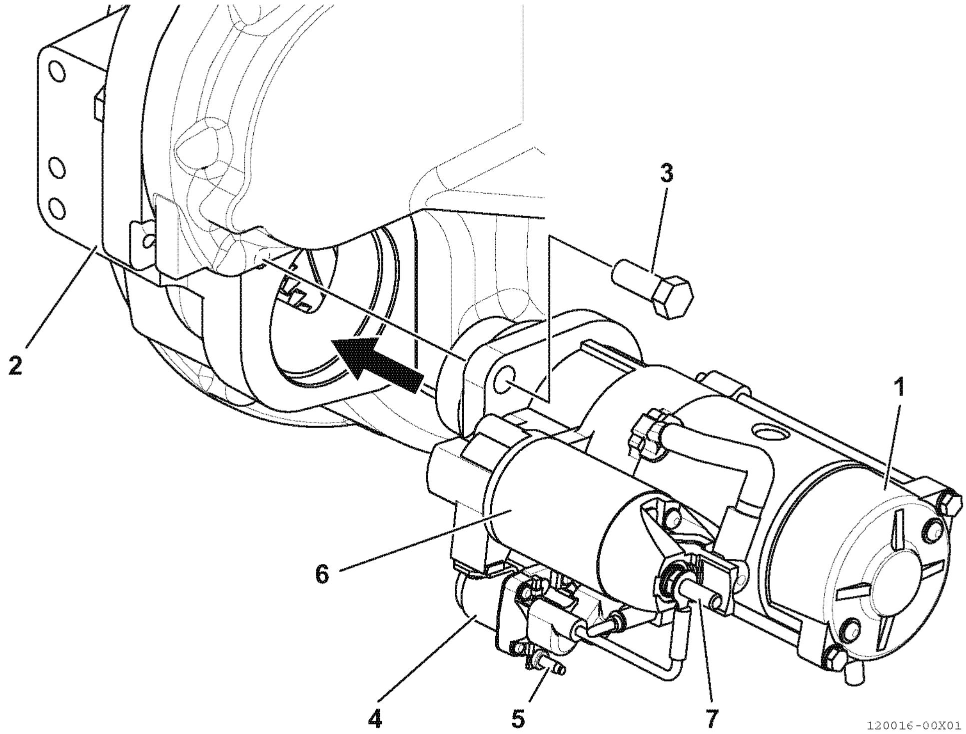


Fig.70-4

3. Connect the electrical wire coming from the driven machine to the terminal (5, Fig.70-4) of the magnetic switch control relay (4, Fig.70-4), and connect the cable coming from the battery to the terminal B (7, Fig.70-4) of the magnetic switch assembly (6, Fig.70-4).
4. Connect the battery cables to the battery. Be sure to place the cover over the battery positive (+) cable connection.

1. Causes and Preventive Measures of Starter Failure

1. Causes of starter failure

The starter may have a starting failure caused by insufficient battery charge or failures in the fuel system. However, there are main two possible malfunctions that cause the starter failure.

- If current flows through the starter S terminal for more than the specified period such as overcranking or overrunning, the holding coil of the magnetic switch will be burned or the insulation in the pull-in coil will deteriorate.
- As the wiring resistance in the starter circuit increases, an electric potential difference is generated between the S terminal and the movable contact. As a result, an arc is generated at the movable contact because the plunger repeatedly moves at high speed, resulting in contact point melting.

If those malfunctions occur, it will lead to the following starter failures.

No.	Malfunction		Analysis
1	When the key switch is turned to START, the pinion repeatedly engages and disengages with the ring gear.		The pull-in coil pulls the plunger, and the pinion is pushed out. However, if the holding coil is burned, the holding force is reduced. As a result, the pinion is pushed back again by the return spring.
2	Even when the key switch is turned back to ON after the engine start, the starter keeps rotating.	Pinion is not returned	As the magnetic force is reduced due to the layer short-circuit in the pull-in coil, the magnetic force in the holding coil is surpassed. As a result, the plunger is continuously pulled. However, as the movable contact is kept closed, the battery current flows through the armature, that rotates the pinion engaged with the ring gear. In addition, the pinion is also driven by the engine.
3		Pinion is returned	When the key switch is turned back to ON, the plunger returns. However, if the movable contact melts, the battery current flows through the armature, and the pinion continuously rotates in the returned position.

Note: The causes of the above malfunctions are as follows: burning of the holding coil for No. 1, insulation deterioration of the pull-in coil for No. 2, and melting of the movable contact for No. 3. Those three are all applicable to the above mentioned two possible malfunctions.
See Fig.70-5 for each part name and location.

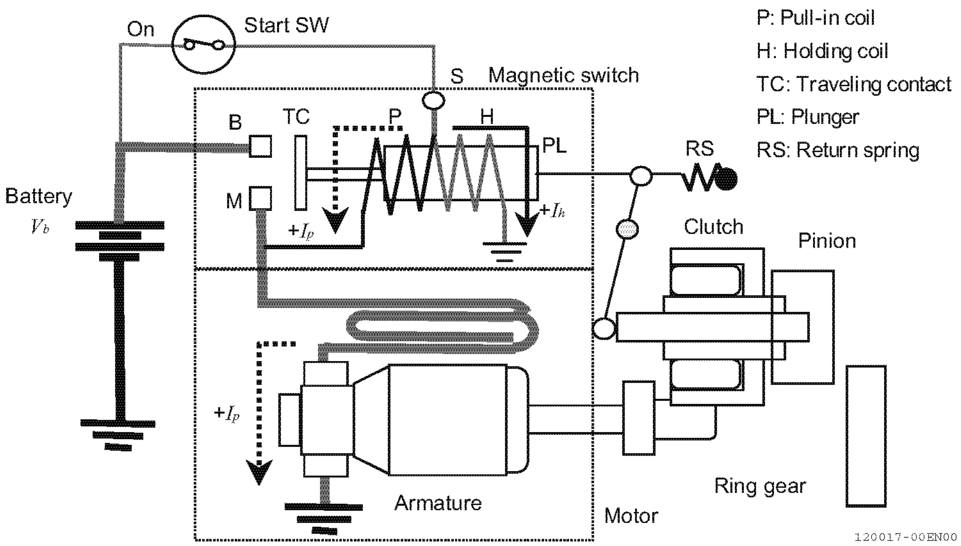


Fig.70-5

2. Preventive measures of starter failure

To prevent failures, follow the cautions for use listed below.

1 - Conform to the energized duration of starter

Do not energize the starter for more than the specified time such as cranking for a long time to bleed air from the fuel supply system.

- Recommended limit of continuous energizing: 15 seconds and the starter motor must never be energized for more than 30 seconds.
- If the starter motor has been energized for 15 seconds or longer, it should be turned off for over one minute.

2 - Check the failure of the key switch

If the key switch does not return from START to ON due to the key switch failure, the holding coil may burn due to the flow of current through the coil for a long period. Check the conduction of the key switch.

3 - Cautions for resistance in the starter circuit

The resistance in the starter circuit should be within the allowable range. The resistance is reduced due to corrosion in the terminal. Check the wire harness of the starer circuit, and remove any corrosion.

1. Structure of Alternator

Alternators with built-in regulators (hereinafter, alternators) are belt driven, and charging the battery and supplying power to the electric load. The alternating current (AC) output by the alternator is rectified into direct current (DC) by an IC regulator. The IC regulator is mounted as part of the alternator.

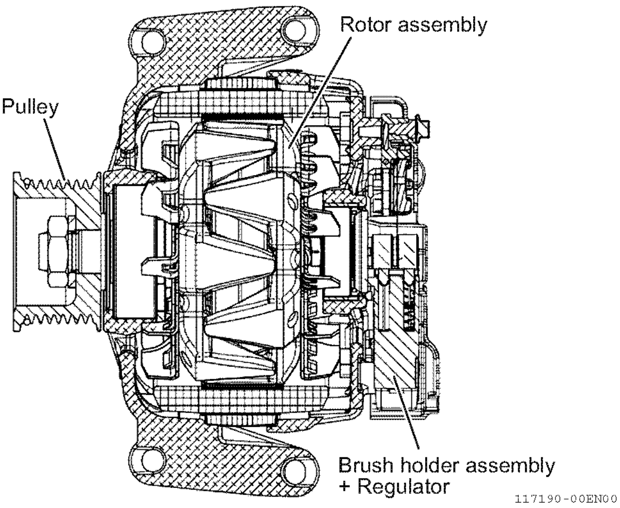
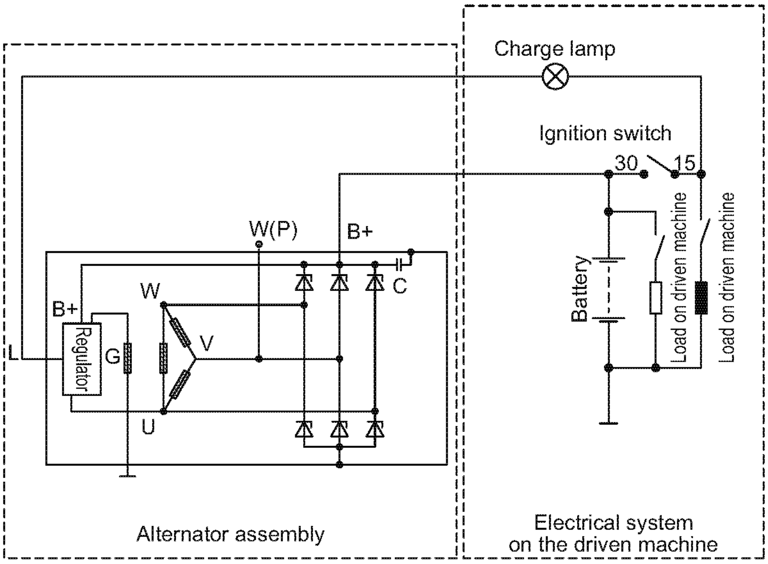


Fig.70-6

2. Alternator Wiring Diagram and Terminal Codes

Fig 70-7 shows the wiring diagram and terminal codes of the alternator assembly (typical 24 V - 80 A: 129G01-77200).



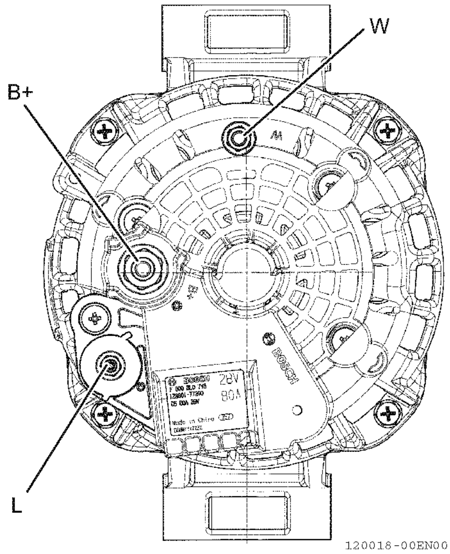


Fig.70-7

3. Main Specifications and Standard Value of the Alternator

3.1 Main specifications

YANMAR Part No.	Mfg.	Manufacturer's part number	Specifications
129G01-77200	SEG	F 000 BL5 0YE	DC 24 V - 80 A (With pulse)
129G01-77250	SEG	0 124 A01 627	DC 24 V - 150 A (With pulse)
129G01-77210	SEG	F 000 BL5 0KE	DC 12 V - 150 A (With pulse)
129G01-77260	SEG	0 124 A01 628	DC 12 V - 240 A (With pulse)

3.2 Standard value

YANMAR Part No.	129G01-77200	129G01-77250	129G01-77210	129G01-77260
Nominal output	28 V - 80 A	28 V - 150 A	14 V - 150 A	14 V - 240 A
Direction of rotation (viewed from pulley)	Clockwise	Clockwise	Clockwise	Clockwise
Rating	Continuous	Continuous	Continuous	Continuous
Battery Voltage	24 V	24 V	12 V	12 V
Rated speed	6000 min^{-1}	6000 min^{-1}	6000 min^{-1}	6000 min^{-1}
Operating range	1400 to 11000 min^{-1}	1700 to 11000 min^{-1}	1400 to 11000 min^{-1}	1700 to 15000 min^{-1}
Grounding characteristics	Grounding on negative (–) side	Grounding on negative (–) side	Grounding on negative (–) side	Grounding on negative (–) side
Integrated regulator	VR	GRH MFR	VR	GRH MFR
Outer diameter of pulley	57.33 mm	57.33 mm	57.33 mm	57.33 mm
Belt shape	V-ribbed belt	V-ribbed belt	V-ribbed belt	V-ribbed belt

1. Removing the Alternator

⚠ WARNING

Shock Hazard!

- **Turn off the battery switch (if equipped) or disconnect the negative battery cable before servicing the electrical system.**
- **Check the electrical harnesses for cracks, abrasions, and damaged or corroded connectors. Always keep the connectors and terminals clean.**
- **Failure to comply could result in death or serious injury.**

1. Remove the battery cables from the battery. Remove the negative cable first.
2. Remove the electrical wires from the alternator.
3. Loosen the auto tensioner of the cooling fan belt, and remove the belt. For removing the belt, see 4000-02-01-01 “Fan belt”.
4. Loosen the four bolts (2, Fig.70-8) that fasten the alternator (1, Fig.70-8), then remove the alternator. At this time, do not remove the top and bottom alternator brackets (3, Fig.70-8).

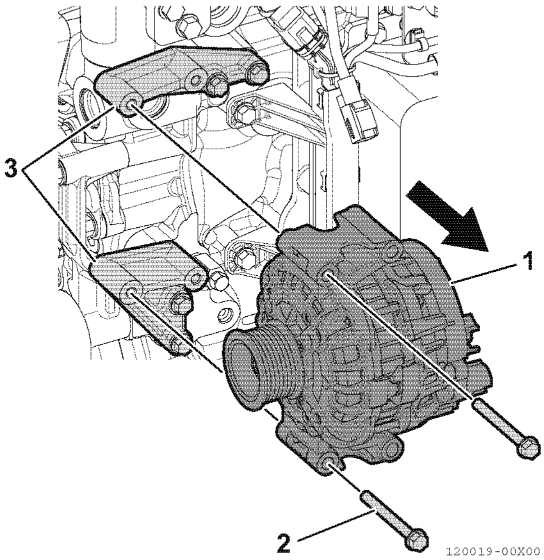


Fig.70-8

1. Installing the Alternator

1. For installing the alternator, follow the reverse procedure to the removal procedure.
2. While holding the alternator with hands, attach the bolts through the mounting holes, and tighten the bolts to install and fasten the alternator to the brackets. Temporarily tighten the bolts, and then fully tighten them to the specified torque.
   See 0000-07-03-01 “Standard Torque”.
3. Connect the electrical wires to the alternator.
   The size and tightening torque for the terminal nuts are as shown in the table below.

Tightening torque	B+ terminal nut (M8 × 1.25)	14.0 ± 1.0 N·m
	W (P) terminal nut (M5 × 0.8)	4.0 ± 1.0 N·m
	L terminal nut (M4 × 0.7)	1.0 ± 0.2 N·m

4. Install the belt. For installing the belt, see 4000-02-03-01 “Fan and belt”.
5. Turn the key switch ON, and make sure that the battery indicator comes on.
6. Start the engine. Make sure that the alternator is not producing unusual sounds.

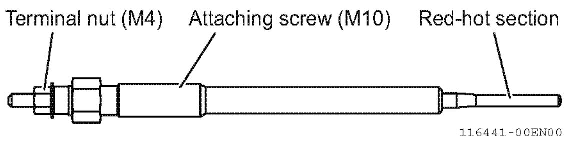
NOTICE

If the alternator is producing unusual sounds, stop the engine.
If not, it will result in damage to the alternator.

7. After starting the engine, make sure that the battery indicator goes out. If the indicator does not go out, check the belt and alternator for failures. If necessary, repair the failed parts and start the engine again.

1. Structure of Glow Plug

A glow plug is an electrically heated coil that is installed in the combustion chamber. Each cylinder is equipped with single glow plug.
It is heated by an electric current from the battery before starting the engine, and the combustion chamber is warmed up by the heat, making engine start easier.



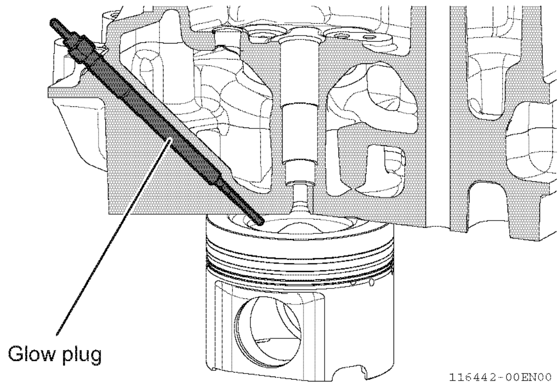


Fig.70-9

2. Glow Plug Specifications

Type name	Glow plug	Glow plug
Part No.	129G01-77800	129G01-77820
Rated voltage	DC23 V	DC11 V
Standard preheat time	10 sec.	6 sec.
Rated capacity	23/2.0 (V/A)	11/3.5 (V/A)
Water resistance	Equivalent to JIS D0203 S2	Equivalent to JIS D0203 S2

3. Engine Starting Aid Control

To easily start the engine at low temperature, the glow plug is energized via the glow plug relay based on the signal from the ECU. The starting aid control includes the following functions as standard.

3.1 On-glow control (preheat)

When the key switch is turned on, the glow plug relay is automatically energized for a time that corresponds to the engine coolant temperature. The preheat lamp comes on during the energization. The preheat time for the on-glow control is set as shown in Fig.70-10. Once the on-glow control has ended, wait until the key switch is in the starting position.

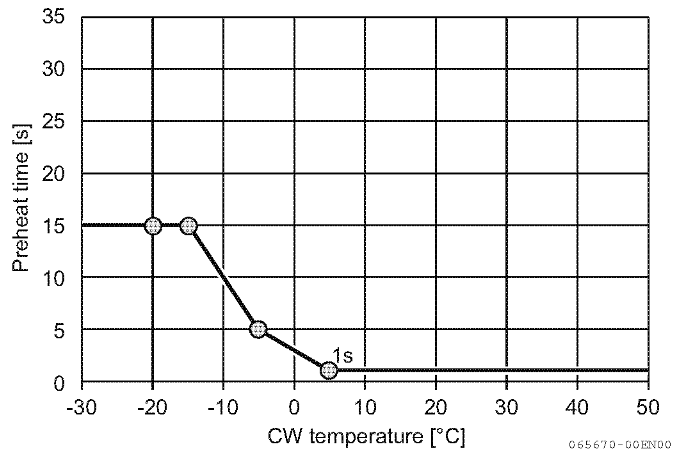


Fig.70-10

3.2 Simultaneous energizing control

Set the key switch to the START position and energize the glow plug relay also during starter actuation to easily start the engine. The finishing condition for the simultaneous energizing control is “Finish on engine start recognition signal” (the glow plug is not energized when the key switch has been operated to a position other than the START position).

3.3 Disconnection detection

Disconnection and short circuit of the glow plug relay are detected by the ECU.

3.4 Glow plug protection function

If the glow plug relay is turned “ON → OFF → ON” repeatedly by the engine starting aid control, the glow plug relay stops being energized for a certain period of time until it is re-energized (re-energizing prohibition time: 480 ms), in order to protect the glow plug and glow plug relay.

1. Removing the Glow Plug

1. Loosen the four M4 terminal nuts that fasten the glow plug connector (1, Fig.70-11) and the glow plug (2, Fig.70-11), and then remove the glow plug connector and the glow plug harness (3, Fig.70-11).

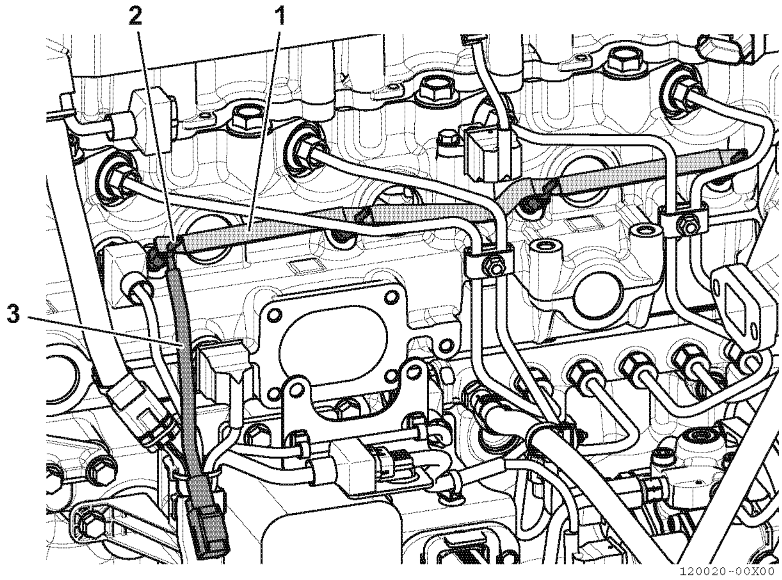


Fig.70-11

2. Loosen the M10 screw of the glow plug (1, Fig.70-12), and remove the glow plug from the cylinder head.

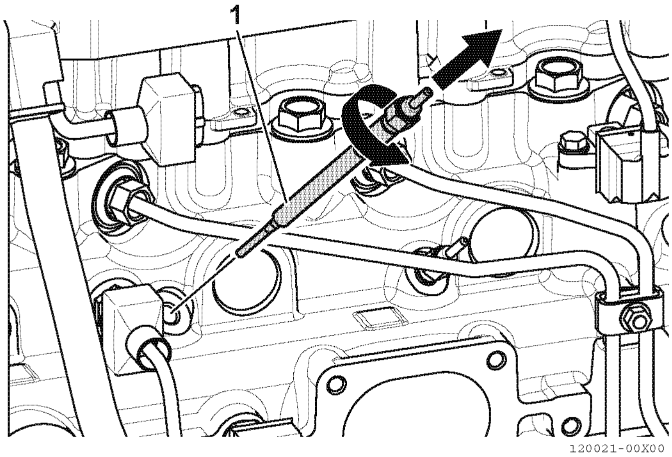


Fig.70-12

1. Installing the Glow Plug

For installing the glow plug, follow the reverse procedure to the removal procedure.

Tightening torque	Glow plug (M10 × 1.25)	17.5 ± 2.5 N·m
	Terminal nut (M4 × 0.7)	1.25 ± 0.25 N·m

1. Wire Harness Assembly Components

Harnesses, harness covers, and harness brackets are installed on the engine intake side as shown in Fig.70-13. The signals between sensors, control devices, and engine controller are sent from the connector coupler on the relay connector bracket via the relay connector on the driven machine.

The harness assembly is firmly mounted to the engine at three points: the harness clip bracket underneath the intake collector, harness cover (block) mounted next to the lubricating oil cooler, and harness covers (bonnet) top.

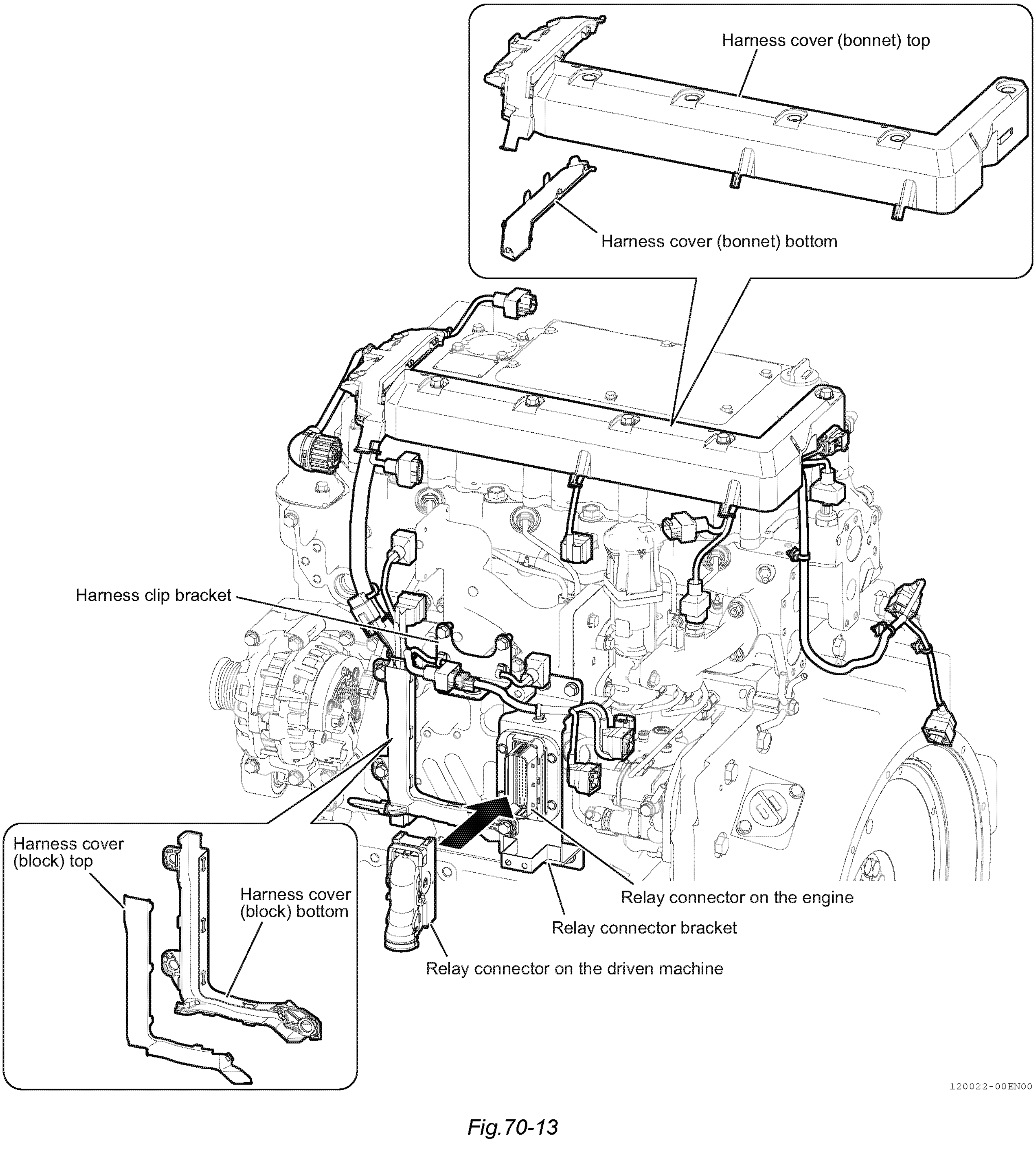


Fig.70-13

2. Sensors and Wire Harness Layout

Fig.70-14 shows the layout of the wire harnesses (standard) that connect sensors and control signal couplers.

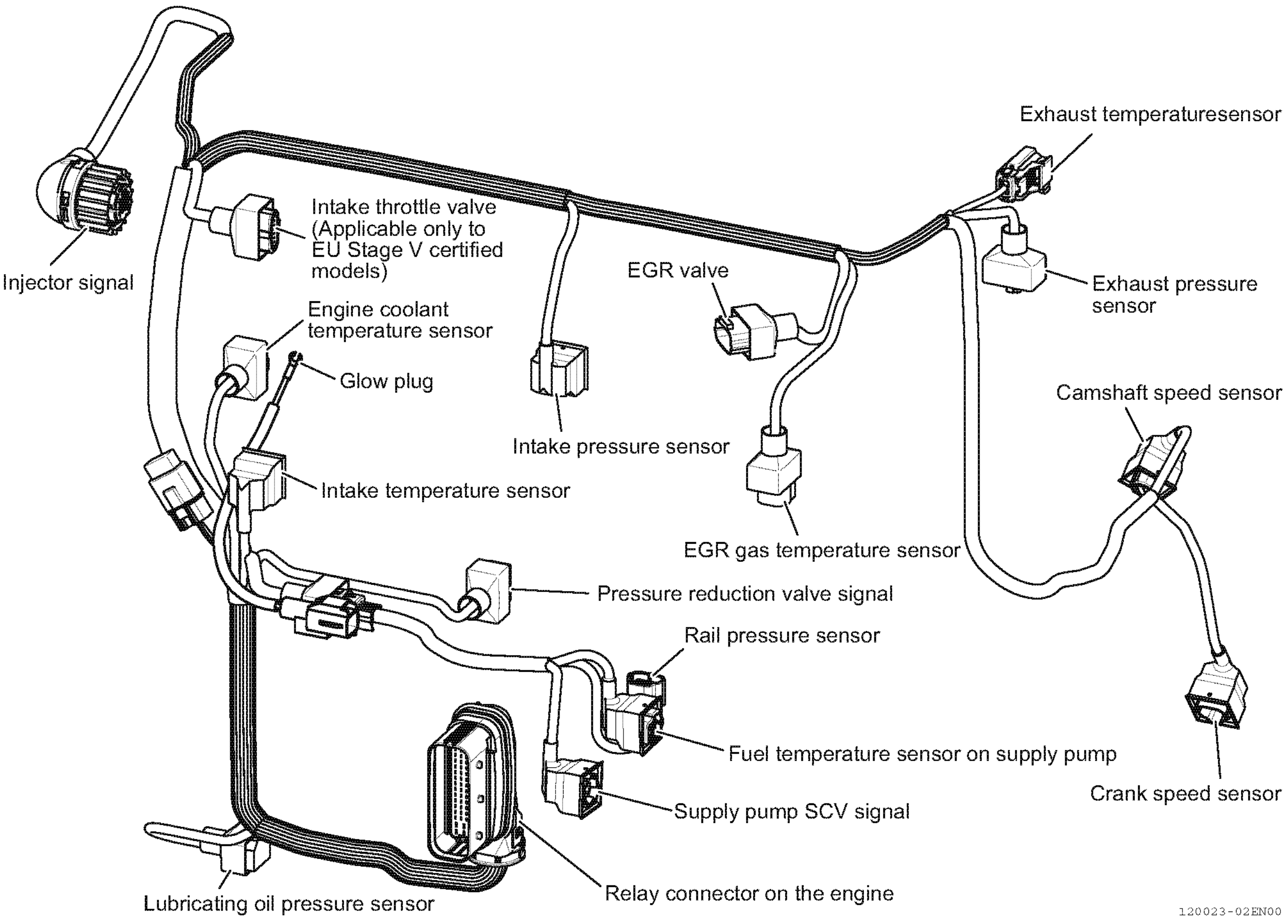


Fig.70-14

1. Removing the Wire Harness Assembly

1. Remove the connectors for sensors and signals shown in Fig.70-14. Remove the clips that fasten the harnesses to the cylinder block (where necessary).
2. Loosen the M8 bolts × 3 (2, Fig.70-15) that fasten the harness cover (block) (1, Fig.70-15). Loosen the M8 bolts × 2 (4, Fig.70-15) that fasten the harness clip bracket (3, Fig.70-15). Loosen the M8 bolts × 4 (6, Fig.70-15) that fasten the relay connector bracket (5, Fig.70-15).
3. Remove the M8 bolts × 7 (8, Fig.70-15) that fasten the harness cover (bonnet) (7, Fig.70-15).

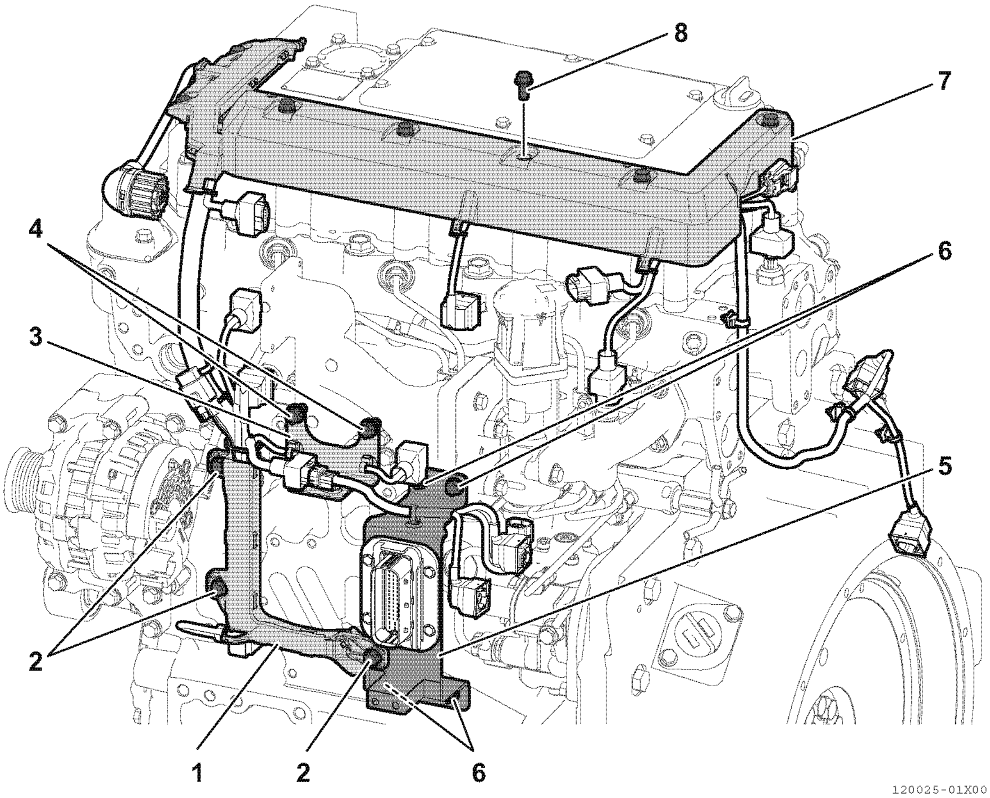


Fig.70-15

4. Remove the harness assembly together with the harness cover (bonnet) (1, Fig.70-16), harness cover (block) (2, Fig.70-16), harness clip bracket (3, Fig.70-16), and relay connector bracket (4, Fig.70-16).

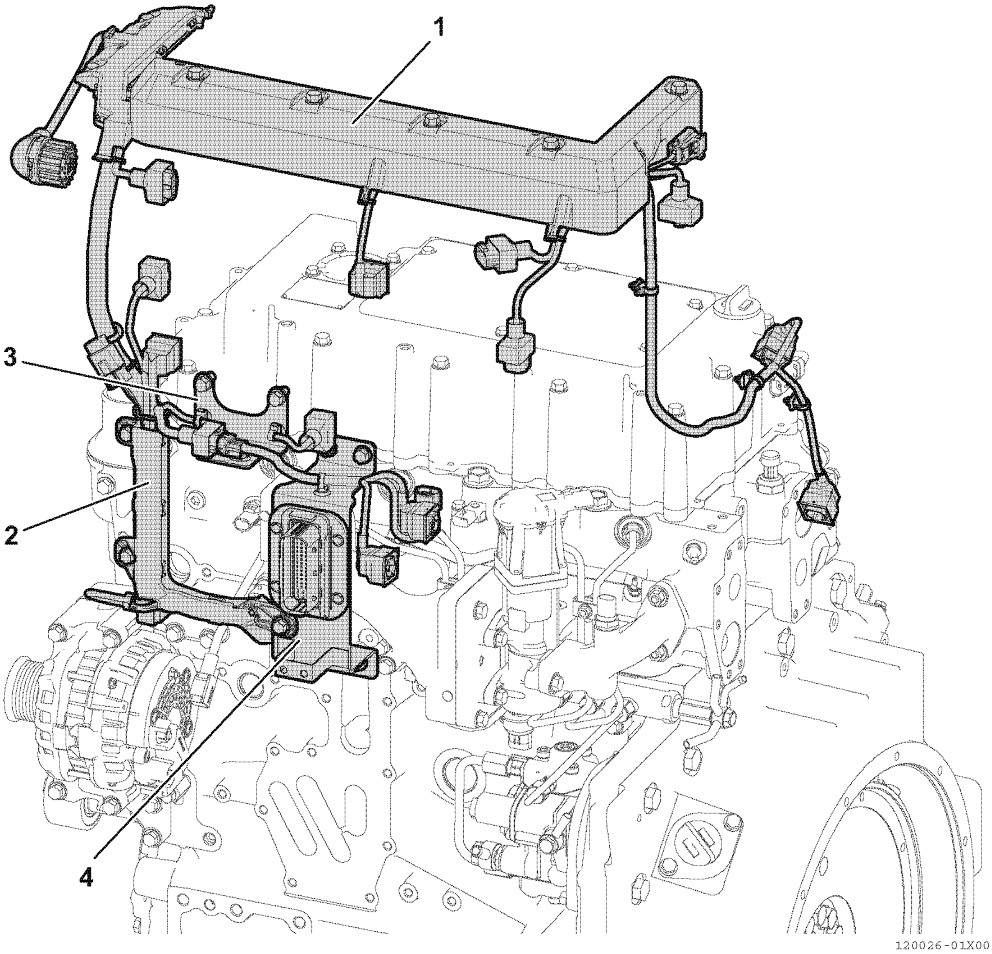


Fig.70-16

5. The structure of the relay connector is shown in Fig.70-17. The engine relay connector is inserted to the connector adapter fitted to the relay connector bracket with bolts, and fastened using the connector clip.

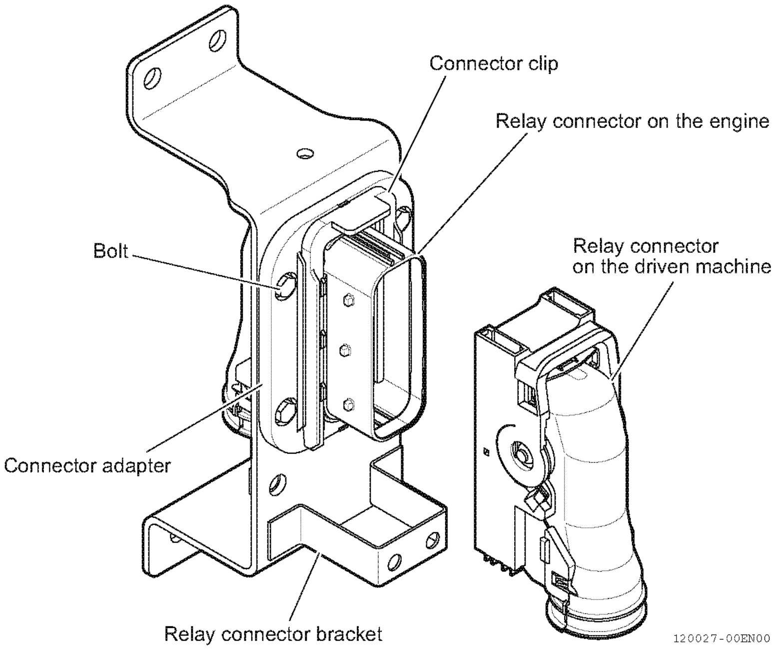


Fig.70-17

6. Fig.70-18 shows the procedure for removing the relay connector of the removed wire harness assembly from the connector bracket.
   1 - Pull the connector clip upward.
   2 - Pull the engine relay connector from the connector adapter.
   3 - If necessary, loosen the bolts, and remove the connector adapter from the relay connector bracket.

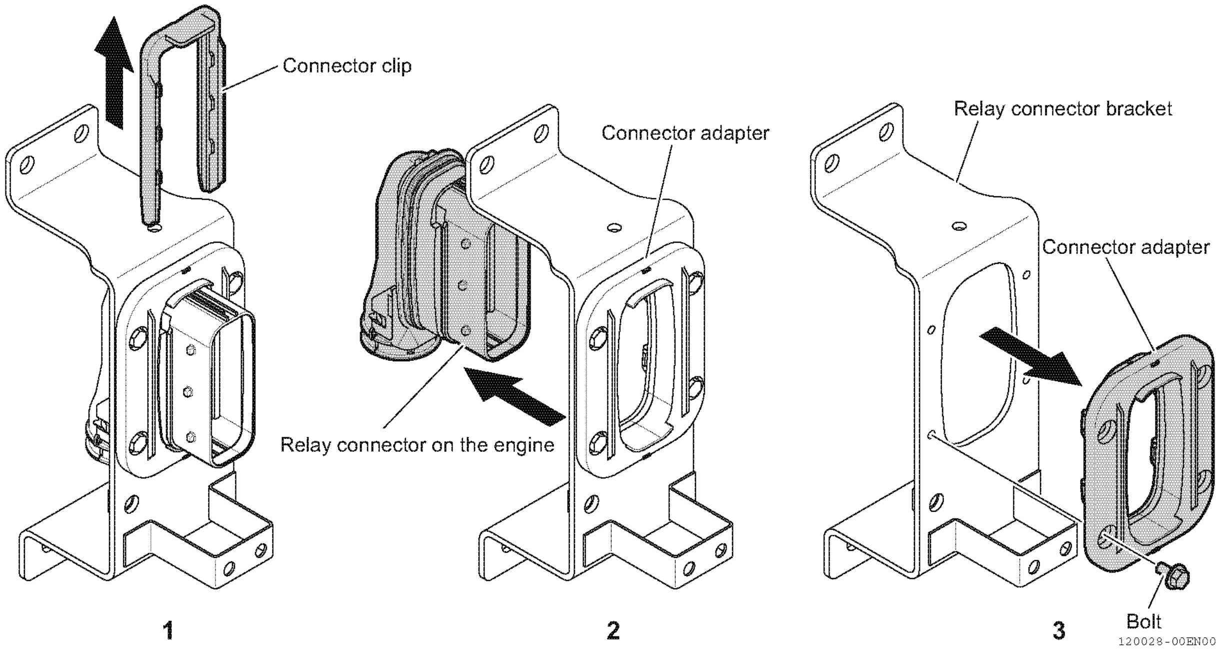


Fig.70-18

1. Installing the Wire Harness Assembly

1. Place the harness assembly on the engine intake side.
2. First, attach the harness cover (bonnet) (1, Fig.70-19) to the bonnet, and fasten it using the M8 bolts × 7 (2, Fig.70-19).
3. Use M8 bolts × 2 (4, Fig.70-19) for the harness clip bracket (3, Fig.70-19), and M8 bolts × 4 (6, Fig.70-19) for the relay connector bracket (5, Fig.70-19), and M8 bolts × 3 (8, Fig.70-19) for the harness cover (block) (7, Fig.70-19), attach and tighten them to the cylinder block.

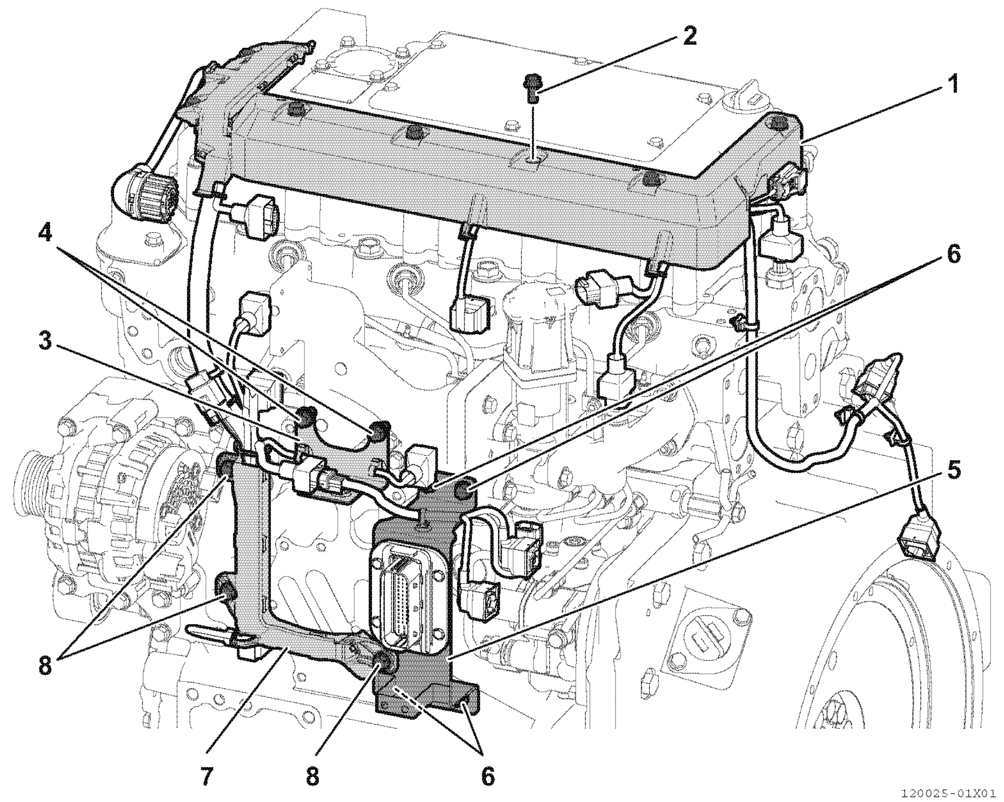


Fig.70-19

4. Attach the sensor and control signal couplers, which were removed, to the counterpart connectors. Put the clamps which were removed while removing the harness assembly.
5. Connect the relay connector on the engine and the relay connector on the driven machine.

1. Installation Location of Sensors

1.1 Engine

Fig.70-20 shows installation locations of sensors and valve signals equipped to the 4TN107 engine.

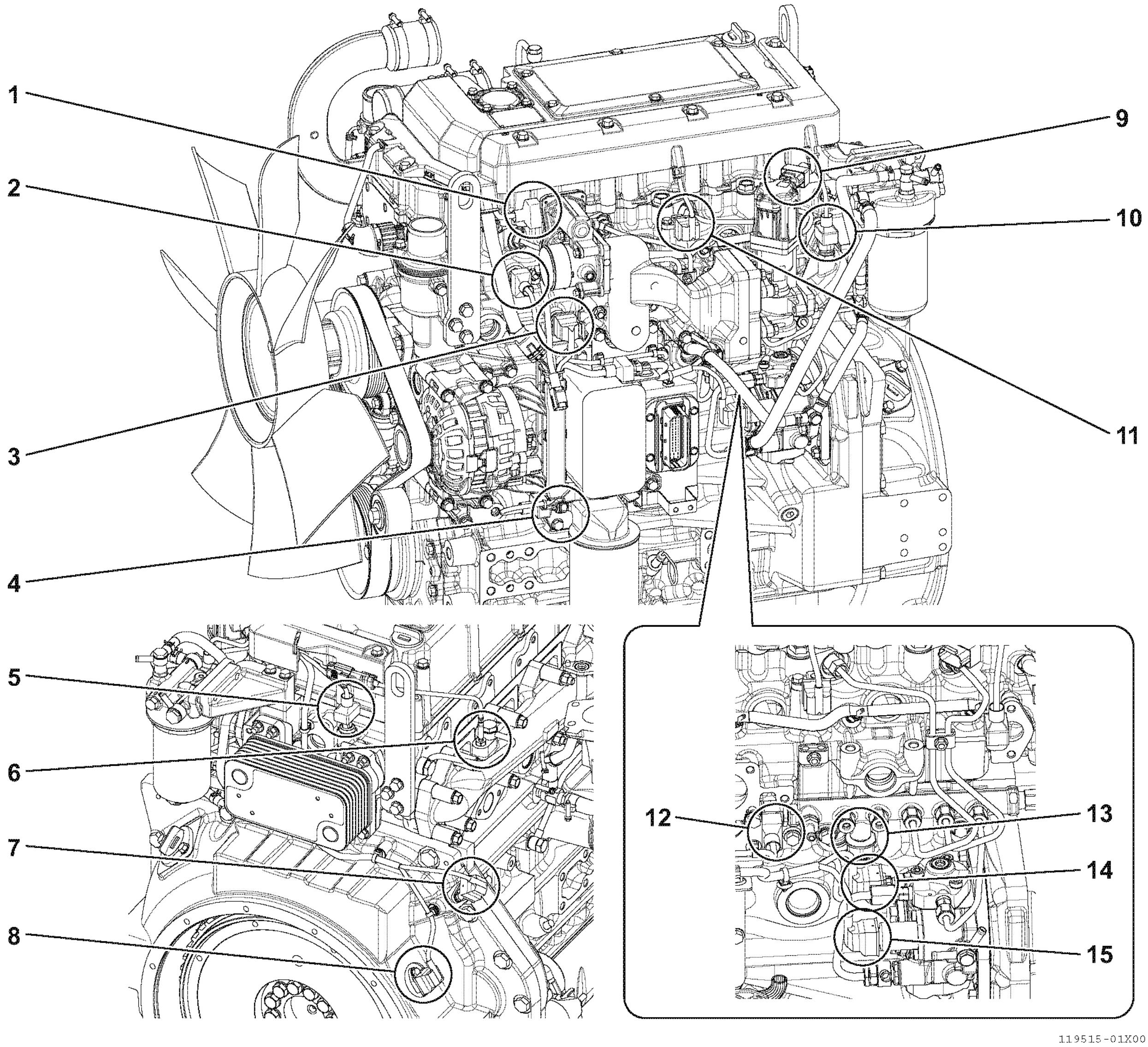


Fig.70-20

1 - Intake throttle valve signal (applicable only to EU Stage V certified models)	8 - Crank speed sensor 9 - EGR valve signal
2 - Engine coolant temperature sensor	10 - EGR gas temperature sensor
3 - Intake temperature sensor	11 - Intake pressure sensor
4 - Lubricating oil pressure sensor	12 - Rail pressure reduction valve signal
5 - Exhaust pressure sensor	13 - Rail pressure sensor
6 - Exhaust temperature sensor	14 - Fuel temperature sensor
7 - Camshaft speed sensor	15 - Supply pump SCV signal

1.2 After-treatment device (applicable only to EU Stage V certified models)

Fig.70-21 shows installation locations of sensors equipped to the after-treatment device (ATD unit).

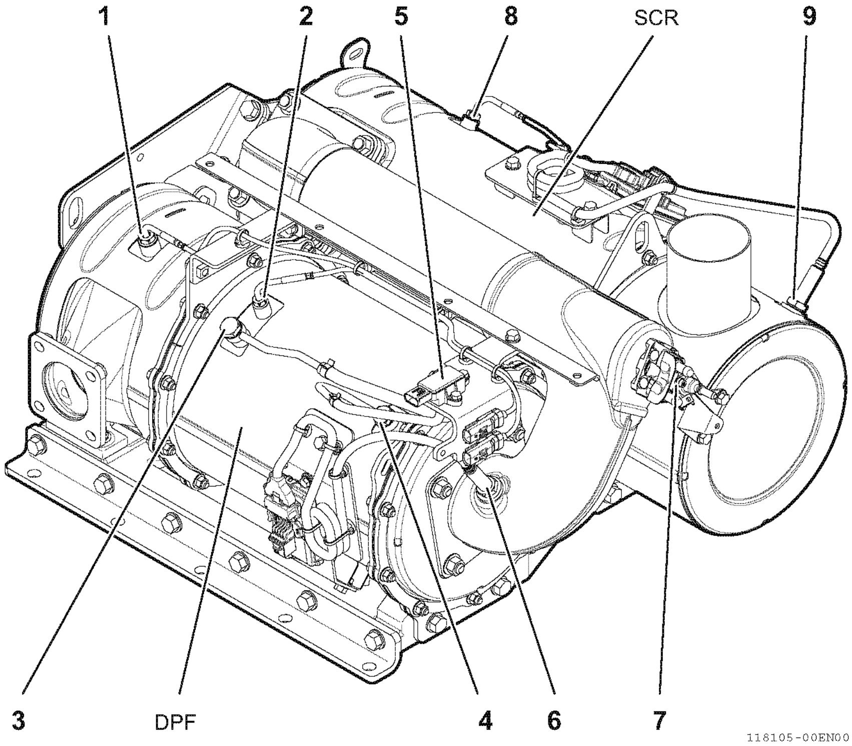


Fig.70-21

1 - DPF inlet exhaust temperature sensor	6 - Upstream NOx sensor
2 - DPF intermediate exhaust temperature sensor	7 - DM (Dosing Module)
3 - DPF SF upstream exhaust pressure port	8 - SCR exhaust temperature sensor
4 - DPF SF downstream exhaust pressure port	9 - Downstream NOx sensor
5 - DPF exhaust differential pressure sensor	

NOTICE

Do not touch couplers of the sensors with your bare hands. Static electricity may damage the sensors.

2. Details of Sensors

2.1 Temperature sensor

■ New air temperature sensor

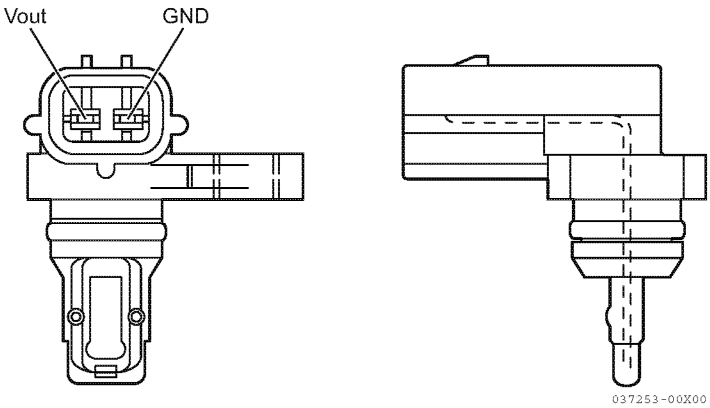


Fig.70-22

Part No.	129A00-12711
Tightening torque	7 ± 1.4 N·m

■ Intake temperature sensor

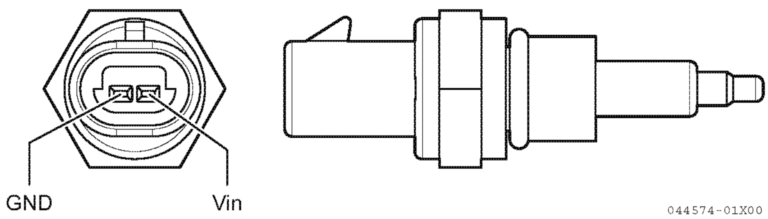


Fig.70-23

Part No.	129A00-12721
Tightening torque	14 ± 3 N·m

■ EGR gas temperature sensor

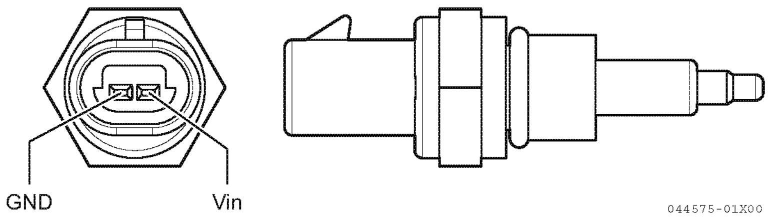


Fig.70-24

Part No.	129A00-13752
Tightening torque	14 ± 3 N·m

■ Engine coolant temperature sensor

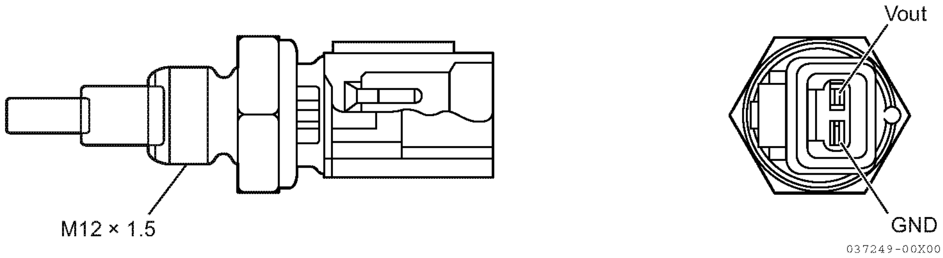


Fig.70-25

Part No.	129927-44900
Tightening torque	22 ± 2 N·m

■ Exhaust temperature sensor

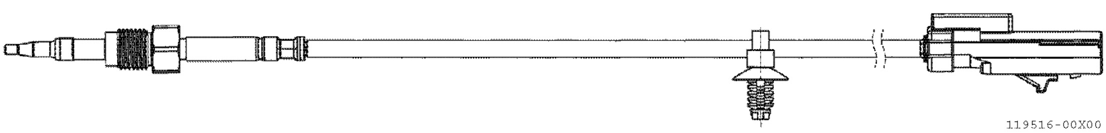


Fig.70-26

Part No.	129G01-13760
Tightening torque	32.5 ± 7.5 N·m

■ Exhaust temperature sensor for after-treatment device (applicable only to EU Stage V certified models)

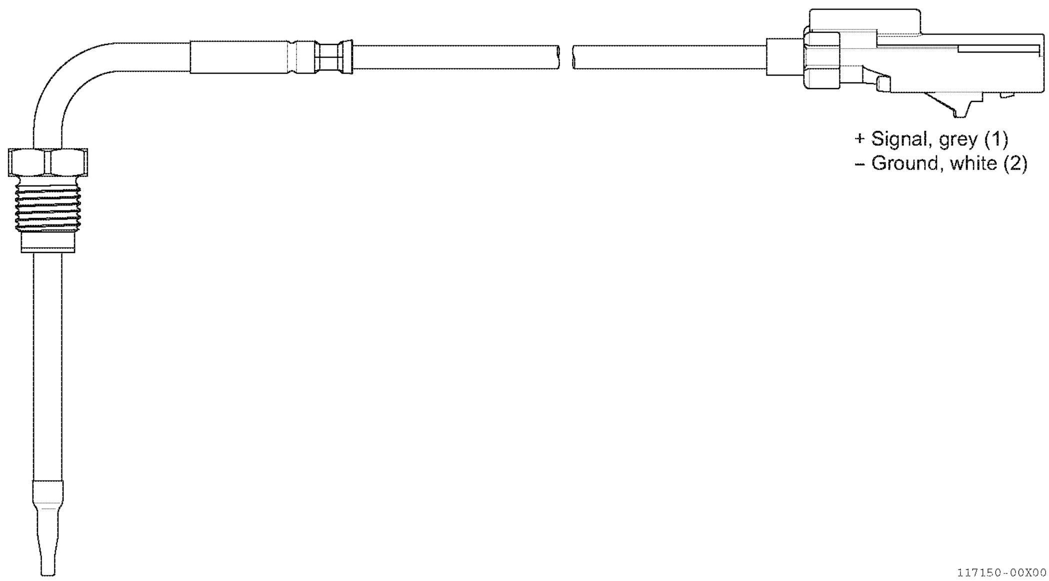


Fig.70-27

	DPF inlet temperature sensor	DPF intermediate temperature sensor	SCR temperature sensor
Part No.	129G01-13770	129G01-13780	129G01-13790
Tightening torque	40 ± 5 N·m		

■ Fuel temperature sensor (equipped to the supply pump)

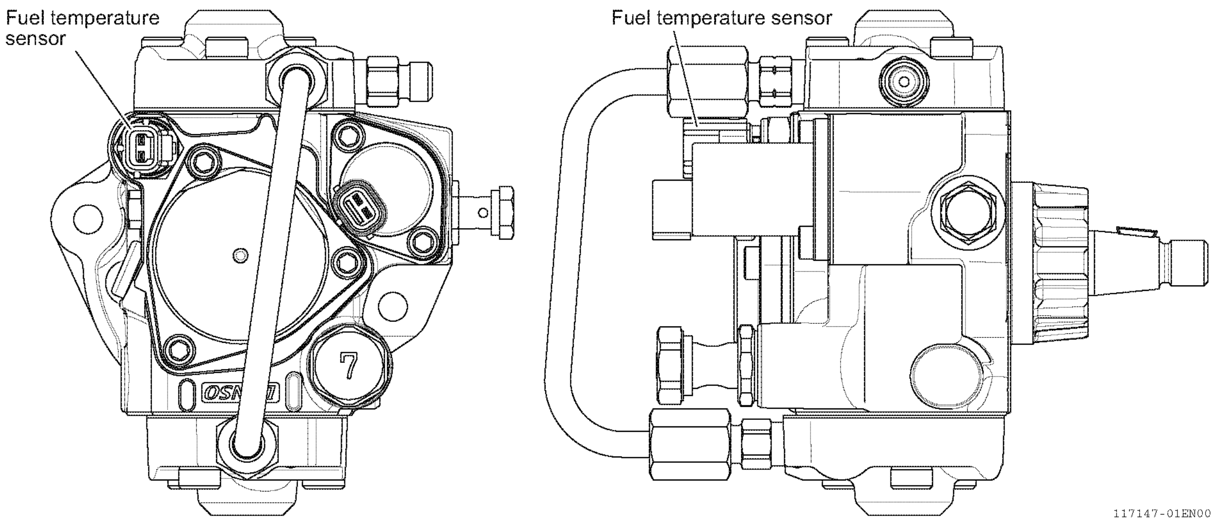


Fig.70-28

Part No.	129978-51210
Tightening torque	22 ± 2 N·m

2.2 Pressure sensor

■ Intake pressure sensor

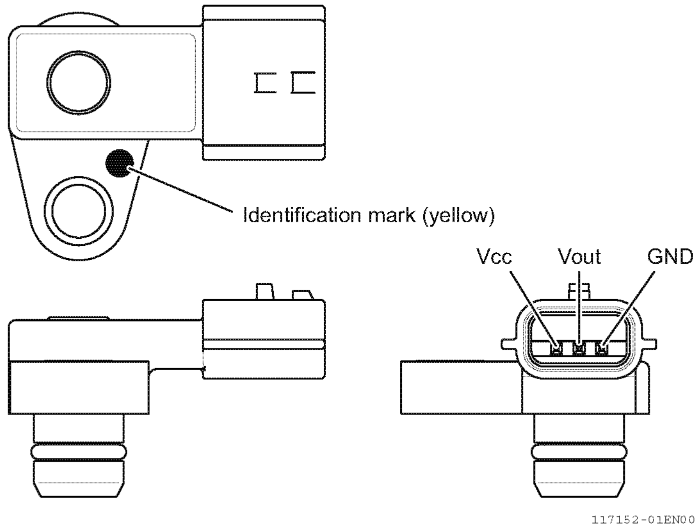


Fig.70-29

Part No.	129G01-12700
Tightening torque	7 ± 1.4 N·m

■ Exhaust pressure sensor

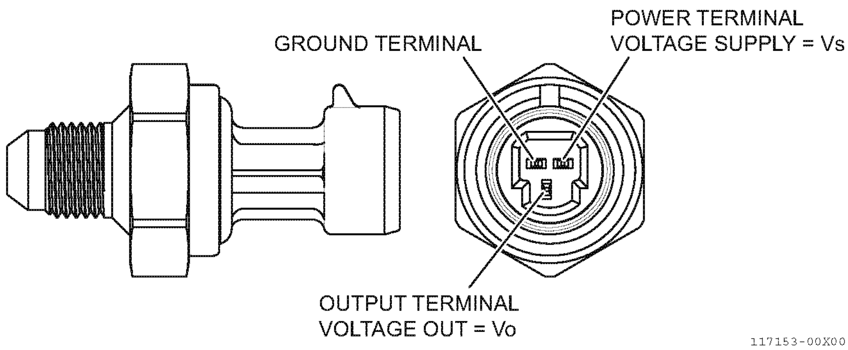


Fig.70-30

Part No.	129G01-13750
Tightening torque	20 ± 2 N·m

■ Lubricating oil pressure sensor

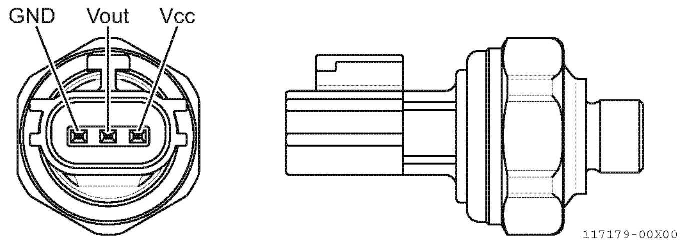


Fig.70-31

Part No.	129G01-39700
Tightening torque	9.8 ± 1.0 N·m

■ Rail pressure sensor

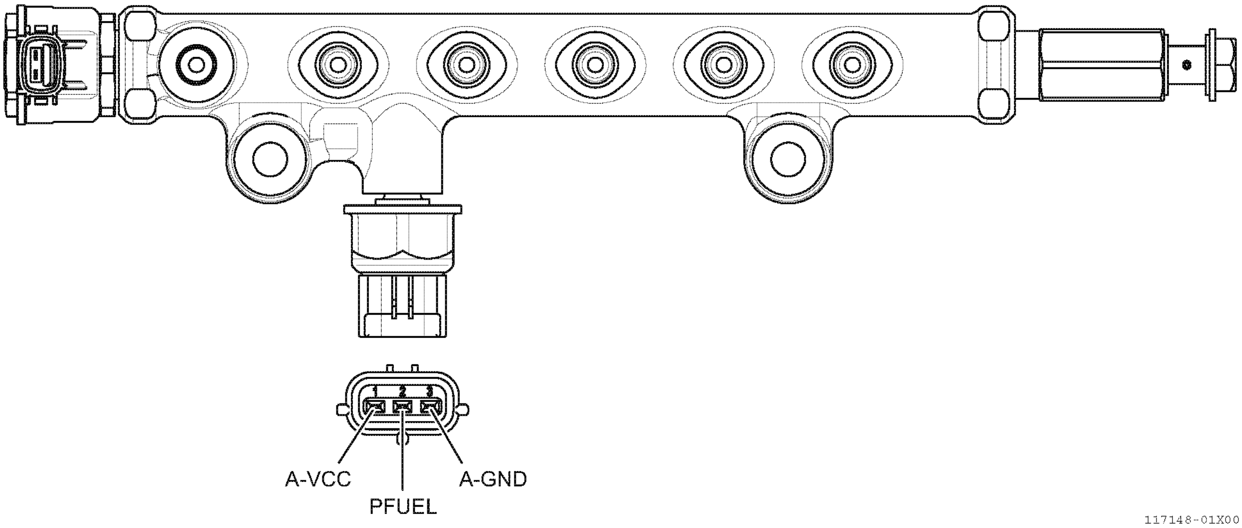


Fig.70-32

Part No.	129G01-57100
Tightening torque	Tighten by the following procedure. 1. Tighten to the snug torque 13 ± 3 N·m. 2. Then tighten further at an angle of 18 ± 1°. 3. Check that the tightening monitor torque T ≤ 60 N·m.

■ DPF exhaust differential pressure sensor (applicable only to EU Stage V certified models)

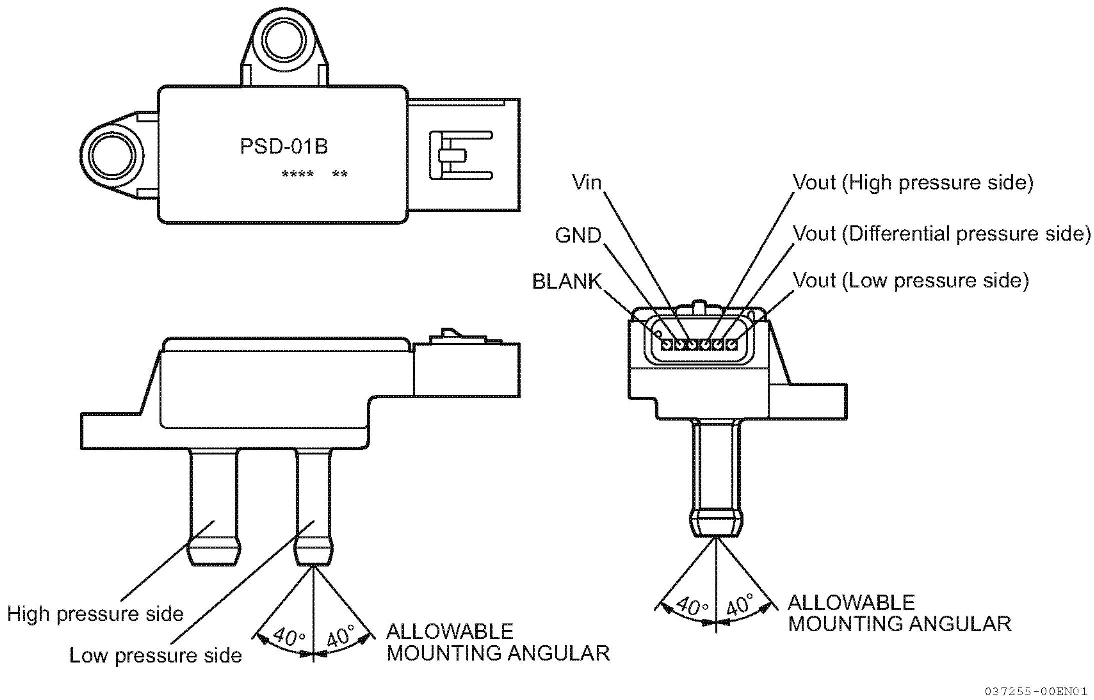


Fig.70-33

Part No.	129978-17700
Tightening torque	7 ± 1.4 N·m

2.3 Concentration sensor

■ NOx sensor

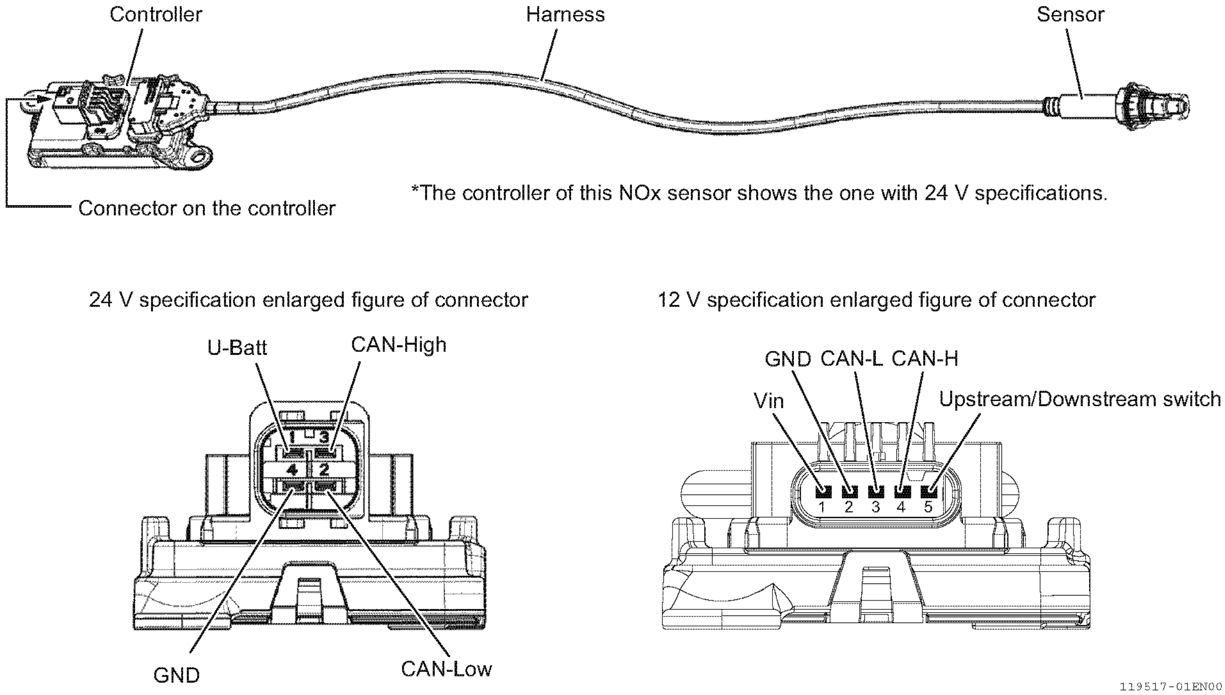


Fig.70-34

Note: The shape of the connector for the controller of the NOx sensor using 24 V has a key groove for distinguishing the application from upstream and downstream use, in order to prevent incorrect connection. With regard to the connector of the NOx sensor using 12 V, it detects in the 5-PIN whether it is connected to GND and switches the application between upstream/downstream. Therefore, it makes no difference to the shape of the connector.

Item	Details				
	24 V specification			12 V specification	
Part No. (harness color)	Upstream	129G01-19800	(Black)	129F01-19800	(Black)
	Downstream	129G01-19810	(Gray)		
Tightening torque	50 ± 10 N·m				

Note: The sensor and the controller of the NOx sensor are connected with a harness. Since the sensor adjustment values are recorded in the controller, the combination cannot be changed. Never remove the harness.

2.4 Rotation (speed) sensor

■ Crank speed sensor

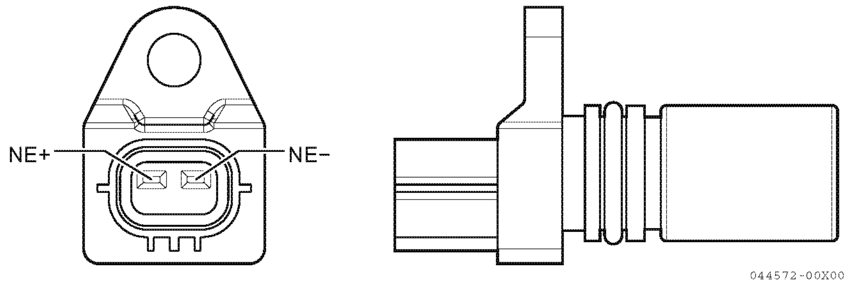


Fig.70-35

Part No.	127677-91260
Tightening torque	5 to 8 N·m

■ Camshaft speed sensor

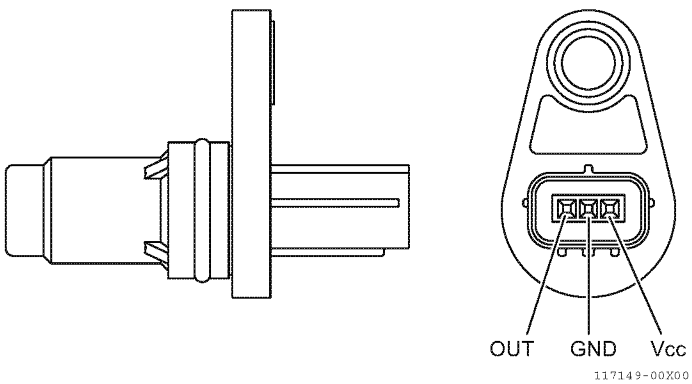


Fig.70-36

Part No.	129G01-14711
Tightening torque	8 to 12 N·m

2.5 Valves

■ Intake throttle valve (applicable only to EU Stage V certified models)

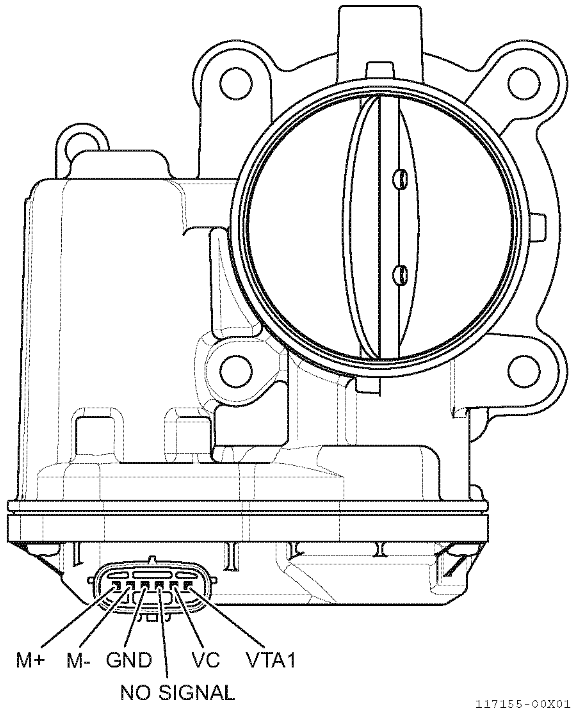


Fig.70-37

Part No.	129G01-12900

■ EGR valve

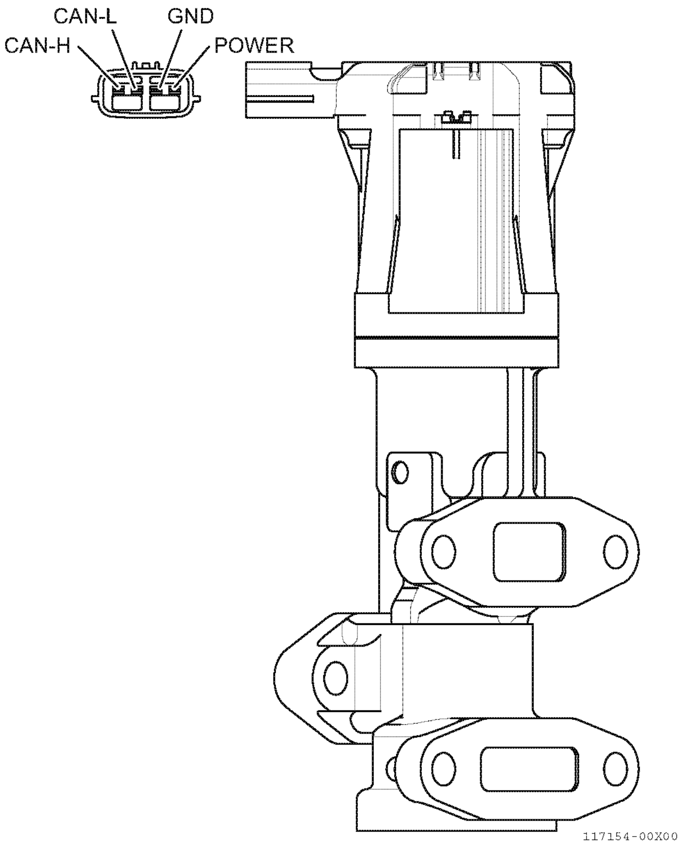


Fig.70-38

Part No.	129G01-13900 (24 V specification) 129G01-13950 (12 V specification)

■ Rail pressure reduction valve

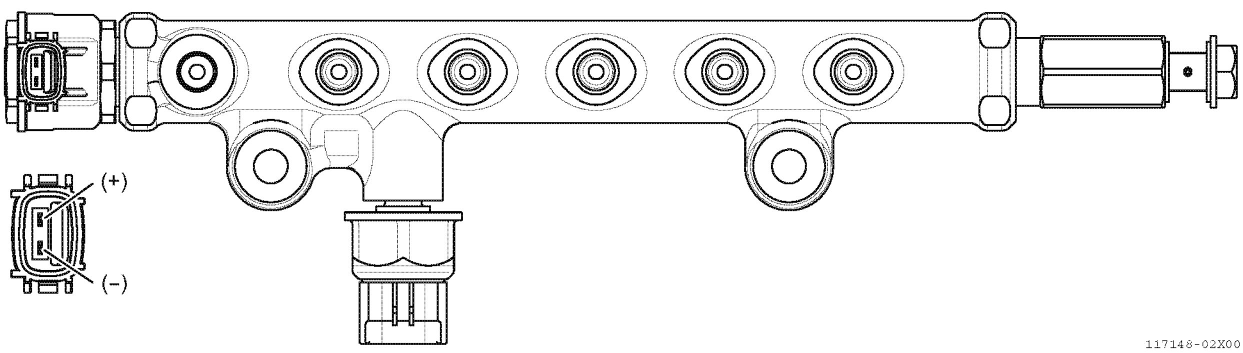


Fig.70-39

Part No.	129G01-57000 (rail assembly)

1. Overview of the Electronic Control System

An emission device, EGR, and an after-treatment device, DPF and SCR systems are installed to 4TN107 engines in order to comply with emission control regulations including EU Stage V and EPA Final Tier4. These systems are controlled by controllers such as ECU and DCU (The DPF system of the after-treatment device, the urea water SCR system, and the DCU that controls the urea water SCR system are applicable only to EU Stage V certified models). Fig.70-40 shows the overview of the electronic control system.

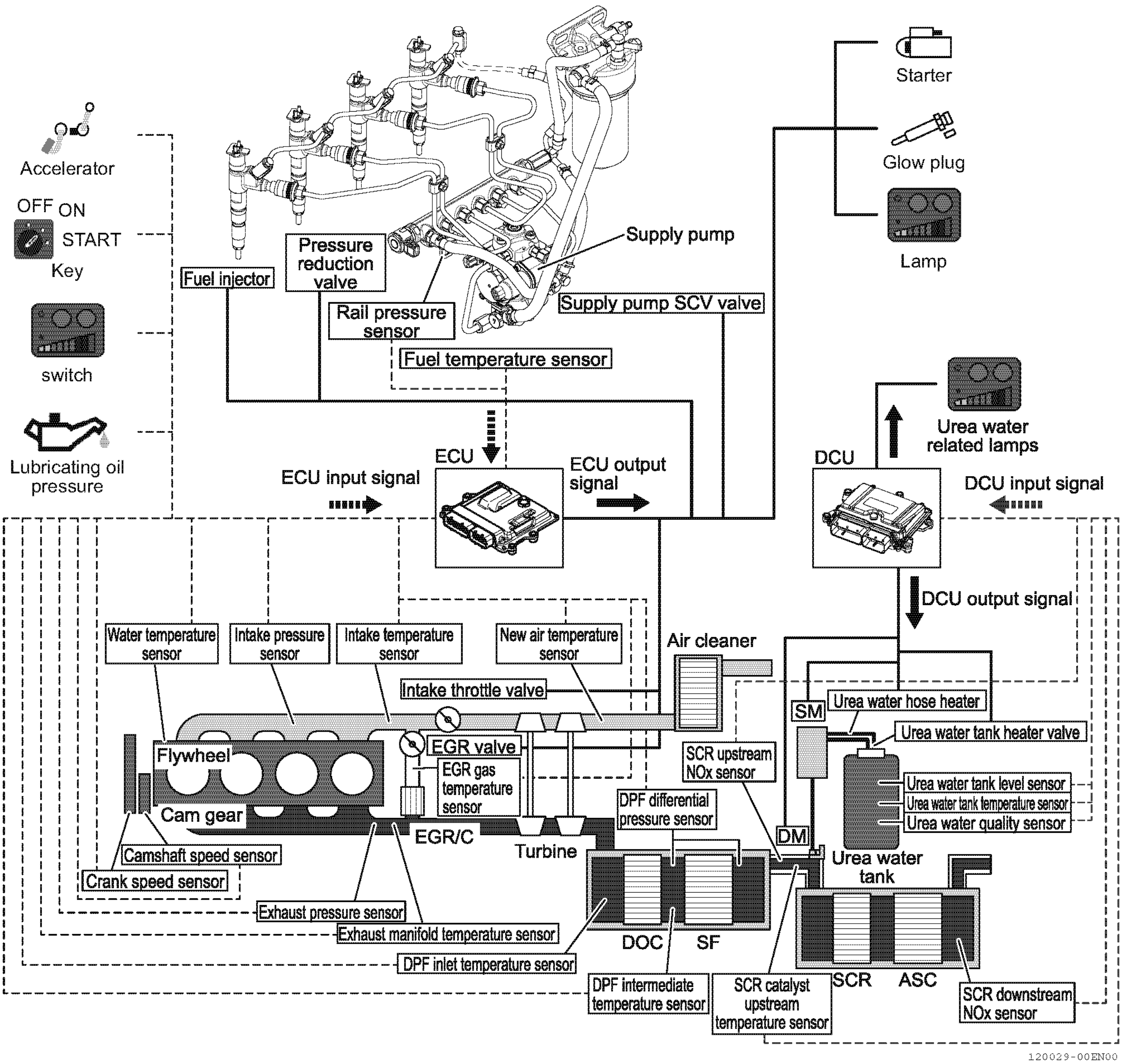


Fig.70-40

2. Input/Output Signals to/from the Controller

Based on the overview of the electronic control system shown in Fig.70-40, input signals (sensors) and output signals (actuators) of the controller (ECU, DCU) are shown in the tables below.

2.1 ECU

Input signal		Sensor	Installation location
Input signal	Rotation	Crank	Flywheel ring gear
		Cam	Cam gear
	Tem-perature	New air	Intake path (*varies depending on the model)
		Intake	Intake manifold
		Exhaust	Exhaust manifold
		EGR gas	EGR pipe
		DPF inlet	DOC inlet
		DPF intermedi-ate	DOC outlet
		Fuel	Supply pump
		Engine coolant	Cylinder head
	Pressure	Intake	Intake manifold
		Exhaust	Exhaust manifold
		DPF differential pressure	SF inlet/outlet
		Lubricating oil	Engine lubricating oil filter inlet
		Common rail	Common rail
	Other	Key switch	
		Accelerator (OP)	

➡ ECU ➡

Output signal	Actuator
Output signal	Fuel injector
	Intake throttle valve
	EGR valve
	Rail pressure reduction valve
	Supply pump SCV valve
	Starter motor
	Glow plug

2.2 DCU (applicable only to EU Stage V certified models)

Input signal		Sensor	Installation location
Input signal	Concen-tration	NOx	SCR inlet/outlet
	Tem-perature	SCR	SCR catalyst
		Urea water temperature	Urea water tank
	Other	Urea water tank level	Urea water tank
		Urea water quality	Urea water tank

➡ DCU ➡

Output signal	Actuator
Output signal	Urea water tank heater valve
	Urea water hose heater
	Supply module
	Dosing module

3. Main Specifications and Standard Value of the ECU

3.1 Main specifications

YANMAR Part No.	Mfg.	Manufacturer's part number
129G01-75000	Denso	1 VDC

3.2 Standard value

Item		Use conditions	
Basic performance	Rated voltage	12 VDC	24 VDC
	Operating voltage range	10.0 VDC to 16.0 VDC	16.0 VDC to 32.0 VDC
	Minimum operating voltage (start warranty volta.ge)	6.0 VDC or higher	9.0 VDC or higher
	Current consumption	(Currently being confirmed)	(Currently being confirmed)
	Dark current	0 A (When the key is OFF, the ECU power is cut by the main relay)	
	ECU weight	Approx. 740 g	
	Noise resistance	ISO13766-1:2018 (Acquisition planned)	
Mounting requirements	Operation ambient temperature range	-30 °C to 100 °C ECU mounting face temperature must be 80 °C or lower.	
	Storage ambient temperature range	-40 °C to 125 °C	
	Waterproofness	Compliant with IP6K9K * Submerged conditions not covered by warranty	

3.3 External appearance

Fig.70-41 shows the external appearance of the ECU.

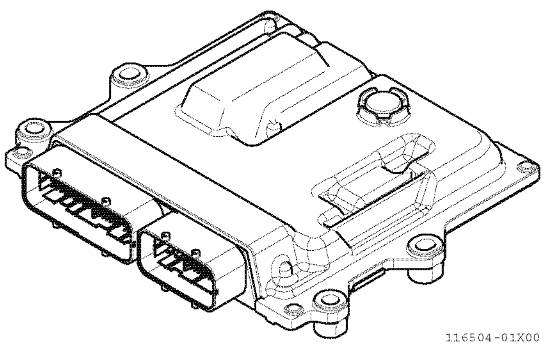


Fig.70-41

3.4 Handling the ECU

⚠ WARNING

- **The engine types and engine serial numbers (specified by YANMAR) must be used in the same combination, for ECU, DCU, and engine. We cannot guarantee the engine performance if an incorrect combination of ECU and DCU is used.**
- **When replacing the ECU, you will need SA-D (SMARTASSIST-DIRECT) for transferring data from the old ECU to the new ECU. Contact your authorized YANMAR dealer who can handle SA-D. We cannot guarantee the engine performance if the ECU has not had the correct injector injection amount adjustment data written to it.**
- **Use the YANMAR's genuine service tool (SA-D) to perform maintenance for the injector injection amount adjustment data stored in the ECU and the SCR-related sensor learning values stored in the DCU. For details, see SMARTASSIST-DIRECT operation manual.**
- **NEVER use the equipment outside the scope specified by YANMAR. Doing so may cause failure or be regarded as a violation of laws related to emission regulations.**
  YANMAR provides no warranty with regard to incorrect use. (Replacing the ECU or DCU, rewriting or modifying the ECU and DCU data, leaving a failure unresolved, removing sensors and actuators, etc.)

NOTICE

- Do not insert or remove the ECU for at least 60 seconds after power supply to the unit has been turned ON or OFF.
- Do not use a ECU that has been dropped or has fallen.
- Do not touch the ECU pins with your hands or dissemble them. Doing so may lead to pin corrosion or breakage of electronic circuits due to static electricity.
- The ECU contains circuits that generate high voltages. Be careful of electric shock.
- Do not to allow foreign material to get inside the connectors. It may cause malfunction due to defective contact of the connector pins.
- Be careful not to let water enter the connectors while removing/inserting them. It may cause malfunction due to corrosion of the pins.
- Do not forcefully insert a tester's measuring probe into female-side connectors. It may cause malfunction due to defective contact of the connector pins.
- Do not disassemble the ECU terminal.

4. Main Specifications and Standard Value of the DCU (Applicable only to EU Stage V certified models)

4.1 Main specifications

YANMAR Part No.	Mfg.	Manufacturer's part number
129G01-75400	BOSCH	HD01

4.2 Standard value

Item		Use conditions	
Basic performance	Rated voltage	12 VDC	24 VDC
	Operating voltage range	10.0 VDC to 16.0 VDC	16.0 VDC to 32.0 VDC
	Minimum operating voltage (start warranty voltage)	6.5 VDC or higher (10.0 V or higher for the SCR system minimum operating voltage)	
	Current consumption	When starting SCR: 6 A; during thawing control: 15 A	
	Dark current	≤ 300 μA	
Mounting requirements	Operation ambient temperature range	-40 °C to 85 °C	
	Storage ambient temperature range	-40 °C to 105 °C	
	Waterproofness	Compliant with IPX4K, IPX6K and IPX9K	

4.3 External appearance

Fig.70-42 shows the external appearance of the DCU.
The DCU is equipped with the pressure adjusting valve. Make sure that there are no paints or dirt on the valve that will cause clogging.

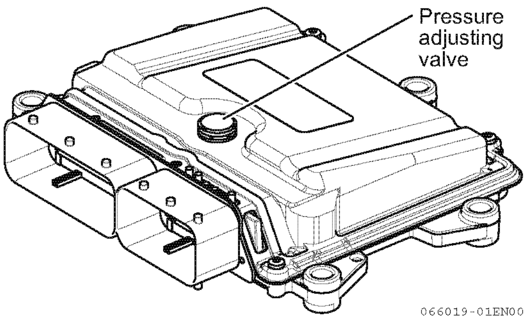


Fig.70-42

4.4 Handling the DCU

NOTICE

- Do not use a DCU that has been dropped or has fallen.
- Do not disassemble the DCU terminal.

■ Precautions when connecting and removing the connector

- Do not remove/insert a connector when the DCU power supply is ON, or for at least 10 minutes after the key switch is turned OFF. Also, do not remove/insert the battery (battery cut switch) during the above period. The DCU will operate for approximately 7 minutes after the key switch is turned OFF. Shutting off the power while it is operating may cause the DCU or SCR to fail.
- Do not remove/insert the connectors more than 10 times.
  Doing so may cause malfunction due to defective contact of the connector pins.

■ Other precautions

- Do not touch the DCU pins with your hands or dissemble them. Doing so may lead to pin corrosion or breakage of electronic circuits due to static electricity.
- The DCU contains circuits that generate high voltages. Be careful of electric shock.
- Do not to allow foreign material to get inside the connectors. It may cause malfunction due to defective contact of the connector pins.
- Be careful not to let water enter the connectors while removing/inserting them. It may cause malfunction due to corrosion of the pins.
- Do not forcefully insert a tester's measuring probe into female-side connectors. It may cause malfunction due to defective contact of the connector pins.

Failures and Corrective Actions for the Electronic Control System

The electronic control engines equipped with a common rail system, DPF system, and SCR system have the engine failure lamp installed. When abnormalities occur in those systems, applicable lamps come on to inform of the failure. The following sections will describe an overview of the failure detection.

1. Control Abnormality Detection Function

On the electronic control engine, the ECU and DCU perform various kinds of self-diagnosis for the common rail system, DPF system, and SCR system based on the information from the sensor for electronic control and various types of preset engine abnormality detection sensors. According to the status of each sensor, you can set the operations during abnormality (optional). When the ECU or DCU detects abnormalities in those sensors, engine failure lamp comes on, and indicator indicates that abnormality is detected, and limitations (fail-safe actions) will be implemented to protect the engine system.

1. Engine failure lamp

The engine failure lamp is installed on the operator's console of the driven machine (1, Fig.70-43).
If even one abnormality is detected, the ECU turns on the engine failure lamp.

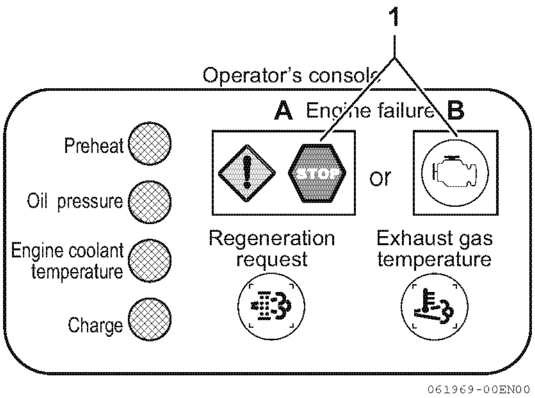


Fig.70-43

Note: This figure is for reference only. The gauges located on the operator's console may vary depending on the machine. Refer to the operation manual provided by the driven machine manufacturer for details.

The engine failure lamp comes on and lights for approximately 2 seconds when the key switch is turned on, then goes off. With this lamp, you can check whether the power is supplied to ECU. Fig.70-44 shows flashing patterns of the engine failure lamp. The engine failure lamp comes on and lights for approximately 2 seconds when the switch is turned on, and goes off while the engine is running.
If an abnormality occurs in ECU, this indicator lamp will come on again 3 seconds after the failure lamp goes off, and the lamp continuously stays on. If an abnormality occurs while the engine is running, the engine failure lamp comes on at the time of abnormality occurrence.

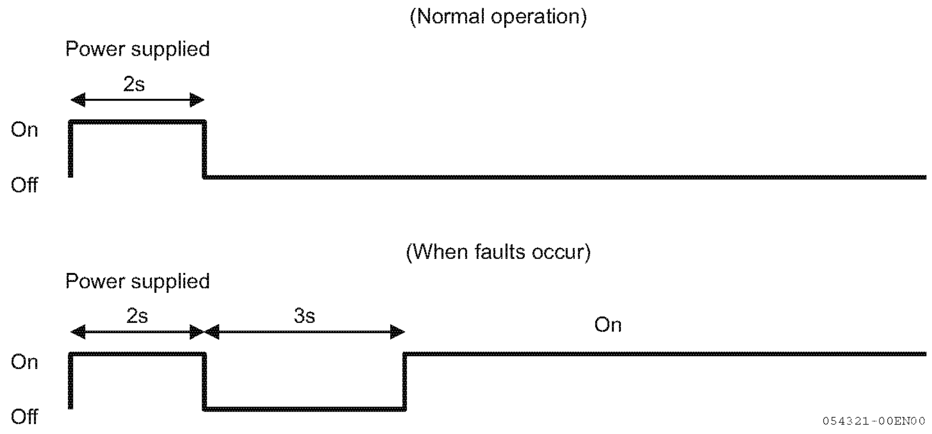


Fig.70-44

NOTICE

- If there is a problem with the engine and/or its control components, the engine failure lamp comes on and indicates the status. Do not keep running the engine while the engine failure lamp is on. It will not only void the engine warranty, but could result in a serious malfunction or damage to the engine.
- If the engine failure lamp comes on, immediately stop the engine and contact your authorized YANMAR dealer or distributor.

2. Checking abnormality information

As shown in Fig.70-45, it is required to connect SMARTASSIST-DIRECT (SA-D), YANMAR genuine diagnosis tool, to the ECU for detailed diagnosis. SA-D then allows reviewing detailed fault information, historical fault/alarm logs, and freeze frame data. In addition, you can monitor the engine status and perform the fault diagnosis by using SA-D. In the fault history display, the time the abnormality occurred (time stamp) can be recorded. For details, see SMARTASSIST-DIRECT operation manual or Trouble-shooting manual.

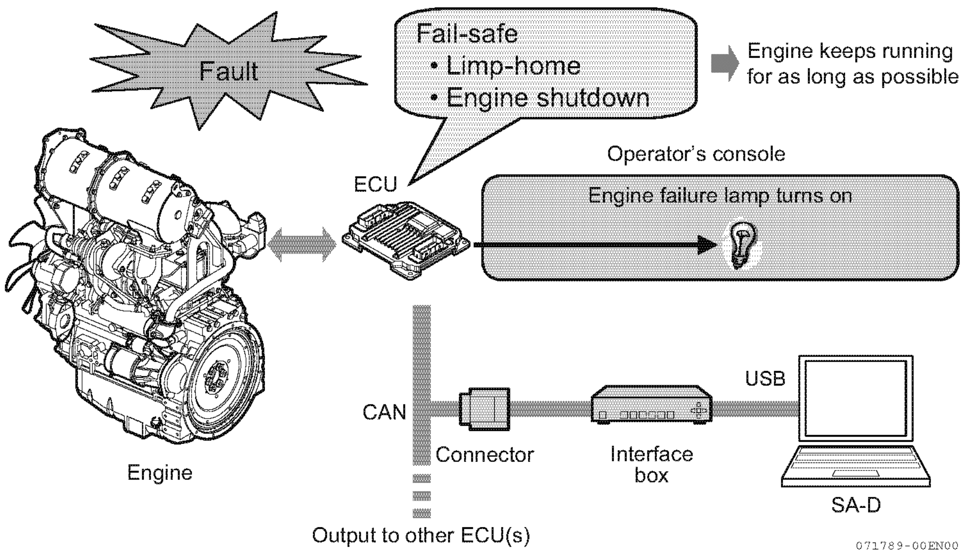


Fig.70-45

2. Failure Diagnosis Tool (SMARTASSIST-DIRECT)

In addition to failure diagnosis for confirming the abnormality information, it is required to rewrite the individual data inside the ECU when replacing the ECU or injectors. A special treatment is also necessary when replacing DPF or sensors that affect the electronic control system.
To perform those works, it is required to connect YANMAR genuine SMARTASSIST-DIRECT (SA-D) as shown in Fig.70-46, and the connector is provided at an end of the harness of the driven machine as shown in Fig.70-47.

Contact your authorized YANMAR dealer or distributor that can handle SA-D to repair or replace the electronic control parts. For details, see SMARTASSIST-DIRECT operation manual.

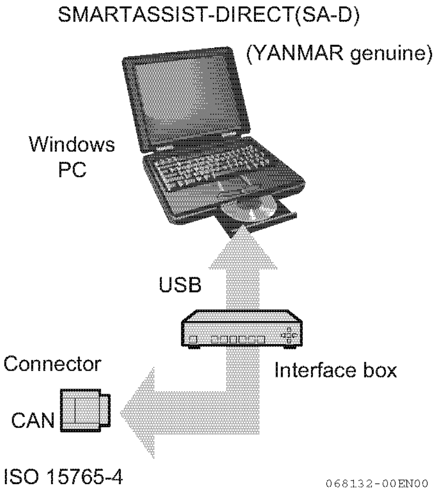
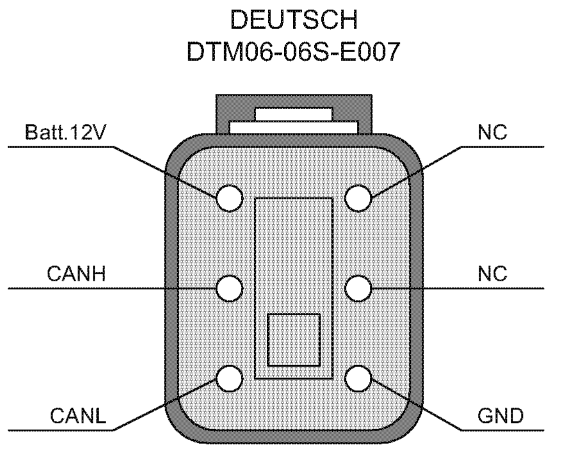


Fig.70-46



Mating connector (SMARTASSIST-DIRECT side)
DEUTSCH
DTM04-06P-E003

Fig.70-47

1. Using SA-D

Before using SA-D, please be aware of following information.
SA-D is a diagnosis tool that automatically transmits the following information to the YANMAR data server (SMARTASSIST-CORE (SA-C)) from the ECU equipped in your driven machine via the Internet.

- Parts replacement information for injectors, exhaust gas after-treatment device, and controllers that are necessary for exhaust gas warranty claims
- Accumulated operation information required for the reuse of exhaust gas after-treatment device
- Operation history of an engine including fault history, operation time, engine speed, and load factor

All the obtained data will be used for the following purposes.

- To prevent improper service in the market
- To provide more accurate and prompt service
- To improve product quality through YANMAR Research and Development

3. Replacing the Components

If it is necessary to repair or replace parts of the electronic control system as a result of periodic inspection or a failure diagnosis by SMARTASSIST-DIRECT performed when the trouble monitor lamp comes on, individual repairs of each device that comprises the system cannot be performed. Based on the results of the failure diagnosis, replacement of the corresponding part or the entire system is required in accordance with the “Troubleshooting Manual”.

1. DPF regeneration process after parts replacement (applicable only to EU Stage V certified models)

The following parts are used for the calculation of the accumulated PM amount. Therefore, when there is a fault in these parts, the accumulated PM amount may be miscalculated. Be sure to perform the DPF regeneration in order to eliminate the calculation error of the accumulated PM amount and amount of adhered NH_3 (ammonia) after replacing parts.

• Injector	• Supply pump	• ECU
• SF	• DOC	• SCR (SCR catalyst + ASC)
• DM (Dosing Module)	• Intake throttle valve	• EGR valve
• Intake temperature sensor	• Exhaust temperature sensor	• EGR gas temperature sensor
• Exhaust temperature sensor for after-treatment device (DPF inlet, DPF intermediate, SCR catalyst upstream)		
• Fuel temperature sensor	• Engine coolant temperature sensor	• DPF exhaust differential pressure sensor
• Intake pressure sensor	• Exhaust pressure sensor	• Rail pressure sensor
• NOx sensor (SCR upstream and SCR downstream)		• Crankshaft rotation sensor

1 - Start the engine, and run it until the engine coolant temperature reaches 60 °C or higher. After warming up, decrease the engine speed to idling.

2 - If the optional recovery regeneration function is not equipped, when the ECU determines that the PM accumulated amount is 10 g/L or more, a DPF regeneration request is displayed. Perform the stationary regeneration. For details on regeneration operation, see 2502-01-02-01 “Stationary regeneratio”.

3 - If the stationary regeneration request lamp does not come on (accumulated amount is 10 g/L or less), connect SMARTASSIST-DIRECT (SA-D) and perform stationary regeneration. For details of stationary regeneration using SA-D, see 6.5.9 “Active Control” in the supplementary material of the SA-D operation manual.

4 - If optional recovery regeneration function is equipped, when the ECU determines that the PM accumulated amount is 12 g/L or more, a recovery regeneration request is displayed. Perform the recovery regeneration. For details, see 2502-01-02-01 “Operation procedures of stationary regeneration”.

5 - If accumulation is 12 g/L or less, then follow the stationary regeneration determination flow.

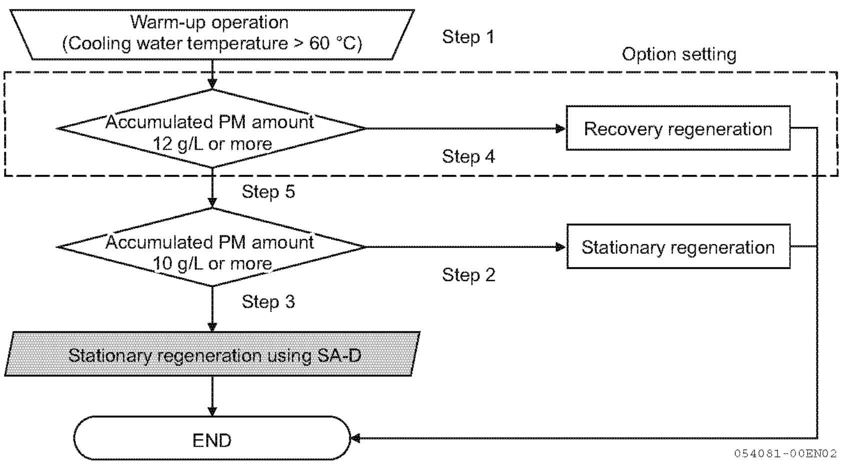


Fig.70-48 Procedure to eliminate calculation errors of the accumulated PM amounts when using method C

2. Method for calculating the amount of PM accumulated in DPF (applicable only to EU Stage V certified models)

The amount of PM accumulated in the soot filter (SF) is calculated by ECU using the following two methods.

- Method C: calculates the difference between the estimated amount of PM discharged from the engine, and the estimated amount of PM combusted in the SF.
- Method P: uses the difference in pressure between the SF inlet and outlet to calculate the amount of PM accumulated in the SF.

Normally, the ECU uses the value obtained from either method C or method P, whichever is greater, as the PM accumulation amount.

3. Process after ECU replacement (when data cannot be inherited from old ECU) (applicable only to EU Stage V certified models)

When the history data could not be inherited from the old ECU at the time of replacing the ECU, the data for the accumulated ash*1 amount is reset. Accordingly, use method P to estimate the PM accumulated amount from the ash accumulated amount, and determine if SF cleaning is necessary.

Procedures for when the history data could not be inherited are shown below.

1 - After ECU replacement, the procedure for burning PM by using DPF regeneration (stationary regeneration or stationary regeneration using SA-D, or recovery regeneration when optional recovery regeneration function equipped) is the same as in the previous chapter.

2 - If PM accumulation is 10 g/L or more, and stationary regeneration is being performed, then after regeneration has completed, connect SA-D so that this can be used to confirm the PM accumulated concentration (P method). If the PM accumulation is 10 g/L or less, and SA-D is connected and stationary regeneration performed, then proceed to the next step while leaving this connected.

3 - Operate the engine at high idling for 10 minutes or more until the situation has stabilized.

4 - After operation has completed, check the ash accumulated amount using SA-D. On the SA-D menu screen, select Pulse/Analog Input/Output and check the “DPF PM accumulation density (method P)” data. For details, see 6.5.10 Supplementary material “Pulse/Analog Input/Output” in the SMARTASSIST -DIRECT operation manual.

5 - When the PM accumulated amount (method P) exceeds 5 g/L, clean the soot filter (SF).

*1: Refer to 2502-01-01-01 “DPF System” for details on PM and ash.

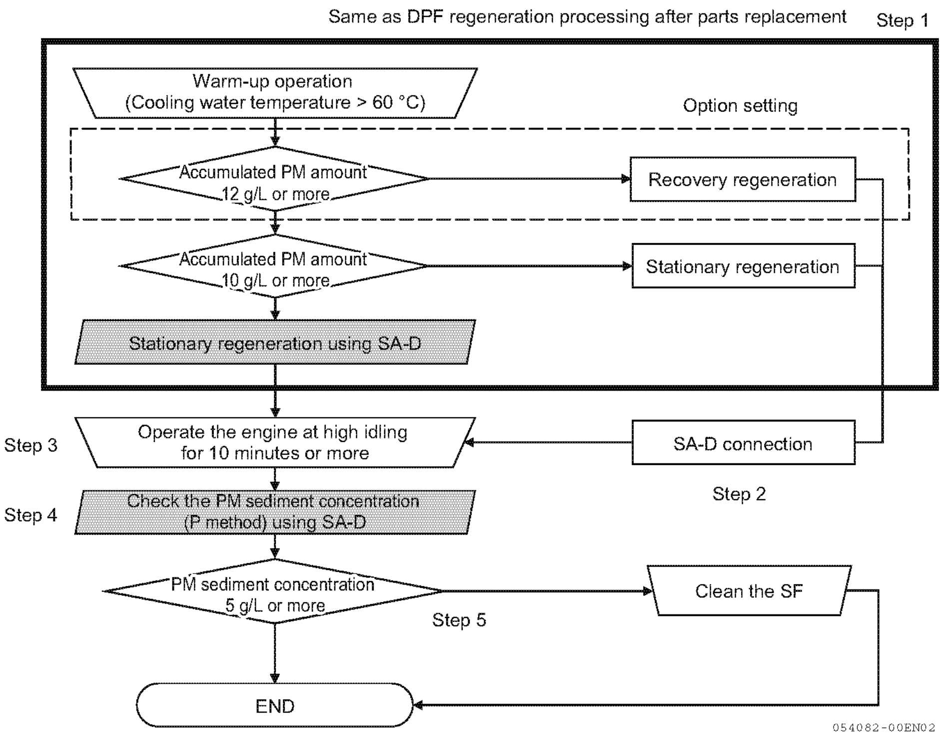


Fig.70-49 Procedure to eliminate calculation errors of the accumulated PM amounts when using method C, and to confirm ash accumulated amount

4. Necessary process when replacing parts related to CR

Replacement parts	SA-D operation		
	Re-writing ECU data/ Clearing data	Re-writing DCU data/ Clearing data *1	DPF regeneration process *1
ECU	○	–	○*2
DCU	–	○	○*3
Injector	○	–	○
DPF	○	○	○
SF	○	○	○
DOC	○	○	○
Supply pump	–	–	○
SCR (SCR catalyst + ASC)	–	○	○
SCR upstream NOx sensor	–	○	○
SCR downstream NOx sensor	–	○	–
SCR catalyst upstream temperature sensor	–	○	○
DM (Dosing Module)	–	○	○
DPF exhaust differential pressure sensor	–	○	○
Intake pressure sensor	–	○	○
Exhaust pressure sensor	–	○	○
Intake temperature sensor	–	○	○
EGR gas temperature sensor	–	○	○
Exhaust temperature sensor	–	○	○
EGR valve	–	○	○
Intake throttle valve	–	○	○
Other*4	–	–	○

**1. Applicable only to EU Stage V certified models*
**2. DPF regeneration is required when the history data could not be inherited from the old ECU. In addition, if the accumulated amount according to method P exceeds 5 g/L even after DPF regeneration, SF cleaning is required.*
**3. DPF regeneration is required when the history data could not be inherited from the old DCU.*
**4. DPF inlet temperature sensor, DPF intermediate temperature sensor, crank speed sensor, fuel temperature sensor, coolant temperature sensor*

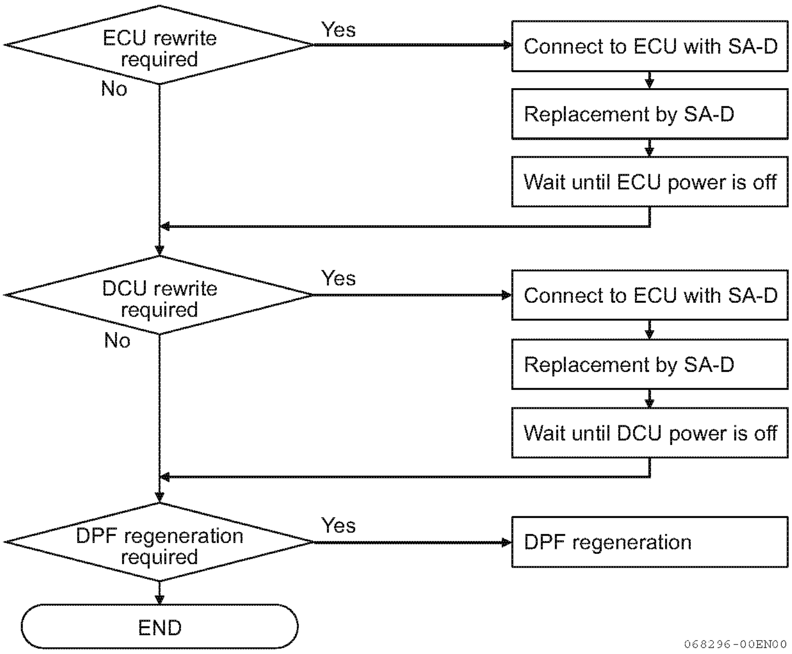


Fig.70-50 Part replacement procedure using SA-D

NOTICE

(DCU is applicable only to EU Stage V certified models)

- Do not insert or remove the ECU for a period of at least 60 seconds after power supply to the unit has been turned ON or OFF.
- Do not insert or remove the connector when the DCU power supply is ON. In addition, after turning the key switch off, make sure that the after-run is complete, then remove the connector.
  You can determine that the after-run is complete by the sound of the SM, or the time required (approx. 10 minutes) from turning off the key switch to shutting off the DCU.
- Do not touch the connector pins of the ECU and DCU directly with your hands. Doing so may result in corrosion of the connector pins and/or damage to the internal circuits of the ECU and DCU due to static electricity.
- Do not forcefully insert a tester's measuring probe into the connector's female coupler. Doing so may cause malfunction due to defective contact of the connector pins.
- Be careful not to let water get into the coupler when removing/inserting a connector. It may cause malfunction due to corrosion of the connector pins.
- Do not remove/insert the connectors more than 10 times. Doing so may cause malfunction due to defective contact of the connector pins.
- Do not use a ECU or DCU that has been dropped or has fallen.
- Do not disassemble the ECU and DCU terminals.

1. Limited Emission Control System Warranty - USA Only

■ Your warranty rights and obligations:

The California Air Resources Board (CARB), the United State Environmental Protection Agency (EPA) and YANMAR POWER TECHNOLOGY CO., LTD. hereafter referred to as YANMAR, are pleased to explain the emission control system warranty on your 2020, 2021, or 2022 model year industrial compression-ignition engine. California-certified, new non-road (off-road) compression-ignition engines must be designed, built and equipped to meet the State's stringent anti-smog standards. In the remaining forty nine (49) states, new non-road (off-road) compression-ignition engines must be designed, built and equipped to meet the United States EPA emissions standards. YANMAR must warrant the emission control system on your engine for the periods of time listed below provided there has been no abuse, neglect or improper maintenance of your engine.

Your emission control system may include parts such as the fuel injection system, the air induction system, the electronic control system, EGR (Exhaust Gas Recirculation) system and the exhaust gas after treatment (diesel particulate filter system, urea SCR system). Also included may be hoses, belts, connectors and other emission-related assemblies.

Where a warrantable condition exists, YANMAR will repair your non-road (off-road) compression-ignition engine at no charge to you including diagnosis, parts and labor.

■ Manufacturer's warranty period:

2020, 2021, or 2022 model year non-road (off-road) compression-ignition engines are warranted for the periods listed below. If any emission-related part on your engine is found to be defective during the applicable warranty period, the part will be repaired or replaced by YANMAR.

If your engine is certified as	And its maximum power is	And its rated speed is	Then its warranty period is
Variable speed or constant speed	kW < 19	Any speed	2,000 hours or two (2) years whichever comes first. In the absence of a device to measure the hours of use, the engine has a warranty period of two (2) years.
Constant speed	19 ≤ kW < 37	3,000 rpm or higher	2,000 hours or two (2) years whichever comes first. In the absence of a device to measure the hours of use, the engine has a warranty period of two (2) years.
Constant speed	19 ≤ kW < 37	Less than 3,000 rpm	3,000 hours or five (5) years whichever comes first. In the absence of a device to measure the hours of use, the engine has a warranty period of five (5) years.
Variable speed	19 ≤ kW < 37	Any speed	3,000 hours or five (5) years whichever comes first. In the absence of a device to measure the hours of use, the engine has a warranty period of five (5) years.
Variable speed or constant speed	kW ≥ 37	Any speed	3,000 hours or five (5) years whichever comes first. In the absence of a device to measure the hours of use, the engine has a warranty period of five (5) years.

■ Warranty coverage:

This warranty is transferable to each subsequent purchaser for the duration of the warranty period. YANMAR recommends that repair or replacement of any warranted part will be performed at an authorized YANMAR dealer.

Warranted parts not scheduled for replacement as required maintenance in the owner's manual shall be warranted for the warranty period. Warranted parts scheduled for replacement as required maintenance in the owner's manual are warranted for the period of time prior to the first scheduled replacement. Any warranted parts scheduled for replacement as required maintenance that are repaired or replaced under warranty shall be warranted for the remaining period of time prior to the first scheduled replacement. Any part not scheduled for replacement that is repaired or replaced under warranty shall be warranted for the remaining warranty period.

During the warranty period, YANMAR is liable for damages to other engine components caused by the failure of any warranted part during the warranty period.

Any replacement part which is functionally identical to the original equipment part in all respects may be used in the maintenance or repair of your engine, and shall not reduce YANMAR's warranty obligations. Add-on or modified parts that are not exempted may not be used. The use of any non-exempted add-on or modified parts shall be grounds for disallowing a warranty.

■ Warranted parts:

This warranty covers engine components that are a part of the emission control system of the engine as delivered by YANMAR to the original retail purchaser. Such components may include the following:

- Fuel injection system (including Altitude compensation system)
- Cold start enrichment system
- Intake manifold and Air intake throttle valve
  (Intake throttle valve is applicable only to EU Stage V certified models)
- Turbocharger systems
- Exhaust manifold and exhaust throttle valve
- Positive crankcase ventilation system
- Charge Air Cooling systems
- Exhaust Gas Recirculation (EGR) systems
- Exhaust gas after treatment (Diesel Particulate Filter (DPF) system, urea SCR system)
  (Applicable only to EU Stage V certified models)
- Electronic Control units, sensors, solenoids and wiring harnesses used in above systems
- Hoses, belts, connectors and assemblies used in above systems
- Emission Control Information Labels

Since emissions related parts may vary slightly between models, certain models may not contain all of these parts and other models may contain the functional equivalents.

■ Exclusions:

Failures other than those arising from defects in material or workmanship are not covered by this warranty. The warranty does not extend to the following: malfunctions caused by abuse, misuse, improper adjustment, modification, alteration, tampering, disconnection, improper or inadequate maintenance, or use of non-recommended fuels and lubricating oils; accident-caused damage and replacement of expendable items made in connection with scheduled maintenance. YANMAR disclaims any responsibility for incidental or consequential such as loss of time, inconvenience, loss of use of equipment/engine or commercial loss.

■ Owner's warranty responsibilities:

As the non-road (off-road) compression-ignition engine owner, you are responsible for the performance of the required maintenance listed in your operation manual. YANMAR recommends that you retain all documentation, including receipts, covering maintenance on your non-road (off-road) compression-ignition engine, but YANMAR cannot deny warranty solely for the lack of receipts, or for your failure to ensure the performance of all scheduled maintenance.

ANMAR may deny your warranty coverage if your non-road (off-road) compression-ignition engine or a part has failed due to abuse, neglect, improper maintenance or unapproved modifications.

Your engine is designed to operate on diesel fuel only. Use of any other fuel may result in your engine no longer operating in compliance with CARB and EPA emissions requirements.

You are responsible for initiating the warranty process. You are responsible for presenting your engine to an authorized YANMAR dealer or distributor as soon as a problem exists. The warranty repairs should be completed by the dealer as expeditiously as possible. If you have any questions regarding your warranty rights and responsibilities, or would like information on the nearest YANMAR dealer or authorized service center, you should contact YANMAR America Corporation.

Website: https://www.yanmar.com

E-mail: CS_support@yanmar.com

Toll free telephone number: 1-800-872-2867, 1-855-416-7091

■ What the emergency stationary type engine owner must do:

The engines for emergency stationary type generators certified by Federal Law (40 CFR Part60) are limited to emergency use only, and the operation for maintenance checks and verification test for functions is required. The total operating hours for maintenance and verification test for functions should not exceed 100 hours per year. However, there is no limitation on the operating hours for emergency use. Keep a log of the number of hours the engine is operated for both emergency use and non-emergency use. Also, note the reason for the operation.

2. Limited Emission Control System Warranty - EU (European Union) Only

■ Your warranty rights and obligations:

The EU (European Union) and YANMAR POWER TECHNOLOGY CO., LTD., hereafter referred to as YANMAR, are pleased to explain the emission control system warranty that has been in place since the model year 2019 industrial compression-ignition engine. Non-road (off-road), compression-ignition engines certified by the EU (European Union) must be designed, built and equipped to meet the EU (European Union) emissions standards “Regulation (EU) 2016/1628 (EU Stage V)”. YANMAR warrants the emission control system on your engine for the periods of time listed below, provided there has been no abuse, neglect, or improper maintenance of your engine.

Your emission control system may include parts such as the fuel injection system, the air induction system, the electronic control system, EGR (Exhaust Gas Recirculation) system and the exhaust gas after treatment (diesel particulate filter system, urea SCR system). Also included may be hoses, belts, connectors and other emission-related assemblies.

Where a warrantable condition exists, YANMAR will repair your non-road (off-road) compression-ignition engine at no charge to you including diagnosis, parts and labor.

■ Manufacturer’s warranty period:

TBD

■ Warranty coverage:

This warranty is transferable to each subsequent purchaser for the duration of the warranty period. YANMAR recommends that repair or replacement of any warranted part will be performed at an authorized YANMAR dealer.

Warranted parts not scheduled for replacement as required maintenance in the owner’s manual shall be warranted for the warranty period. Warranted parts scheduled for replacement as required maintenance in the owner’s manual are warranted for the period of time prior to the first scheduled replacement. Any warranted parts scheduled for replacement as required maintenance that are repaired or replaced under warranty shall be warranted for the remaining period of time prior to the first scheduled replacement. Any part not scheduled for replacement that is repaired or replaced under warranty shall be warranted for the remaining warranty period.

During the warranty period, YANMAR is liable for damages to other engine components caused by the failure of any warranted part during the warranty period.

Any replacement part which is functionally identical to the original equipment part in all respects may be used in the maintenance or repair of your engine, and shall not reduce YANMAR’s warranty obligations. Add-on or modified parts that are not exempted may not be used. The use of any non-exempted add-on or modified parts shall be grounds for disallowing a warranty.

■ Warranted parts:

This warranty covers engine components that are a part of the emission control system of the engine as delivered by YANMAR to the original retail purchaser. Such components may include the following:

- Fuel injection system (including Altitude compensation system)
- Cold start enrichment system
- Intake manifold and Air intake throttle valve
- Turbocharger systems
- Exhaust manifold and exhaust throttle valve
- Positive crankcase ventilation system
- Charge Air Cooling systems
- Exhaust Gas Recirculation (EGR) systems
- Exhaust gas after treatment (Diesel Particulate Filter (DPF) system, urea SCR system)
- Electronic Control units, sensors, solenoids and wiring harnesses used in above systems
- Hoses, belts, connectors and assemblies used in above systems
- Emission Control Information Labels

Since emissions related parts may vary slightly between models, certain models may not contain all of these parts and other models may contain the functional equivalents.

■ Exclusions:

Failures other than those arising from defects in material or workmanship are not covered by this warranty. The warranty does not extend to the following: malfunctions caused by abuse, misuse, improper adjustment, modification, alteration, tampering, disconnection, improper or inadequate maintenance, or use of non-recommended fuels and lubricating oils; accident-caused damage and replacement of expendable items made in connection with scheduled maintenance. YANMAR disclaims any responsibility for incidental or consequential such as loss of time, inconvenience, loss of use of equipment/engine or commercial loss.

■ Owner’s warranty responsibilities:

As the non-road (off-road) compression-ignition engine owner, you are responsible for the performance of the required maintenance listed in your operation manual. YANMAR recommends that you retain all documentation, including receipts, covering maintenance on your non-road (off-road) compression-ignition engine, but YANMAR cannot deny warranty solely for the lack of receipts, or for your failure to ensure the performance of all scheduled maintenance.

YANMAR may deny your warranty coverage if your non-road (off-road) compression-ignition engine or a part has failed due to abuse, neglect, improper maintenance or unapproved modifications.

Your engine is designed to operate on diesel fuel only. Use of any other fuel may result in your engine no longer operating in compliance with CARB and EPA emissions requirements.

You are responsible for initiating the warranty process. You are responsible for presenting your engine to an authorized YANMAR dealer or distributor as soon as a problem exists. The warranty repairs should be completed by the dealer as expeditiously as possible.If you have any questions regarding your warranty rights and responsibilities, or would like information on the nearest YANMAR dealer or authorized service center, you should contact YANMAR Europe B.V.

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