FOREWORD

This manual has been prepared to provide information regarding structures, features and repair procedures on Hino Vehicles.

Applicable for A09C engine

When making any repairs on your vehicle, be careful not to be injured through improper procedures.
As for maintenance items, refer to the Owner's Manual.
All information and specifications in this manual are based upon the latest product information available at the time of printing.
Hino Motors reserves the right to make changes at any time without prior notice.

Hino Motors, Ltd.

CHAPTER REFERENCES REGARDING THIS WORKSHOP MANUAL

Use this chart to the appropriate chapter numbers for servicing your particular vehicle.

CHAPTER		MANUAL NO.	S5-MA09E02B
		MODEL	A09C
STRUCTURES AND FEATURES			
	INTRODUCTION		1
	ENGINE		2
INSPECTION AND MAINTENANCE			
	GENERAL INTRODUCTION		GN01-001
	ENGINE INTRODUCTION		EN01-001
	ENGINE MECHANICAL		EN02-001
	AIR INTAKE SYSTEM		EN03-001
	EXHAUST SYSTEM		EN04-001
	LUBRICATING SYSTEM		EN05-001
	COOLING SYSTEM		EN06-001
	FUEL SYSTEM		EN07-001
	TURBOCHARGER		EN08-001
	EMISSION CONTROL		EN10-001
	ALTERNATOR		EN11-001
	STARTER		EN12-001
	AIR COMPRESSOR		EN13-001
	ENGINE P.T.O. (POWER TAKE-OFF)		EN14-001
	ENGINE RETARDER		EN15-001
	ENGINE CONTROL		EN16-001
	ENGINE CONTROL		DN01-001
	FUEL CONTROL		DN02-001

STRUCTURES AND FEATURES

HINO

INDEX: STRUCTURES AND FEATURES

STRUCTURES AND FEATURES

Hino Motors, Ltd.

INTRODUCTION

IDENTIFICATION OF VEHICLE MODEL CODE

LIST OF VEHICLE MODEL CODES

LIST OF APPLICABLE VEHICLE MODELS

JP18Z00010102007

VEHICLE MODEL		ENGINE MODEL	TRANSMISSION MODEL
FM	1A	A09C	FULLER RTO11909ALL
			ALLISON 3500RDS

DESIGNATION OF VEHICLE MODEL CODE

JP18Z00010102008

F	M	1A	R	K	A
①	②	③	④	⑤	⑥

①	CLASSIFICATION OF VEHICLE TYPE F: Cab-over-engine truck
②	VEHICLE CLASS AND DRIVE SYSTEM
③	CLASSIFICATION OF ENGINE 1A: A09C
④	CLASSIFICATION OF WHEEL BASE L: 4,750 to 4,999 mm {187.0 to 196.8 in.} R: 5,750 to 5,999 mm {226.4 to 236.1 in.} W: Over 7,000 mm {275.6 in.}
⑤	POSITION OF STEERING WHEEL K : Right-hand steering wheel
⑥	INDICATION OF VEHICLE BODY CONFIGURATION A: Leaf-suspension type cargo truck M: Mixer truck G: Air-suspension type cargo truck

	CLASS OF PAYLOAD (TONNAGE)	DRIVE SYSTEM
M	10.0	6 x 4 (FOUR-REAR-WHEEL DRIVE)

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INTRODUCTION TO VEHICLE MODEL SERIES

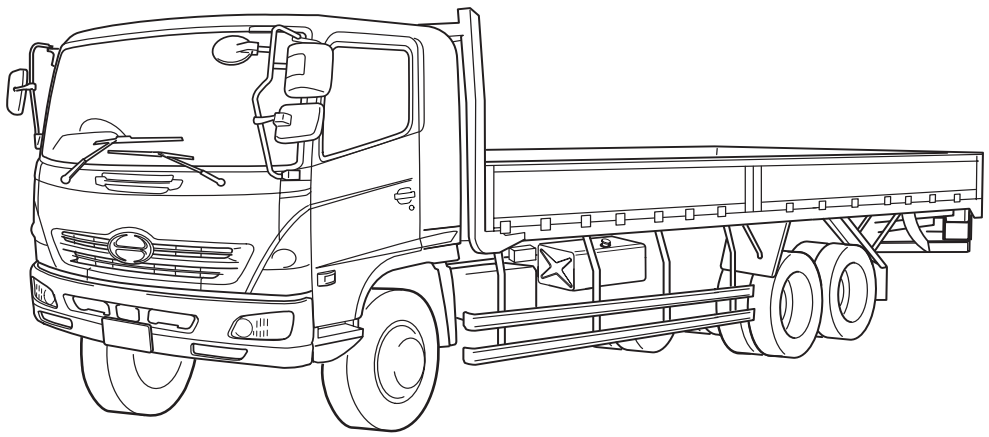
JP18Z00010102001

FM MODEL

FM

Long cargo trucks

Mixer trucks



FEATURES OF VEHICLE MODEL

- Payload: 10 to 15.75 tons
- Drive system: 6 x 4 (four-rear-wheel drive)
- Features of FM model:

  The FM model is a perfect model for transporting heavy cargos and/or traveling on rough roads, featuring powerful drive performance with four-rear-wheel drive (6 x 4). Hino offers a wide variation of products ranging from dump trucks to long-body trucks.
  Hino's new light-weight, fuel-efficient in-line six-cylinder diesel engine (A09C) complements Hino's product lineup.

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OBJECTIVE OF DEVELOPMENT

SUMMARY

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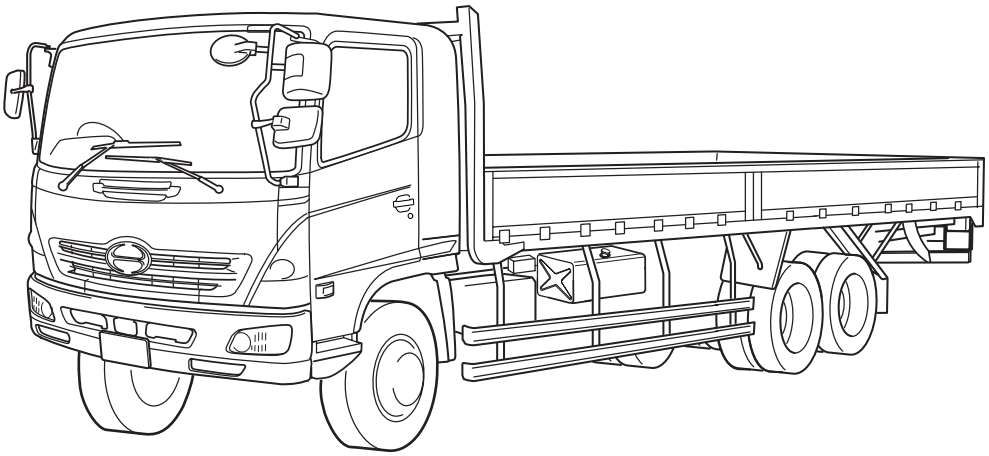
Keyword - More user-friendly, more powerful !

ENGINE

- New A09C engine in compliance with US04 emission standards



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NEW A09C ENGINE IN COMPLIANCE WITH US04 EMISSION STANDARDS

ENGINE

ENGINE UNIT

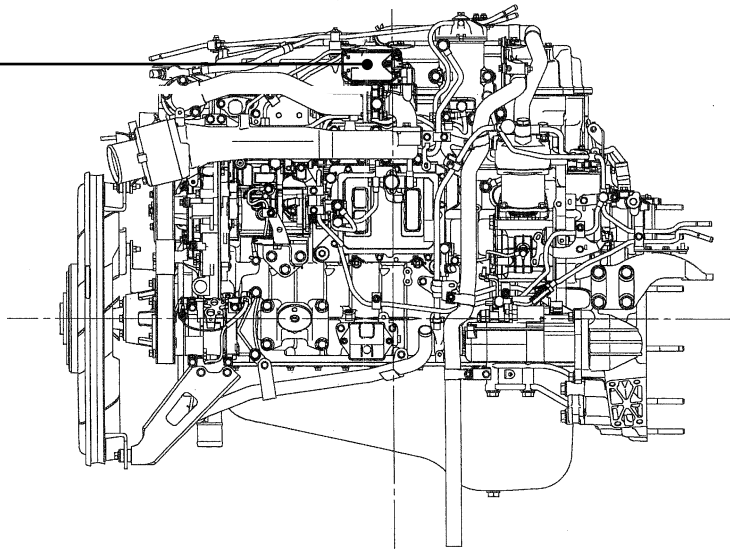
● Hino's all-out effort with state-of-art technologies produced this new light-weight, fuel-efficient engine. Hino developed a new high-strength cylinder block and a new basic structure. This development produced a engine that can withstand a high combustion pressure and exert high fuel efficiency and high power output.

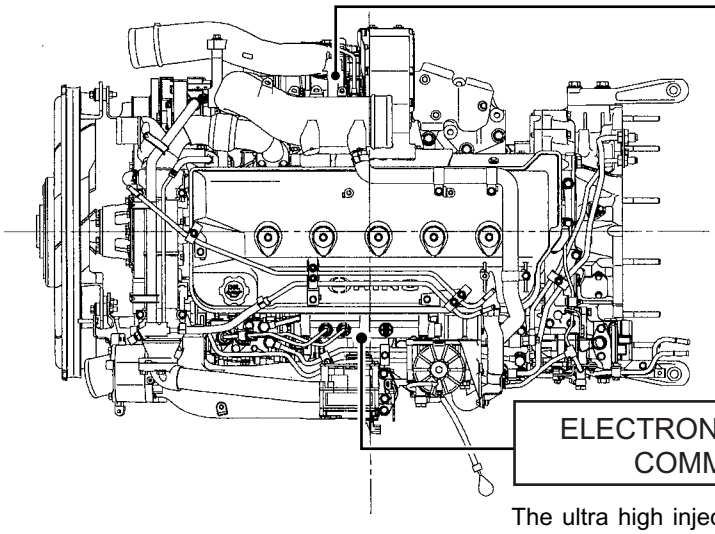
ENGINE ECU

The engine ECU analyses the changeable operation conditions based on the information obtained from various sensors and controls the intake air flow, EGR gas flow and fuel injection flow for optimum combustion. Other features include high fuel efficiency and dramatic reduction in NOx and PM emissions during rapid acceleration/deceleration.

ELECTRONIC CONTROLLED COOL EGR SYSTEM

Introduction of a new efficient EGR cooler and an electronic controlled variable EGR valve in combination with the A09C engine made a great contribution to reduction of NOx emissions.





ELECTRONIC CONTROLLED VARIABLE NOZZLE TURBOCHARGER

A new electronic variable nozzle turbocharger installed at the turbine inlet precisely controls an air flow and an exhaust pressure (EGR gas flow) and improves the combustion efficiency.

ELECTRONIC CONTROLLED HIGH-PRESSURE COMMON RAIL INJECTION SYSTEM

The ultra high injection pressure atomizes the fuel to accelerate mixing with air for higher fuel efficiency. The number of fuel injections, the injection timing and the injection flow are precisely controlled to ensure the combustion controllability in response to driving conditions.

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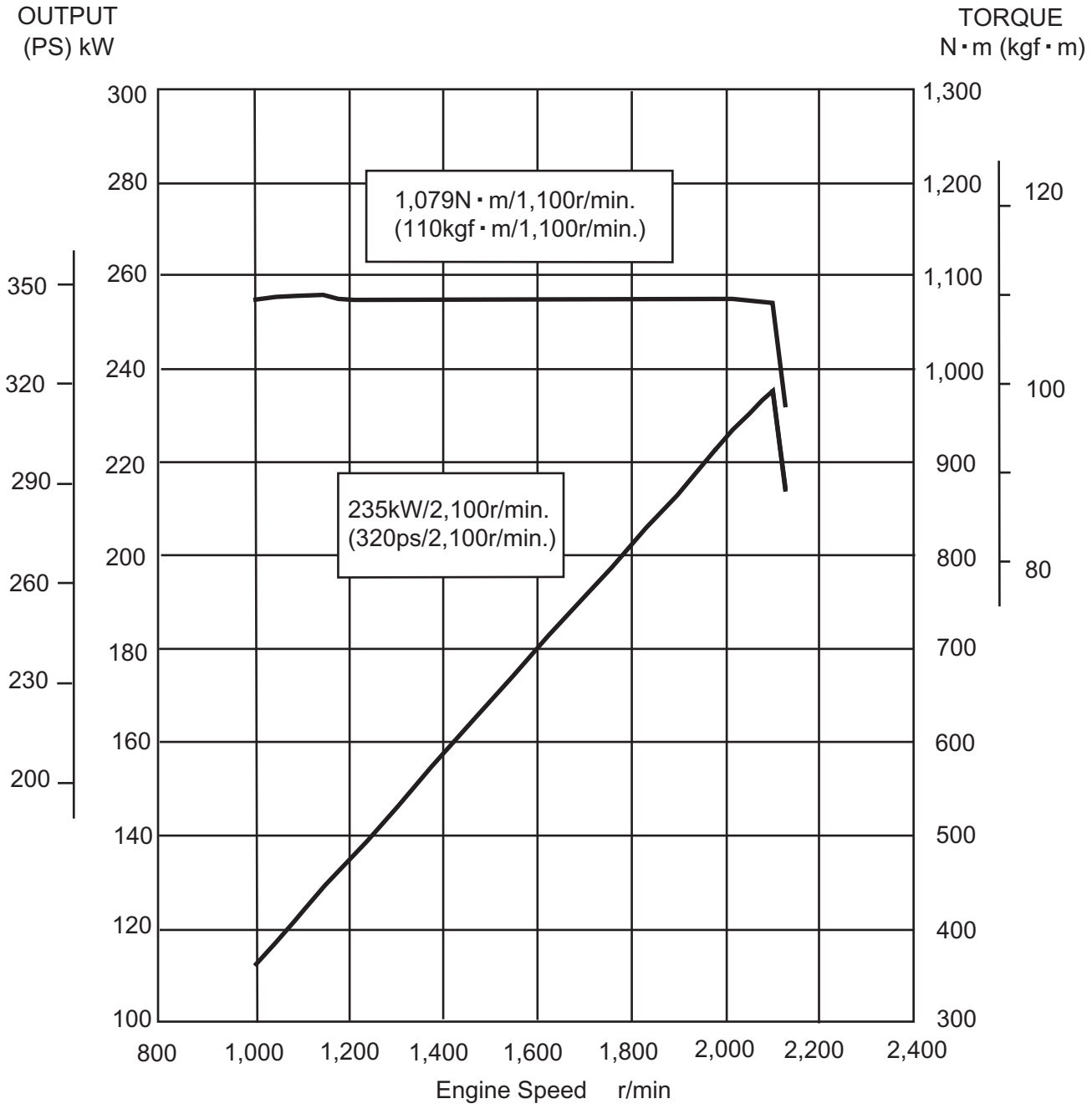
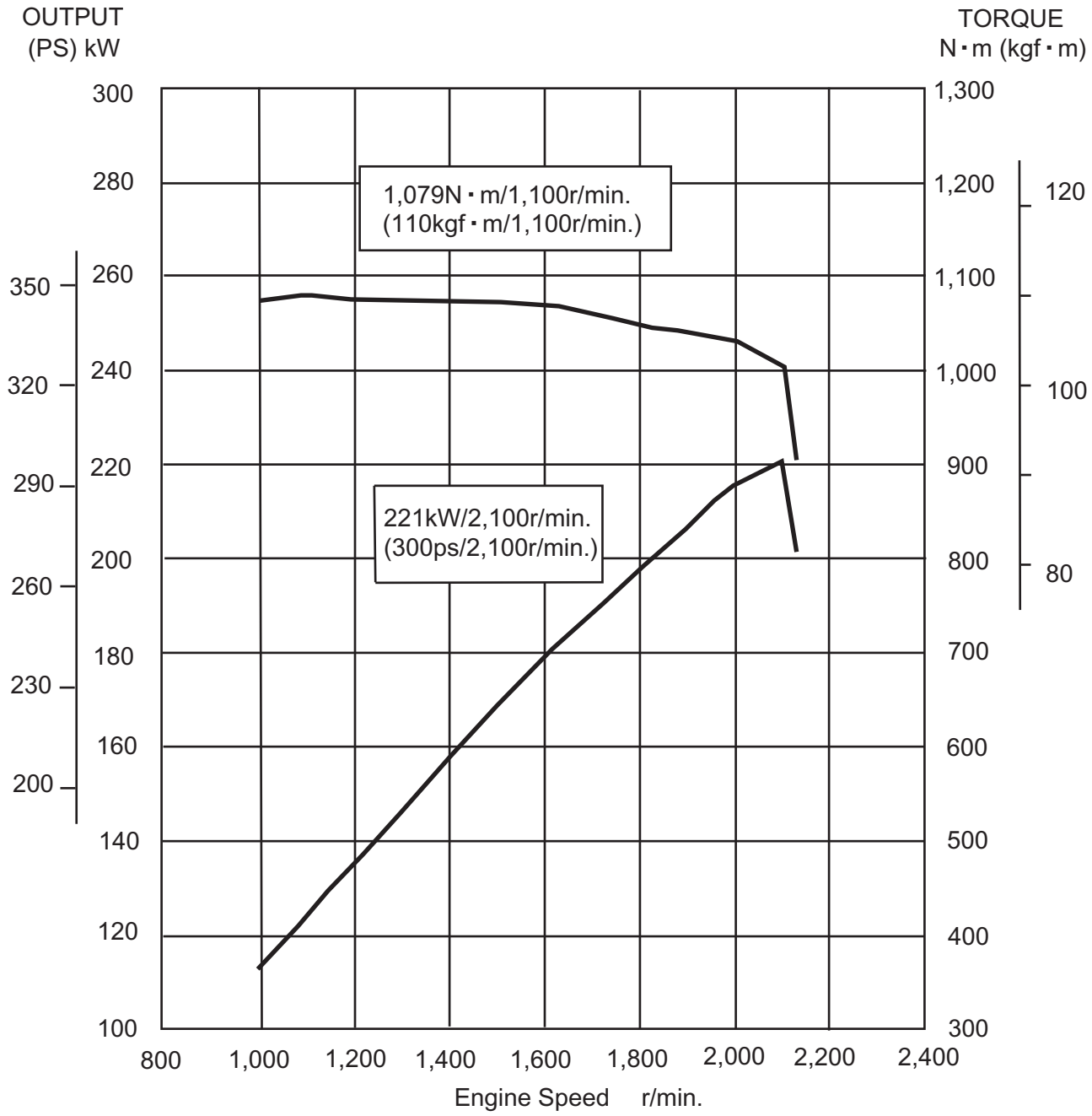
CHARACTERISTICS OF ENGINE

- The A09C engine outputs a high torque at a low engine speed. This is an advantage in gaining higher fuel efficiency and good drivability at a low engine speed. A09C-TK engine is used for the manual transmission model. A09C-TJ is used for the automatic transmission model.

A09C-TK ENGINE



A09C-TJ ENGINE



OUTLINE OF VEHICLE (CHANGE)

LIST OF VEHICLE (CHANGE) OUTLINE

LIST OF CHANGE OUTLINE

JP18Z00010102011

RELEVANT CHAPTER			NAME OF COMPONENT	OUTLINE OF VEHICLE (CHANGE)	EFFECTIVENESS
02	Engine	[A09C] Engine control	Engine ECU	Increased accuracy of injection system; versatile engine ECU specialized in controlling the engine; connection to vehicle control ECU via CAN communication	
02	Engine	[A09C] Engine control	Engine ECU	Use of ECU cooler (cooling by fuel) for ECU directly mounted on engine (with anti-vibration mechanism)	Higher reliability
02	Engine	[A09C] Engine control	Harness assembly	Addition of twist tube and thermal-resistant tube into corrugation	Higher reliability
02	Engine	[A09C] Fuel system	Supply pump	Use of Bosch's supply pump	Compliance with US04 emission standards
02	Engine	[A09C] Fuel system	Supply pump	Separately arranged layout of flange mount, geared feed pump, fuel temperature sensor and priming pump	Higher reliability and serviceability
02	Engine	[A09C] Fuel system	Common rail	Use of Bosch's common rail	Compliance with US04 emission standards
02	Engine	[A09C] Fuel system	Injector (nozzle & nozzle holder)	Use of Bosch's injector	Compliance with US04 emission standards
02	Engine	[A09C] Fuel system	Injector (nozzle & nozzle holder)	Fuel leakage circuit built in the cylinder head	Higher reliability and serviceability
02	Engine	[A09C] Fuel system	Common rail pressure sensor	Use of high-accuracy common rail pressure sensor	Higher immunity to electromagnetic interference
02	Engine	[A09C] Fuel system	Fuel filter	Optimization of relief valve opening pressure	

RELEVANT CHAPTER			NAME OF COMPONENT	OUTLINE OF VEHICLE (CHANGE)	EFFECTIVENESS
02	Engine	[A09C] Fuel system	Injection pipe	Use of isometric injection pipe; conformity to the Bosch system	Compliance with US04 emission standards
02	Engine	[A09C] Emission control	EGR system	New system	Compliance with US04 emission standards
02	Engine	[A09C] Emission control	EGR valve	Use of butterfly valve	Compliance with US04 emission standards
02	Engine	[A09C] Emission control	EGR actuator	Use of brushless DC motor	Compliance with US04 emission standards
02	Engine	[A09C] Emission control	EGR cooler	Chamber structuring for coolant inlet/outlet	Higher cooling efficiency and fuel efficiency
02	Engine	[A09C] Emission control	Ventilation system	Breather built in the head cover	
02	Engine	[A09C] Intake	Air flow sensor	Use of compact air flow sensor	
02	Engine	[A09C] Engine mechanical	Cylinder head	Integration with cam housing	
02	Engine	[A09C] Engine mechanical	Cylinder head	Integrated structure of nozzle sleeve	
02	Engine	[A09C] Engine mechanical	Cylinder head	Double cooling jet; built-in fuel leak circuit	Higher reliability
02	Engine	[A09C] Engine mechanical	Cylinder head cover	Fastening with five center bolts	
02	Engine	[A09C] Engine mechanical	Cylinder head cover	Use of breather integrated with head cover	
02	Engine	[A09C] Engine mechanical	Cylinder block	OHC structure	Higher power output and reliability
02	Engine	[A09C] Engine mechanical	Cylinder block	Use of semi-open deck water jacket and two-bore type piston cooling jet	Higher reliability

RELEVANT CHAPTER			NAME OF COMPONENT	OUTLINE OF VEHICLE (CHANGE)	EFFECTIVENESS
02	Engine	[A09C] Engine mechanical	Soundproof cover	Installation of soundproof cover to supply pump gear	Lower gear noise
02	Engine	[A09C] Engine mechanical	Piston	Use of FCD piston	Higher power output and fuel efficiency
02	Engine	[A09C] Engine mechanical	Piston	Three piston rings; optimization of combustion chamber geometry	Compliance with US04 emission standards
02	Engine	[A09C] Engine mechanical	Piston	Optimization of skirt profile	Higher reliability
02	Engine	[A09C] Engine mechanical	Connecting rod	Embedded cap bolt; improved positioning accuracy with knock pin	Higher reliability and power output
02	Engine	[A09C] Engine mechanical	Crankshaft	Reduction from 8 to 4 counterweights; elimination of counterweight machining	Weight saving
02	Engine	[A09C] Engine mechanical	Crank pulley	Weight-saving of damper; elastic angle control method for bolting	Higher reliability and fuel efficiency
02	Engine	[A09C] Engine mechanical	Crank pulley	Optimization of damper characteristic value	
02	Engine	[A09C] Engine mechanical	Valve system	Two versions of crosshead on the exhaust side: i.e. with retarder and no retarder	
02	Engine	[A09C] Engine mechanical	Valve system	Arm assembly: Two versions available: i.e. retarder for 3-cylinder (standard) and for 6-cylinder	
02	Engine	[A09C] Engine mechanical	Valve system	Intake rocker arm: FC material, bushless	
02	Engine	[A09C] Engine mechanical	Camshaft	Use of sintered camshaft; 7-journal	Higher reliability and weight-saving
02	Engine	[A09C] Engine mechanical	Camshaft	Addition of brake cam	Optimum braking force

RELEVANT CHAPTER			NAME OF COMPONENT	OUTLINE OF VEHICLE (CHANGE)	EFFECTIVENESS
02	Engine	[A09C] Engine mechanical	Camshaft	Optimization of valve timing and lift cam profile	Compliance with US04 emission standards; higher fuel efficiency and power output
02	Engine	[A09C] Engine mechanical	Engine retarder	Two versions of braking force: i.e. activation for 3-cylinder and for 6-cylinder	Selectable to user needs
02	Engine	[A09C] Engine mechanical	Engine retarder	Brake rocker arm with brake cam and line contact between master piston	Higher reliability
02	Engine	[A09C] Engine mechanical	Timing gear	Use of high teeth and change of pressure angle	Lower noise; higher reliability
02	Engine	[A09C] Engine mechanical	Timing gear	Use of gas-nitrocarburized gear; multiple tightening of heavy-duty idle gear shaft	Higher reliability
02	Engine	[A09C] Engine mechanical	Timing gear cover	Installation of cover to front geartrain for driving supply pump	
02	Engine	[A09C] Engine mechanical	Timing gear cover	With timing adjust pointer	Higher serviceability
02	Engine	[A09C] Engine mechanical	Flywheel housing	Aluminum die-cast; rear geartrain	Weight-saving
02	Engine	[A09C] Engine mechanical	Engine mounting	Change of engine mount bracket shape	Higher assemblability
02	Engine	[A09C] Engine mechanical	Engine mounting	Front mounting: addition of roll stopper	
02	Engine	[A09C] Exhaust	Exhaust manifold	Integrated bellows	Reduction of the number of parts
02	Engine	[A09C] Exhaust	Exhaust manifold	Reduction of fastening bolts on the cylinder head side	
02	Engine	[A09C] Cooling	Coolant pump	Installation on the front face of block	Reduction of the number of parts; weight-saving
02	Engine	[A09C] Cooling	Thermostat case & thermostat	Change of each pipe to press-fit type for outlet control, EGR water return, and air vent	

RELEVANT CHAPTER			NAME OF COMPONENT	OUTLINE OF VEHICLE (CHANGE)	EFFECTIVENESS
02	Engine	[A09C] Lubrication	Oil pan	New parts; 8 L difference between upper and lower	Longer interval of oil refilling
02	Engine	[A09C] Lubrication	Oil strainer	Aluminum mould	
02	Engine	[A09C] Lubrication	Oil pump	Built in the cylinder block ; elimination of feed pipe	Weight-saving
02	Engine	[A09C] Lubrication	Oil cooler	Integrated full-flow/bypass element; reduction from 11 to 8 rows in cooler core	Weight-saving
02	Engine	[A09C] Lubrication	Oil cooler	Sealing surface in contact with block: change from gasket to O-ring	Higher reliability
02	Engine	[A09C] Starting/charging	Belt auto tensioner	Use of auto tensioner	Higher serviceability
02	Engine	[A09C] Starting/charging	V-belt	Use of poly V-belt (one belt to drive a coolant pump, a cooler compressor and an alternator)	Higher serviceability
02	Engine	[A09C] Turbocharger	Variable nozzle turbocharger	Variable nozzle drive: DC motor drive	Compliance with US04 emission standards
02	Engine	[A09C] Turbocharger	Variable nozzle turbocharger	Variable nozzle control: variable control	Compliance with US04 emission standards
02	Engine	[A09C] Turbocharger	Variable nozzle turbocharger	Variable nozzle support: both-ends-supported	Higher reliability
02	Engine	[A09C] Turbocharger	Variable nozzle turbocharger	New controller	
02	Engine	[A09C] Air compressor	Air compressor	Use of water-cooling and lead valve	Lower discharge temperature
02	Engine	[A09C] Air compressor	Air compressor	Extended piston skirt	Reduction of oil leak into combustion chamber via piston ring
02	Engine	[A09C] Flywheel PTO	Flywheel PTO	Applicable to mixer truck Output torque: 45 kg·m Ratio: 1	Applicability to heavy-duty body build

LAWS AND REGULATIONS

AUTOMOBILE EMISSION REGULATIONS

SUMMARY

JP18Z00160102001

- Emission-controlled components and/or parts are installed in the US04 compliant low emission vehicles to meet the exhaust emission limits specified in the safety standards. These components and/or parts must not be retrofitted or detached, or must be placed back to their original positions after being detached for the purpose of servicing.

APPROACH FOR EMISSION CONTROL

JP18Z00160102003

APPROACH	Common rail, Cool EGR and Variable nozzle turbocharger

FAILURE DIAGNOSIS

FAILURE DIAGNOSIS WITH COMPUTER (Hino-DX)

ABOUT Hino-DX

JP01D01ZZZ040102002001

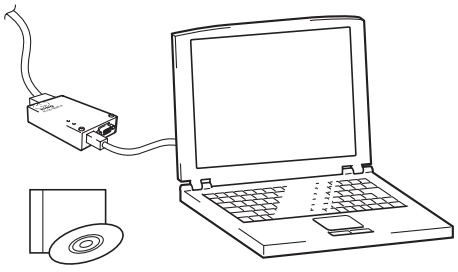
- The Hino-DX diagnoses failures in the common-rail fuel injection system and some of chassis systems. Connection of the Hino-DX to a vehicle must use either of the interface box (Hino-Bowie) as an interface function, and the dedicated cables.

SPECIAL TOOLS

NO.	NAME OF ITEMS	ITEM NO.
1	Interface box (Hino-Bowie)	09993-E9070
	Cable between vehicle and Hino-Bowie	(09042-1220)
2	Field support system software CD-ROM "Hino Diagnostic eXplorer (Hino-DX)"	

Reference

- Use the "Hino-Bowie" (see the No.1 in the table above) as an interface.
- A cable to be used to connect a computer and the Hino-Bowie is supplied with the Hino-Bowie kit. Use either of a RS-232C cable or a USB cable.
- Install the Hino Diagnostic eXplorer (Hino-DX) software on a computer. For details of installation, see the instruction manual supplied with a CD-ROM.
- For further details, see the "Maintenance Manual - Failure Diagnosis".
- Listed in the table above are item numbers designated for first edition. These item numbers may be revised or altered in line with future design changes without prior notice.



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GLOSSARY

DEFINITION OF ABBREVIATION

LIST OF ABBREVIATIONS

JP18Z00010102010

ABBREVIATION	DEFINITION AND UNABBREVIATED TERMINOLOGY
CAN	Controller Area Network
DC motor	Direct Current motor
ECU	Electronic Control Unit
EEPROM	Electronically Erasable and Programmable Read Only Memory (rewritable memory)
EGR	Exhaust Gas Recirculation
ENG	Engine
FBC	Fuel Balance Control
FMU	Fuel Metering Unit
Fr	Front
GND	Ground (earth)
I.S.C.	Idle Speed Control
IC	Integrated Circuits
ID	Identification
I/O	Inlet/Outlet
LH	Left Hand
LIN	Local Interconnect Network
MPROP	Metering-unit PROPortional
NOx	Nitrogen oxide
OHC	Over Head Camshaft
OPT	Option
PCV	Pump Control Valve
PM	Particulate matter
PTO	Power Take-Off
PVD	Physical Vapor Deposit
QR code	Quick Response code
RH	Right Hand
ROM	Read Only Memory

ABBREVIATION	DEFINITION AND UNABBREVIATED TERMINOLOGY
Rr	Rear
TI	Turbo Intercooler
TWV	Two Way Valve
Repro	Re-programming

ENGINE

2

[A09C] ENGINE CONTROL

ENGINE CONTROL SYSTEM

STRUCTURE

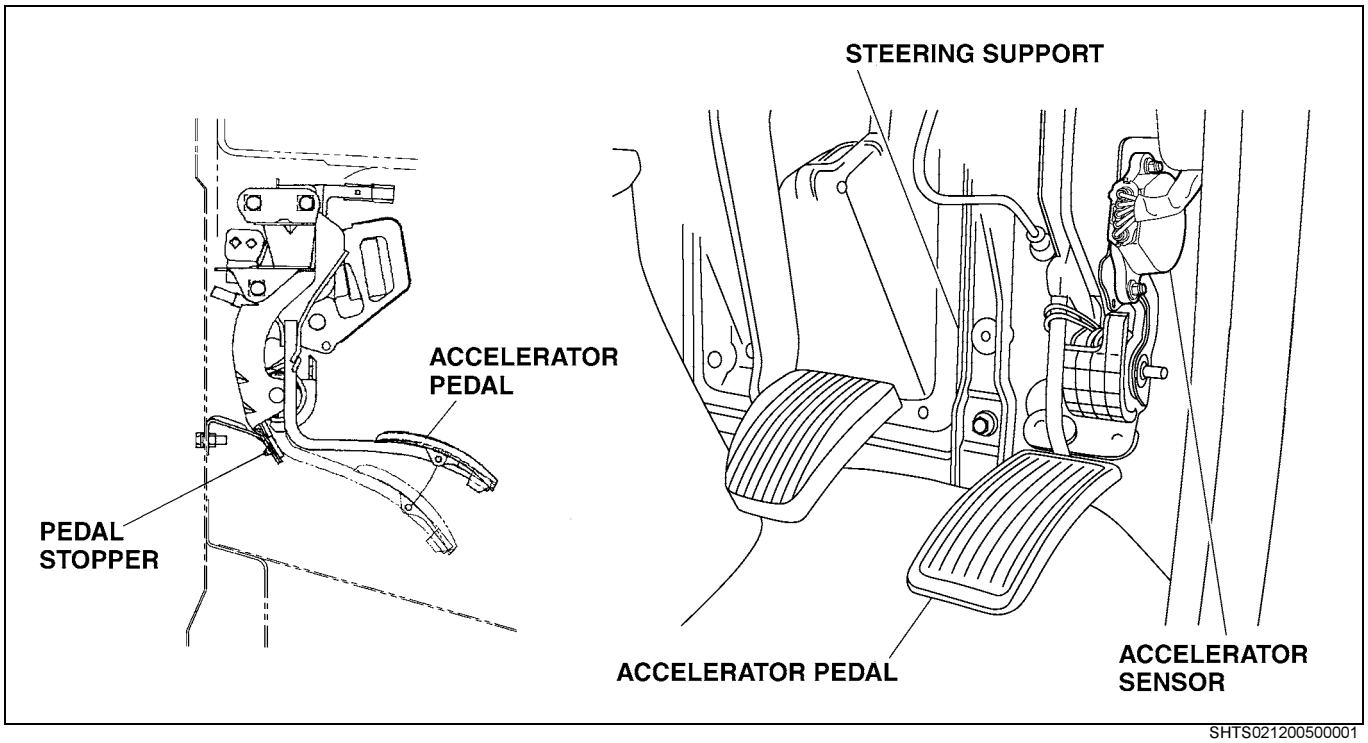
JP18Z01020301001

ACCELERATOR CONTROL

- The accelerator control is connected to the accelerator sensor via a pedal link, and electrical signals are input from the accelerator sensor to a computer.
- The suspended type accelerator pedal is installed.
- The suspended type accelerator pedal is a perfect fit for motions of a foot and gives an aid in reducing tiredness during long-distance travel through its flexibility for ideal pedaling operations in all driving situations.
- A flat floor under the suspended type accelerator pedal has an advantage of easier floor cleaning.

STROKE

- A stroke is controlled by an idle stopper of the accelerator sensor during idling or by a full stopper of the accelerator sensor at a full load. In addition, a pedal stopper installed at the bottom of a pedal prevents an excessive operating force from being applied to related components/parts at a full load.



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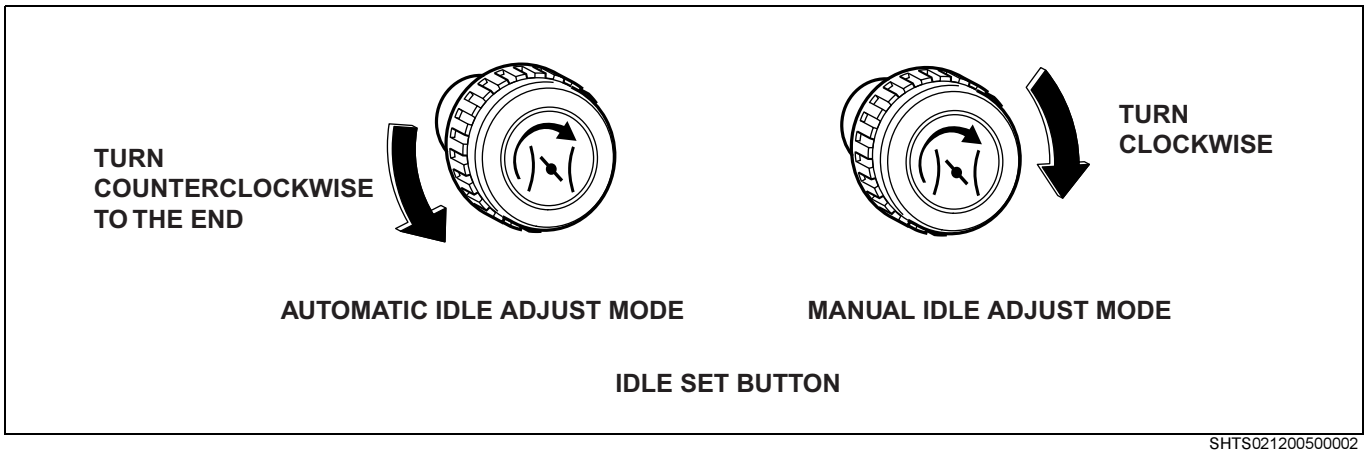
IDLE SET BUTTON

- The idle set button is an integrated component consisting of a potentiometer and a switch and is installed on the right side of the panel in front of a driver's seat. Electrical signals converted from button operations will be input to a computer.
- Turning a knob of the idle set button counterclockwise to the end will activate the automatic idle adjust mode in which an idling speed will be automatically adjusted based on the engine coolant temperature. When a coolant temperature exceeds 60°C, the idling speed will be automatically set to the standard idling speed.
- Turning a knob of the idle set button clockwise will activate the manual idle adjust mode. The idling speed can be set at user's desired setting by manually turning a knob (settable range: 450 to 900 r/min.).



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Standard idling speed: 500 r/min.

[A09C] FUEL SYSTEM

FUEL INJECTION SYSTEM

SUMMARY

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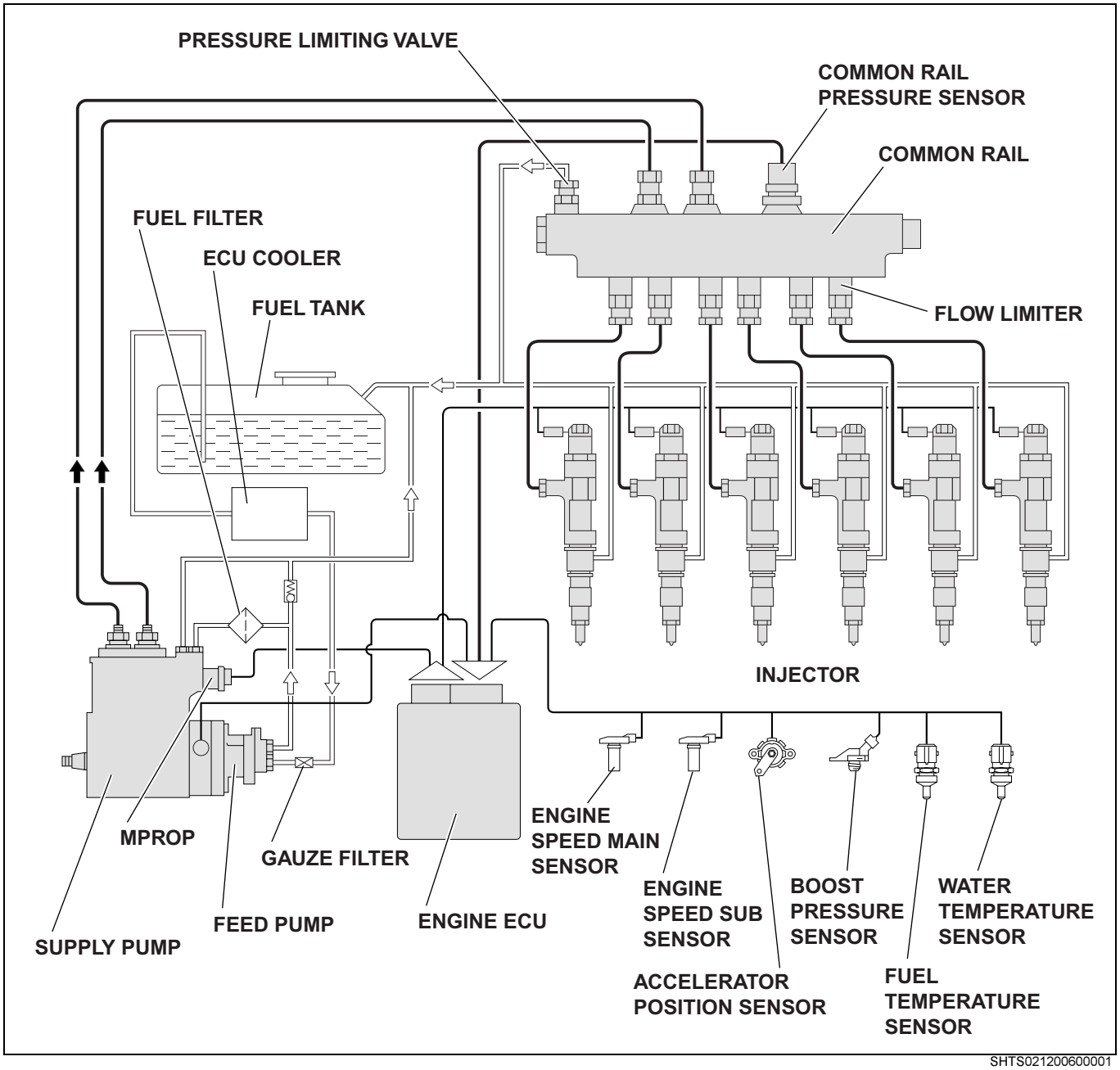

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- The common-rail fuel injection system is installed.
- This system consists of a supply pump, a common rail, injectors, an engine ECU (for controlling these aforesaid components), sensors, switches, relays and lights.
- The supply pump discharges the fuel for producing a fuel pressure in the common rail. The fuel discharge rate is controlled by the supply pump MPROP (solenoid valve for fuel metering). The MPROP is electronically controlled by the engine ECU.
- The common rail distributes the fuel of a high pressure produced by a supply pump to each cylinder injector. This fuel pressure is detected by the common-rail pressure sensor installed on the common rail. The engine ECU performs the pressure feedback control to ensure the consistency between an actual pressure value and a command pressure value predetermined in proportion to an engine speed and an engine load.
- An injection flow and an injection timing are controlled in the injector through the magnet valve ball switching between ON and OFF. When a magnet is turned 'ON' (current applied), the fuel circuit will switch over to open a valve ball so that high-pressure fuel in the control chamber will flow out through the orifice and the nozzle valve opening force applied by high-pressure fuel in the nozzle needle chamber will lift the nozzle needle valve and start injection. When a magnet is turned 'OFF' (no current applied), the fuel circuit will switch over to apply the high-pressure fuel to the control chamber via orifice so that the nozzle needle valve will move down and stop injection. In other words, the injection timing can be controlled by the timing of magnet energization start and the injection flow can be controlled by the magnet energization time.
- The PM (particulate matter) emissions were reduced by good and clean combustion, resulting from the finer atomization of fuel injection by increased fuel pressure. This was achieved by increasing the withstanding pressure of individual components and parts.

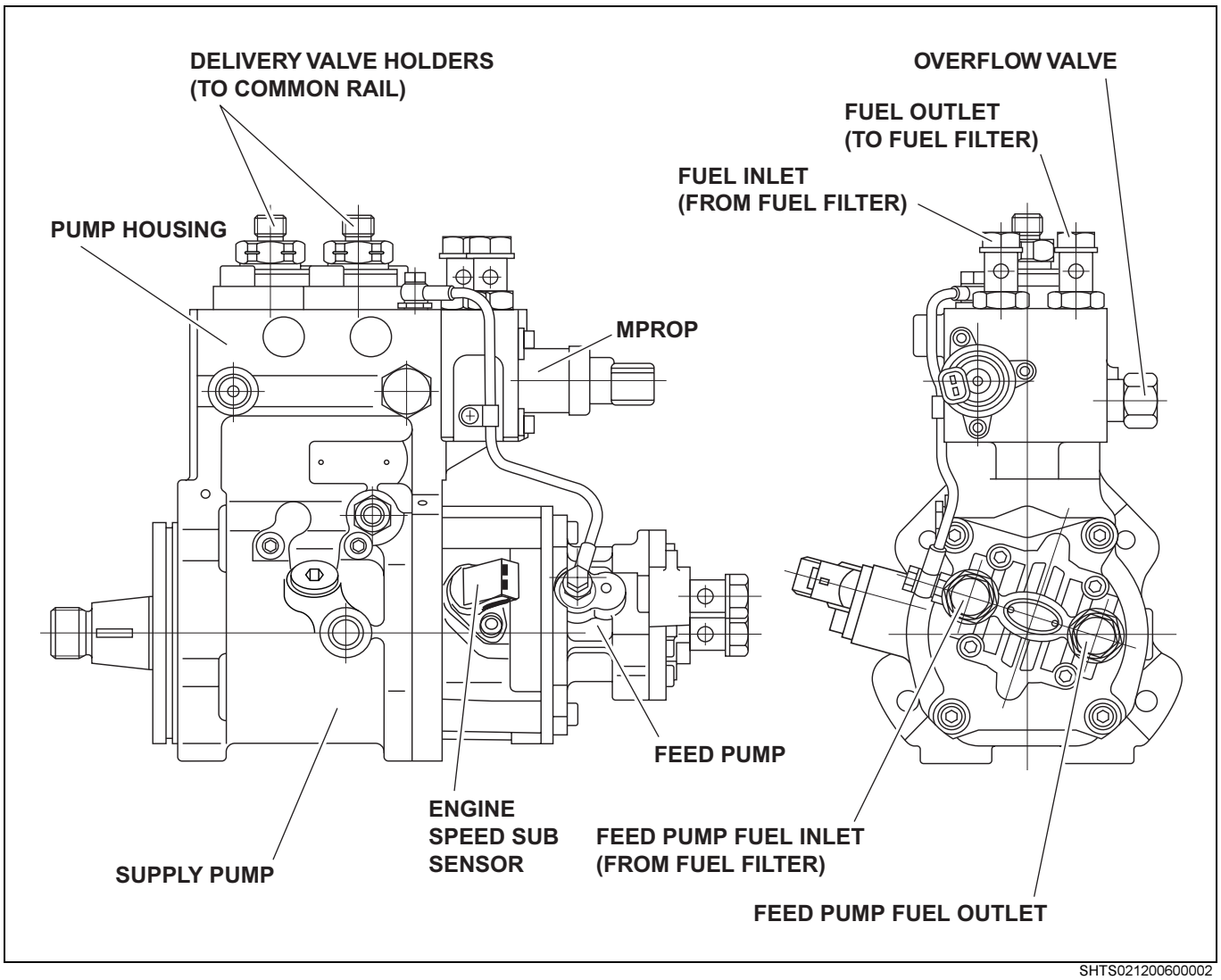
(Reference) MPROP : Metering-unit PROPortional (Fuel metering electromagnetic valve)

STRUCTURE

JP18117020301004

SUPPLY PUMP ASSEMBLY

- The supply pump assembly consists of a feed pump, a MPROP and a supply pump, and is designed to charge the fuel for producing the fuel pressure in the common rail.



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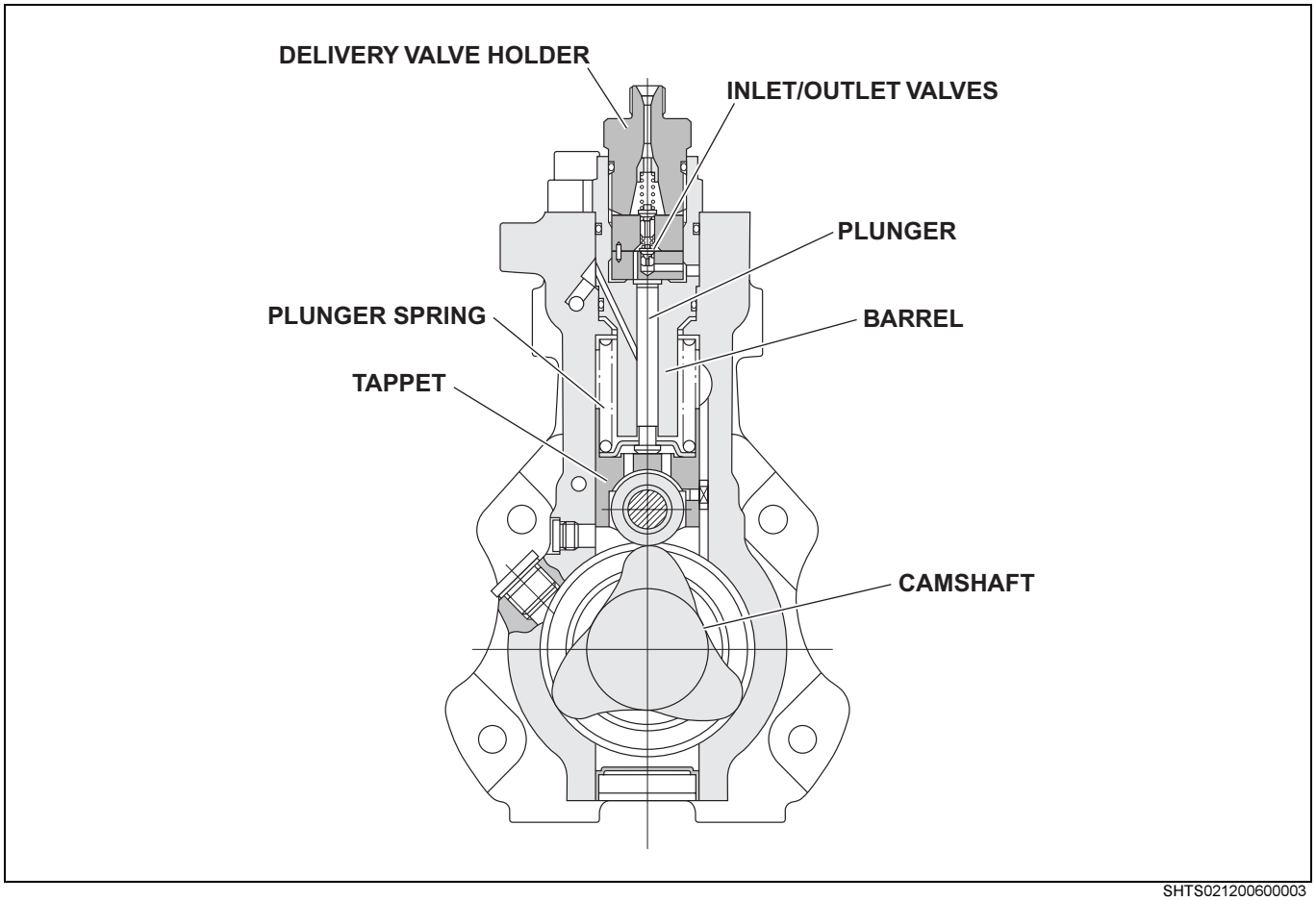
SUPPLY PUMP

- The supply pump supplies the fuel to the common rail, after a plunger increases a pressure of fuel, supplied by the MPROP.

1. STRUCTURE
   - The supply pump consists of delivery valve holders, inlet/outlet valves, a plunger, a barrel, a plunger spring, a tappet, a camshaft and a pump housing. A rotation sensor and a fuel temperature sensor are mounted to the pump housing.
   - The fuel gallery is installed within the pump housing to reserve the fuel pressurized by a feed pump and regulated by an overflow valve.



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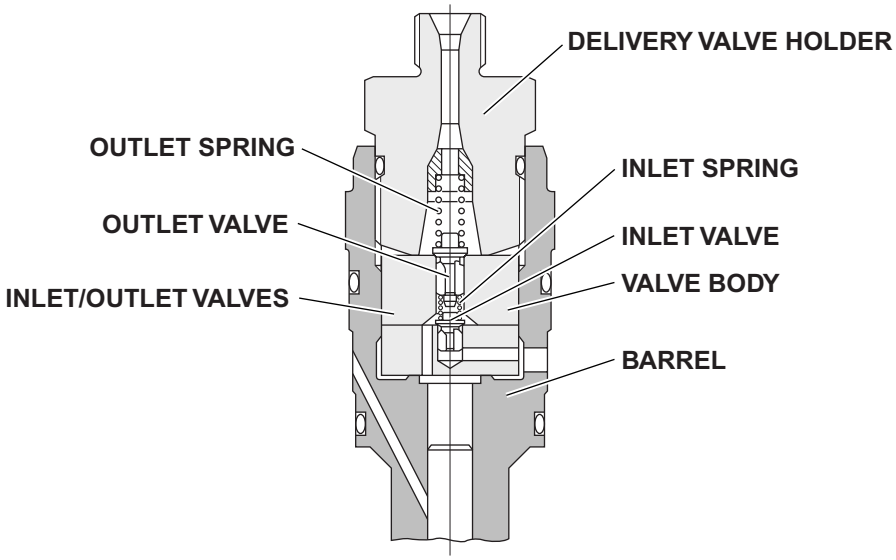
2. OPERATION
   - When engine cranking or starting rotates a camshaft, a plunger will be lifted in the cam upstroke to increase a pressure of fuel and supply the fuel to the common rail via inlet/outlet valves.
   - When a cam rotates and a plunger is lowered by a plunger spring in the cam downstroke, the fuel will flow into the plunger chamber via inlet/outlet valves after being adjusted to the optimum fuel flow by the MPROP.
   - Two cams are located at different phases in the camshaft. One rotation of a camshaft will deliver six discharges.

INLET/OUTLET VALVES

- The inlet/outlet valves receive the fuel from the MPROP, supply it to the plunger chamber and prevent the fuel from flowing back into the MPROP when the fuel of a high pressure applied by a plunger is supplied to the common rail.

1. STRUCTURE
   - The inlet/outlet valves consists of an inlet valve, an outlet valve, an inlet spring, an outlet spring and a valve body, and are assembled to the location between a delivery valve holder and a barrel.



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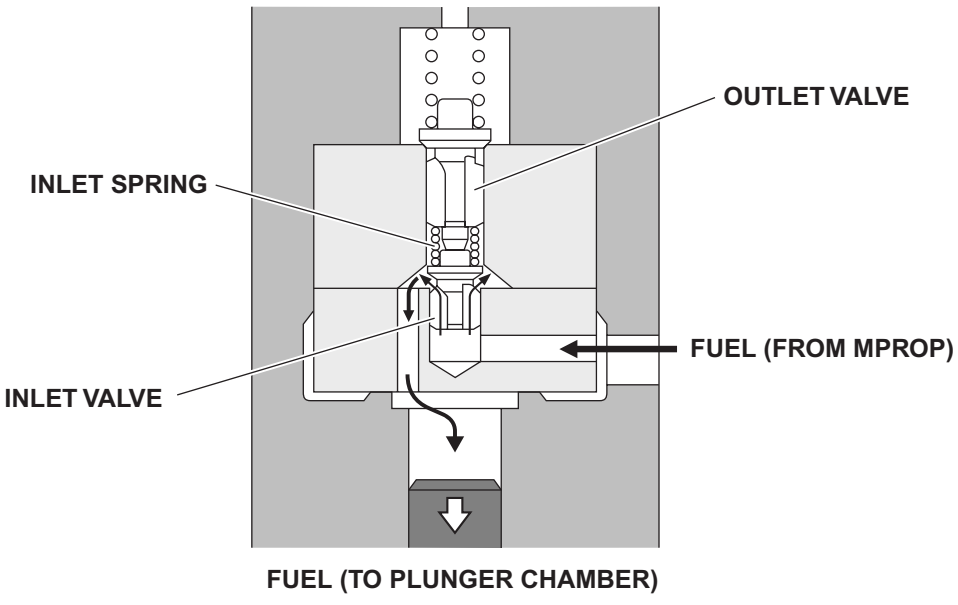
2. OPERATION
   a. INTAKE STROKE OF PLUNGER
      - After a plunger starts its downstroke, a fuel pressure will overcome an inlet spring, lift an inlet valve and flow into the plunger chamber (an outlet valve will remain closed in this stage.)



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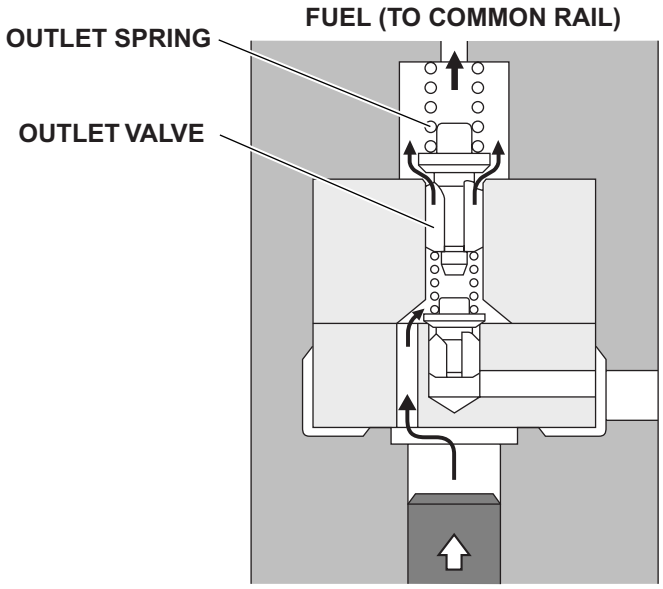
b. COMPRESSION STROKE OF PLUNGER

- After a plunger starts its upstroke, the fuel will be pressurized. When a fuel pressure overcomes an outlet spring, the fuel will lift an outlet valve and flow into the common rail. In this stage, an inlet valve will remain closed.
- In the compression stroke of a plunger, an inlet valve will be pushed down by a force applied by partial portion of fuel.



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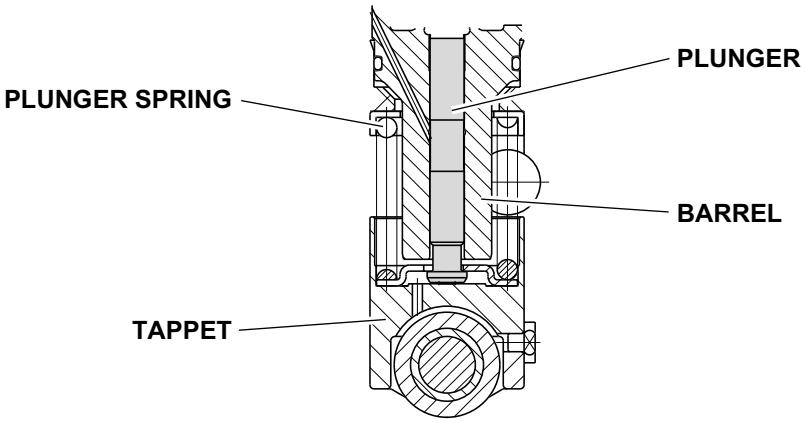
PLUNGER ASSEMBLY

- The plunger assembly pressurizes the intake fuel and discharge the high-pressure fuel.

1. STRUCTURE
   - The plunger assembly consists of a plunger and a barrel, and takes in and compresses the fuel through up-and-down motions converted from revolving motions of a camshaft via the tappet.



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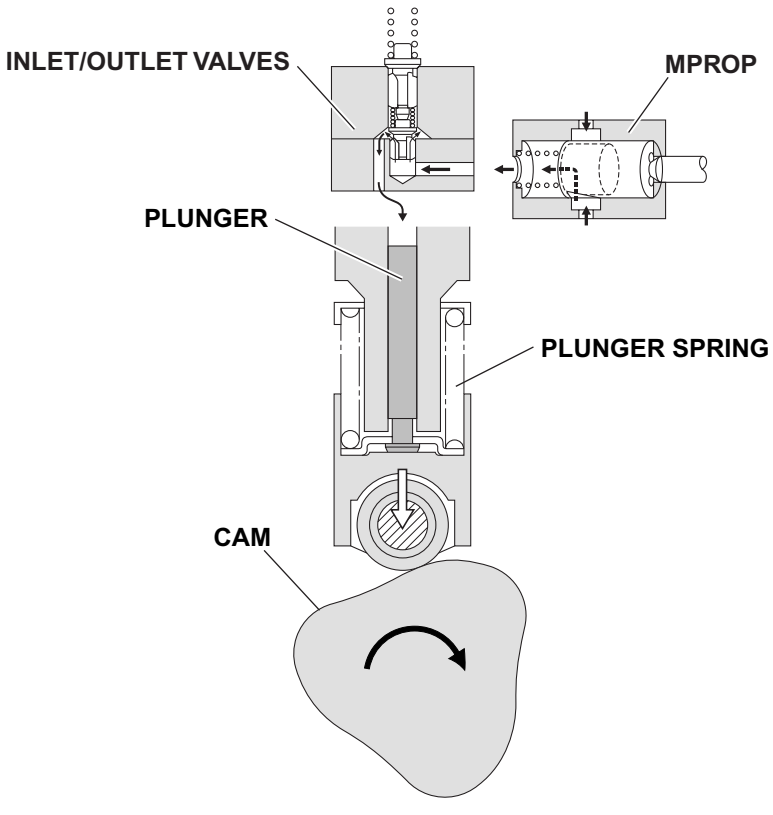
2. OPERATION
   a. INTAKE STROKE OF PLUNGER
      - When a cam on the camshaft rotates in the direction from the top dead center to the bottom dead center, a plunger will be lowered by a plunger spring and take in the fuel.



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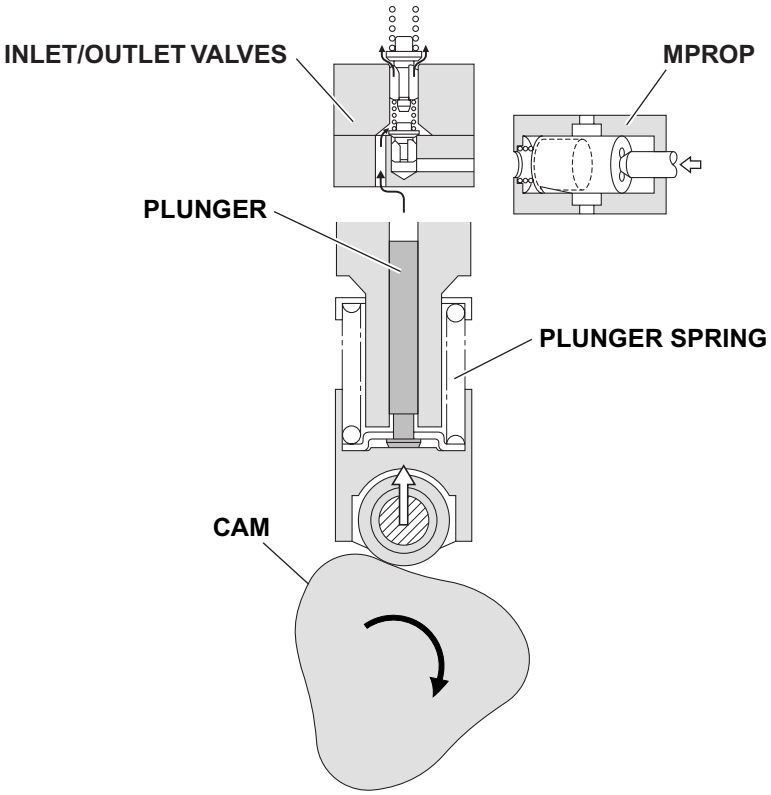
b. COMPRESSION STROKE OF PLUNGER

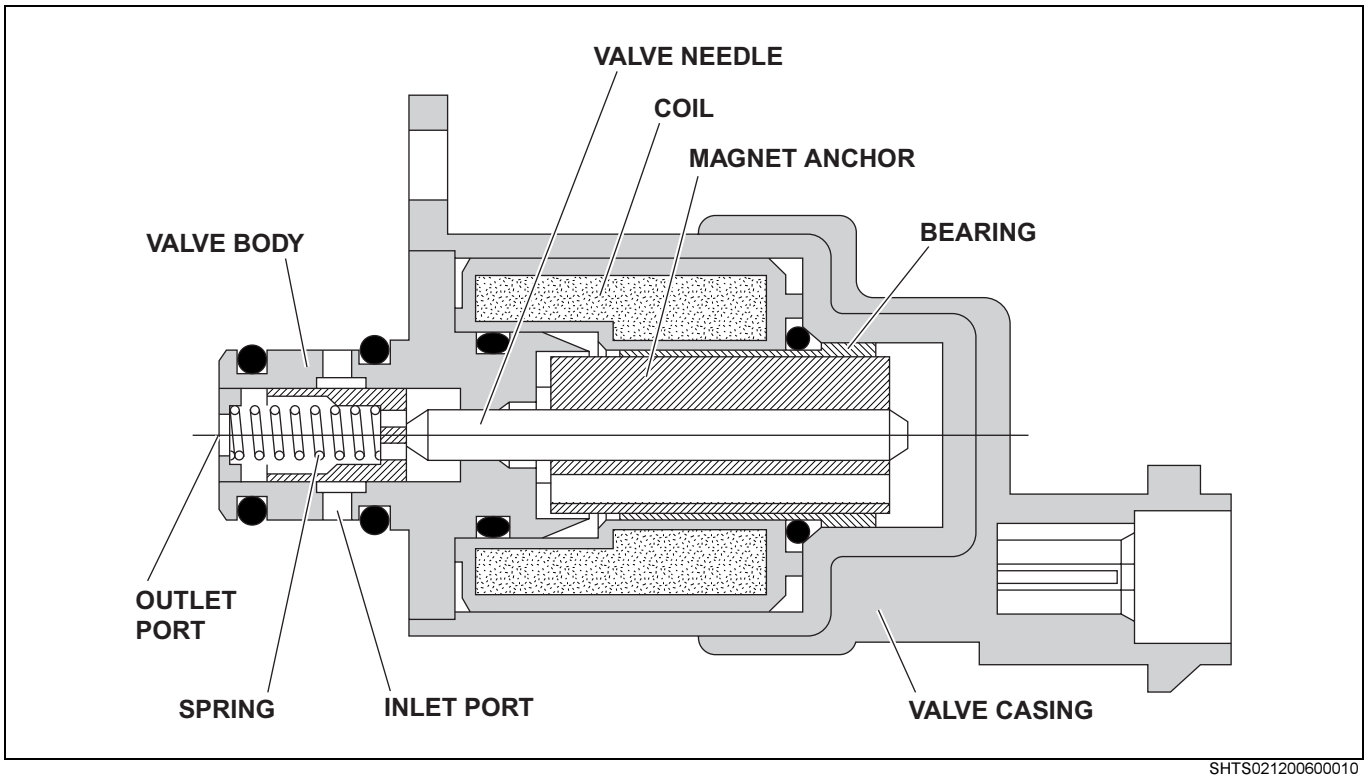
- When a cam on the camshaft rotates in the direction from the bottom dead center to the top dead center, a plunger will be lifted by a cam and compress and discharge the fuel.



SHTS021200600009

MPROP

1. STRUCTURE
   - The MPROP consists of a valve body, a valve needle, a valve casing, a magnet anchor (moving magnet core) and a coil.
   - An inlet port and an outlet port are located on the valve body and the valve needle is seated via the valve piston.
   - Rapid opening/closing motions (cycle) of the valve needle activates the MPROP to operate as a variable throttle.
   - The MPROP keeps monitoring the signals from the ECU and controls the feed rate of fuel from a supply pump.



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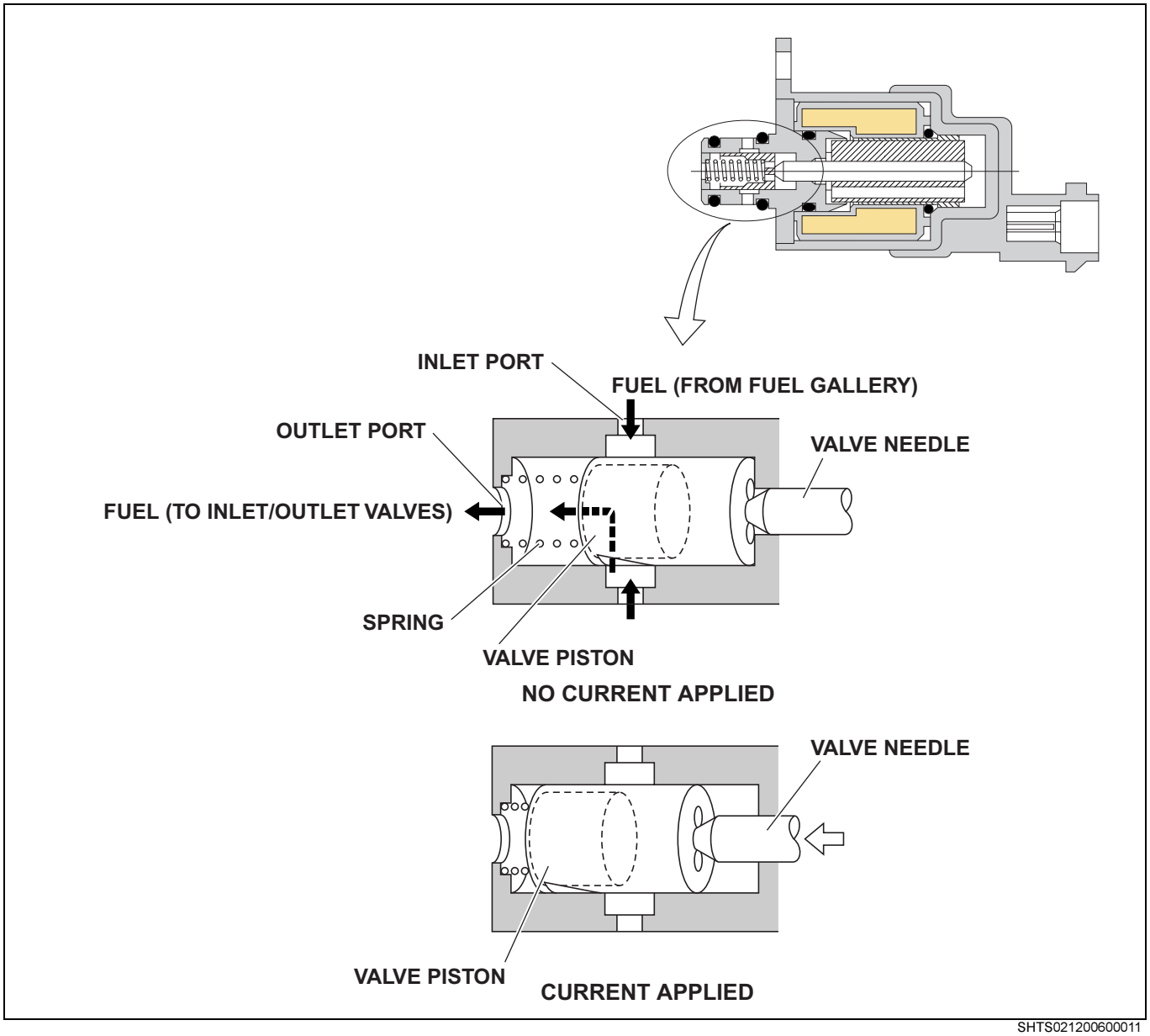
2. OPERATION

- Current is directly applied from the ECU to the MPROP coil under the duty ratio control. The fuel feed rate of a supply pump will reach a peak when no current is applied (0% duty). Higher the duty ratio is (closer to 100%), lower the feed rate will be.
- When no current is applied, the valve needle and the valve piston will be pushed by a spring, and the inlet and outlet ports will have a flow path. After pressure-fed by a feed pump and regulated by the overflow valve, the fuel in the fuel gallery will flow into the inlet/outlet valves.
- In the meantime, when a ratio of drive duty from the ECU increases, the valve needle will lift and the valve piston will throttle the areal size of a linkage channel between an inlet port and an outlet port. This will decrease the rate of flow into the inlet/outlet valves.



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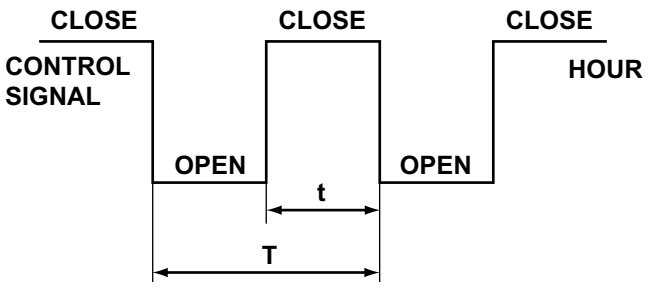
3. MPROP DUTY RATIO CONTROL
   - The MPROP is controlled by a duty ratio of the control signal, and the duty ratio is set by the ECU.
   - The duty ratio is a ratio of the close time to the time of one operating cycle of the MPROP under the OFF duty control.
     Duty ratio = t / T x 100 (%)



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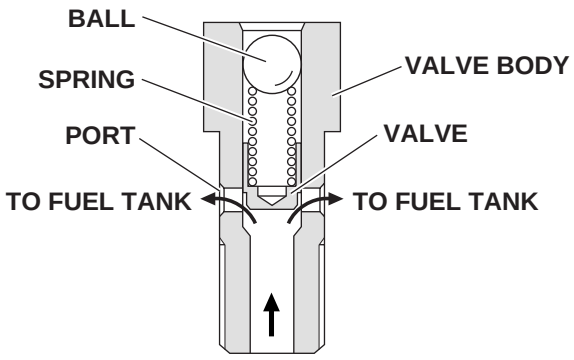
OVERFLOW VALVE

1. STRUCTURE
   - The overflow valve returns the fuel back to the fuel tank when a pressure of fuel delivered from a feed pump exceeds a given value.
   - The overflow valve consists of a valve body, a valve, a spring and a ball. The valve body has ports.
   - The valve is pushed by a spring force and closes the ports.
2. OPERATION
   - When the feed pump rpm increases and the feed pressure of fuel delivered from a feed pump exceeds a spring force of the overflow valve, the valve will lift up and the fuel will return to the fuel tank through ports.
   - When the feed pump rpm decreases and the feed pressure drops, the valve will be pushed up by a spring force and close the ports.
     This function stabilizes a pressure in the fuel gallery and ensures accurate fuel flow adjustment of a throttle valve.



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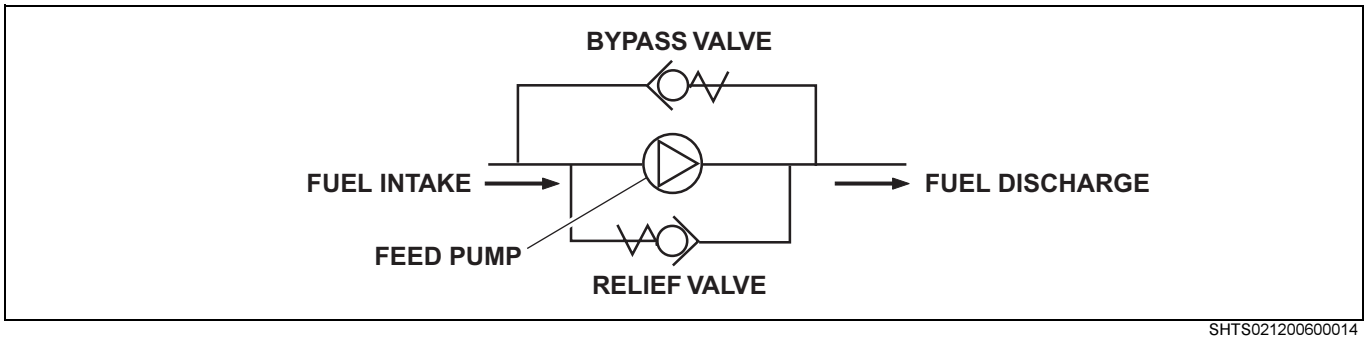
FEED PUMP

- The feed pump built in the supply pump takes up the fuel from a fuel tank and deliver it to the MPROP.

1. STRUCTURE
   - The external gear pump is installed as a feed pump and consists of a drive gear, a driving gear and a driven gear.
   - The inner gear is secured on the camshaft, and the drive gear engaged with the inner gear is linked to the gear pump via the shaft.
   - The drive gear rotation speed will be increased to approximately three times higher than the camshaft rotation speed. Built-in components are a relief valve for protecting the fuel filter and a bypass valve required in priming.



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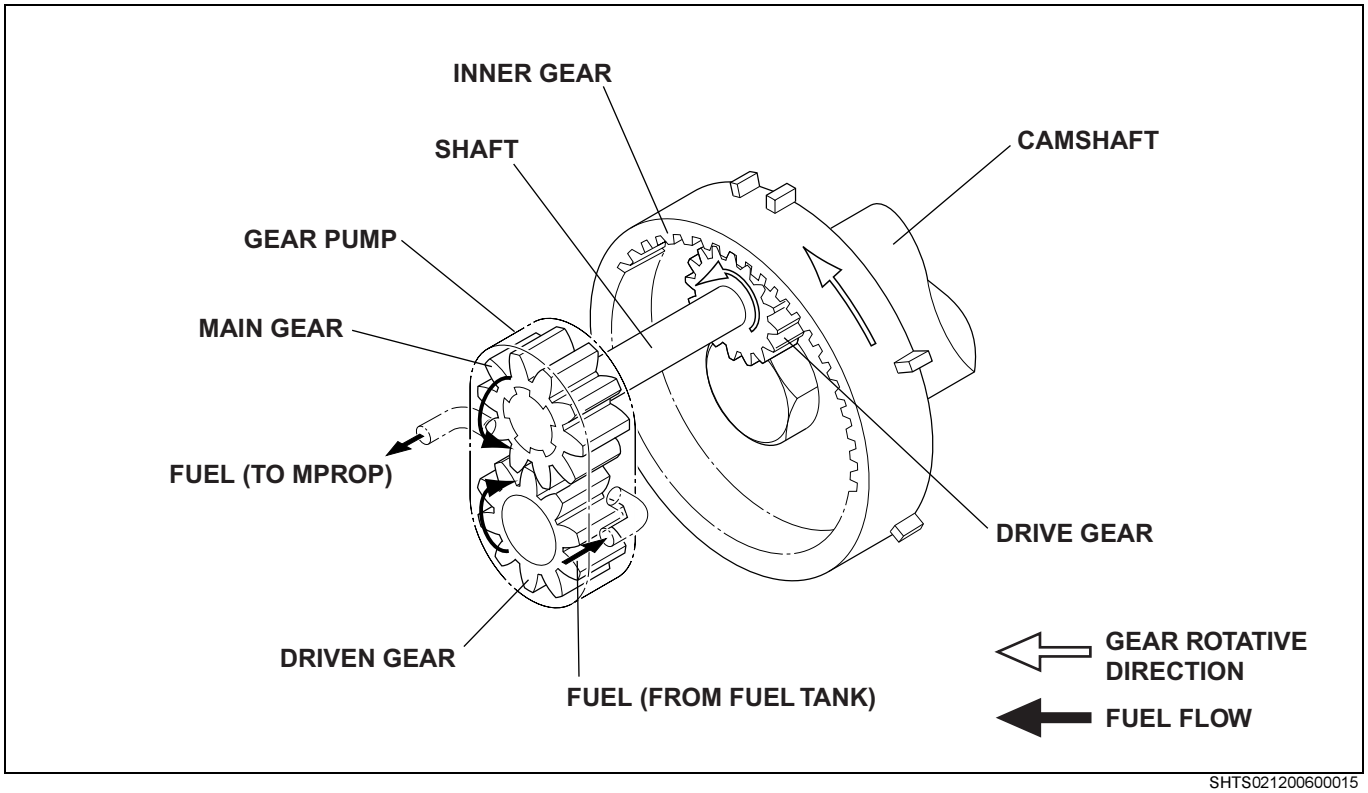
2. OPERATION
   - When the camshaft rotates upon engine cranking or startup, the inner gear secured on the camshaft will also revolve and increase the drive gear rotation speed to approximately 3 times higher than the camshaft rotation speed.
     At the same time, the gear pump linked to the drive gear via the shaft will activate, take in the fuel from a fuel tank and supply the fuel to the MPROP via the fuel filter.
   - An increase of the feed pump speed is set to approximately 3 times so as to ensure a sufficient fuel flow after cranking.



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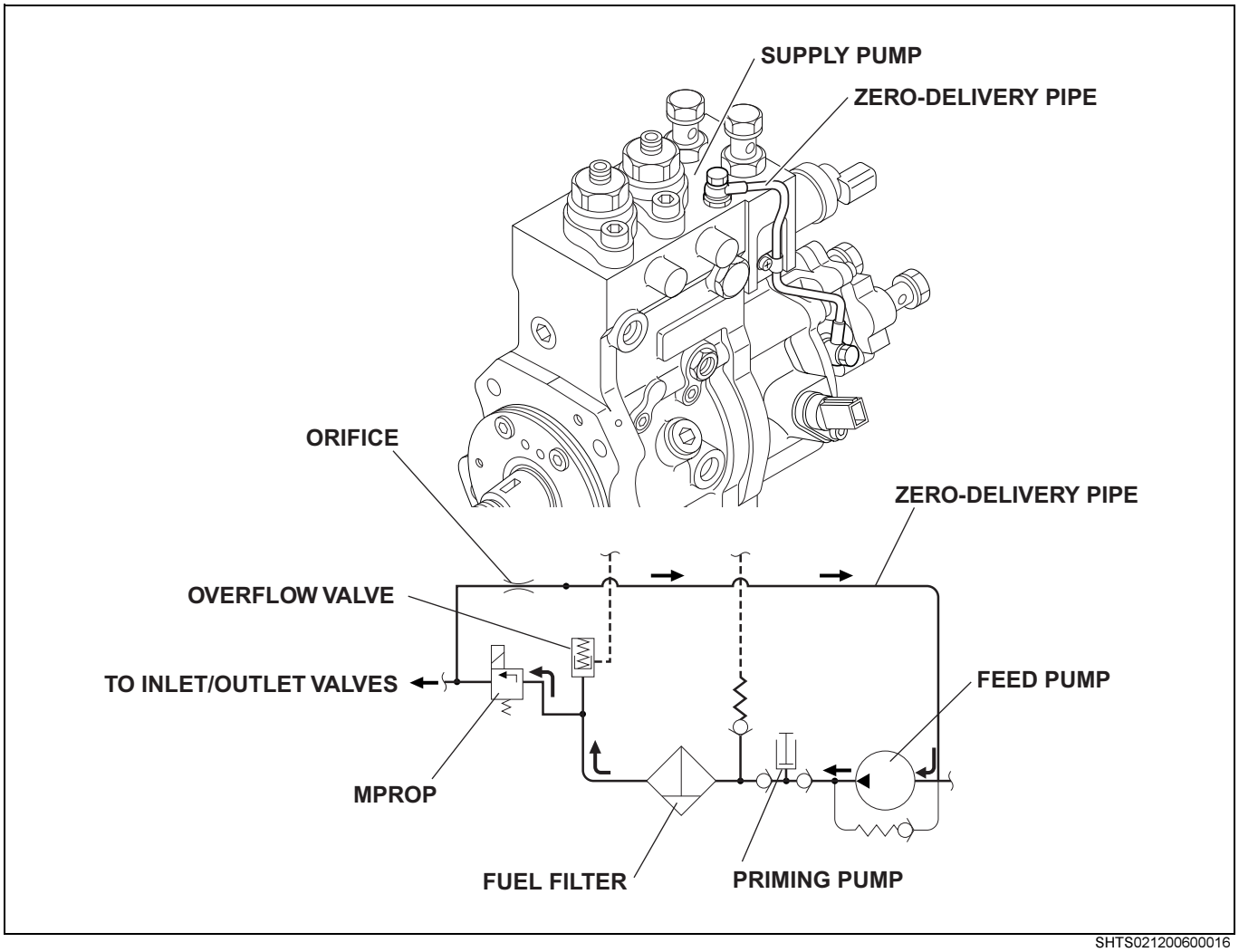
ZERO-DELIVERY PIPE

- The zero-delivery pipe is installed in the location between a supply pump and a feed pump and links the downstream of the MPROP (upstream of inlet/outlet valves) to the upstream of a feed pump on the fuel circuit. One orifice is installed in the delivery pipe.
- The MPROP controls a rate of fuel flow into the plunger chamber via inlet/outlet valves (inlet flow control). It is ideal to have zero fuel flow into the plunger chamber and no pressure-feed from the supply pump during no injection in engine braking. However, a slight amount of fuel flows into the plunger chamber due to an intake vacuum pressure in the downstroke of a plunger in real-world situations. This is prevented by utilizing an intake vacuum pressure in the upstream of a feed pump to take the fuel back from the downstream of the MPROP (upstream of inlet/outlet valves) and ensure no pressure-feed from the supply pump.
  During pressure-feeding of fuel in other situations than engine braking, the installed orifice will prevent the fuel from flowing beyond a given amount. The fuel will not flow back from a plunger because of an overwhelmingly high feed rate from the feed pump.



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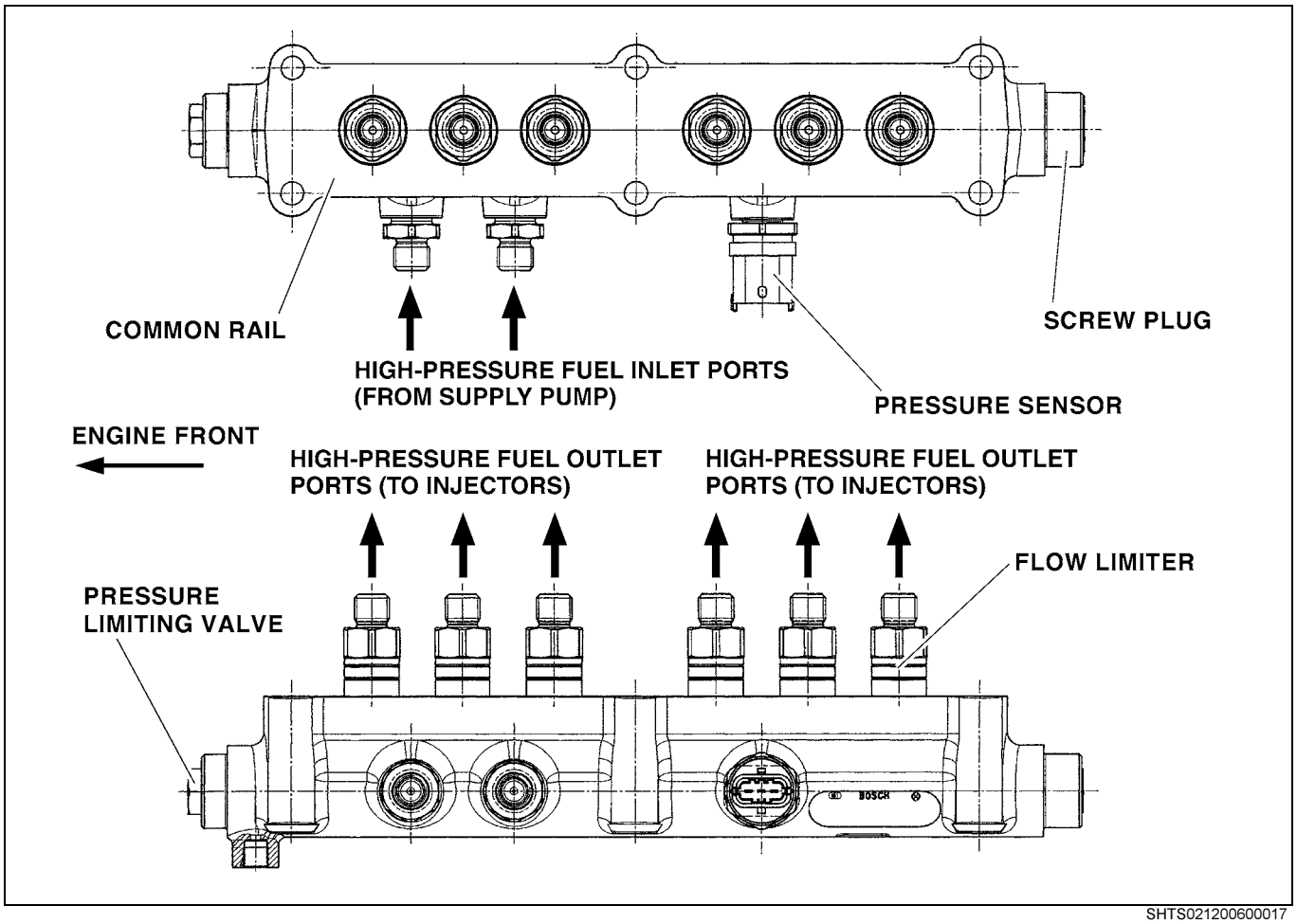
COMMON RAIL

- The common rail distributes the fuel of a high pressure produced by a supply pump, to each cylinder injector.
- The common rail pressure sensor mounted to the common rail detects a fuel pressure, and the engine ECU performs the pressure feedback control to ensure consistency between an actual pressure value and a command pressure value predetermined based on an engine speed and an engine load.
- The common rail is installed on the cylinder head and is equipped with a flow limiter, a pressure limiting valve and a pressure sensor.
- The common rail has a common fuel channel, individual fuel inlet/outlet ports and mounting holes.
- A common fuel channel is a through-hole bored in the common rail and reserves the high-pressure fuel. The pressure limiting valve is installed at the front end. The rear end is sealed by a screw plug.



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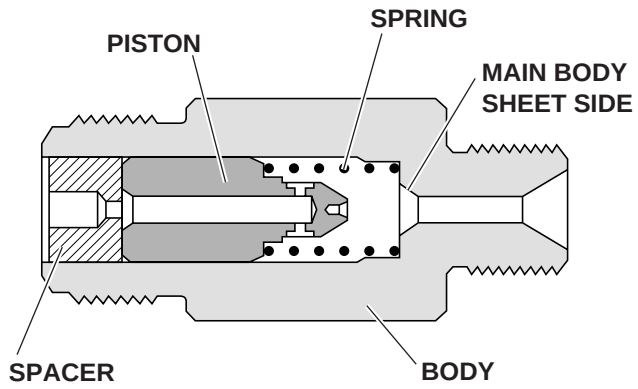
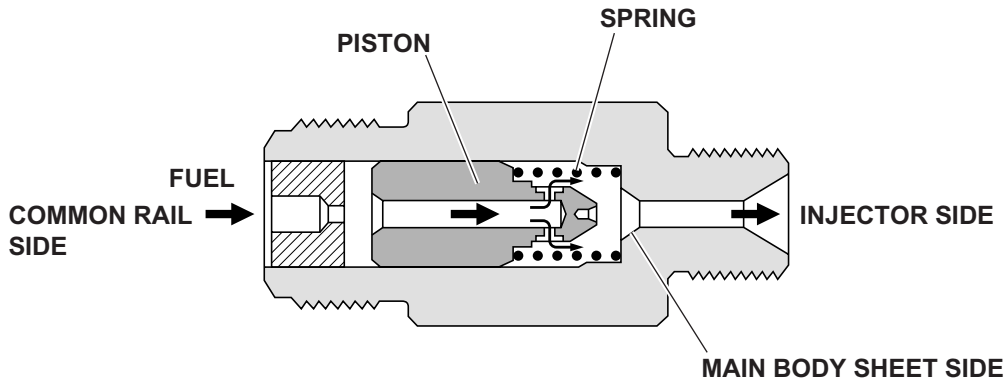
FLOW LIMITER

- The flow limiter consists of a body, a piston, a spring and a spacer.
- The flow limiter shuts off a fuel channel to prevent erratic fuel outflow if fuel leaks out from an injection pipe or excessive fuel is injected from the injector assembly.



SHTS021200600018

1. OPERATION
   1. REGULAR OPERATION
      - When injectors start activating, a piston will travel to right at an appropriate distance for one fuel injection. In regular operations, a piston will not contact the seat.
      - When fuel injection is finished, a piston will be returned to its initial position by a spring force.



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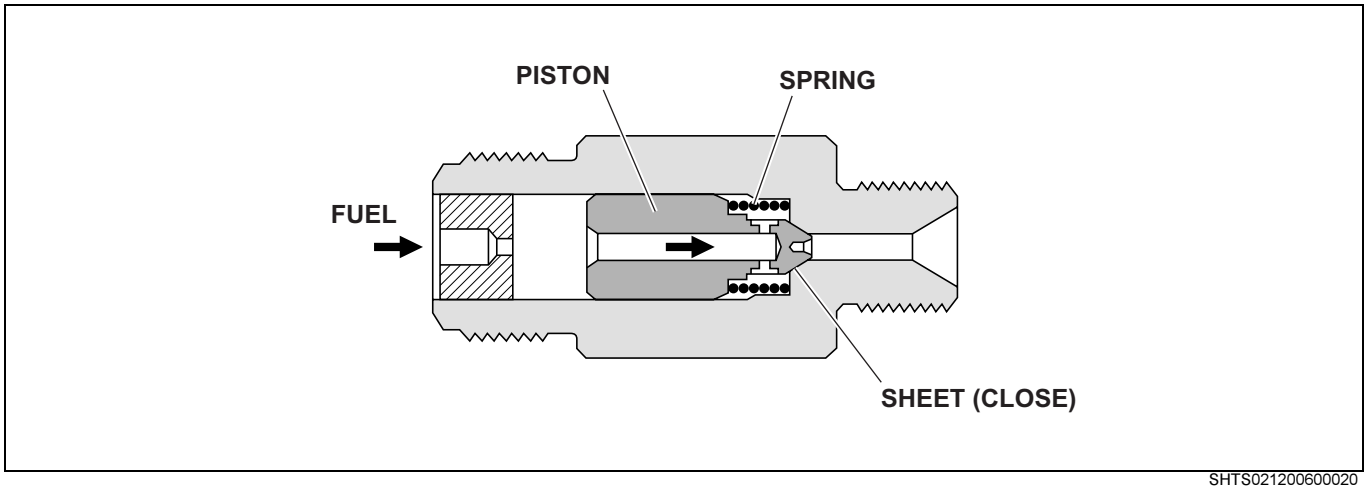
2. ERRATIC EVENT
   - If excessive fuel flows through a flow limiter, a piston will contact the seat to shut off the fuel flow and prevent erratic fuel outflow.
   - Once a piston contacts the seat, it will not return to its initial position until the engine stops and the fuel pressure in the common rail drops.



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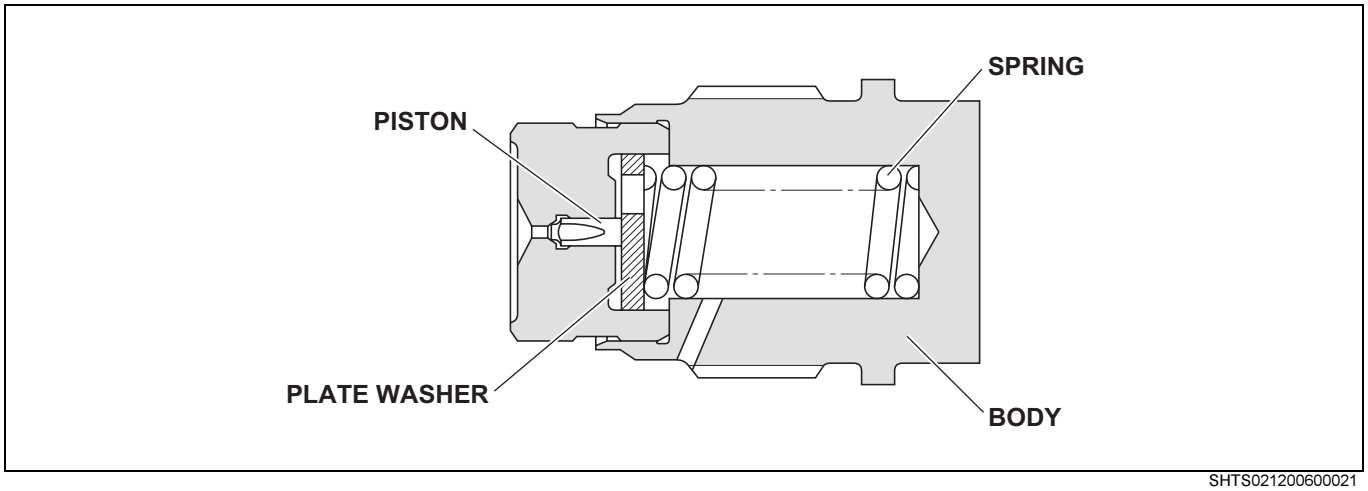
PRESSURE LIMITING VALVE

- The pressure limiting valve sends the fuel back to the fuel tank when a fuel pressure in the common rail exceeds the specified pressure value.
- The pressure limiting valve consists of a body, a piston, a plate washer and a spring.



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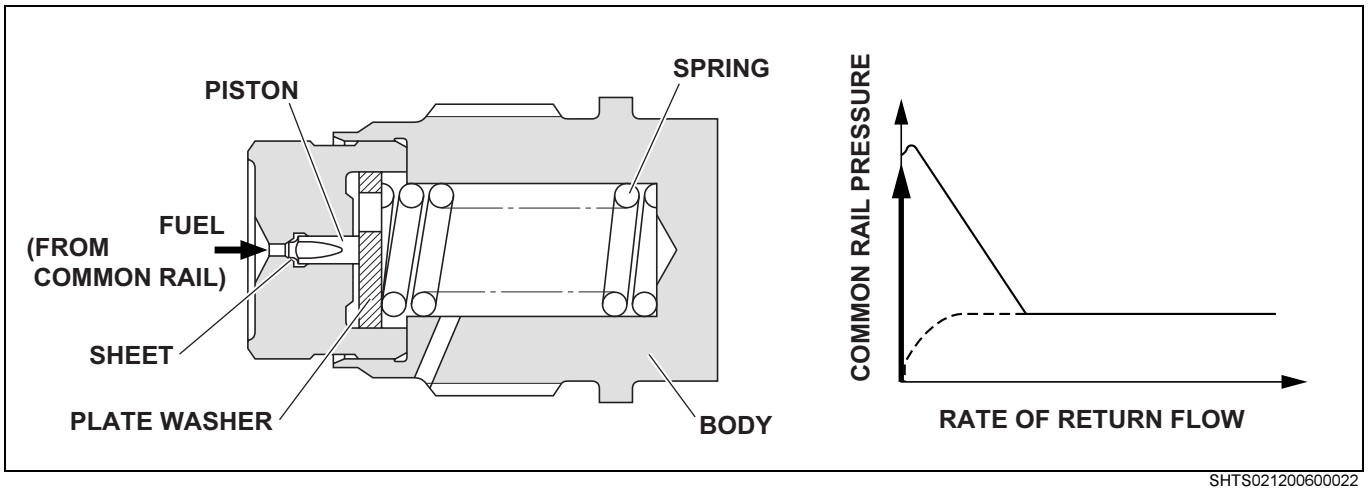
1. OPERATION
   1. PRESSURE INCREASE (BEFORE VALVE OPENING)
      - When a fuel pressure in the common rail stays at or below the specified pressure value, a piston will be kept in contact with the seat by a spring force via the plate washer.
      - A fuel pressure in the common rail will keep increasing because it is not yet at a valve opening pressure of the pressure limiting valve.



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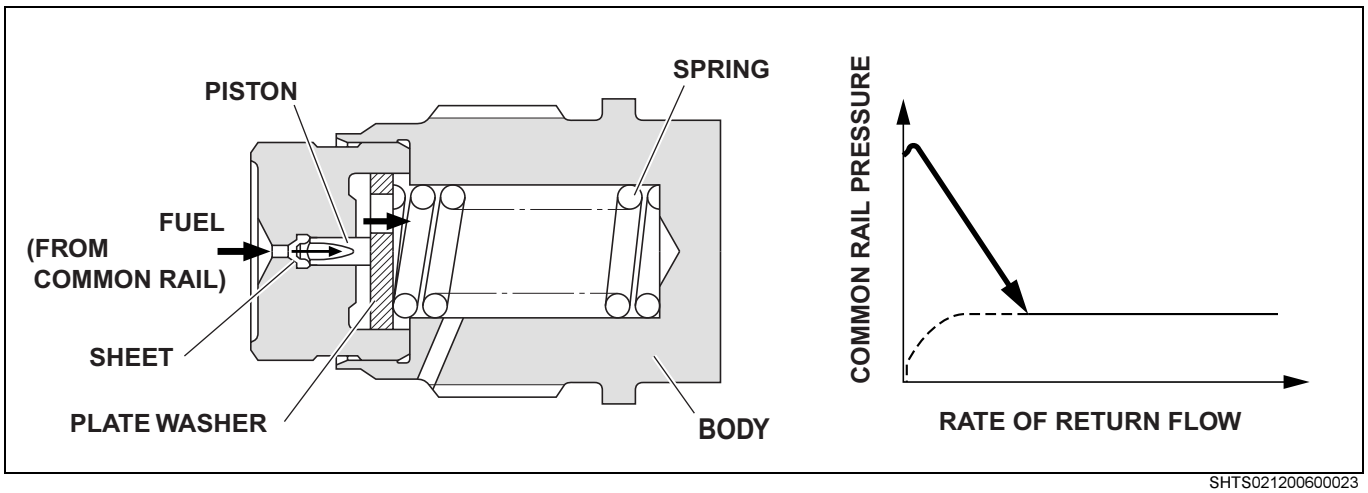
   2. PRESSURE INCREASE (IN VALVE OPENING)
      - When a fuel pressure in the common rail reaches or exceeds the specified pressure value, a piston will overcome a spring force and travel to right. The fuel in the common rail will be returned to the fuel tank through the seat.
      - A fuel pressure in the common rail will rapidly drop after the pressure limiting valve opens.



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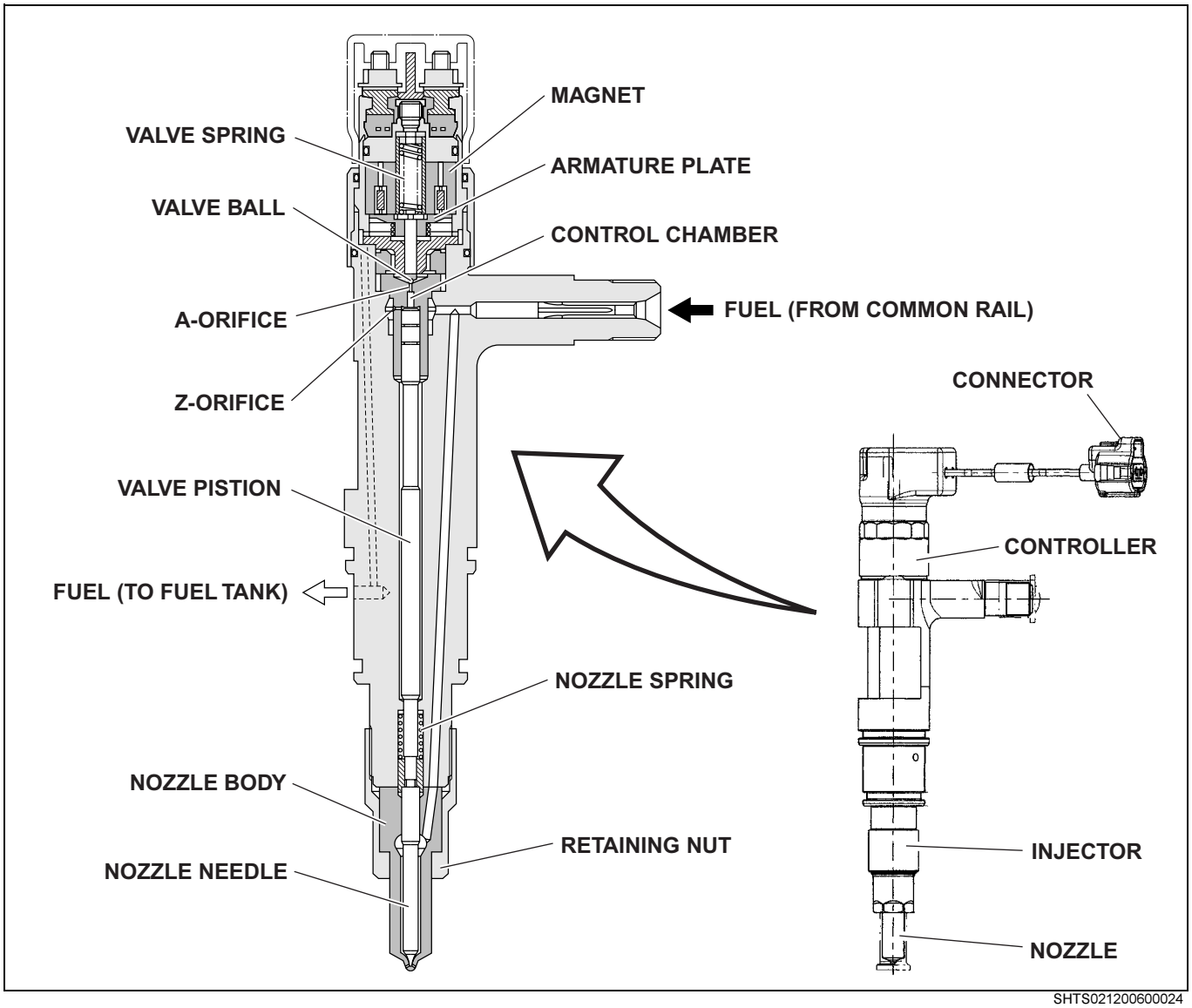
INJECTOR

- The injector finely atomizes the high-pressure fuel distributed by the common rail and directly injects the atomized fuel into the combustion chamber at an optimum timing and at an optimum injection flow.
- The injector assembly consists of a controller and an injector. A pressure is controlled within the control chamber in the controller to govern the injection flow, injection timing and injection rate.
- The controller consists of a control chamber, a magnet, a valve spring, an armature plate, a valve ball, a valve body, a valve piston, an A-orifice and a Z-orifice. A valve piston is installed between a controller and an injector.
- The injector consists of a nozzle body, a nozzle needle, a nozzle spring and a nozzle nut.
- The injector body is clamped. The O-ring is located in the insertion area to the cylinder head, in order to prevent the engine oil from flowing into the injector bore in the cylinder head.
- New next-generation injectors are used to meet a higher pressure, and the nozzle specification is optimized. The solenoid valve is sealed by means of a ceramic ball to ensure high sealing performance and durability.
- Higher accuracy of injection flow is achieved by shorter injection intervals, multiple injections (four injections) per stroke and use of a high-responsive solenoid valve having a smaller void volume in the control chamber.
- Attached to an upper area is the data matrix code on which an injection flow offset was recorded for one single injector. In vehicle assembly works in the production line, an offset recorded on the data matrix code for each injector is read in and output to the engine ECU so as to electronically control and compensate a variance between individual cylinders.



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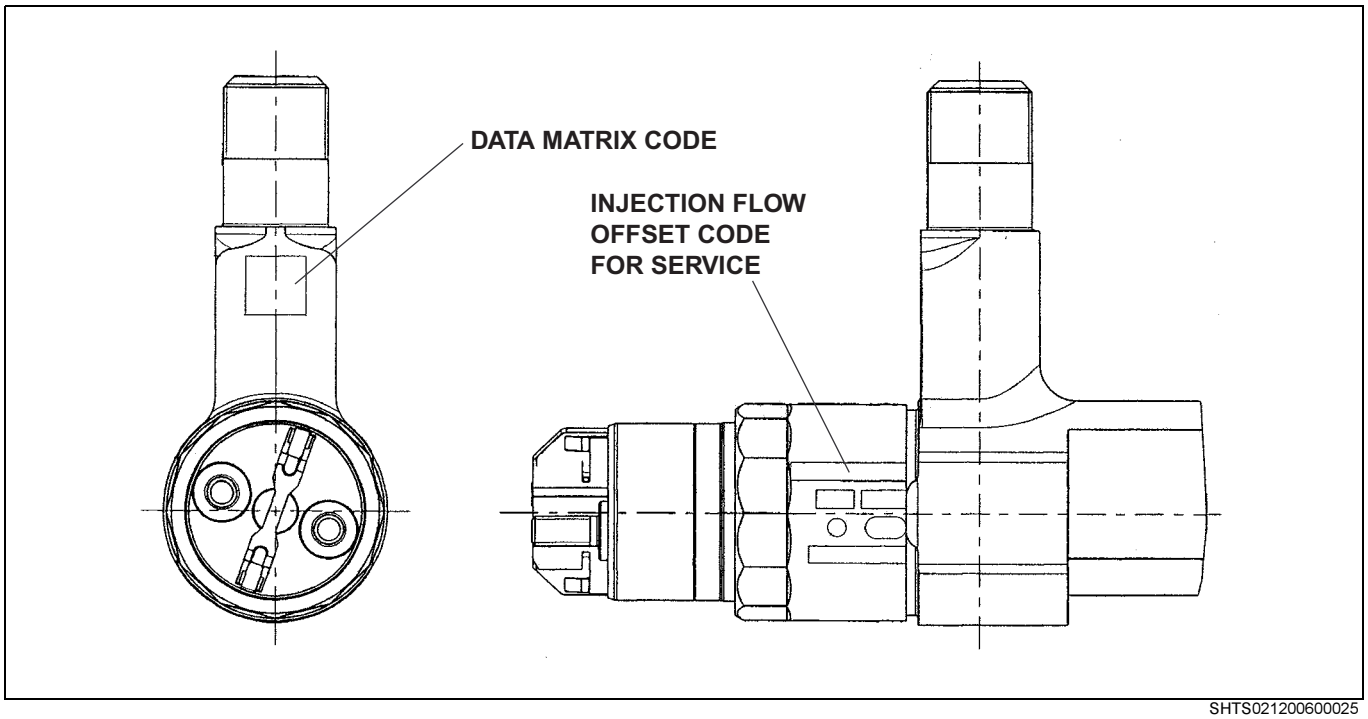
• The data matrix code and the injection flow offset code for service are indicated on the valve body.



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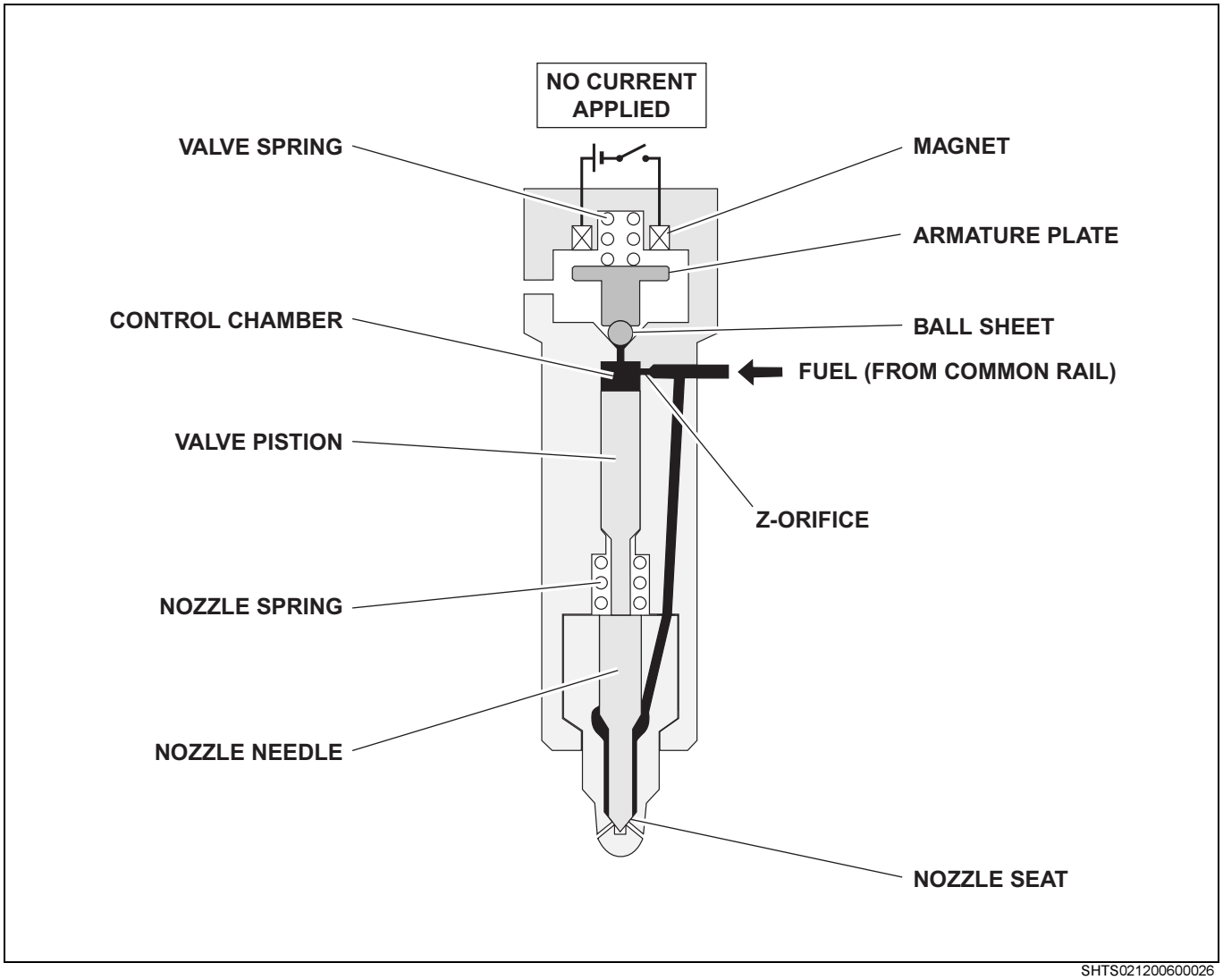
OPERATION OF INJECTOR

1. NO INJECTION
   - When current is not applied to a magnet, the armature plate will be kept in its lowest position by a valve spring and the ball seat will remain closed.
   - A high fuel pressure will be applied to the control chamber via the Z-orifice. Similarly, a pressure is applied to the nozzle needle.
   - The nozzle seat will be closed by the nozzle needle pushed down by a set force of the nozzle spring and by a difference in a pressure-applied area from the valve piston.
     Under this condition, the fuel will not be injected.



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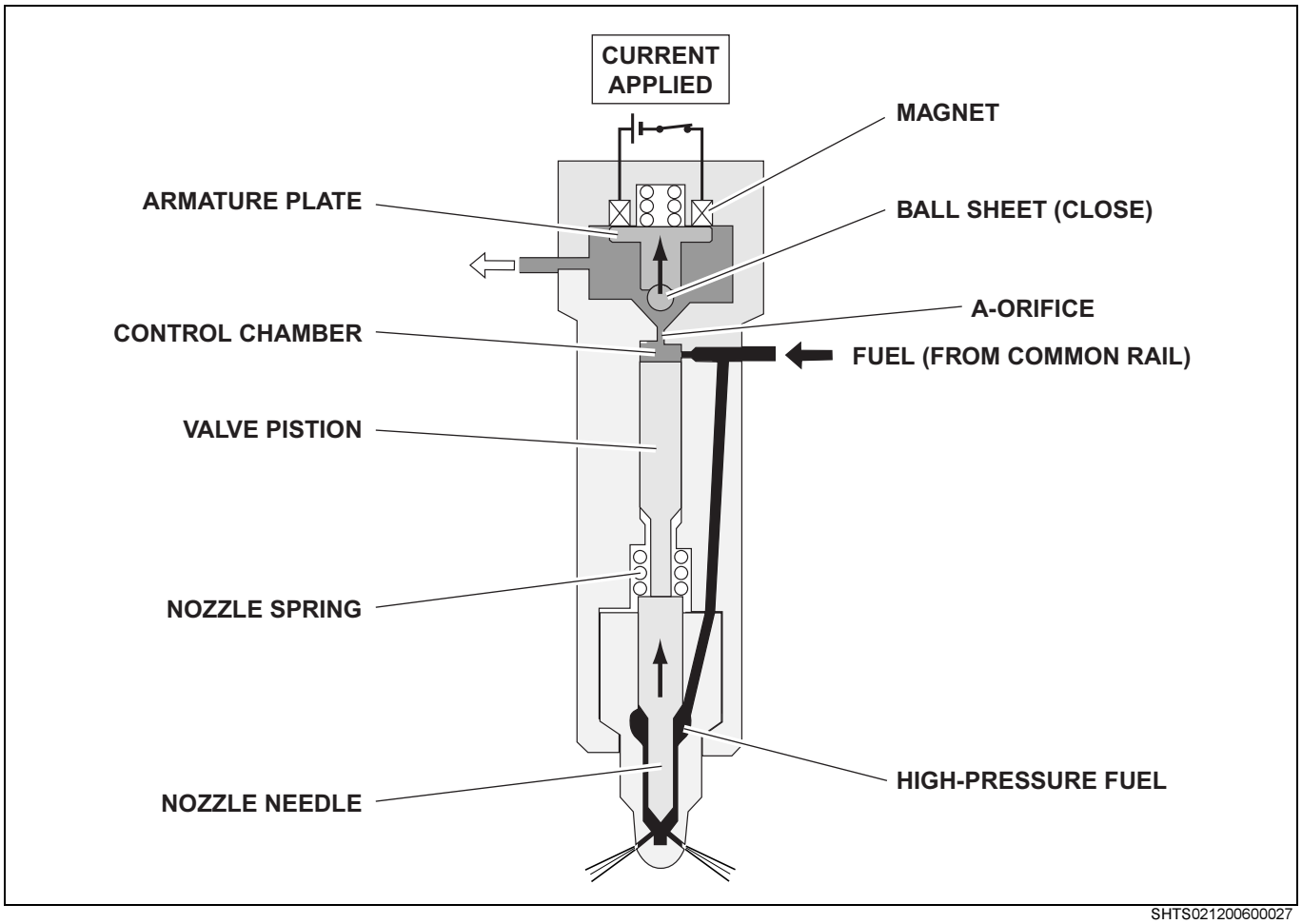
2. START OF INJECTION
   - When current is applied to a magnet, an electromagnetic force will lift the armature plate in the upward direction and open the ball seat.
   - The high pressure fuel in the control chamber will flow out into the fuel tank through a ball seat and an A-orifice. As a result, the high-pressure fuel on the nozzle needle side will overcome the set forces of a valve piston and a nozzle spring and lift the nozzle needle. The fuel injection will start under this condition.
   - When current is continuously applied, the injection rate will be maximum.



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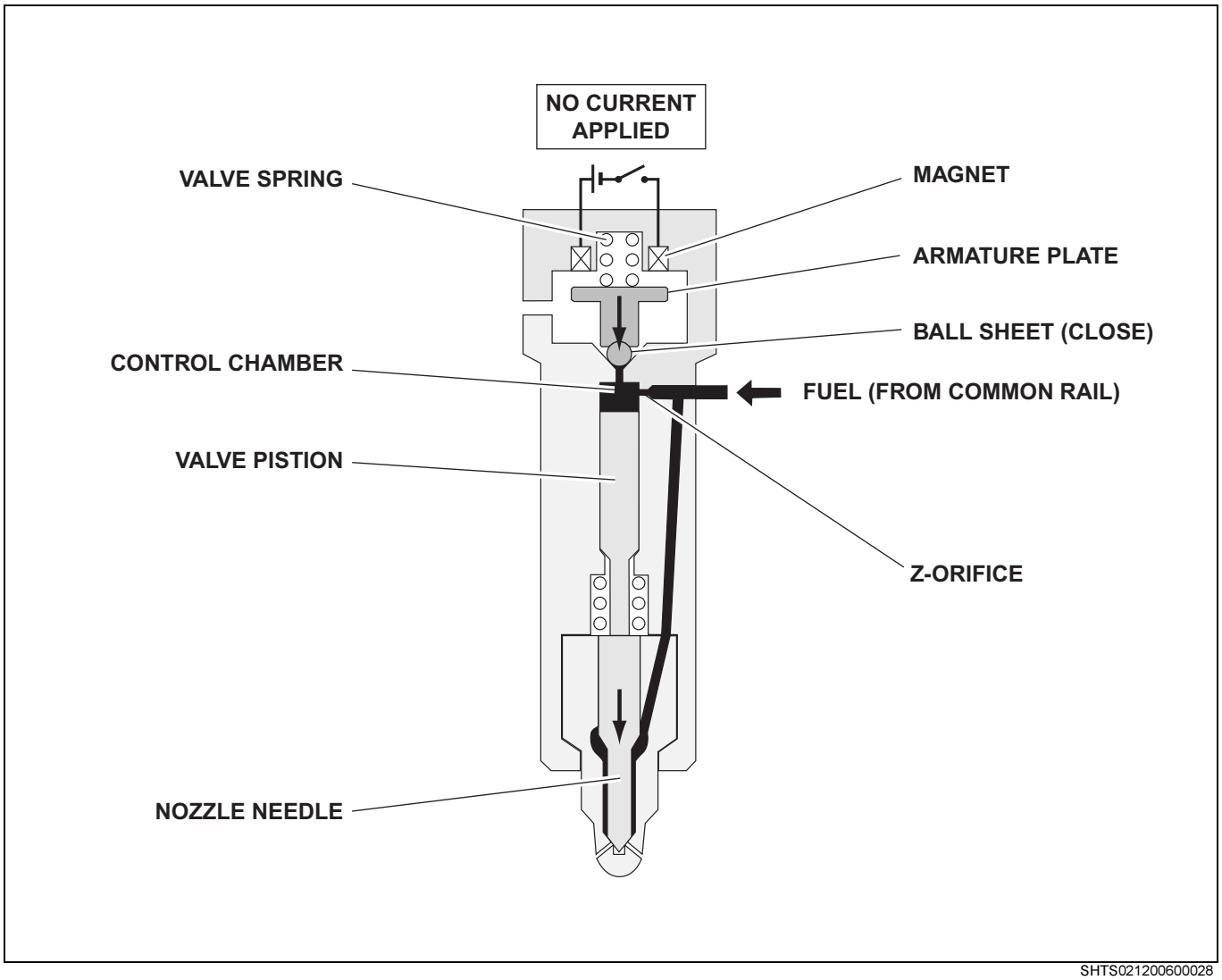
3. END OF INJECTION
   - When current applied to a magnet is stopped, the ball seat will be closed by the armature plate pushed down by a valve spring. The high-pressure fuel will flow into the control chamber through a Z-orifice and push down a valve piston and a nozzle needle. Then, the fuel injection would be finished.



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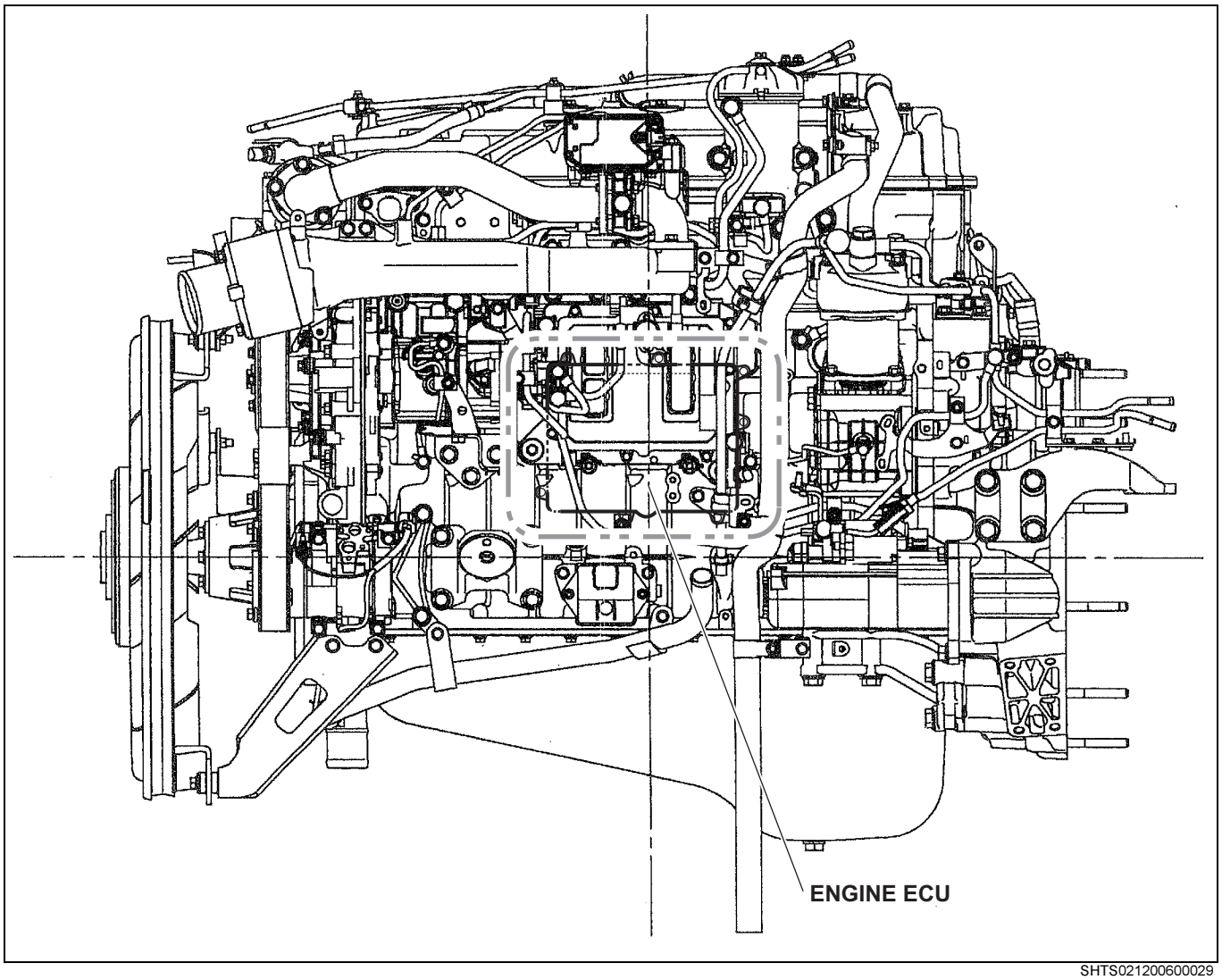
ENGINE ECU

- The engine ECU installed on the left side of the engine processes the information transmitted from individual sensors and switches and controls injectors, a supply pump, individual relays, solenoid valves and lights. The engine ECU features various functions: i.e. self-diagnosis function (failure diagnosis function) to continuously monitor the system operations; alarm function to warn a driver or a service engineer of failures if any; failsafe and backup processing functions to continuously control to minimize impacts on the engine performance and service life; failure memory hold function to store a history of failure events so as to facilitate the analysis and repair works on nonreproducible failures. The injector drive circuit is also built in the engine ECU for multi-injection.
- The CAN communication is provided to harmonize the engine ECU controls with the vehicle control ECU and other systems.



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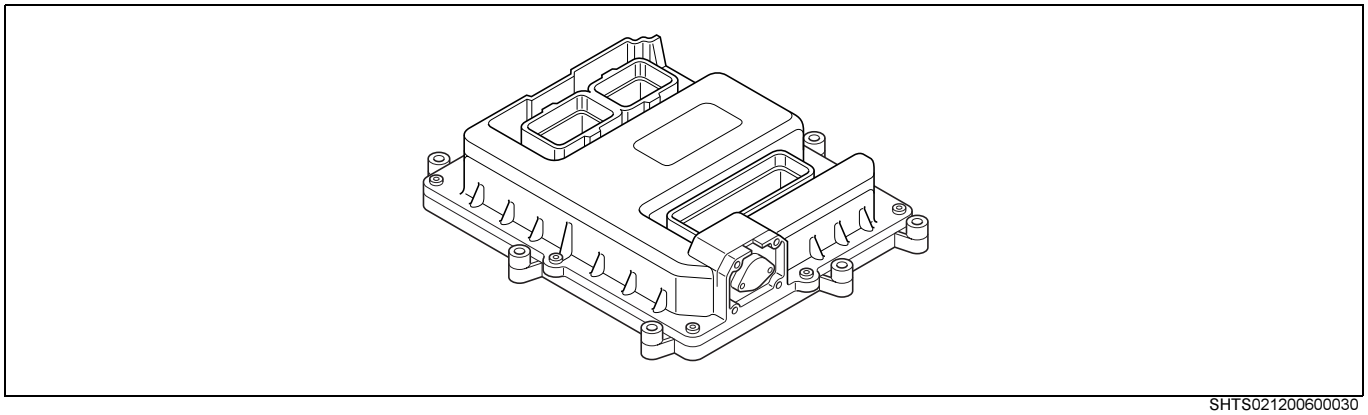

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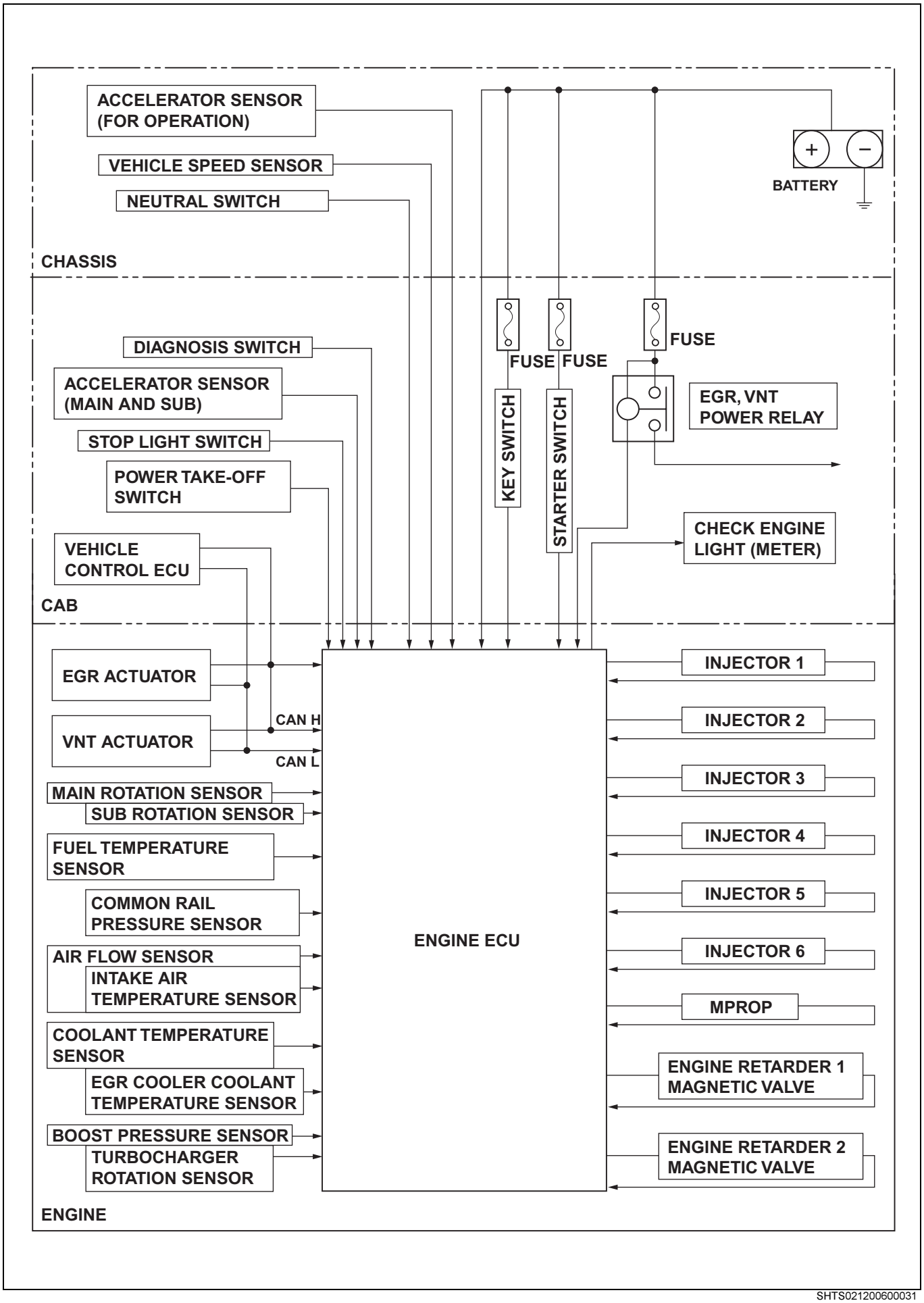
SYSTEM BLOCK DIAGRAM



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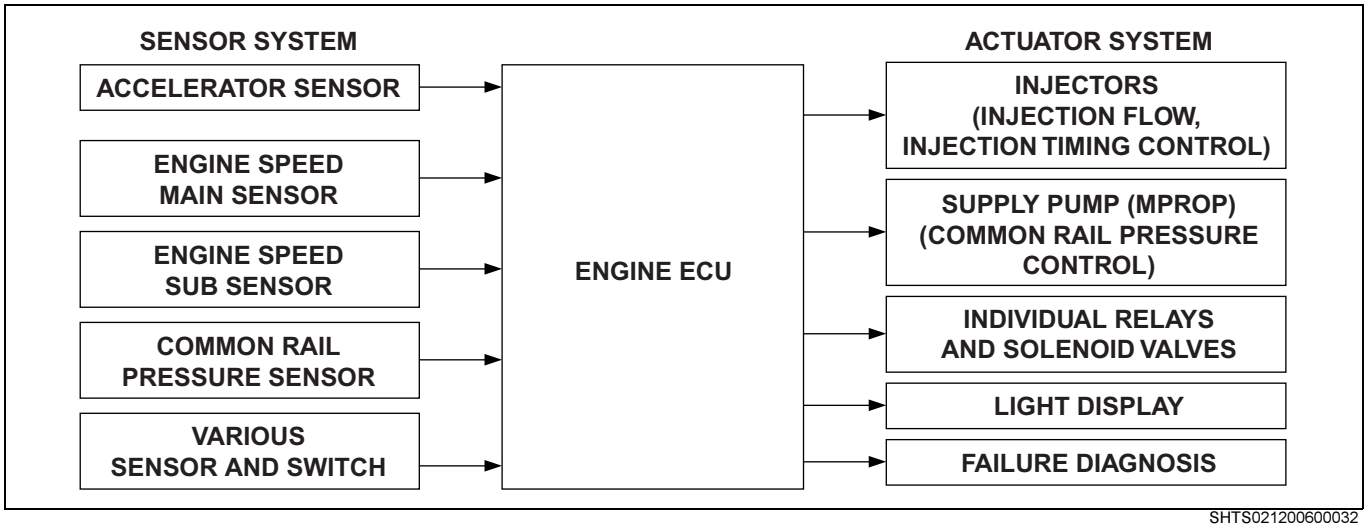
FUEL INJECTION CONTROL

- The engine ECU receives and processes the input signals from individual sensors and switches and controls injectors, a supply pump, individual relays and solenoid valves.



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INJECTION FLOW CONTROL

- This system features the multi-injection at a high pressure and the accurately controlled injection flow for each cylinder by means of the engine ECU.
- Based on the signals of an engine speed and an accelerator opening, the injectors are controlled for optimum injection flow. The final injection flow is calculated from the following injection flow control for each condition such as engine stop/start.

INJECTION FLOW OFFSET CONTROL

- The offset to the datum maximum injection flow predetermined for each injector is measured and the measured offset is recorded on the engine ECU as an injection offset data matrix code. The engine ECU uses this offset to correct the datum maximum injection flow predetermined for each cylinder and minimizes a variance in maximum injection flows.

INJECTION PRESSURE CONTROL (COMMON RAIL PRESSURE CONTROL)

- The common rail pressure is controlled for the injection pressure control.
- The common rail pressure is controlled by adjusting a discharge rate of the supply pump and performing the pressure feedback control so that a reading taken by the common rail pressure sensor will be equal to a target value calculated from engine speed and injection flow.

INJECTION TIMING CONTROL

- The injection timing is optimized by controlling the injectors based on the engine speed and injection flow.
  1. MAIN INJECTION TIMING
     - The main injection timing characteristics are selected based on the coolant temperature. The datum injection timing is calculated based on the final injection flow and the engine speed among the selected characteristics.
  2. PRE-/AFTER-INJECTION TIMINGS
     - To control the pre- and after-injection timings, the pre- and after-intervals are added to the main injection timing.
     - The pre- and after-intervals are calculated based on the final injection flow, engine speed and coolant temperature.

INJECTION RATE CONTROL

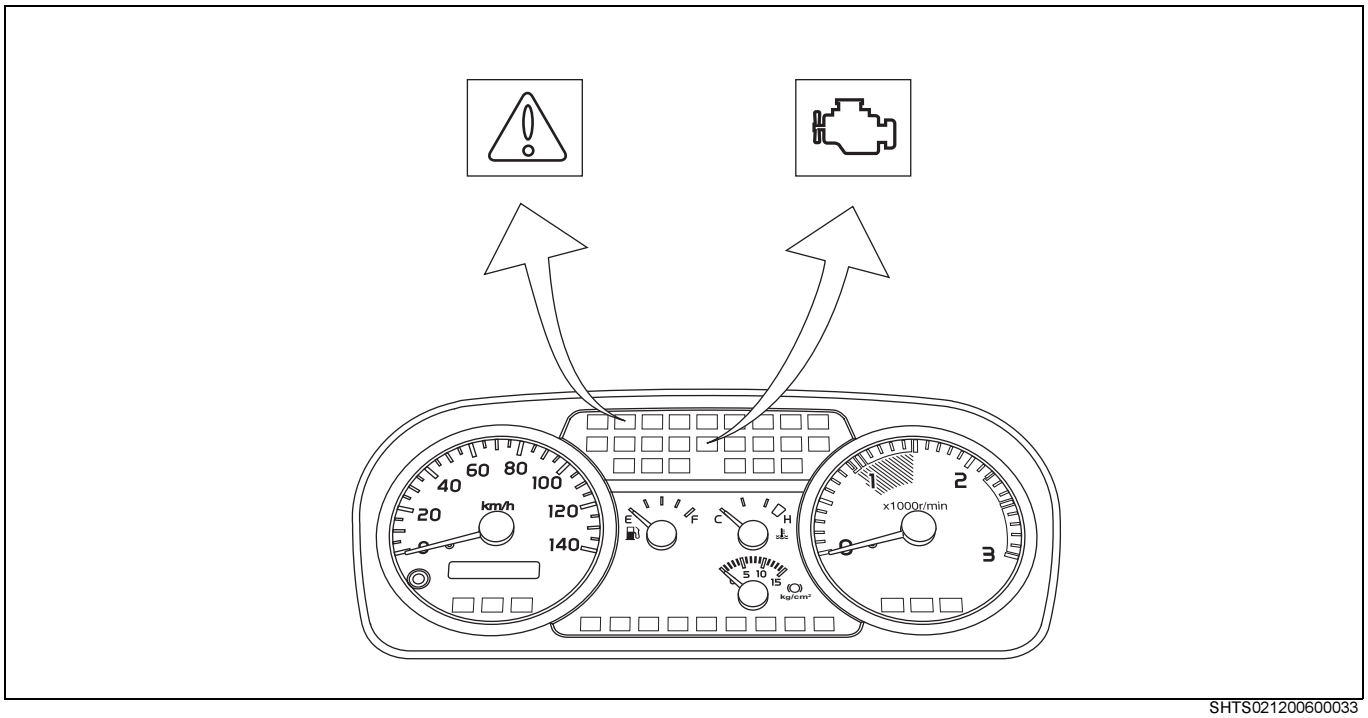
- The injection rate profile is controlled by a specific injection method. One explosion stroke is comprised of first one injection of a small amount of fuel (pre-injection), second injection (main injection) after firing, and third injection (after-injection.)
- As for pre- and post-injection flows, a predetermined value is calculated based on the final injection flow and engine speed.

FBC CONTROL (FUEL BALANCE CONTROL)

- The FBC control is designed to monitor its rotation sensor to detect a rotational fluctuation caused by a variance in injection flow or combustion between cylinders and balance the injection flow between cylinders.
- This function contributes to reduction in rotational fluctuations.

FAILURE DIAGNOSIS FUNCTION

- The engine ECU continuously monitors the systems and activates the check engine lights to give a warning of detected failures.



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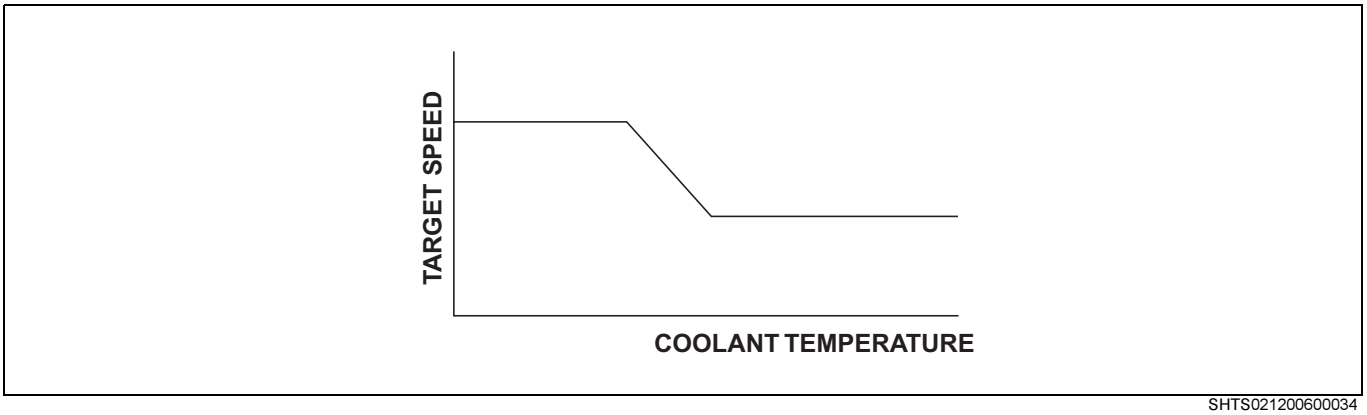
IDLE SPEED CONTROL (I.S.C.)

- The idling speed is controlled by increasing/decreasing the injection flow in order to ensure consistency between an actual speed and a target speed calculated based on the coolant temperature.

1. AUTO I.S.C.
   - This function controls the idling speed based on the coolant temperature.



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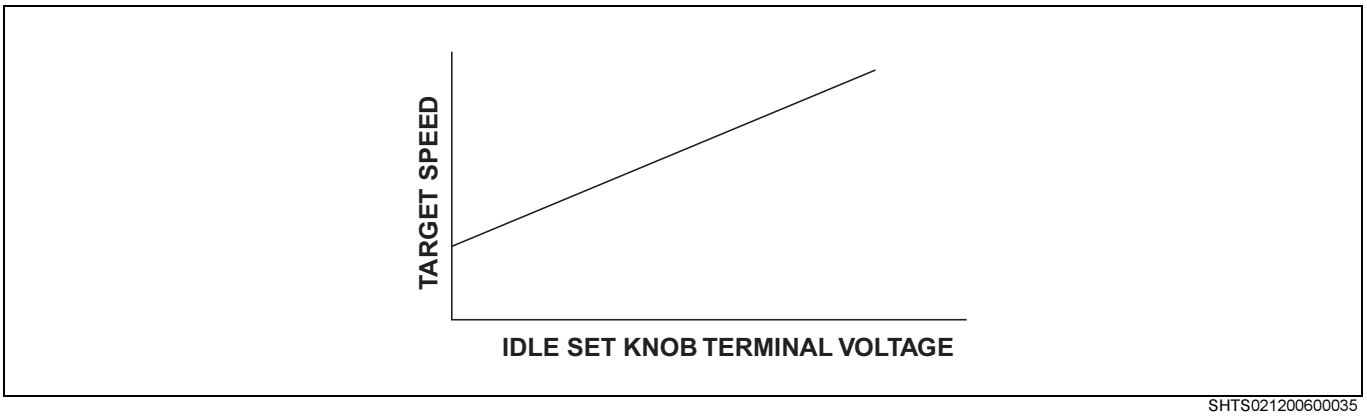
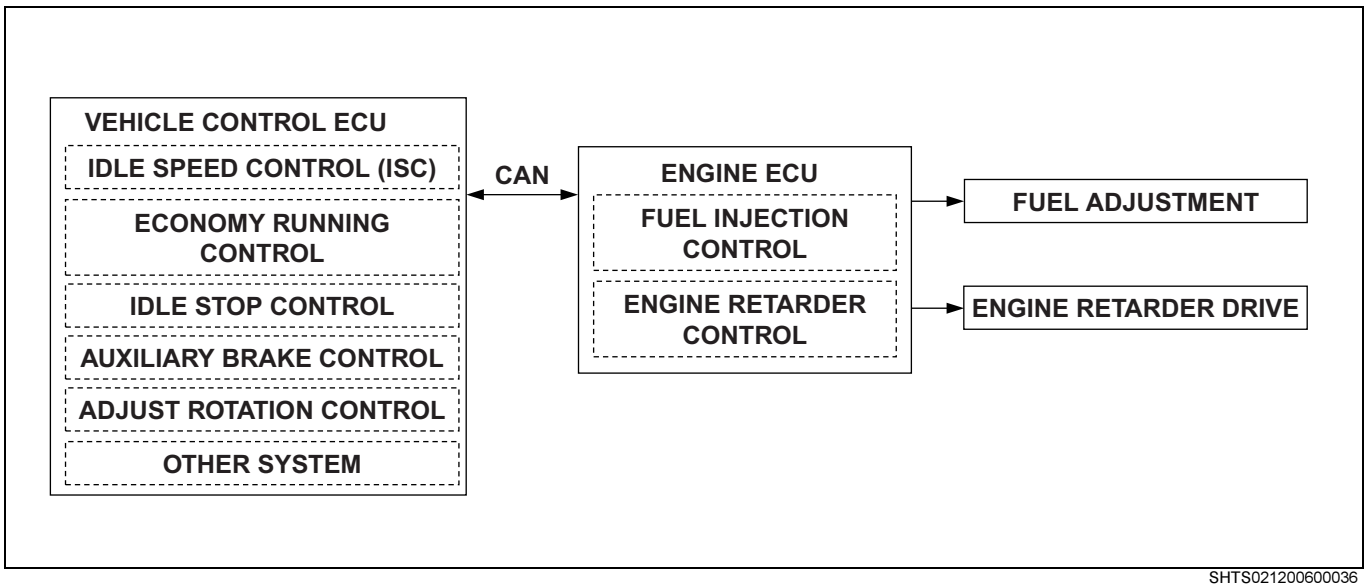
2. MANUAL I.S.C.
   - This function controls the idling speed based on the idling speed setting selected on the idle set knob in the driver's seat.



SHTS021200600035

CAN COMMUNICATION

- The engine information obtained by the engine ECU is output to the CAN communication through which the vehicle control ECU can obtain the information required to control each system.
- The CAN communication transmits the engine control commands to the engine ECU as required by the vehicle control ECU to control each system.



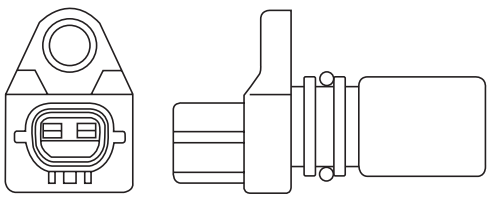
SHTS021200600036

INDIVIDUAL SENSORS AND SWITCHES

- These devices are designed to detect the engine conditions and vehicle operations.
- The engine rotation sensors and the accelerator sensors are particularly important to systems. Two of these sensors each are installed so that unexpected breakdown of one sensor will not affect driving operations. (Two sensor circuits are built in one accelerator sensor assembly.)

ENGINE SPEED SENSORS

1. ENGINE SPEED MAIN SENSOR
   - This sensor consists of a permanent magnet, a coil and an iron core, and is installed in the fly wheel housing. When the engine starts rotating, the signal holes located on the circumference of a fly wheel will intermit the magnetic field made by a sensor magnet, which will generate AC voltage in the coil.
   - The signal holes are located at every 6° in the fly wheel. There are no holes in two locations, thus a total of 58 signal holes are located on one circumference of a fly wheel. This means that two rotations will output 116 pulses.
   - The engine speed and the crank angle at every 6° are detected from these signals.



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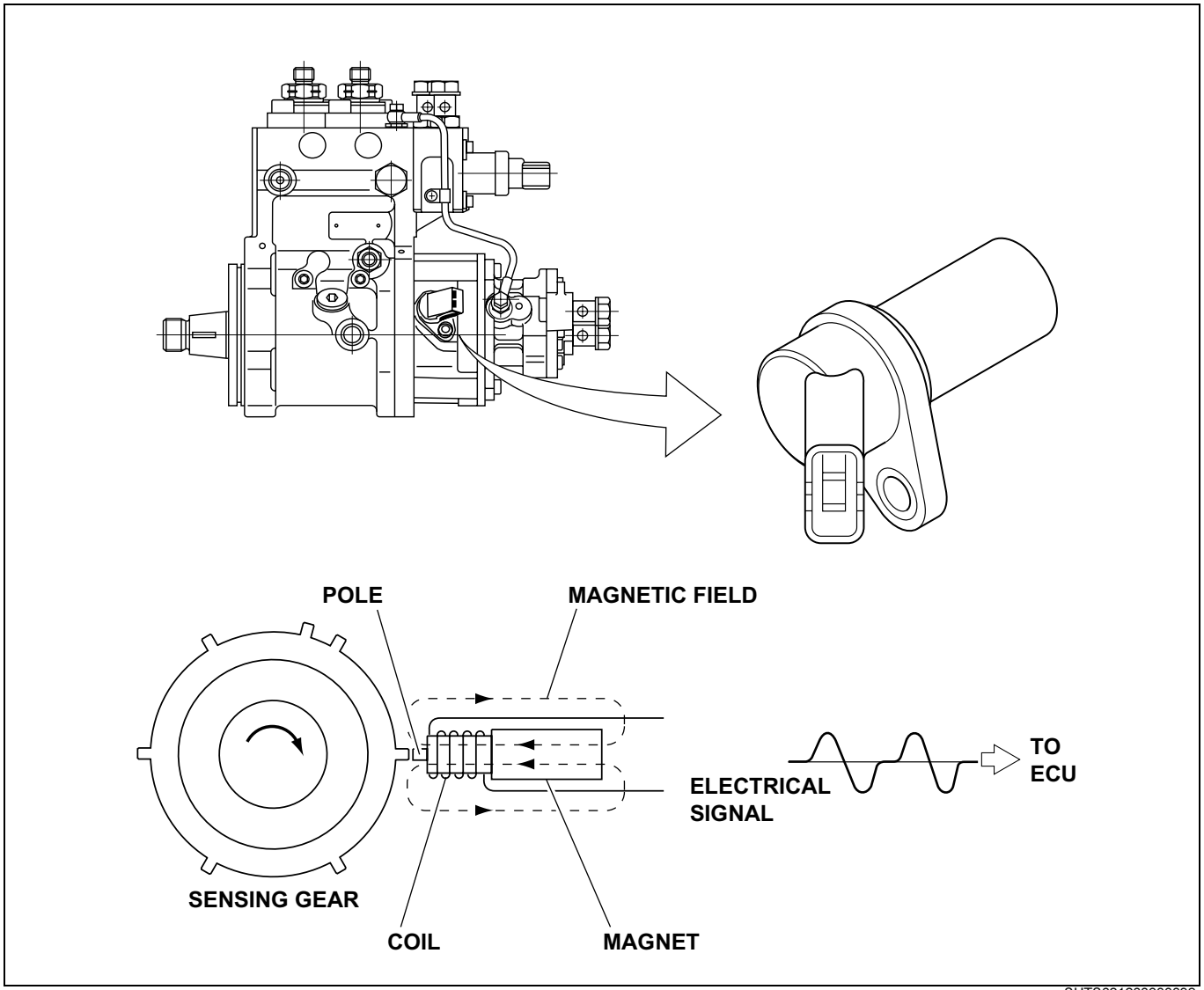
2. ENGINE SPEED SUB SENSOR

- This sensor installed on the supply pump converts the camshaft rotation speed into electrical signals. The electrical signals are transmitted to the engine ECU as a cylinder identification signal and are used as a datum in determining the injection timing, fuel injection flow and injection pressure.
- The sensor is integrated with a magnet, a pole and a coil.
- When a sensing gear installed on the supply pump camshaft rotates, the magnetic field of the auxiliary rotation sensor will be changed by protrusions on the sensing gear.
  A change in the magnetic field generates the voltage in the coil. This voltage change is detected as an electrical signal.
  The sensing gear has six protrusions at every 60° and one protrusion for identifying a cylinder.



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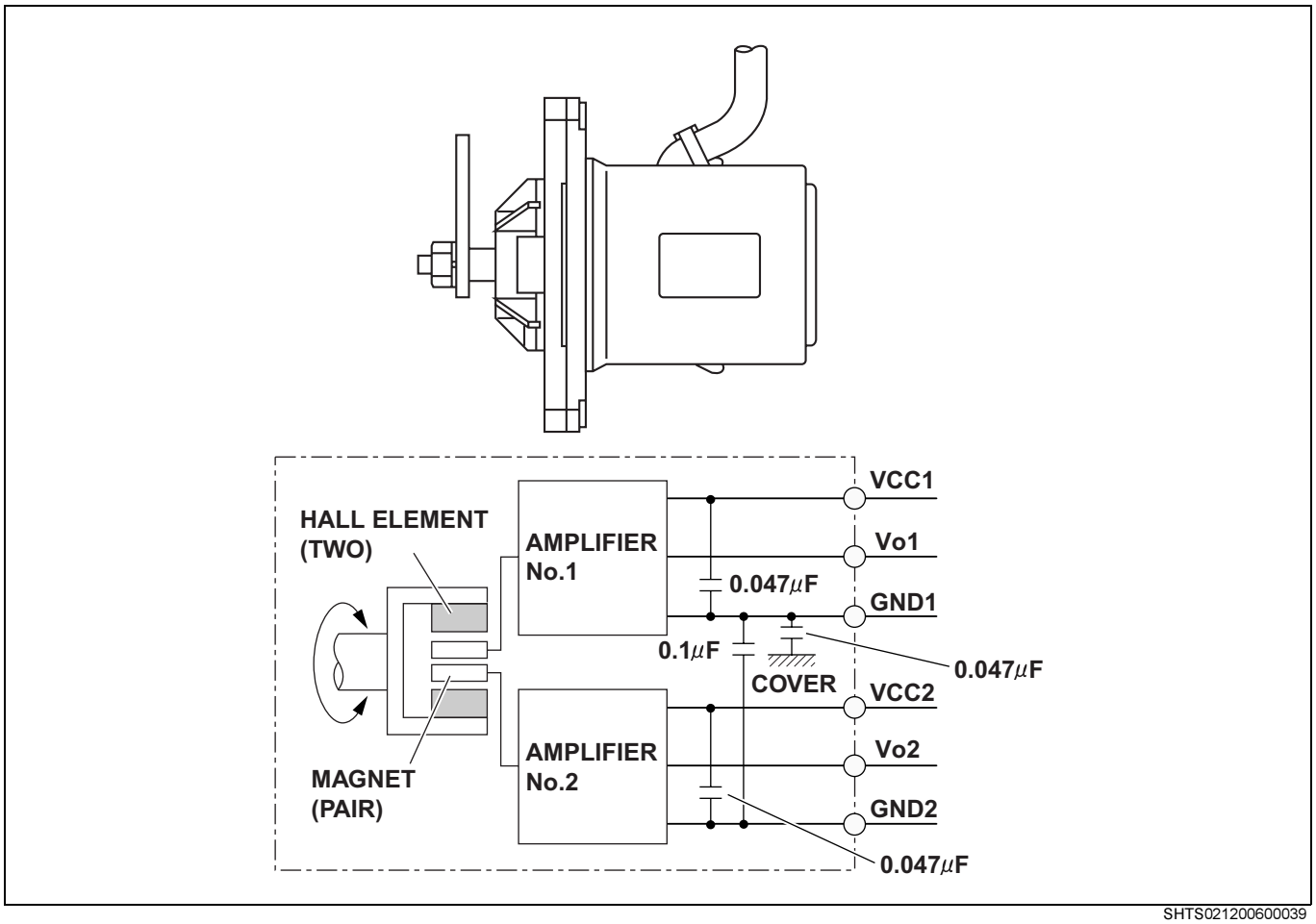
ACCELERATOR SENSOR

- This sensor is a hall effect IC sensor. The accelerator pedal travel is converted into an electrical signal and transmitted to the engine ECU. The accelerator sensor is installed in the location behind the accelerator pedal under the driver's seat and is connected to an accelerator pedal via a link. There are two sensors in the accelerator sensor assembly.



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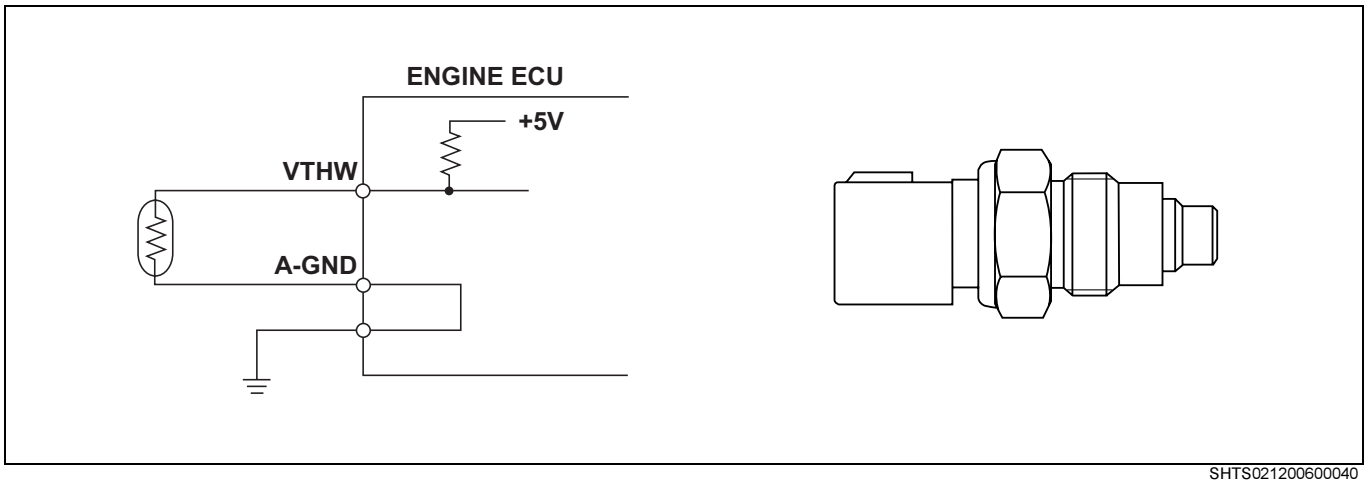
COOLANT TEMPERATURE SENSOR

- The coolant temperature sensor is a thermistor temperature sensor and is installed in the thermostat case.
- A change in coolant temperature is converted into an ohmage change signal and transmitted to the engine ECU. This signal is used to optimize the fuel injection control.
- The engine ECU applies the voltage to a thermistor and measures an ohmage change by detecting the voltage divided into the engine ECU ohmage and the thermistor ohmage.



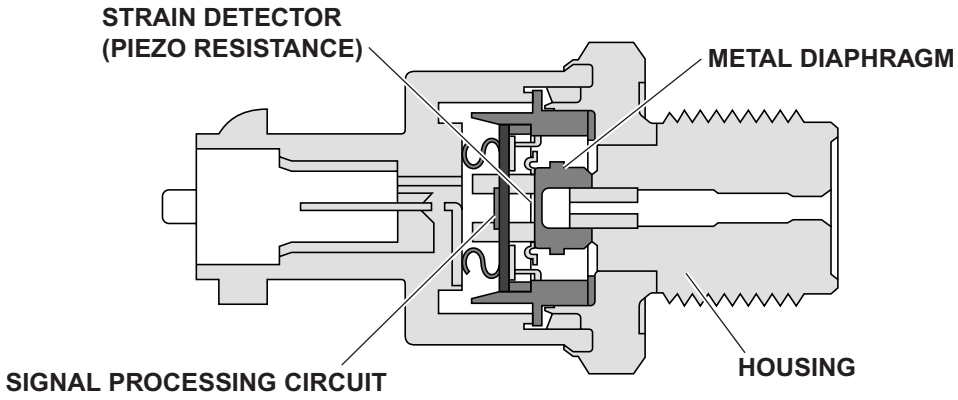
SHTS021200600040

FUEL TEMPERATURE SENSOR

- The fuel temperature sensor is installed in the fuel pipe near the ECU cooler.
- A change in fuel temperature is transmitted to the engine ECU in the form of an ohmage change signal and is used to optimize the fuel injection control.

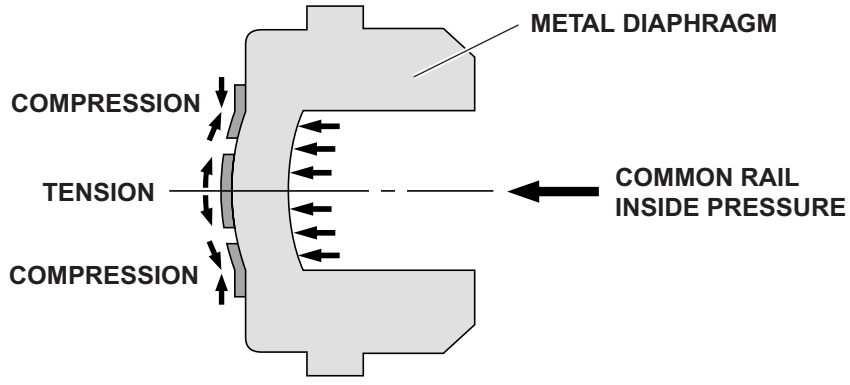
COMMON RAIL PRESSURE SENSOR

- The common rail pressure sensor detects a fuel pressure within the common rail and transmits it to the engine ECU upon conversion into an electrical signal. This electrical signal is used for MPROP feedback control.
- The common rail pressure sensor consists of a metal diaphragm, a strain detector (piezo resistance), a signal processing circuit and a housing.
- The strain detector has a bridge circuit of piezo resistance.



SHTS021200600041

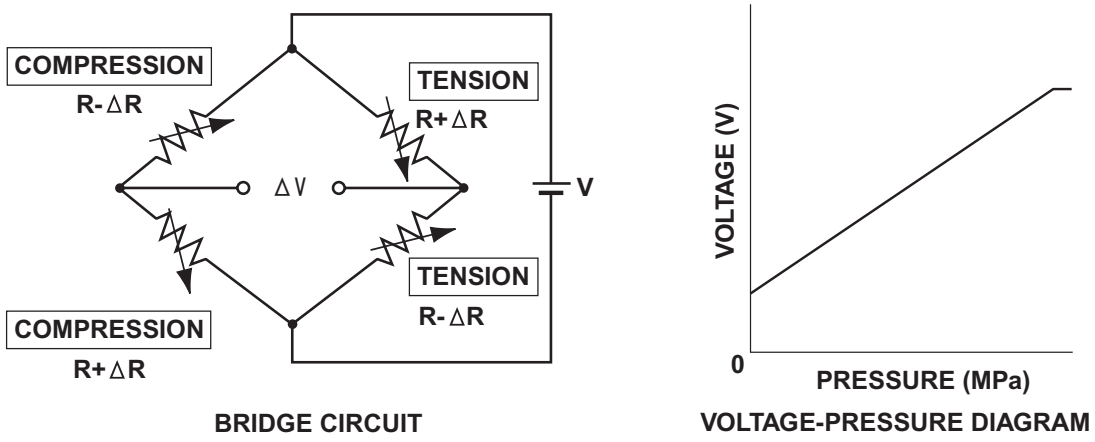
1. OPERATION
   - When a fuel pressure within the common rail is applied to the metal diaphragm, the diaphragm will deform as shown in the figure below.
   - The piezo resistances are located in the center and on the periphery of the metal diaphragm respectively, in order to apply a tensile force or a compressive force.
     A difference in ohmage occurs depending on the direction of a force applied. This difference is converted into a voltage value in the bridge circuit. A voltage value varies depending on the degree of a pressure (strain). The common rail pressure sensor detects a voltage value as a pressure value.



SHTS021200600042

2. BRIDGE CIRCUIT

- When the piezo resistance wiring is routed as shown in the figure below, the output voltage ΔV can be calculated from the equation shown below.
  ΔV = V/R x ΔR
  This equation expresses that an output voltage is proportional to a change in ohmage.
  V: applied voltage
  R: ohmage when no deformation occurs
  ΔR: ohmage change when deformation occurs
- According to the equation described above, an output voltage changes linearly in dependence upon a pressure and an applied voltage.



BRIDGE CIRCUIT VOLTAGE-PRESSURE DIAGRAM

SHTS021200600043

TURBOCHARGER ROTATION SENSOR

- This sensor is a pulse type rotation sensor installed to the turbocharger.

BOOST PRESSURE SENSOR

- This is a semiconductor sensor and converts a pressure change into an electrical signal.
- This sensor detects an intake pressure of the turbocharger. The detected reading is used to calculate the maximum injection flow in the transition stage.
- A range is broadened to meet an increased intake pressure.
- Improvements in corrosion resistance and smudge resistance increased the reliability.

AIR FLOW SENSOR AND INTAKE AIR TEMPERATURE SENSOR

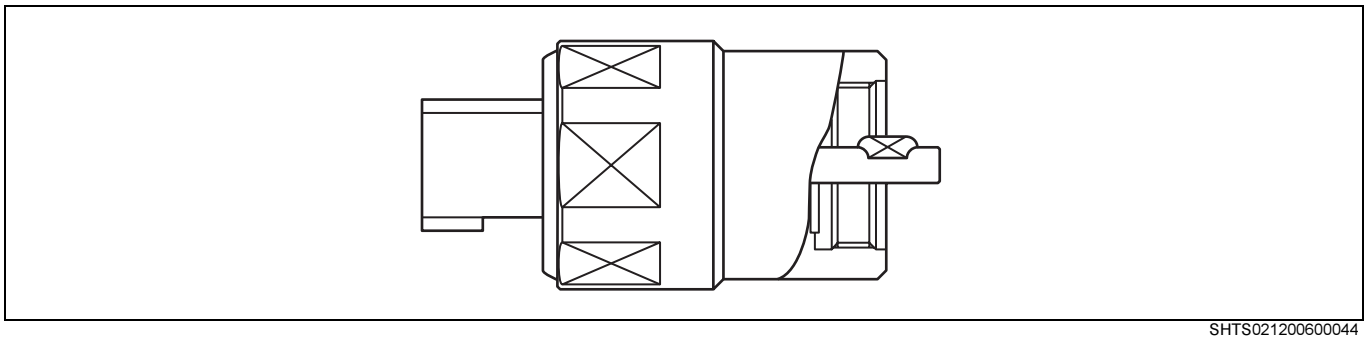
- An air flow sensor is integrated with an intake air temperature sensor.
- The air flow sensor is a hot-wire type sensor. When the wire is heated by current, this heat is absorbed into air flowing in the intake pipe. The air flow is measured by measuring the degree of heat absorption.

EGR COOLER OUTLET COOLANT TEMPERATURE SENSOR

- This sensor monitors a coolant temperature at the outlet of the EGR cooler and detects EGR troubles if any.

VEHICLE SPEED SENSOR

- This sensor is installed on the speedometer driven gear of the transmission.
- The rotation speed of the speedometer driven gear is monitored to detect the vehicle speed.



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RELAYS AND INDICATORS

- A common rail actuator power relay is provided. As an indicator, there are various warning and indicator lights to display the status of system operations.

RELAYS

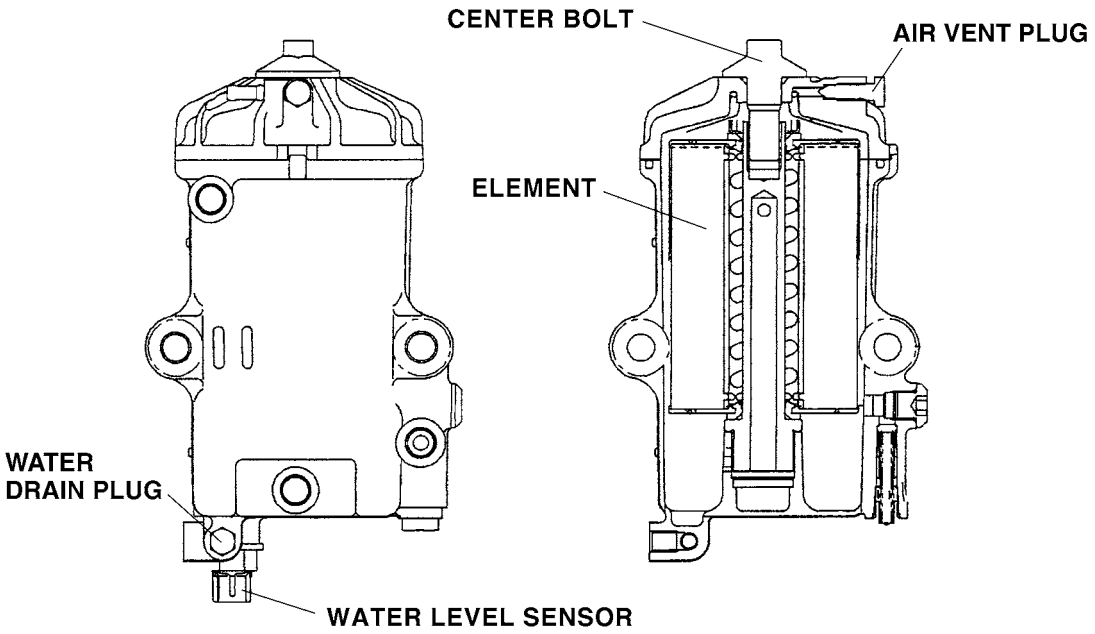
1. COMMON RAIL ACTUATOR POWER RELAY
   - This is a 'normal open' type relay. The point will be closed when current is applied to the coil. The relay supplies the power source to the actuators such as cool EGR and variable nozzle turbocharger.
     Color: black

FUEL FILTER

SUMMARY

JP18Z01020301004

- Contaminated fuel will cause earlier damage or wear of and degrade the supply pump and injectors. The fuel must be fully filtered.
- This up side down fuel filter provides serviceability that only an element can be replaced. This reduces fuel dripping during element replacement works. The center bolting structure requires no special tools for replacement works and features high serviceability. The symmetric geometry of an element eliminates an anxiety of top/bottom orientation during assembly works.
- The upper body of a fuel filter has an air vent plug and the lower body has a water drain plug.
- This fuel filter has a water separator to separate water contained in fuel and prevent improper water flow into the fuel system. When water trapped in the filter reaches a specified level, the water level sensor will activate and turn on an indicator light to tell a driver to drain the water.
- The fuel filter element is an eco-filter made of paper and resin, not using any metal materials. After replacement, an old element can be disposed as burnable garbage.



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INJECTION PIPE

SUMMARY

JP18117020301006

- The injection pipe is a special solid-drawn steel pipe.
- All risks of damage and bend must be avoided during handling.
- The cylinder No. is stamped on the flare nut on the common rail side in order to prevent misassembly.

PRESSURE-FEED PIPE

SUMMARY

JP18117020301007

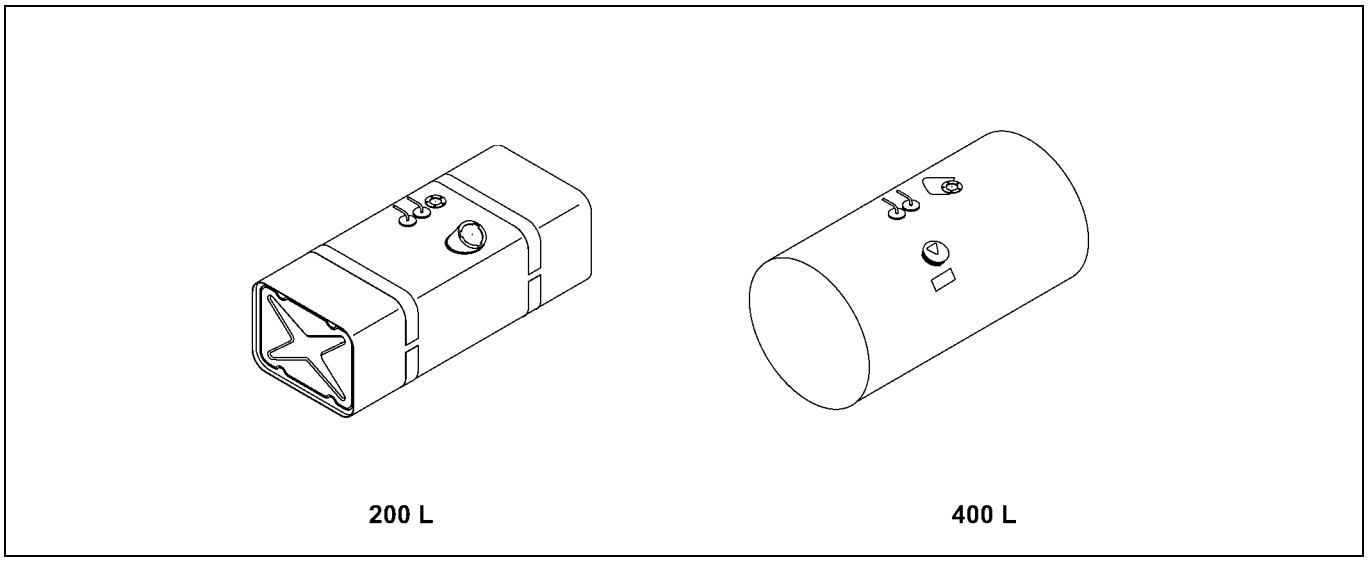
- The pressure-feed pipe delivers the fuel charged by a supply pump, to the common rail.

FUEL TANK

SUMMARY

JP18Z01020301007

- Some types of fuel tanks are available: i.e. 200 L {43.9 UK.gal, 52.8 US.gal} capacity and 400 L {87.9 UK.gal, 105.6 US.gal} capacity. The tank of whichever appropriate capacity is installed for intended applications of each vehicle type.

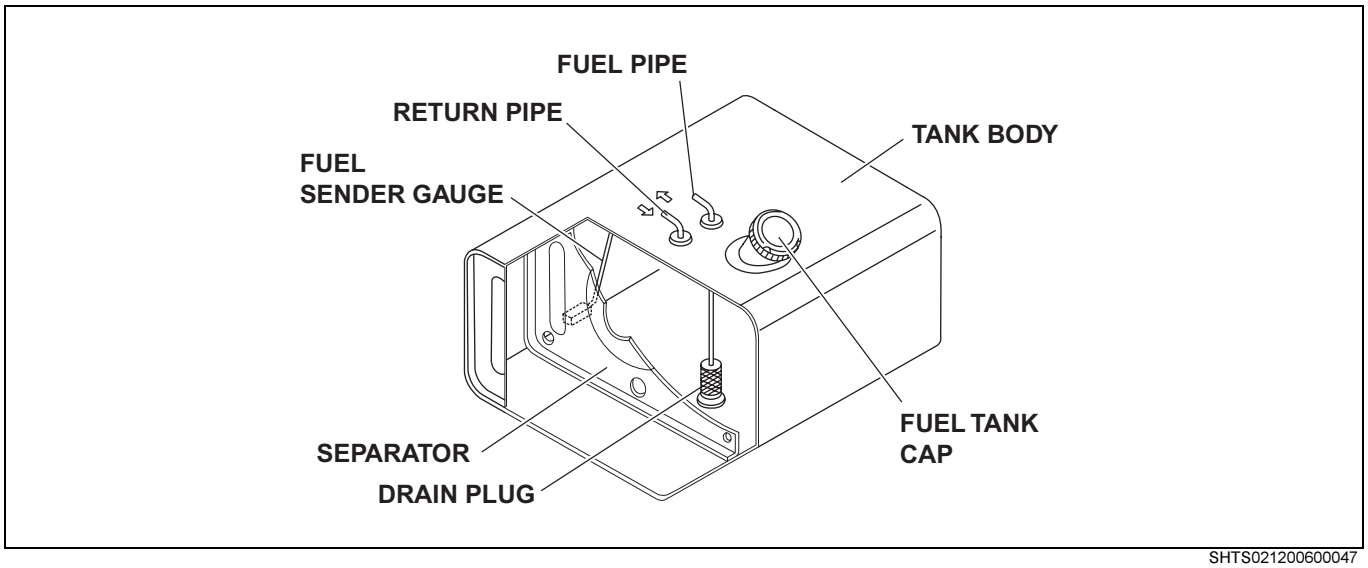


STRUCTURE

JP18Z01020301008

TANK BODY

- The fuel tank consists of a tank body, a fuel tank cap, a fuel sender gauge, a drain plug and other parts.
- The inner surface of a tank body is rustproof. Water and/or smudges can be drained from a drain plug installed at the bottom of a tank body.
- The fuel tank has a separator to increase the tank strength and minimize the fuel riffling.



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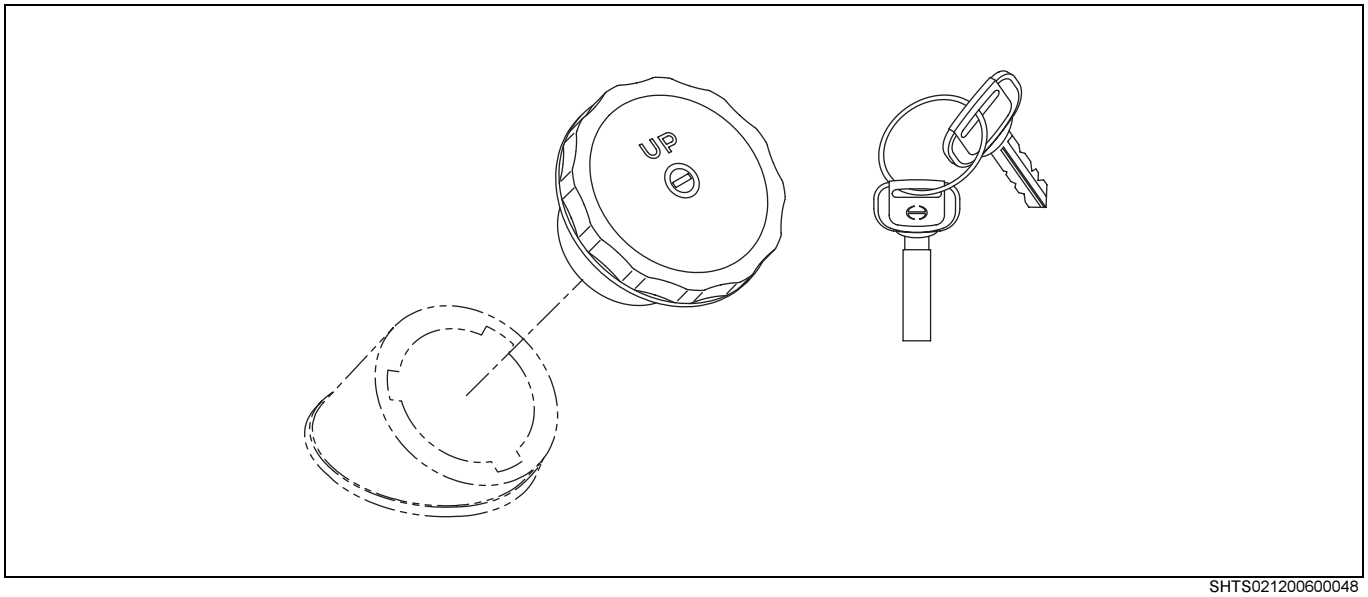
CAP

- The standard fuel tank cap is a keyless cap. The keyed cap is also available as an option.



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REPROGRAMMING

SUMMARY

JP01D02120060301019001

- The data are stored in control software for the engine ECU and the vehicle control ECU in the production line.
- The injection flow offset must be arranged for each vehicle (engine) because each injector has unique specificity in injection flow.
  To meet this variation, the reprogramming system was employed in the control software writing process.
- In the reprogramming system, the engine ECU and the vehicle control ECU have unique data for each vehicle. At the conventional parts level, it was difficult to make improvements in a variance in injection flow between injectors. The reprogramming system reduces this variance.
- The engine identification data (injector flow offset data, engine manufacturing No., etc.), the vehicle data (vehicle No. (chassis No.) and the option specification (exhaust brake, glow plug, etc.) are stored in the engine ECU.
- The vehicle identification data are stored in the vehicle control ECU, including a vehicle type (dumper, tractor, bus, etc.), production No. (chassis No.) and final reduction gear ratio (differential gear ratio.)
- The data stored in the engine ECU and the vehicle control ECU respectively are unique to each vehicle. If parts are replaced or optional parts are installed, these ECUs can be rewritten (updated) respectively. This significantly reduces the number of parts of the ECU.
- Other functions include a user customization function that allows for addition of control functions as required to meet customer's needs; a reprogramming function that allows for control software updating; and other functions. These functions increase user's convenience.

PROCEDURES

JP01D02120060301019002

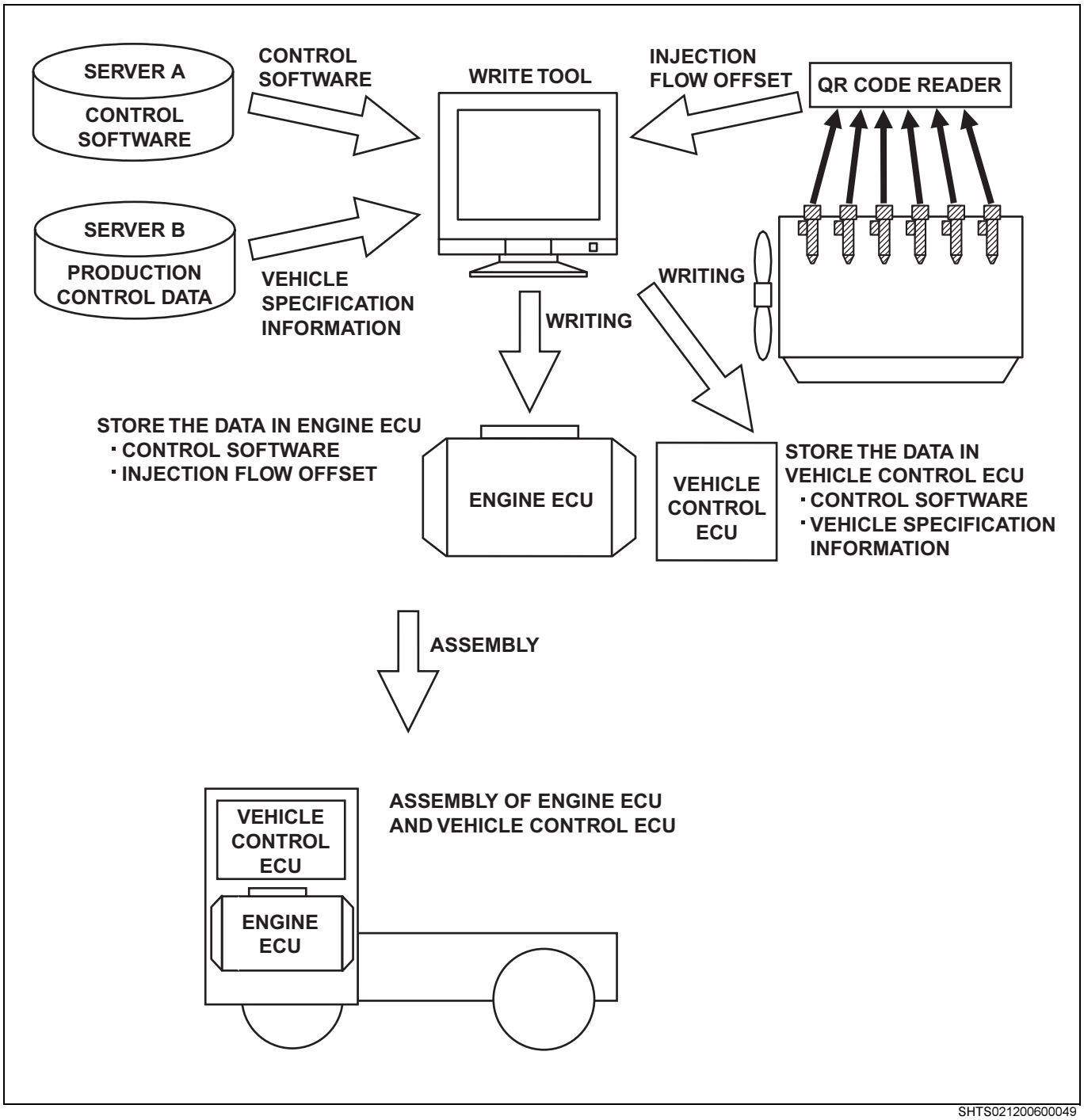
a. The control software is stored in the Server A.

b. The vehicle specification data is stored in the Server B.

c. Read a QR code of the injector in the engine assembly line.

d. Store the data described in the Steps a. to c. above into the engine ECU.

e. Store the data described in the Steps a. and b. into the vehicle control ECU.



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FUNCTION

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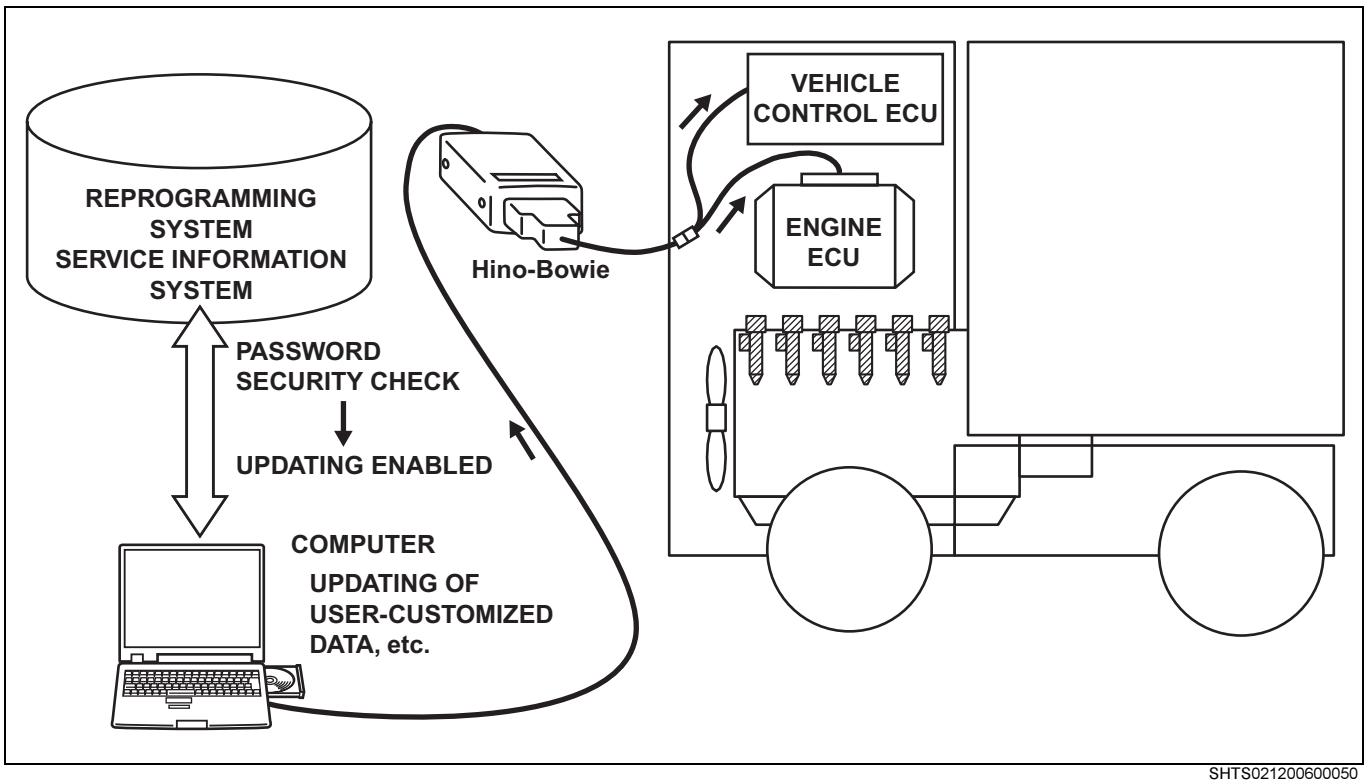
- The reprogramming system is a great aid in precisely meeting customer's needs and providing prompt services, with its variety of functions: i.e. a user customization function that can set the idle speed and the upper limit of a vehicle speed in line with customer's needs; a reprogramming function that allows distributors to rewrite or update the data in the engine ECU and the vehicle control ECU; and a new type of failure diagnosis function using a computer.

USER CUSTOMIZATION FUNCTION

- With the user customization function, user-customized data stored in the engine ECU and the vehicle control ECU can be rewritten/updated as required by customer's needs, type of vehicle body build and driving conditions.



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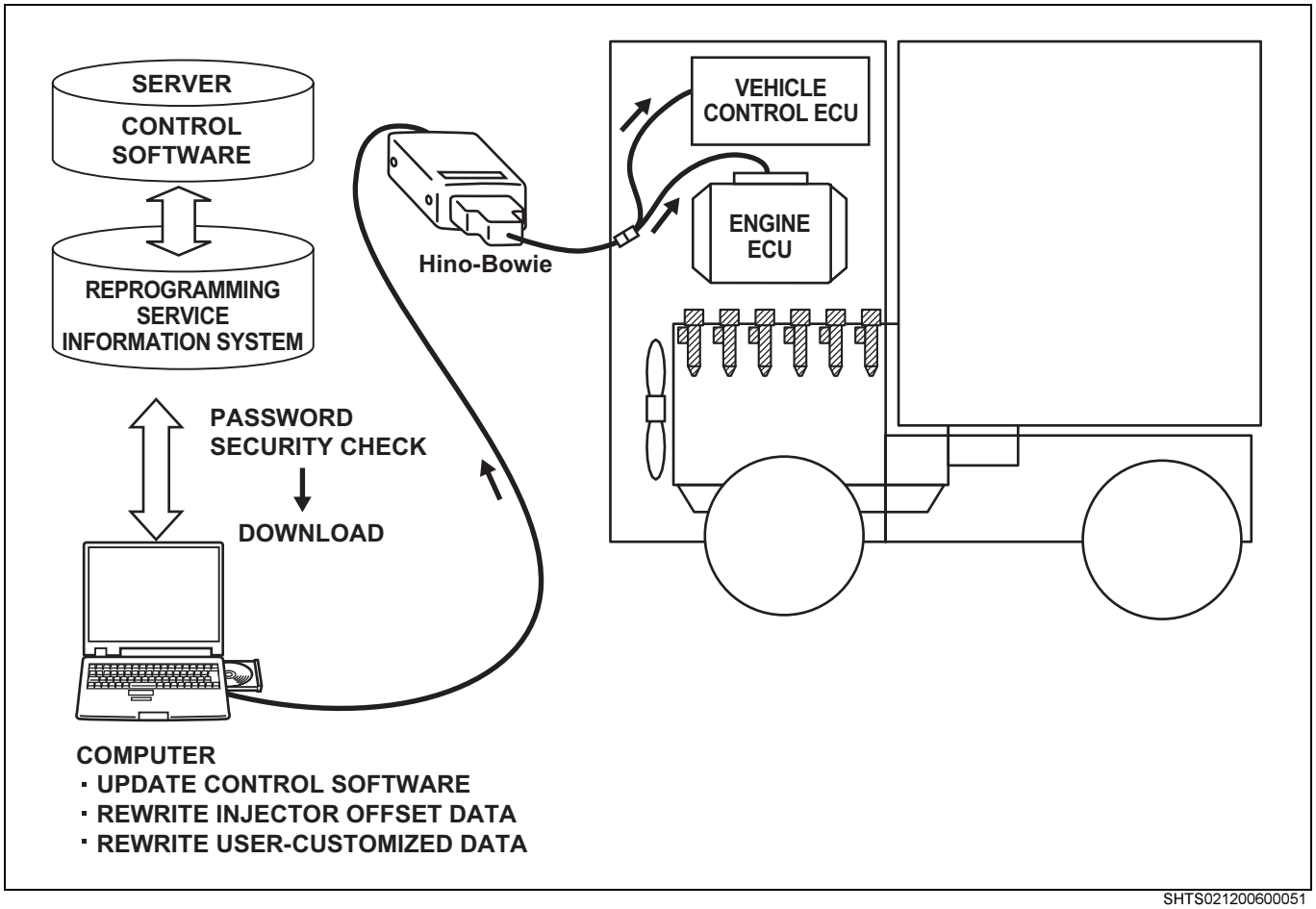
REPROGRAMMING FUNCTION

- If the user customization function is used to update the data and/or upgrade the version of control software for engine ECU or vehicle control ECU or if the engine ECU or vehicle control ECU is replaced because of breakdown, the data must be rewritten (updated) into the engine ECU and/or vehicle control ECU.
  The reprogramming function is designed to enable the necessary data to be rewritten (updated) by using a computer.

SUMMARY OF REPROGRAMMING PROCEDURES

1. Data rewriting for control software version upgrade
   a. Use a computer to access the reprogramming service information system through distributor's LAN and download the control software.
   b. Connect a computer to the engine ECU and the vehicle control ECU via the interface (Hino-Bowie.)
   c. Use the reprogramming manager in the computer to update the data of the engine ECU and the vehicle control ECU.
   d. Use a computer to access the reprogramming service information system and correct the data stored in the server (for a changed part No. of the control software.)



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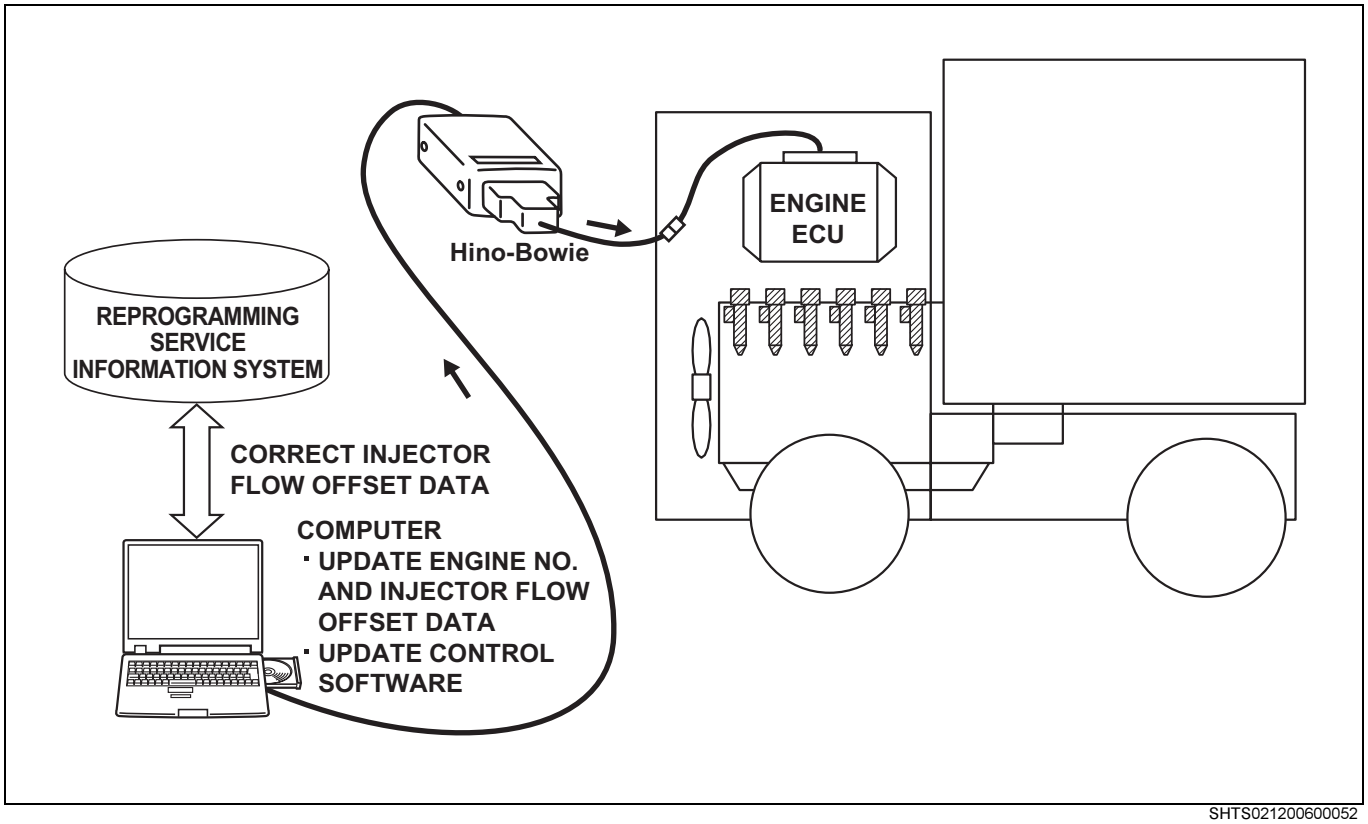
2. Data updating in engine replacement
   a. Use a computer to access the reprogramming service information system and download the engine data.
   b. Connect a computer to the engine ECU via the interface (Hino-Bowie.)
   c. Use a computer to send the data to the engine ECU and rewrite the control software.
   d. Use a computer to access the reprogramming service information system and correct the data (engine No. and old data) stored in the server.



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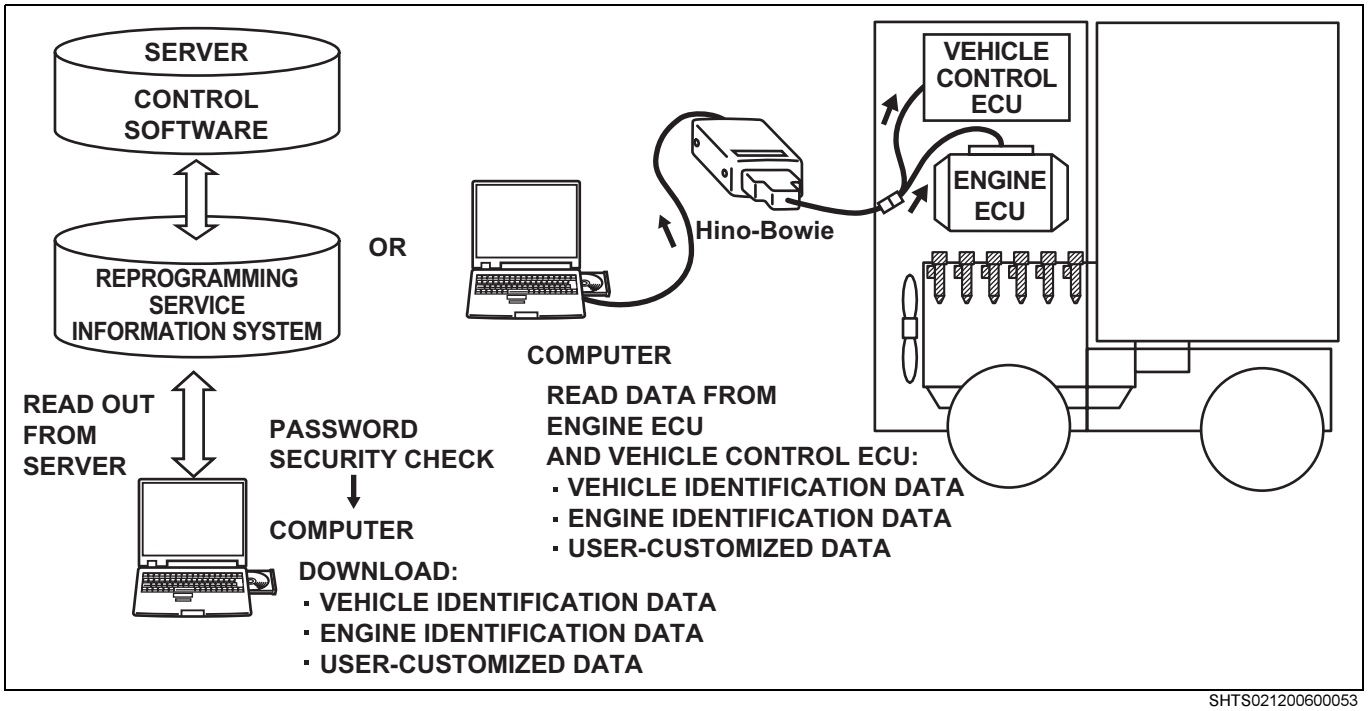
3. Data updating in replacement of engine ECU and vehicle control ECU
   a. Use a computer to access the reprogramming service information system (or connect a computer to the old engine ECU and the old vehicle control ECU) and read the vehicle identification data, the engine identification data and the user-customized data.



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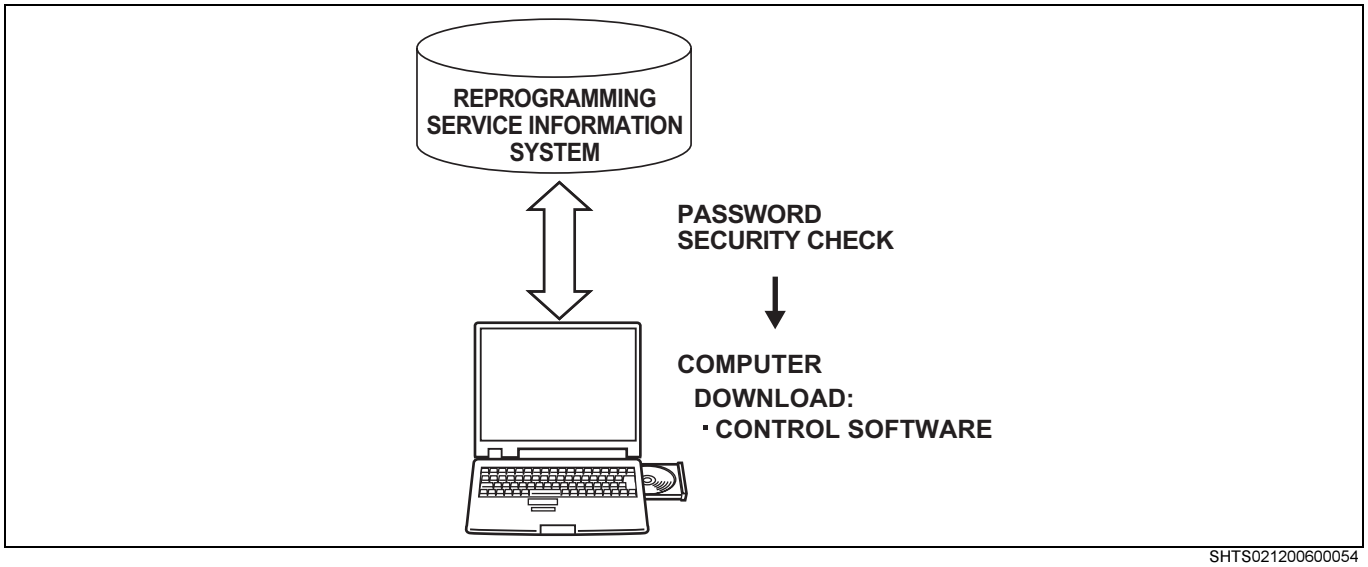
b. Use a computer to access the reprogramming service information system through distributor's LAN (if the data are read from the old engine ECU and the old vehicle control ECU in the Step a. above), download the control software.



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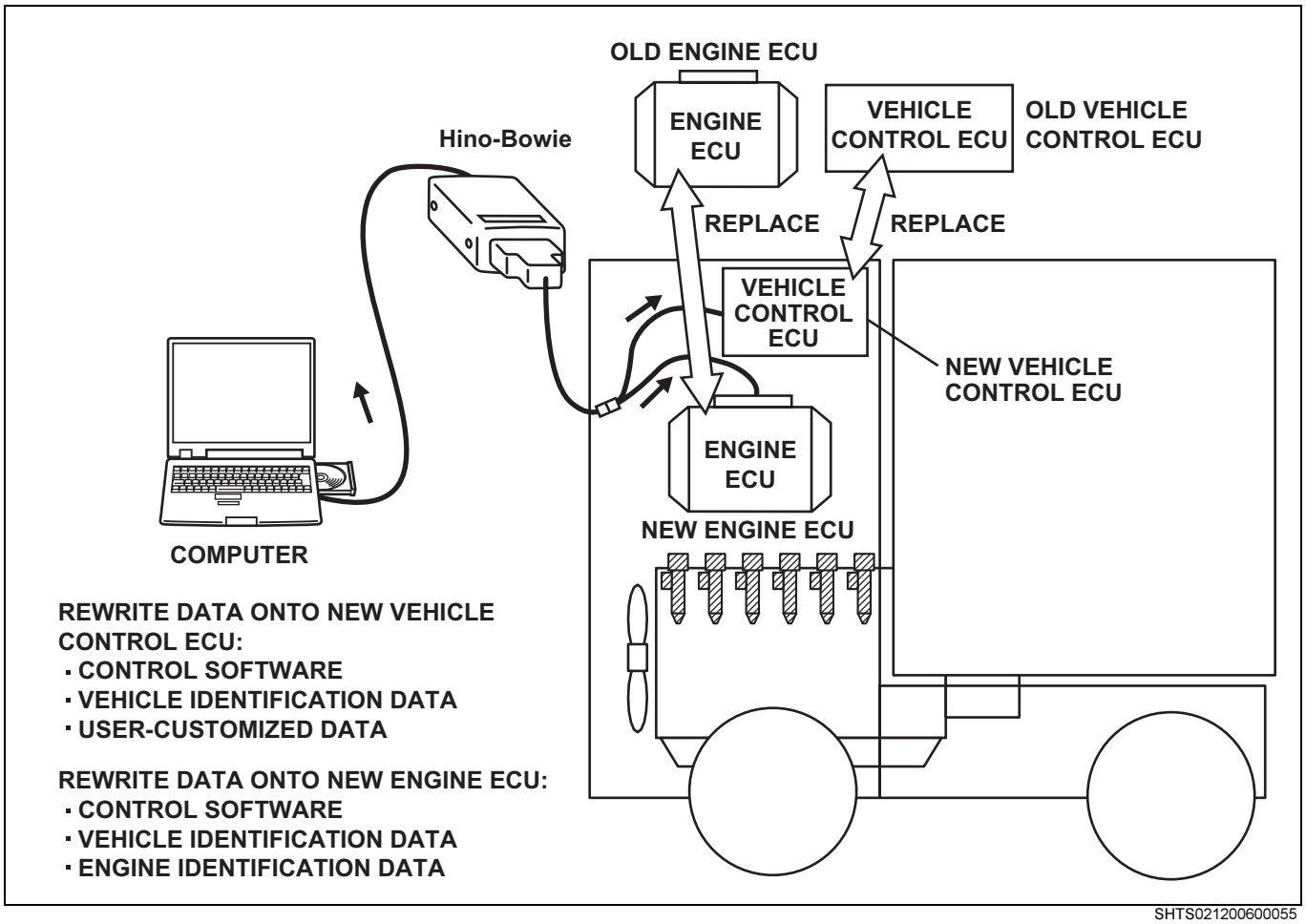
c. After downloading the data by using the reprogramming manager in the computer, rewrite the downloaded data onto the engine ECU and the vehicle control ECU.



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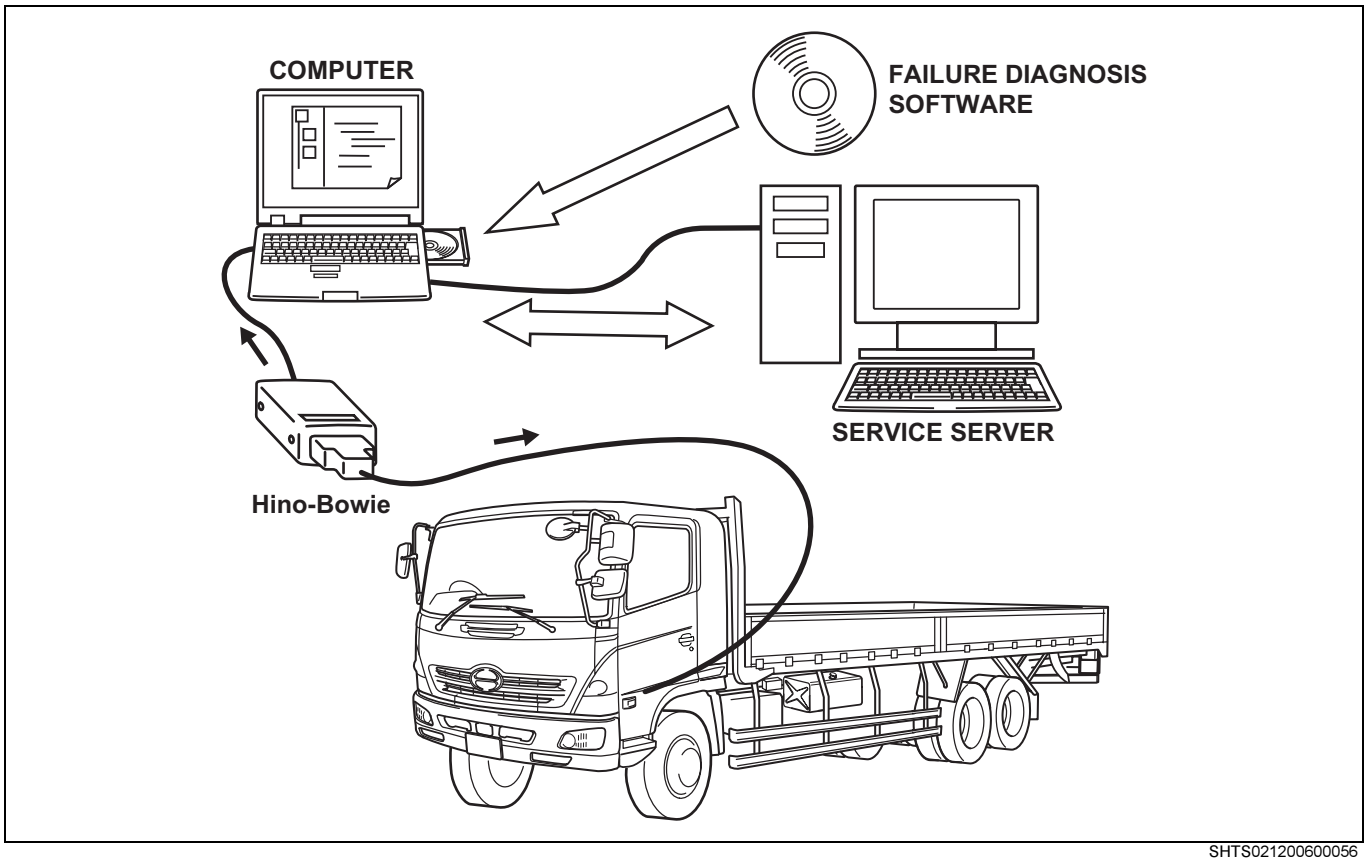
FAILURE DIAGNOSIS FUNCTION (Hino-DX)

- A computer is used to diagnose failures if any.
- In addition to typical failure diagnosis, this new failure diagnosis function also covers the data monitor function and the active test function.



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SYSTEM CONFIGURATION

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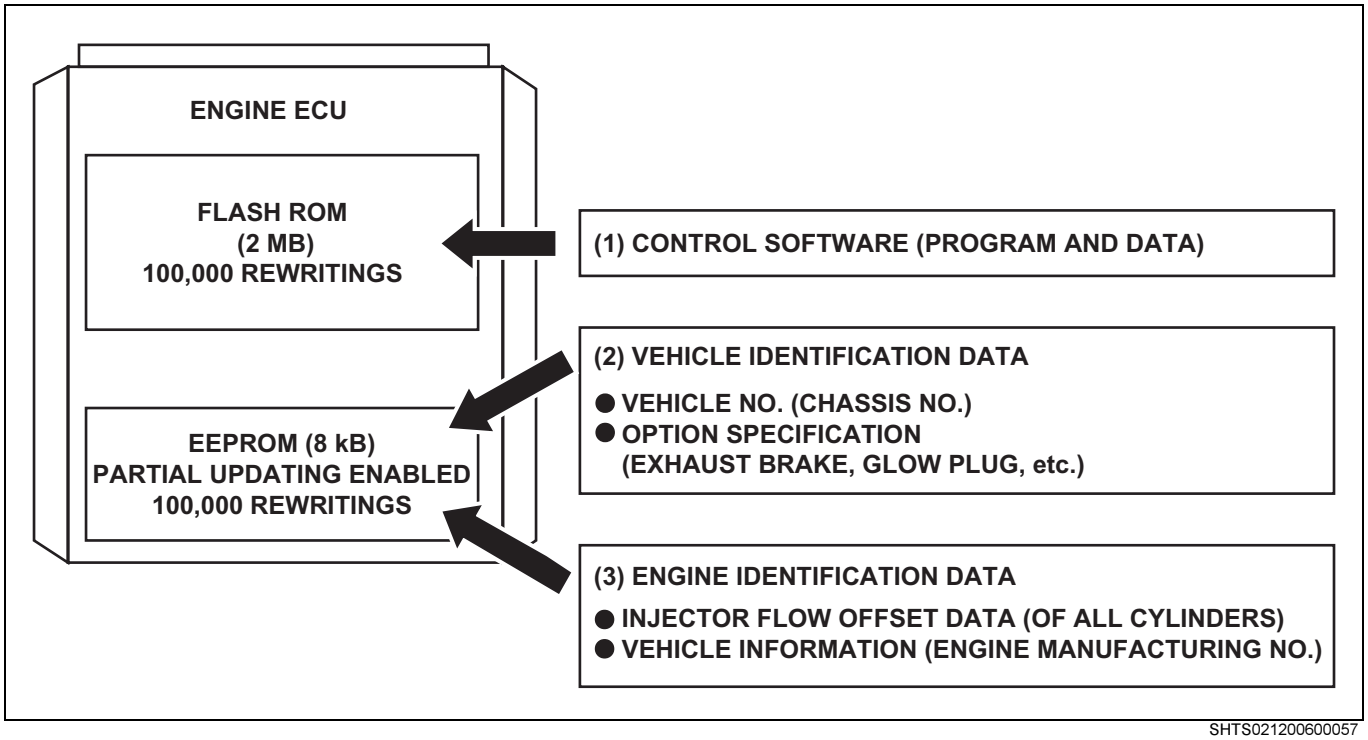
ENGINE ECU

- The engine ECU controls the common rail fuel injection system and other engine-related systems, based on the stored control software, vehicle identification data, engine identification data and user-customized data.
- The internal memory consists of the flash ROM and the EEPROM. The data are stored in either of these memories depending on the data type.
- For detailed information on control of the engine ECU control, see the section "Engine ECU" under the "Structure" in the "Fuel injection system" of "[A09C] Fuel System" in this chapter (Page 2-27.)

1. FLASH ROM
   - The flash ROM has a capacity of 2 MB. The control software (program and data) is stored in the flash ROM.
   - The flash ROM can accommodate 100,000 rewritings.
2. EEPROM
   - The EEPROM has a capacity of 8 kB. The vehicle identification data and the engine identification data are stored in the EEPROM.
   - The EEPROM can accommodate 100,000 rewritings.



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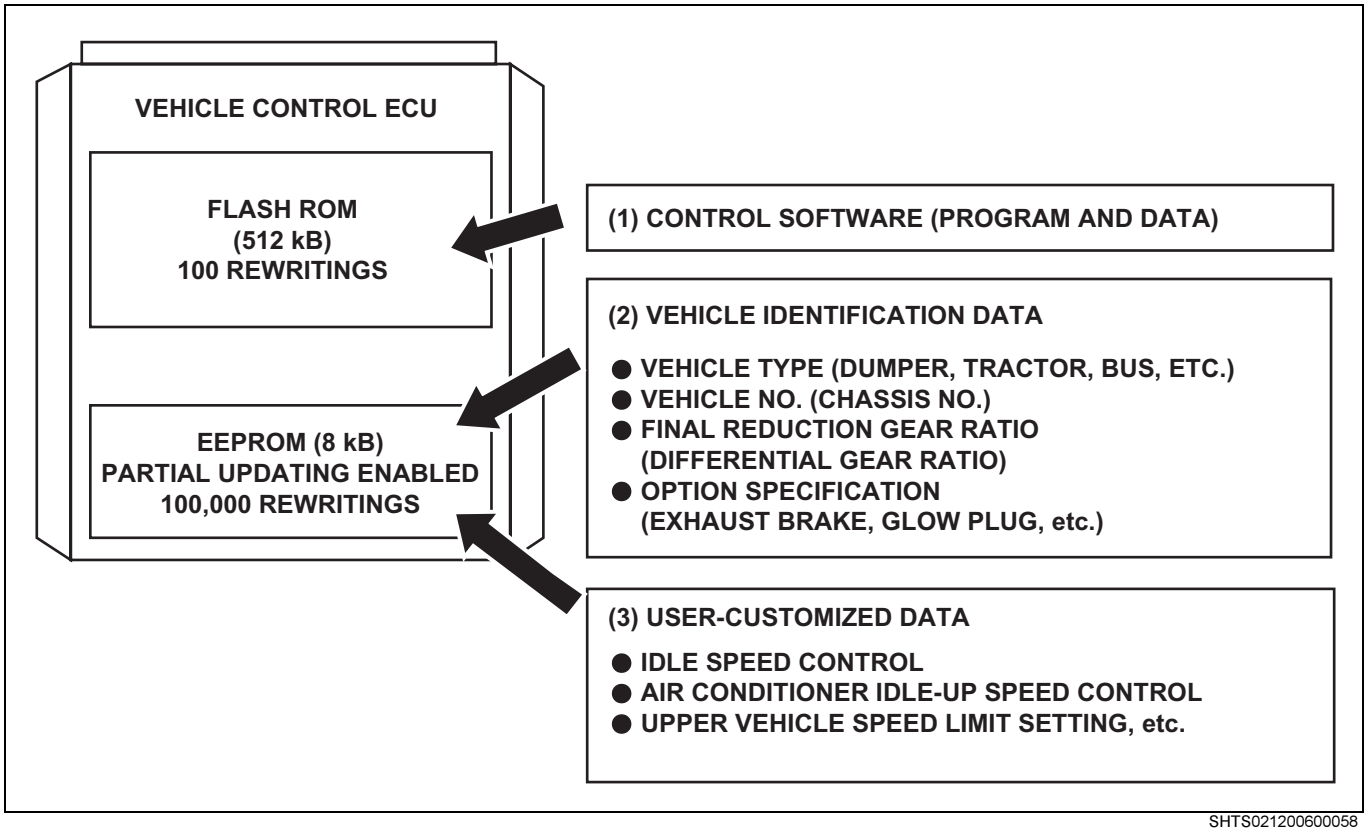
VEHICLE CONTROL ECU

- The vehicle control ECU controls the vehicle control related systems, based on the stored control software, vehicle identification data and user-customized data.
- The internal memory consists of the flash ROM and the EEPROM. The data are stored in either of these memories depending on the data type.
  1. FLASH ROM
     - The flash ROM has a capacity of 512 kB. The control software (program and data) is stored in the flash ROM.
     - The flash ROM can accommodate 100 rewritings.
  2. EEPROM
     - The EEPROM has a capacity of 8 kB. The vehicle identification data and the user-customized data are stored in the EEPROM.
     - The EEPROM can accommodate 100,000 rewritings.



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CONTROL SOFTWARE

1. ENGINE ECU
   - The control software is provided for each specification: i.e. applicable laws and regulations (automobile emission regulations, etc.), engine power and torque. Each control software has its part No.
   - A computer is used to access the reprogramming service information system, download the software of an applicable part No. from the control software server, and rewrite the control software. To access the system, the authentication ID and password are required.
   - The vehicle No. must be entered to download the control software.
2. VEHICLE CONTROL ECU
   - A computer is used to access the reprogramming service information system, download the software of an applicable part No. from the control software server, and rewrite the control software. To access the system, the authentication ID and password are required.
   - The vehicle No. must be entered to download the control software.

VEHICLE IDENTIFICATION DATA

- The vehicle identification data contains the information on one specific vehicle: i.e. a vehicle type, specifications and other information as listed below.

ENGINE ECU

a. Vehicle No. (chassis No.)

b. Option specification (exhaust brake, glow plug, etc.)

VEHICLE CONTROL ECU

a. Vehicle type (dumper, tractor or bus)

b. Vehicle No. (chassis No.)

c. Final reduction gear ratio (differential gear ratio)

d. Option specification (exhaust brake, glow plug, etc.)

ENGINE IDENTIFICATION DATA

- The engine specification code is read by the QR code reader, and the engine identification data is stored in the engine ECU.
- The engine identification data consists of the following two types of data.

a. Injection flow offset data (of all cylinders)

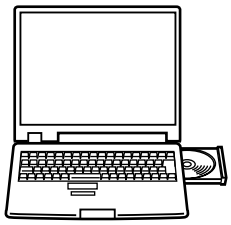
b. Vehicle information (engine manufacturing No.)

USER-CUSTOMIZED DATA

- The user-customized data are written by using the user customization function and includes idle speed control, air conditioner idle-up speed control, upper vehicle speed limit setting, etc.

COMPUTER

- This system uses a computer in rewriting/updating the data and in diagnosing failures.



EXEMPLUM: COMPUTER

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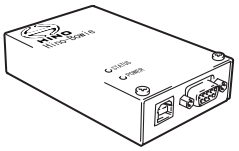
INTERFACE

- The Hino-Bowie must be selected as an interface when connecting a computer to the engine ECU and the vehicle control ECU.



Hino-Bowie

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REPROGRAMMING SERVICE INFORMATION SYSTEM

- The reprogramming service information system within dealer's LAN prompts a password for security check. If a proper password would not be entered, the access to the server will be denied.

REPROGRAMMING MANAGER

- This software is used to install to the computer. By using this software, could read and rewrite the data of the engine ECU and the vehicle control ECU.

[A09C] EMISSION CONTROL

COOL EGR

SUMMARY

JP18117020301015

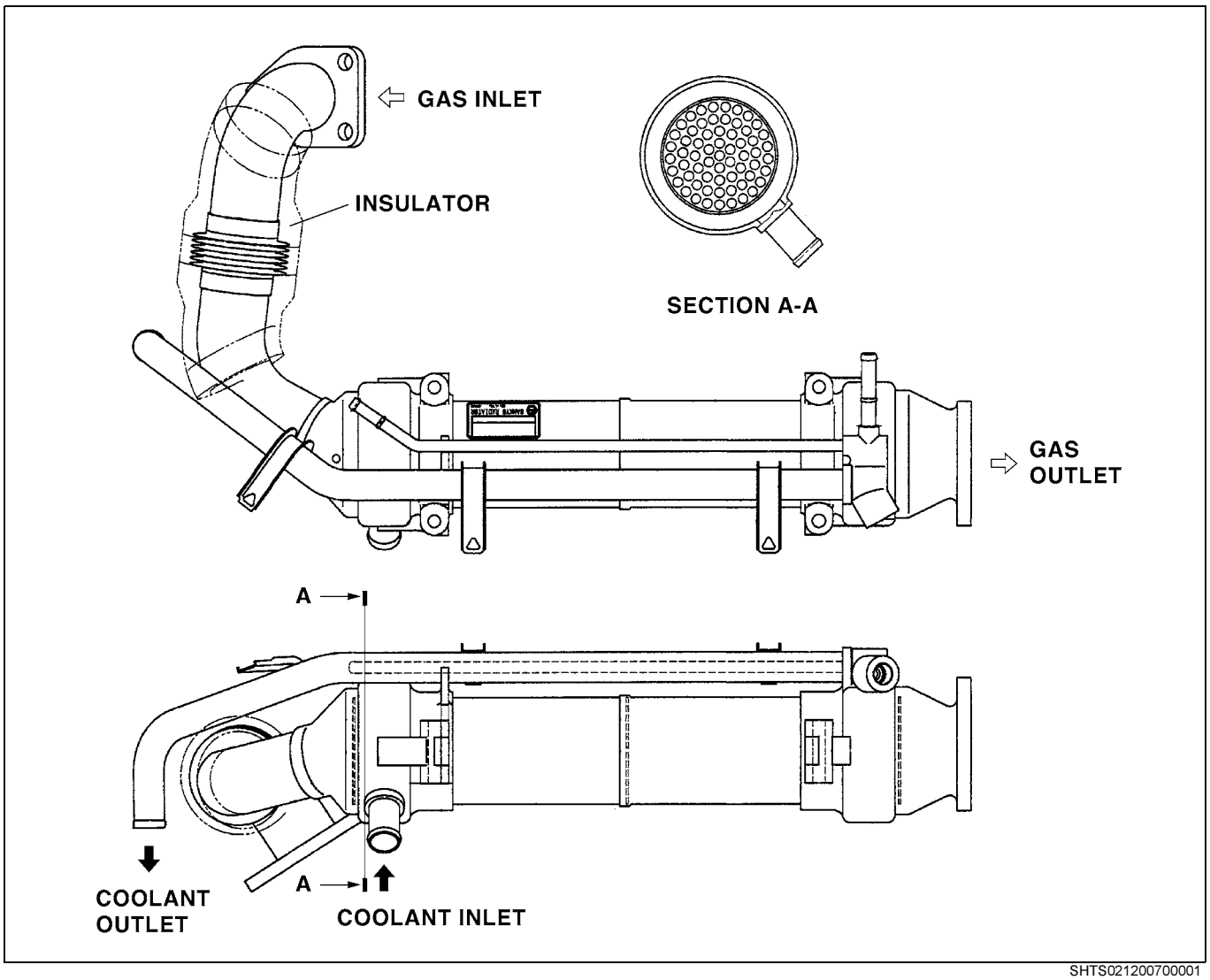
- The cool EGR is comprised of the water-cooling multi-tubular EGR cooler build in the external pipe type EGR. The coolant is used to cool the emission gas flowing back from the exhaust side to the intake side, and the high-density emission gas is delivered to the intake side. This increases the efficiency of the EGR.
- The cool EGR consists of an EGR cooler that cools the emission gas; an EGR valve that adjusts the gas flow rate; and a DC motor that electrically controls the EGR valve opening/closing operations.

STRUCTURE

JP181170203010 16

EGR COOLER

- The EGR cooler has 63 tubes each within the coolant-filled tank, through which passing EGR gas is cooled. The spiral shape was added to theses tubes to precisely balance the cooling efficiency and the reduction in performance degradation. This improvement achieves the compliance with exhaust emission regulations and increases the fuel efficiency.
- The EGR cooler body made of thermally-resistant, anti-corrosive stainless steel to ensure the reliability. Especially, the tubes for gas passage are made of ultra low carbon stainless steel to ensure further reliability of corrosion resistance.



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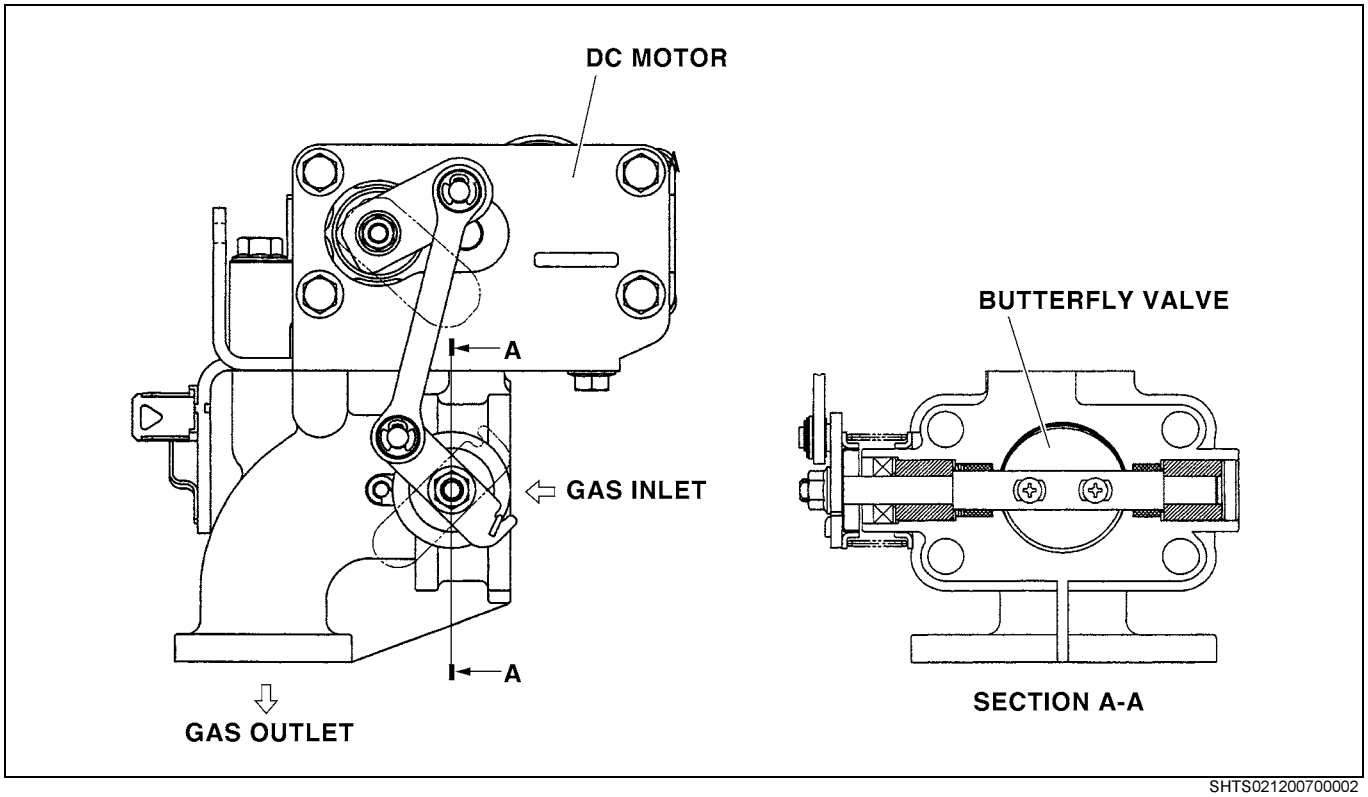
EGR VALVE

- The butterfly valve is used as an EGR valve in order to increase the EGR gas flow.
- To meet the US04 emission standards, the valve is driven by the DC motor and is under continuously variable precise control.
- The DC motor is controlled by CAN communication signal from ECU.
- Besides the nitrocarburized stainless steel valve, the valve seat and the shaft are of stainless steel to ensure corrosion resistance, abrasion resistance and reliability.

OPERATION OF EGR VALVE

- To improve the exhaust gas purification performance with the EGR, the engine ECU performs the feedback control based on the EGR valve opening so that the intake oxygen concentration dependent on the EGR meets the target value according to engine conditions (engine speed, boost pressure, each temperature, loading, intake air flow.)
- To expand the EGR range, the EGR rate is controlled by the EGR valve opening through a command from the engine ECU, based on the predetermined variable nozzle turbocharger opening.



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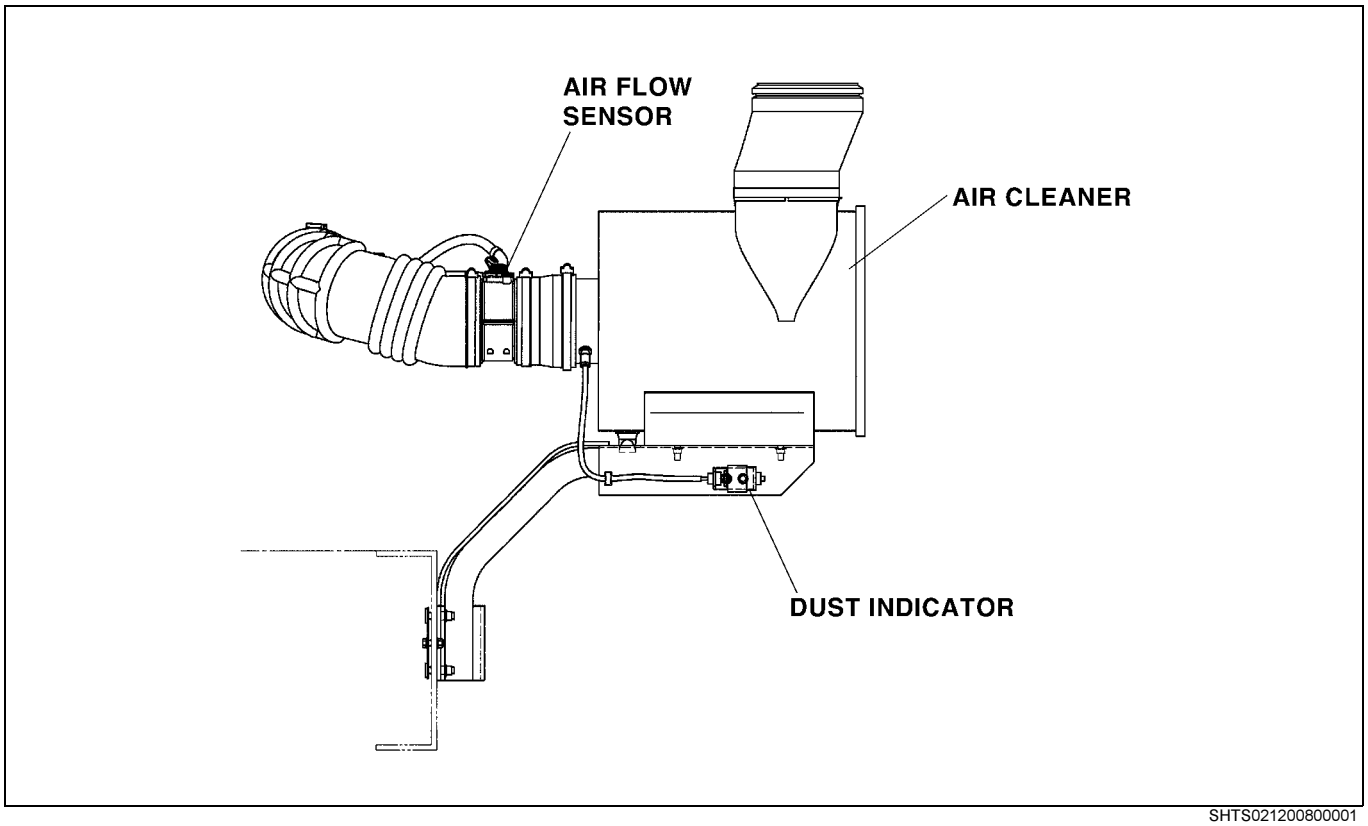
[A09C] INTAKE

INTAKE SYSTEM

SUMMARY

JP181170203010 20

- The air is delivered from the air duct to the air cleaner for filtration. After an intake temperature is lowered at the intercooler, the air is supplied to the engine.
- In compliance with the US04 emission standards, the air flow sensor is installed at the outlet of an air cleaner.
- The dust indicator is installed for clogging check and air cleaner cleanup timing check.



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FUNCTION AND STRUCTURE

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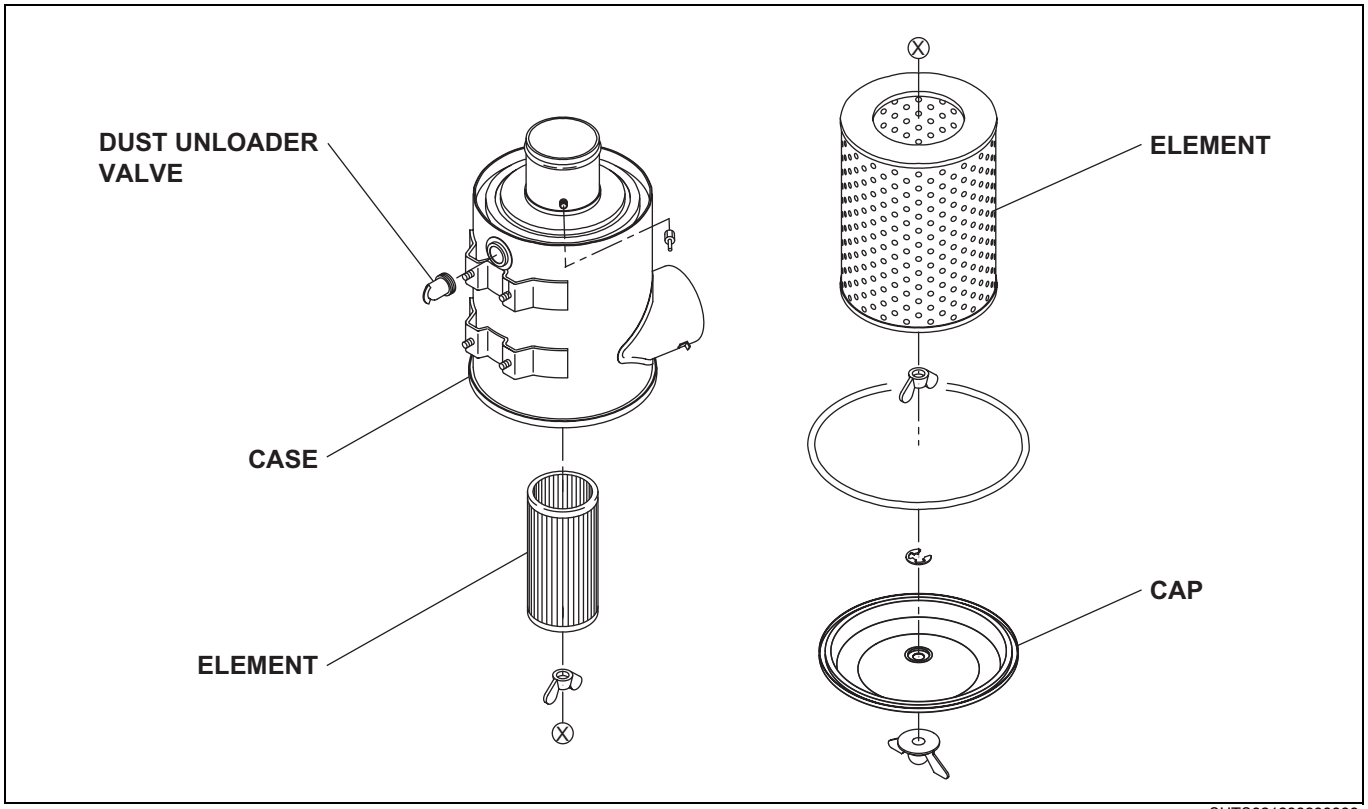
AIR CLEANER

- The center intake type air cleaner is used and consists of a case, an element and a cap.
- A dry and double type element that is excellent in collecting road dusts is the standard specification.
- The dust unloader valve is installed at the bottom of an air cleaner body and automatically scavenges dusts.



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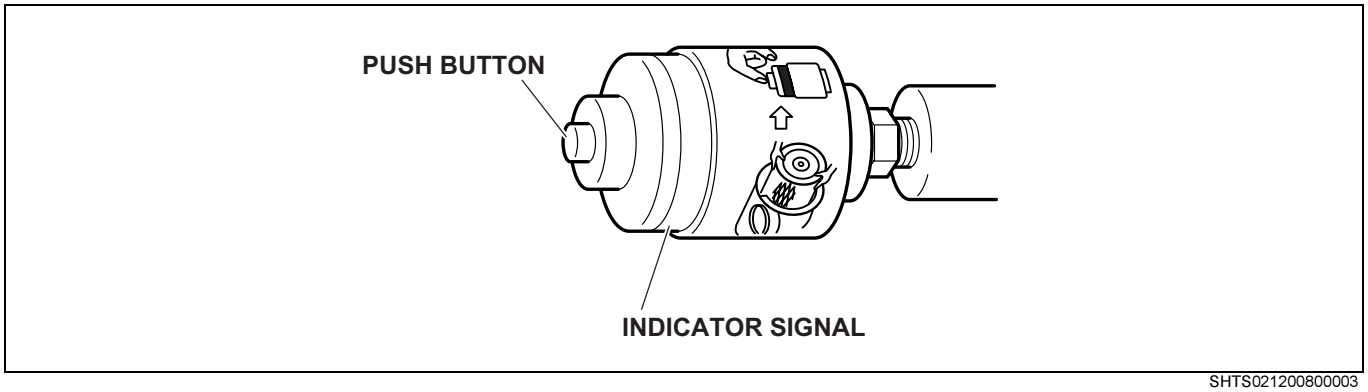
DUST INDICATOR

- The dust indicator is a device that indicates the clogging in an element and uses a vacuum pressure produced by air intake of the engine to tell the necessity of cleanup/replacement of an element.
- The element must be cleaned or replaced when the dust indicator signal turns red and keeps lighting red even after the push button at the end of the indicator is pressed for resetting.



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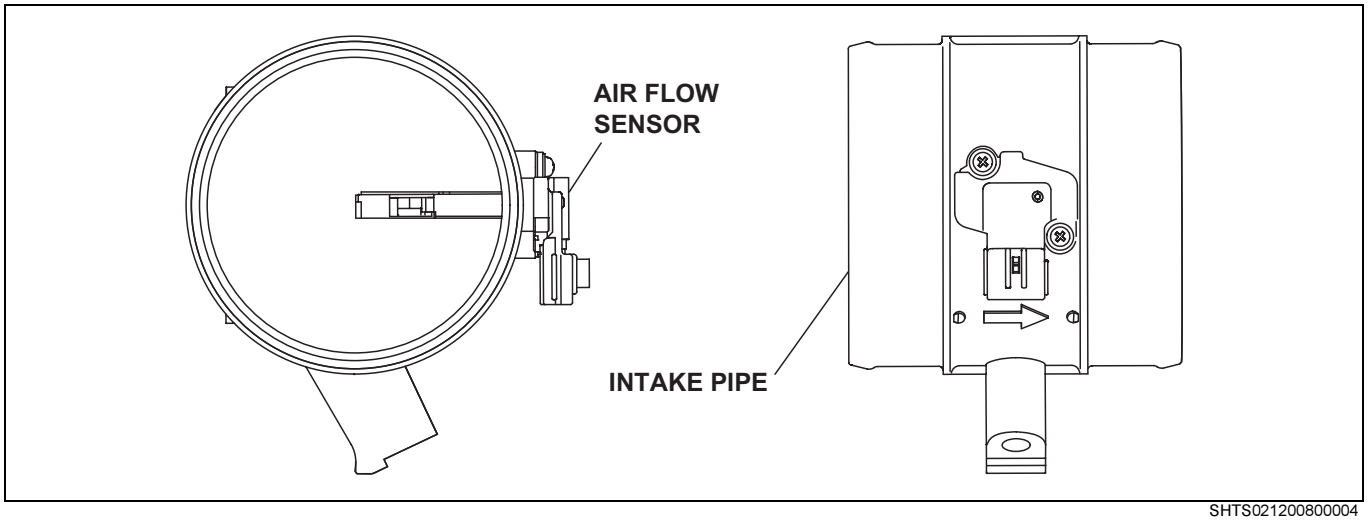
AIR FLOW SENSOR

- The air flow sensor measures a volume of air supplied to the engine and transmits the measurement data to the engine ECU for optimum engine combustion.



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INTAKE PIPE

STRUCTURE

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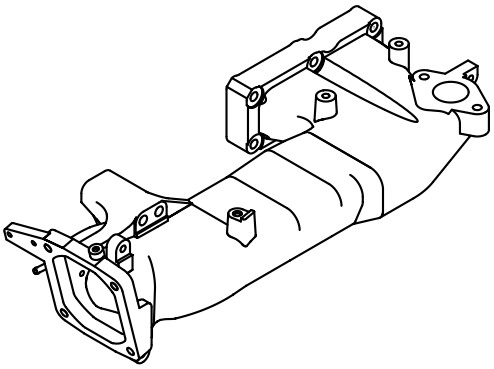
- The intake pipe is of aluminum alloy and has a return port for EGR gas.
- The optimum pipe port diameter increases the intake efficiency for high engine power output.



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[A09C] ENGINE MECHANICAL

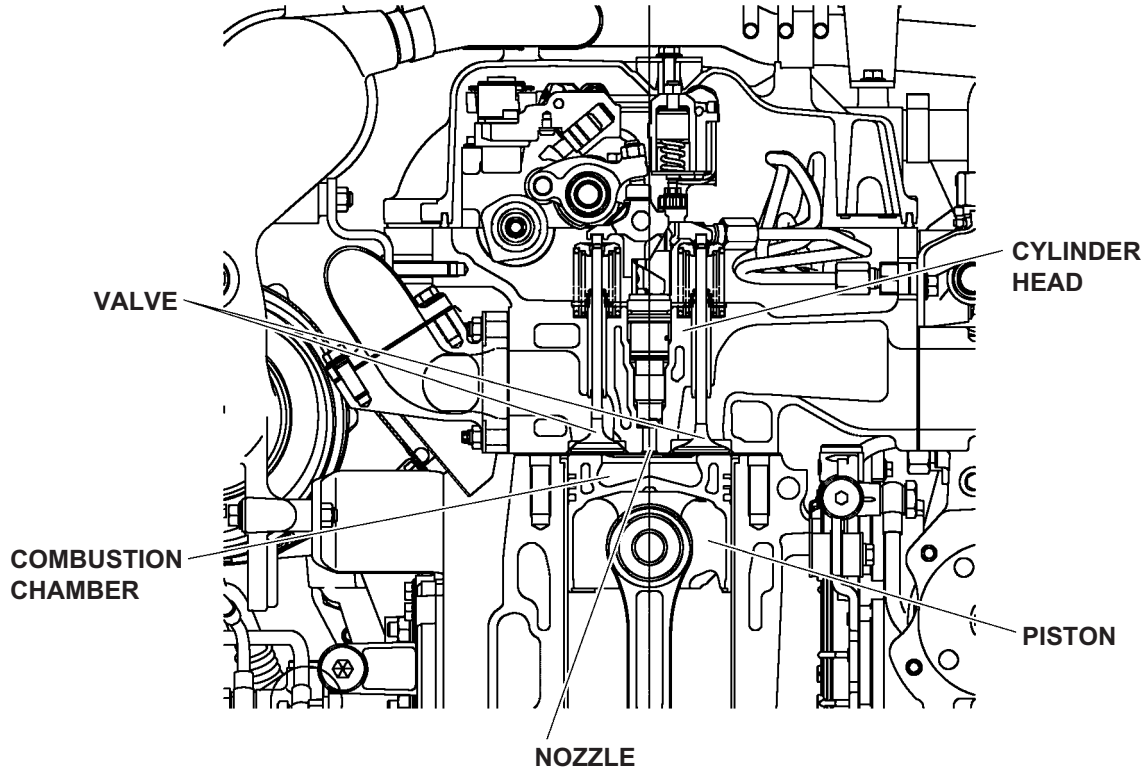
CYLINDER HEAD

STRUCTURE

JP181170203010 24

COMBUSTION CHAMBER

- The direct injection system has a reentrant type combustion chamber. The injector nozzle is located in the piston center. The quad valve system (two intake valves and two exhaust valves) and the special shape of an intake port are incorporated in the structure to ensure good combustion, along with improvements in intake distribution and intake efficiency.



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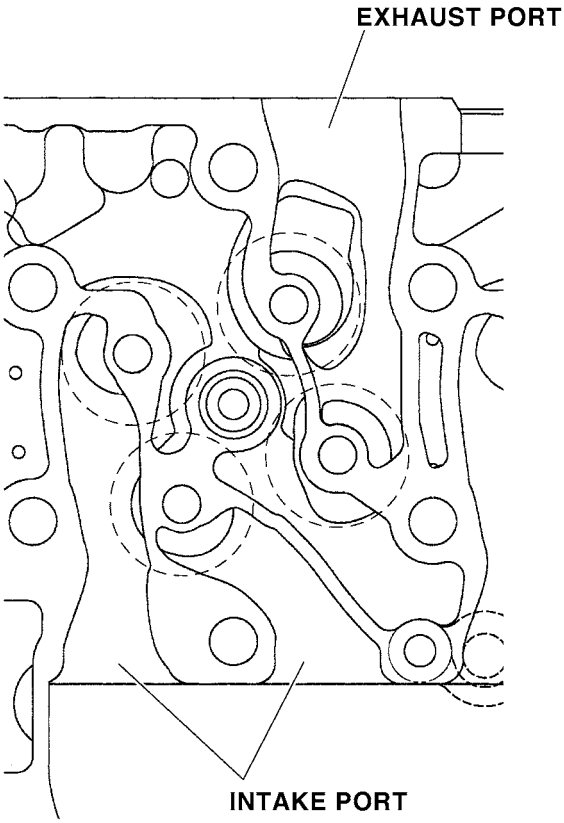
CYLINDER HEAD

- This crossflow cylinder head is characterized by alternately laid out two intake valves and two exhaust valves made of special thermal-resistant alloy cast iron and is integrated with an intake manifold and a camshaft housing. This type of cylinder head helps improving the reliability to the continuous high-speed, heavy-duty operations.
- The intake port has a unique structure as shown in the figure below and is designed to have optimum mixing swirl within a cylinder for good combustion. The improved geometry of a port increases the performance.
- The exhaust port is so located that exhaust energy loss will be minimized for effective operations of a turbocharger. The improved geometry of a port increases the performance.
- The intake and exhaust valve seats respectively have a sintered insert.
- Use of the wet type nozzle sleeve ensures sufficient durability. The cooling performance is increased by means of a double cooling jet by using coolant used to cool the nozzle sleeve and the area between a head and a valve.
- The OHC structure involves various improvements: i.e. higher strength and weight saving of cylinder structure, higher engine power output, longer service life and higher reliability.



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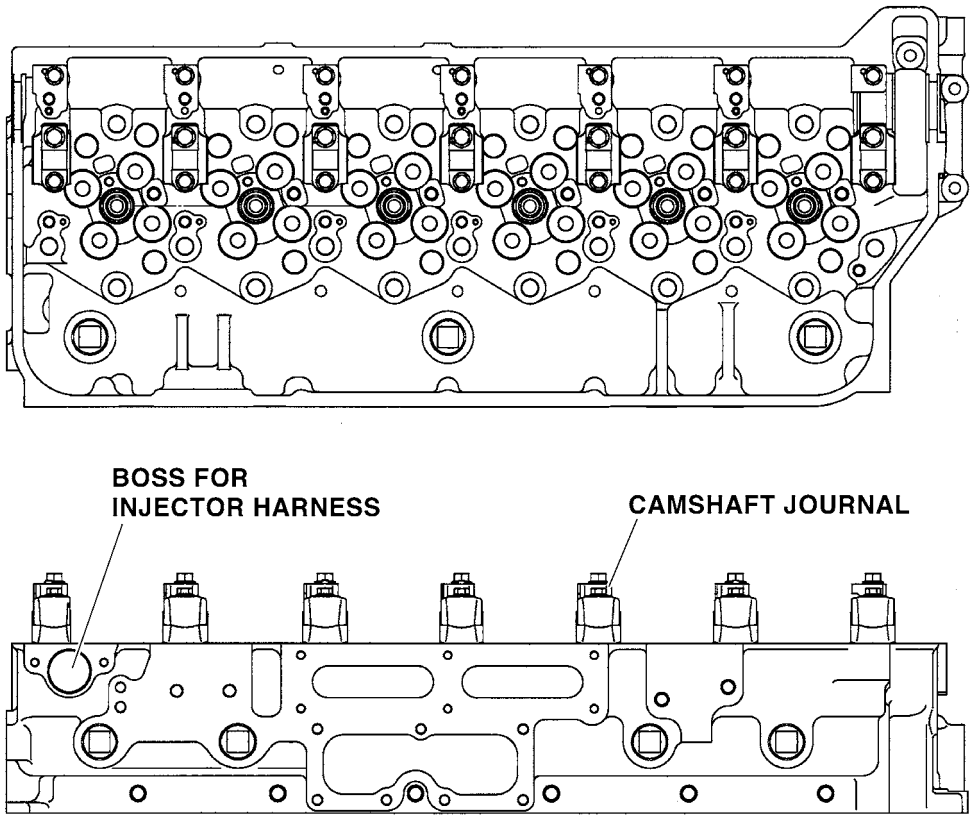
CAMSHAFT HOUSING

- The camshaft housing is integrated with the cylinder head.
- To accommodate the common rail fuel injection system, the boss for injector harness is integrated with the camshaft housing.



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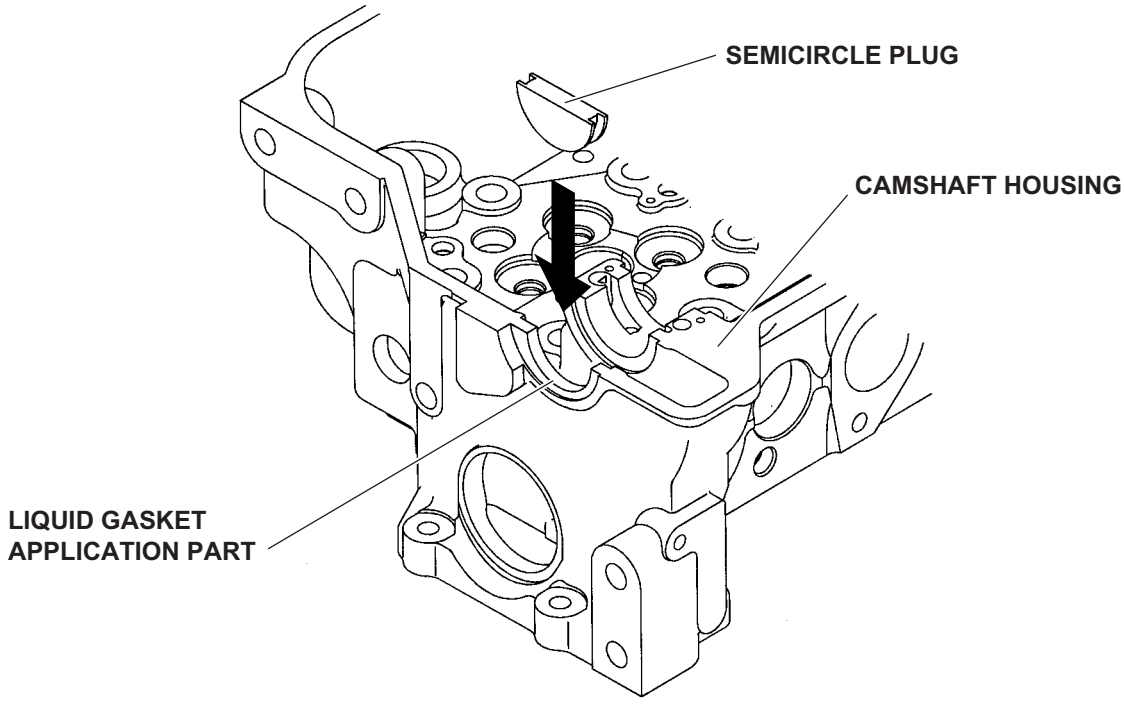
- The liquid gasket is applied to the area where a semicircle plug of the cylinder head is attached, in order to ensure the sealing performance.



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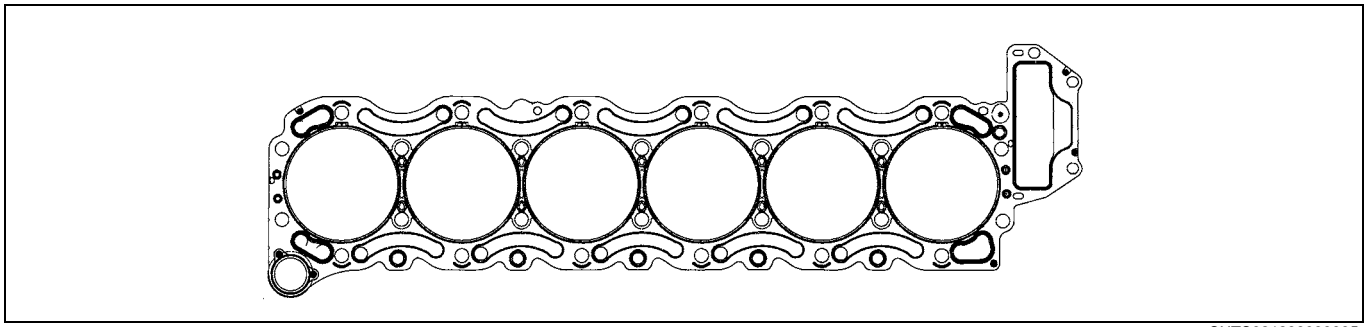
CYLINDER HEAD GASKET

- The cylinder head gasket has good sealing performance relevant to gas, coolant and oil.



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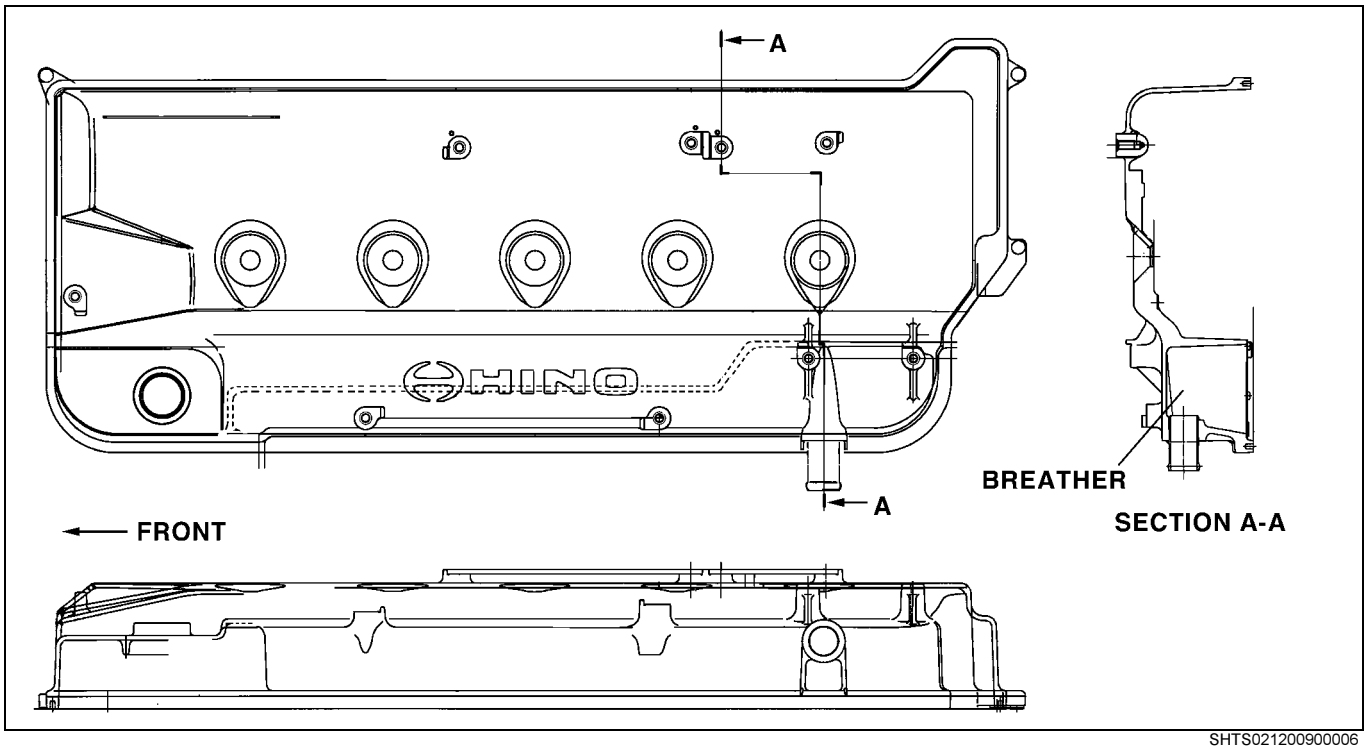
HEAD COVER

- The head cover is made of aluminum die-cast and is secured by five center bolts. The floating structure of the head cover reduces noise in the vehicle.
- The breather is built in to increase the reliability.



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CYLINDER BLOCK

STRUCTURE

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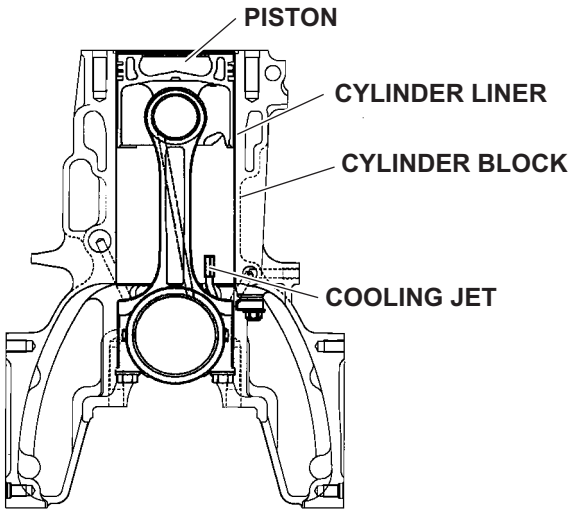
CYLINDER BLOCK AND CYLINDER LINER

- The cylinder block is made of special cast iron and has a highly rigid dry liner structure. This structure increases the rigidity of cylinder areas.
- Newly developed water jackets are incorporated in the semi-open deck structure. The water jackets located on the top surface of the cylinder block cools the upper area of a cylinder block. The semi-open deck structure increases the cooling efficiency in cylinders and liners, which results in lower oil consumption.
- The cooling jets are installed to each cylinder and cool the piston.
- The cylinder liner is made of special cast iron having high tensile strength. A reasonable clearance gives a good assembled condition between the cylinder liner and the cylinder block, and the surface treatment on the inner and outer peripheries of the cylinder liner yields a good fit with the piston ring and cylinder block.



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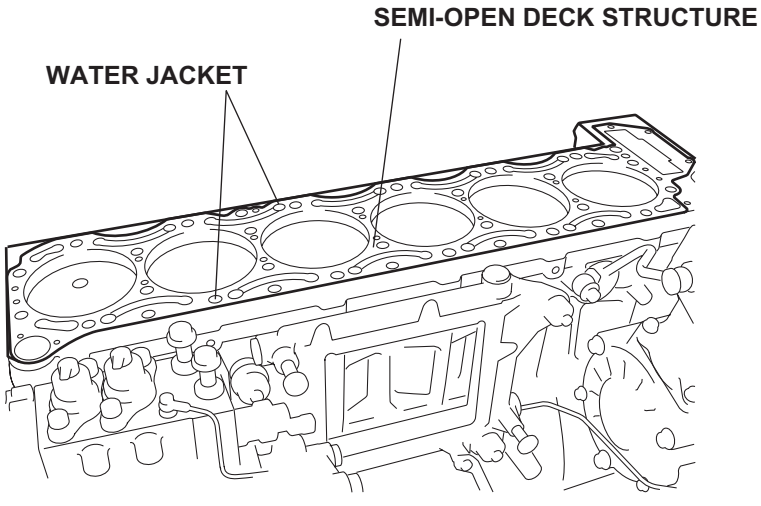

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PISTON, PISTON PIN AND PISTON RING

STRUCTURE

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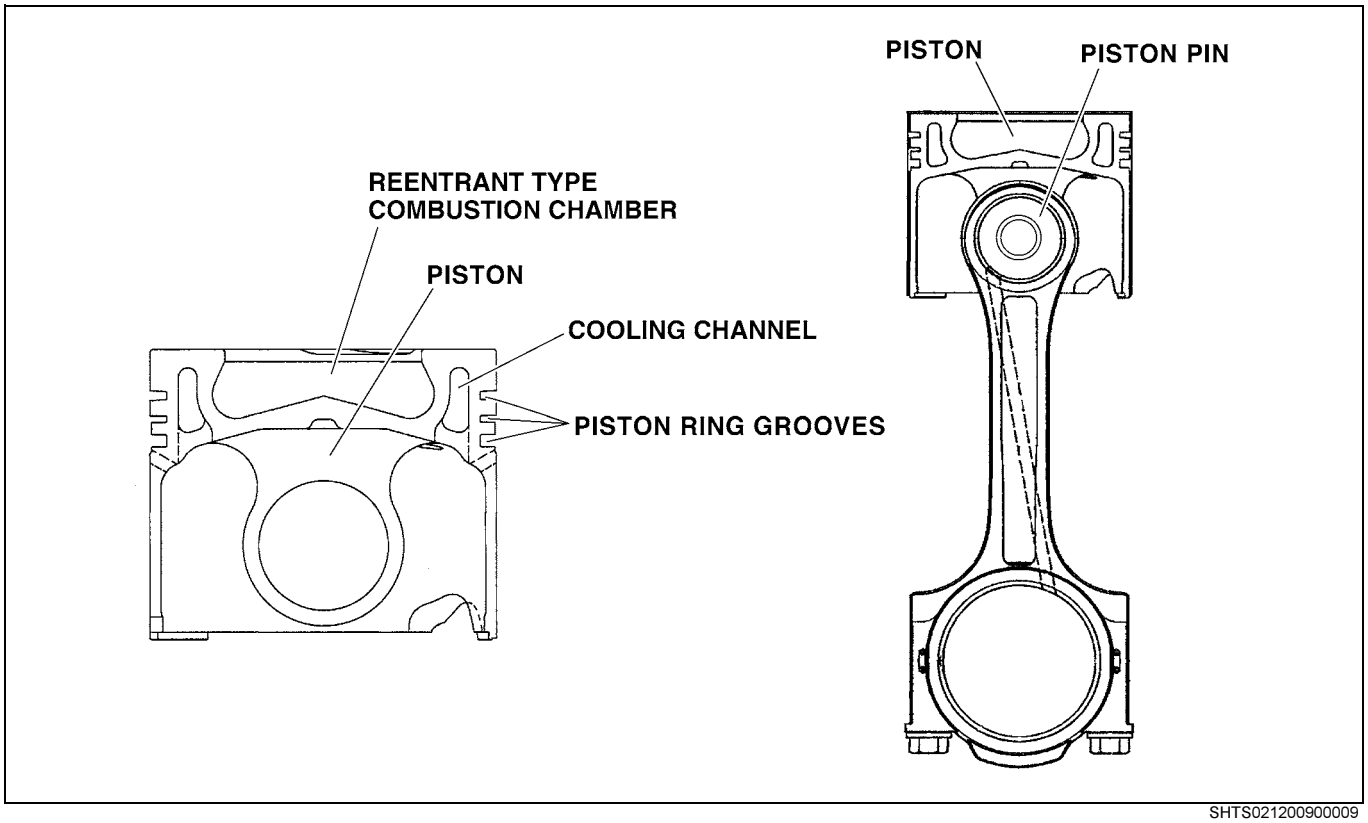
PISTON AND PISTON PIN

- The piston is made of thermal-resistant special cast iron and has high durability for increased engine power output. The reentrant type combustion chamber characterized by its high combustion efficiency leads to good combustion and high fuel efficiency.
- The outer periphery of a piston has geometry of special barrel form in respect to material. A gap between the piston and the liner was reduced to lower a piston slap.
- The piston is kept at an appropriate temperature by the piston cooling jet that directly cools inside the cooling channel. Modification to the cooling channel enhances a cooling effect.
- The floating type piston pin is made of case-hardened steel. This piston pin is allowed to insert into a piston at an ambient temperature.
- The optimized piston pin diameter meets the increased engine power output.



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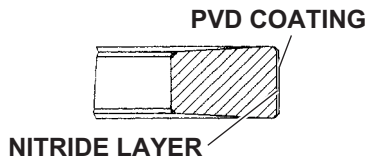
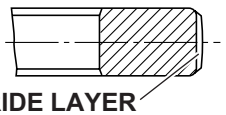
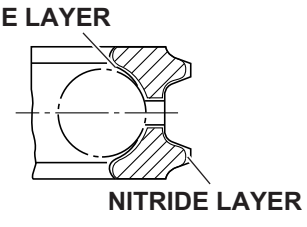
CONTROL FOR TOP CLEARANCE

- An important key to ensuring the performance (e.g. engine power output) is reduction of a variance in clearance between the top face of a piston and the bottom face of a head at the top dead center of a piston. Particularly, the dimensional accuracy of components/parts listed below is subject to critical control.

Piston	From piston pin bore center to piston top face
Connecting rod	From bore center at the large end to bore center at small end
Crankshaft	From journal center to pin center
Main bearing	Bearing thickness
Connecting rod bearing	Bearing thickness
Cylinder head gasket	Seat thickness

PISTON RING

- Use of the nitrided steel piston ring increases the wear resistance.
- The PVD coating applied to the top ring dramatically increases the wear resistance, which results in reductions of oil consumption and blowby gas.
- An improvement in cross-sectional profile of a ring emphasizes optimization of oil consumption, reduction of abrasive loss and prevention against gas leakage or scuffing (galling).
  * PVD stands for physical vapor deposit.

TOP RING	
SECOND RING	
OIL RING	

CONNECTING ROD AND CRANKSHAFT

STRUCTURE

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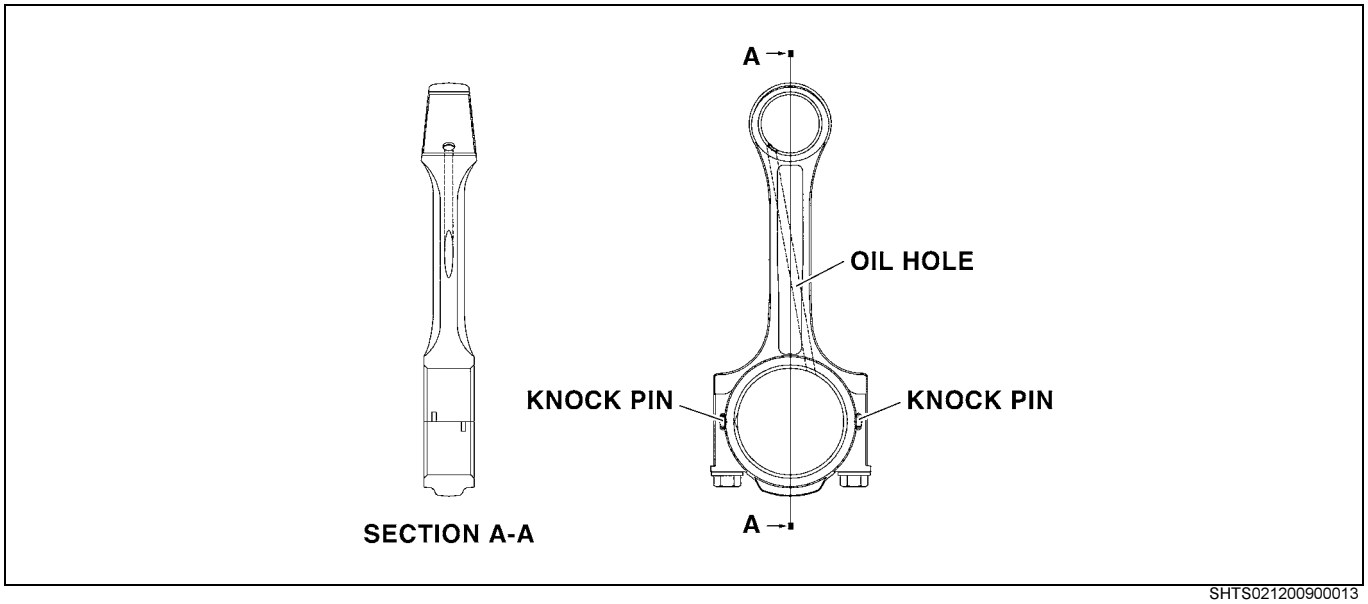
CONNECTING ROD

- The connecting rod is a carbon-steel forged rod. A large end of the connecting rod has a horizontal split, which is advantageous in rigidity. The roll bushing press-fit into a small end has an oil hole in the center.
- The mating surface of the connecting rod uses a knock pin to increase the positioning accuracy and meet the increased engine power output. In contrast to a conventional fastening method using bolts and nuts, this directly female-threaded connecting rod eliminates use of nuts and increases the assemblability.
- The connecting rod is bolted by means of the plastic region bolting method.



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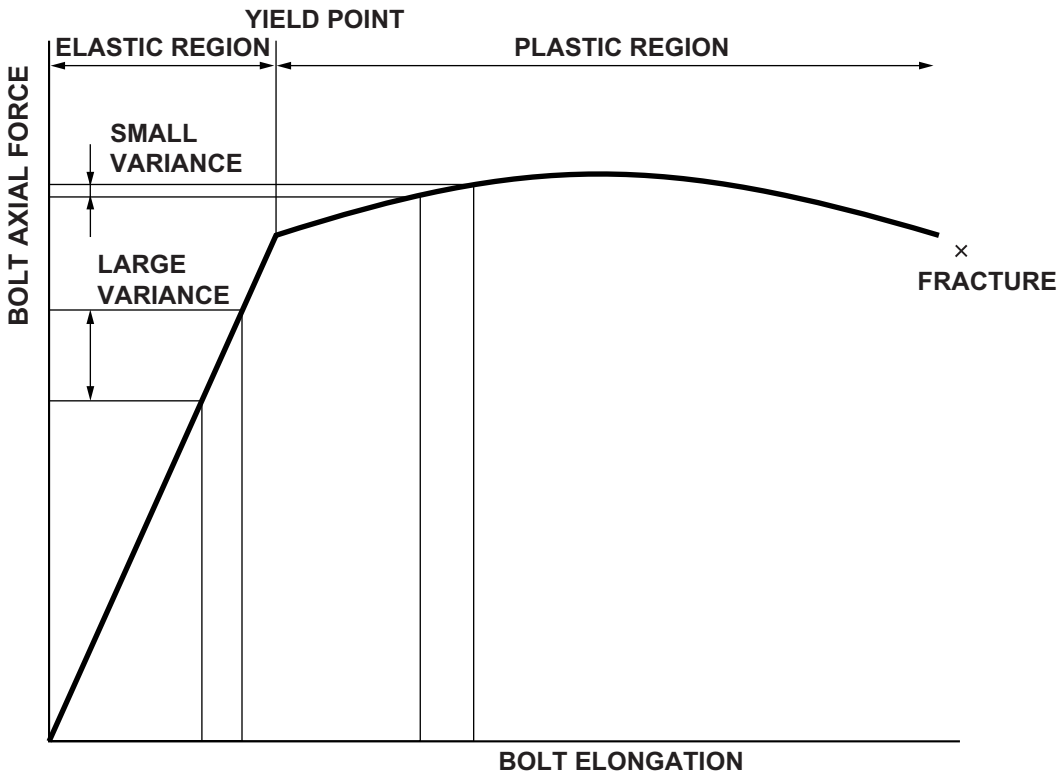
- The plastic region bolting method is a technique of tightening bolts in the plastic region where an axial force is small relevant to bolt elongation as shown in the figure below, and is characterized by:

Stable axial force:	The axial force is stabile because of a smaller variance in axial force in comparison with the elastic-region bolting method.
Higher axial force Limited reusability:	The plastic elongation is incremental in every reuse, thus the reusability is limited.



CHARACTERISTICS OF BOLT IN PLASTIC REGION

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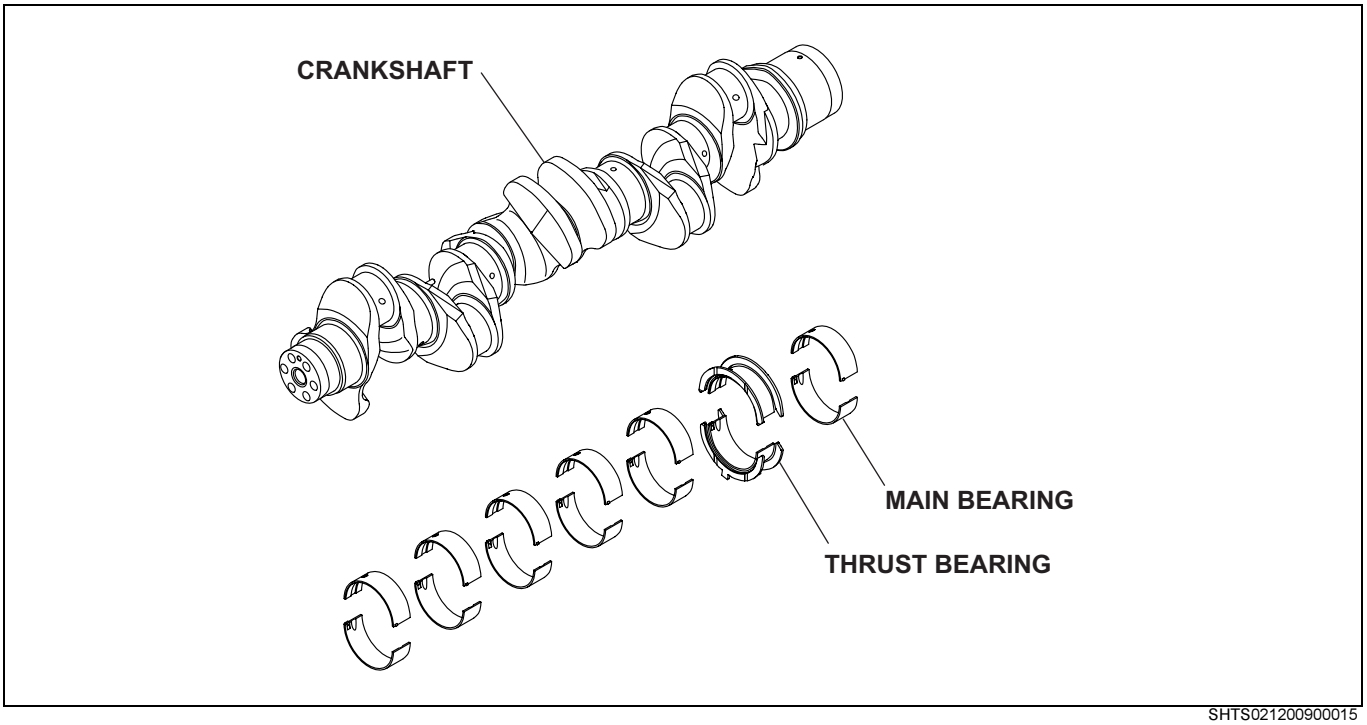
- The plastic region bolting method is used to connecting rod bolts, head bolts, main bearing cap bolts and camshaft gear mounting bolts.

CRANKSHAFT

- The crankshaft is precisely forged from special steel. The crankshaft pins and the journals are high-frequency-hardened to ensure sufficient rigidity and wear resistance.
- The crankshaft is mounted to the cylinder block by seven main bearings via bearing caps. Two thrust bearings are attached to the block side and to the cap side of the 6th journal respectively.
- A larger journal diameter improves durability and reliability to meet the increased engine power output.



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VALVE SYSTEM

STRUCTURE

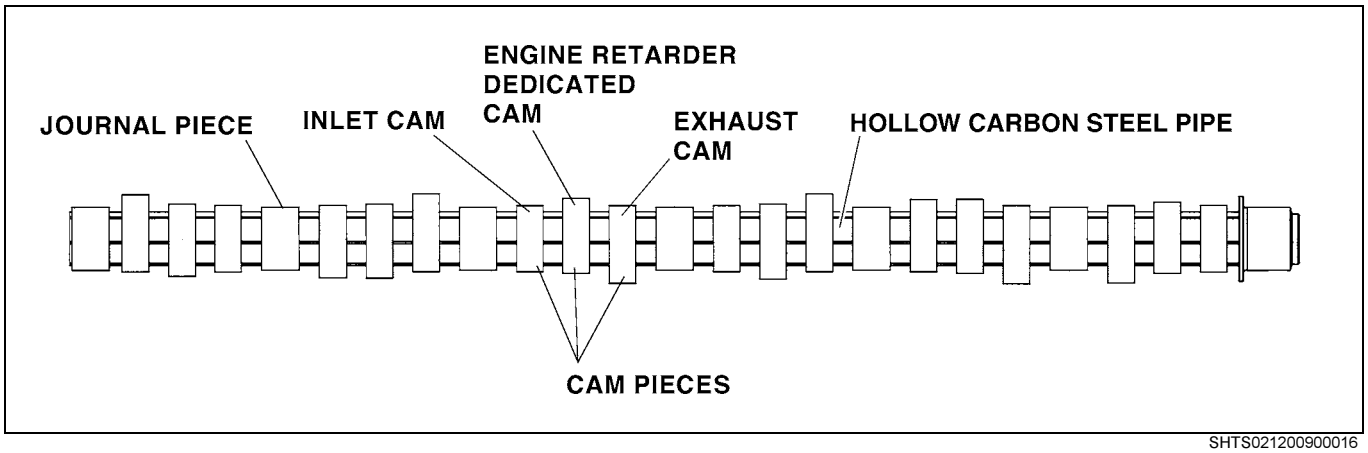
JP18117020301025

VALVE SYSTEM

- The overhead camshaft type valve system reduces the weight of valve train mechanism and increases the rigidity.
- The camshaft is installed on the cylinder head. Rotations of the crankshaft gear are transmitted to a camshaft gear via timing gear to drive a camshaft.
- The valve is opened or closed via roller rocker arm.

CAMSHAFT

- The assembled type of camshaft is installed. Cam pieces and journal pieces are inserted into a hollow carbon steel pipe. The sintering-diffusion bonding method is used for cam pieces and first to sixth journal pieces, and the copper soldering method is used for seventh journal.
- The special profile of a cam is expected to achieve noiseless operations and increase the intake efficiency.
- Optimum valve lift and increased intake air improve the combustion efficiency.



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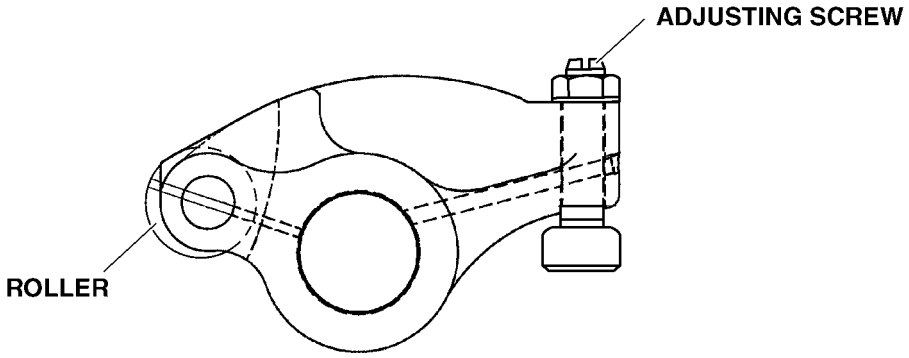
ROCKER ARM

- The rocker arms for exhaust system and engine retarder are respectively made of special steel. The roll bushings are press-fit in the area exposed to sliding motions of a shaft. All rocker arms installed are of roller type (roller rocker arm) to increase the fuel efficiency and reliability.
- The rocker arm for engine retarder is lifted by a spring force. This prevents fluttering when the engine retarder is inactive.
- The adjusting screw made of special steel is precisely threaded and ensures accurate adjustment of a valve clearance.
- An appropriate amount of lubricant is supplied through properly preset oil grooves and hole clearances in the rocker arm bushings. This lubrication increases the wear resistance of a contact surface of the crosshead camshaft valve, etc.



(EXAMPLE) ROCKER ARM FOR INTAKE

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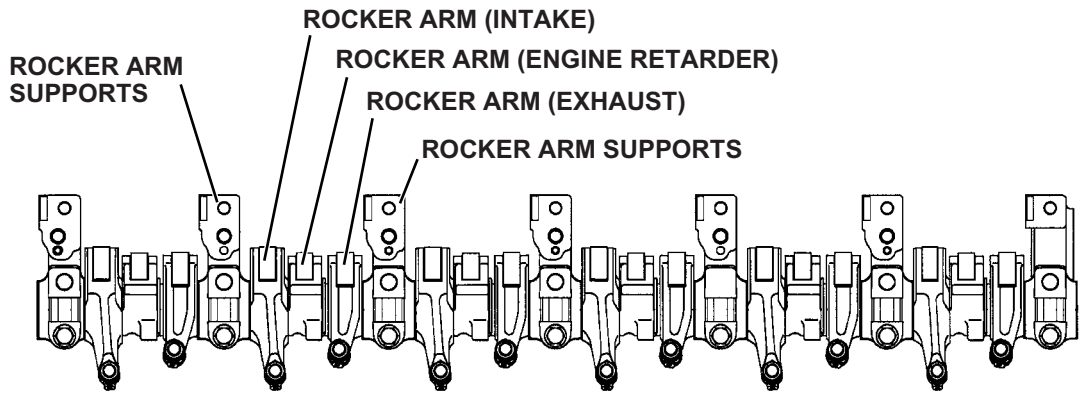
ROCKER ARM ASSEMBLY

- The rocker arm assembly consists of a rocker arm shaft and rocker arms, rocker arm supports and collars.
- The rocker arm dedicated for engine retarder is installed for each cylinder position.



(EXAMPLE) 6-CYLINDER RETARDER

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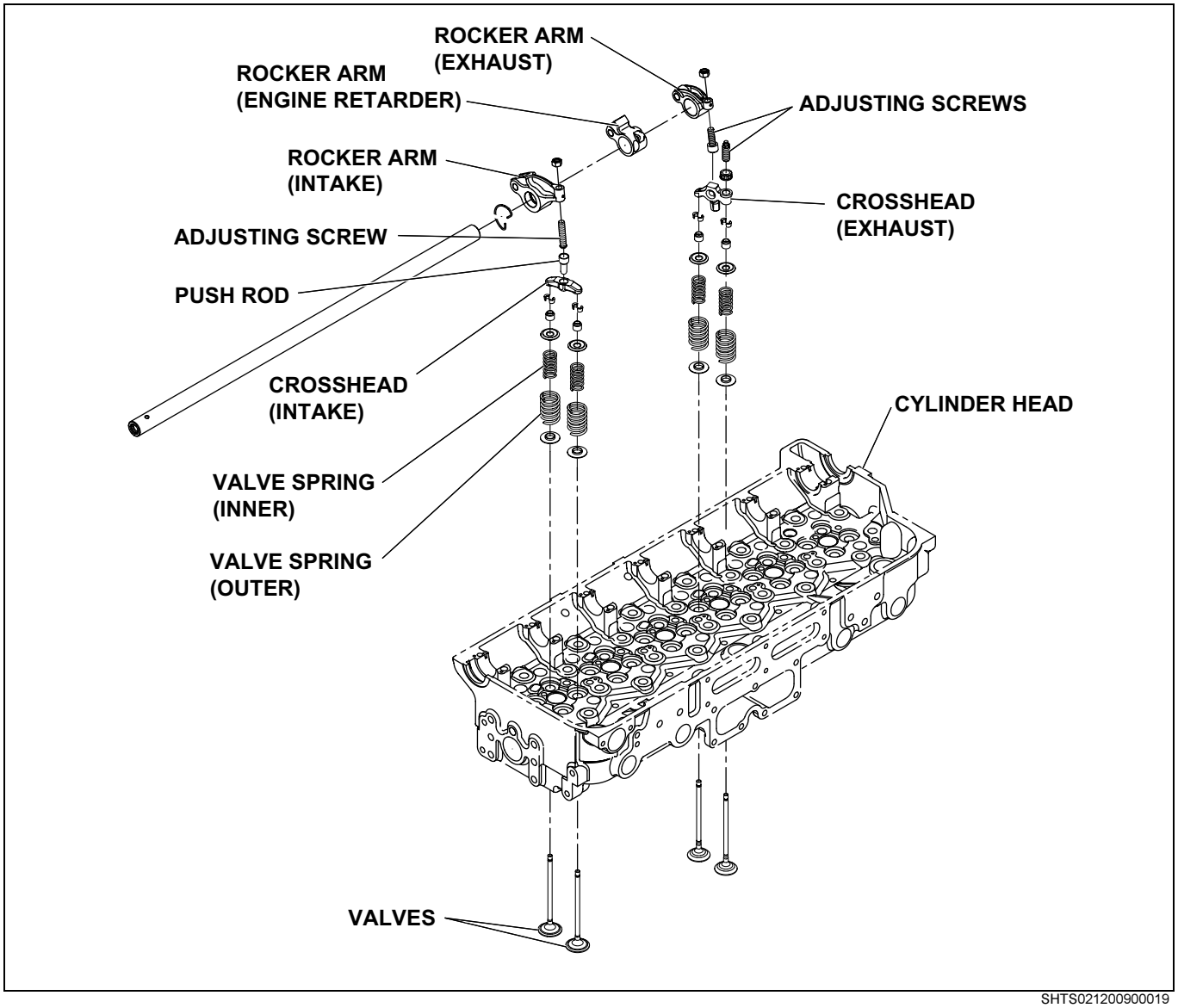
CROSSHEAD

- The intake crosshead is made of special steel. A whole periphery is carburized and quenched to increase the wear resistance.
- The exhaust crosshead is made of special steel. The contact surfaces with a rocker arm and a valve are high-frequency-hardened to increase the wear resistance. The exhaust crosshead moves along a guide pin. Adjusting screws are installed on the valve side to adjust a variance in height between two valves.



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VALVE AND VALVE SPRING

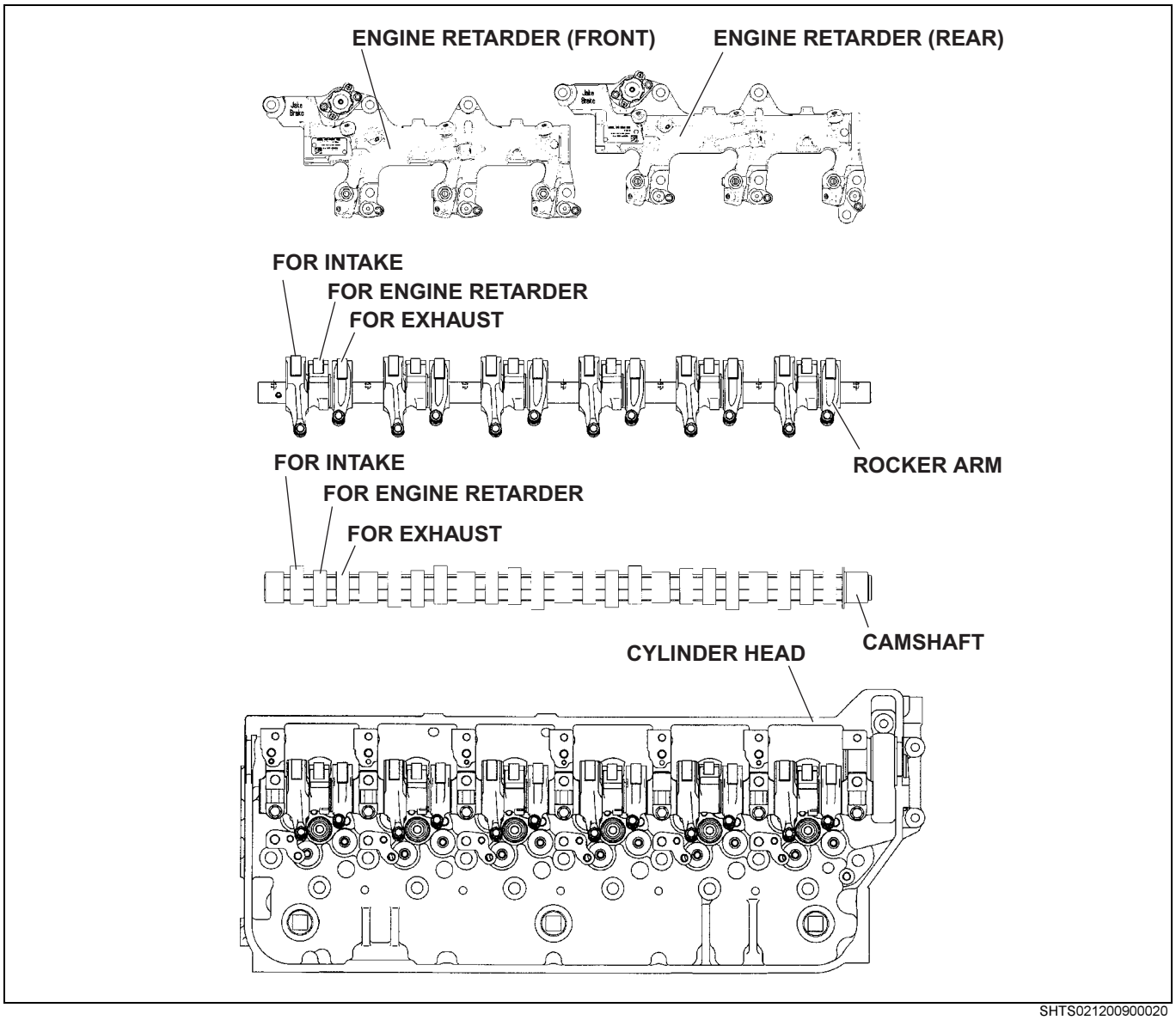
- The shape and material differ between the intake valve and the exhaust valve.
- The top end of the valve guide has stem seal to prevent oil leakage into a combustion chamber via valve guide.
- The constant-pitch springs are used as an outer and an inner valve springs. Both intake and exhaust valves use the same spring.

ENGINE RETARDER

SUMMARY

JP18118020301030

- The engine retarder is a device designed to increase an engine braking force.
- The engine retarder opens the exhaust valve in proximity to the top dead center of combustion to release compressed air and decrease a pressure within the cylinder. As a result, the energy for lowering a piston is decreased in the next expansion stroke, which increases an engine braking force.
- This device is located on the top of the valve mechanism in the engine unit as shown in the figure below. The engine retarder is hydraulically operated by oil pressure of the lubrication system in the engine unit.
- One unit of engine retarder handles three cylinders. Two variations are available: i.e. 3-cylinder retardation type having only one unit; and 6-cylinder retardation type having two units.



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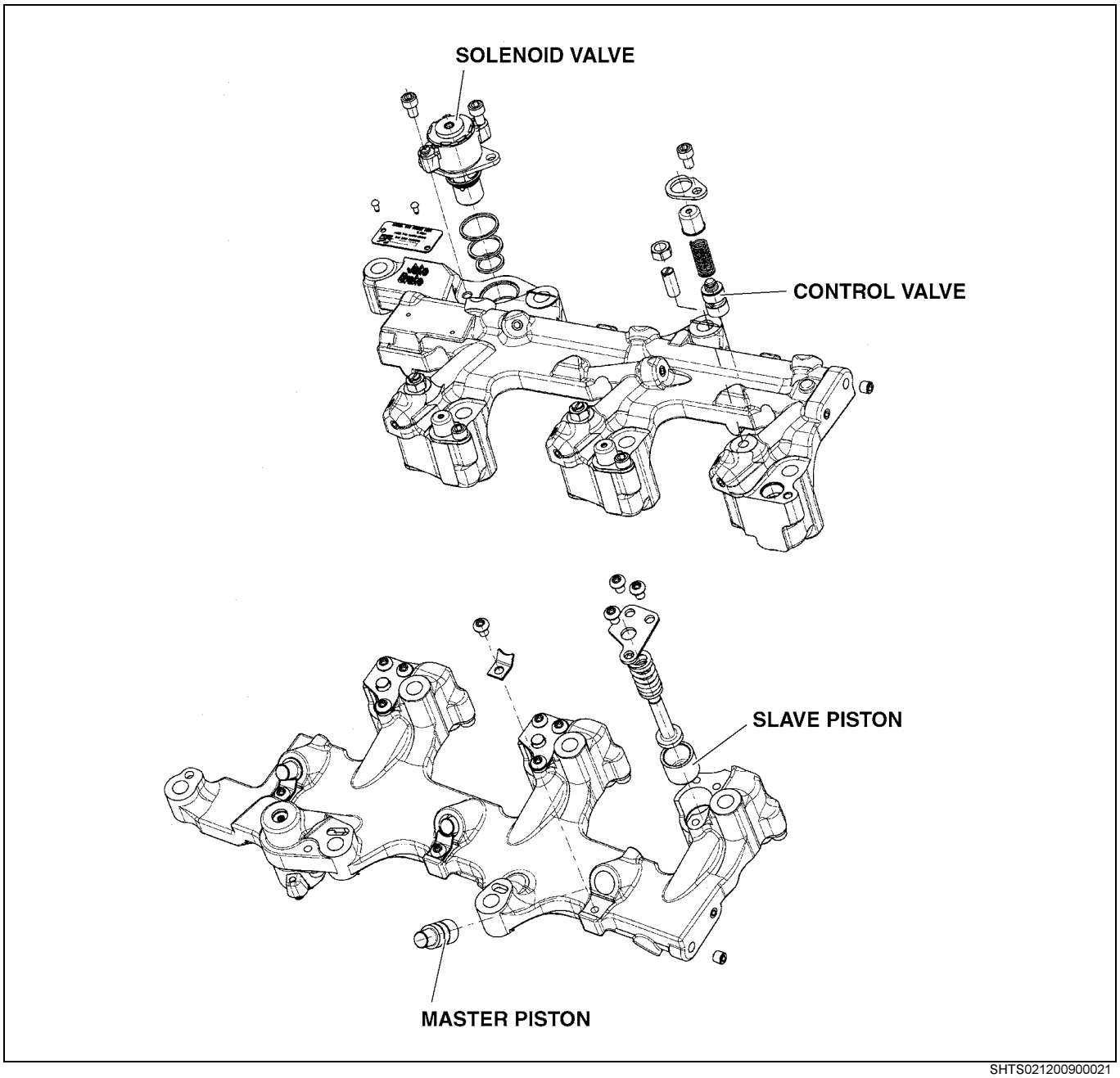
STRUCTURE

JP18118020301031

- The engine retarder consists of a retarder unit installed on the top of the valve mechanism in the head cover, cams for engine retarder on the camshaft, and the engine ECU that control the aforesaid components.
- The retarder unit consists of a solenoid valve that turns the engine oil pressure on and off; a control valve that opens and closes the oil circuit; a master piston that pushes a piston by means of cam operations; and a slave piston that hydraulically pushes the exhaust valve.



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OPERATION

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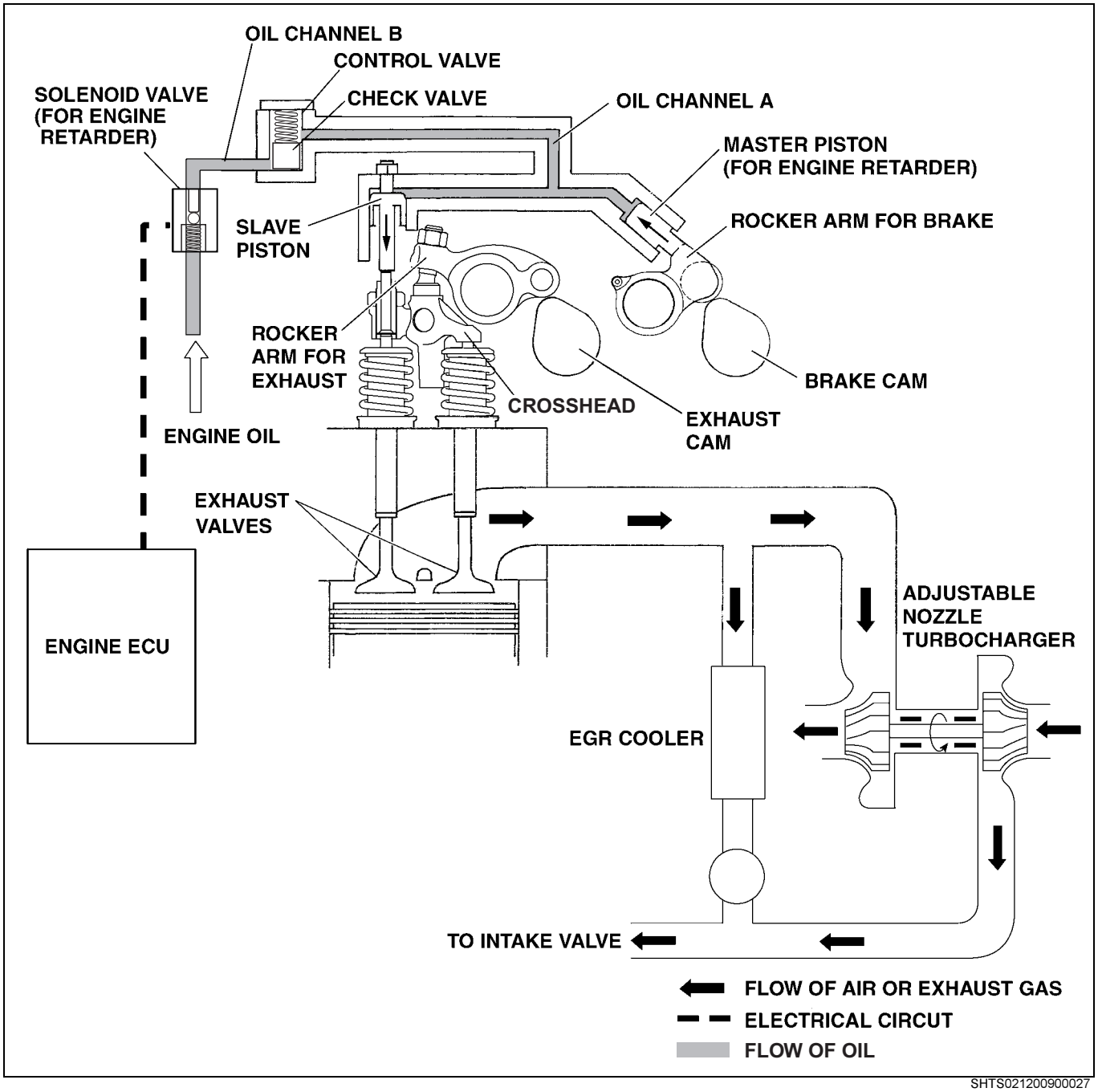
- An electrical signal from the engine ECU opens the solenoid valve on the engine retarder side.
- An oil pressure from the engine pushes a control valve and a check valve inside the control valve to supply engine oil to the oil channel A between a master piston and a slave piston.
- The master piston is usually kept in its upward position by spring force. A pressure of engine oil supply pushes a master piston until the brake rocker arm contacts the brake cam.
- In proximity to the top dead center of combustion, the master piston is lifted by a brake cam via the brake rocker arm and sends oil back in the oil channel A.
- When a pressure in the check valve inside the control valve on the oil channel A side is higher than the oil channel B side (engine oil pressure), the check valve will close the oil channel and produce an oil pressure.
- An increase of this oil pressure pushes down a slave piston to open the exhaust valve.
- When the exhaust valve is opened, compressed air will be released and a force will no longer push the piston. A braking force gained in the compression stroke can be effectively utilized without any losses.



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GEAR TRAIN

SUMMARY

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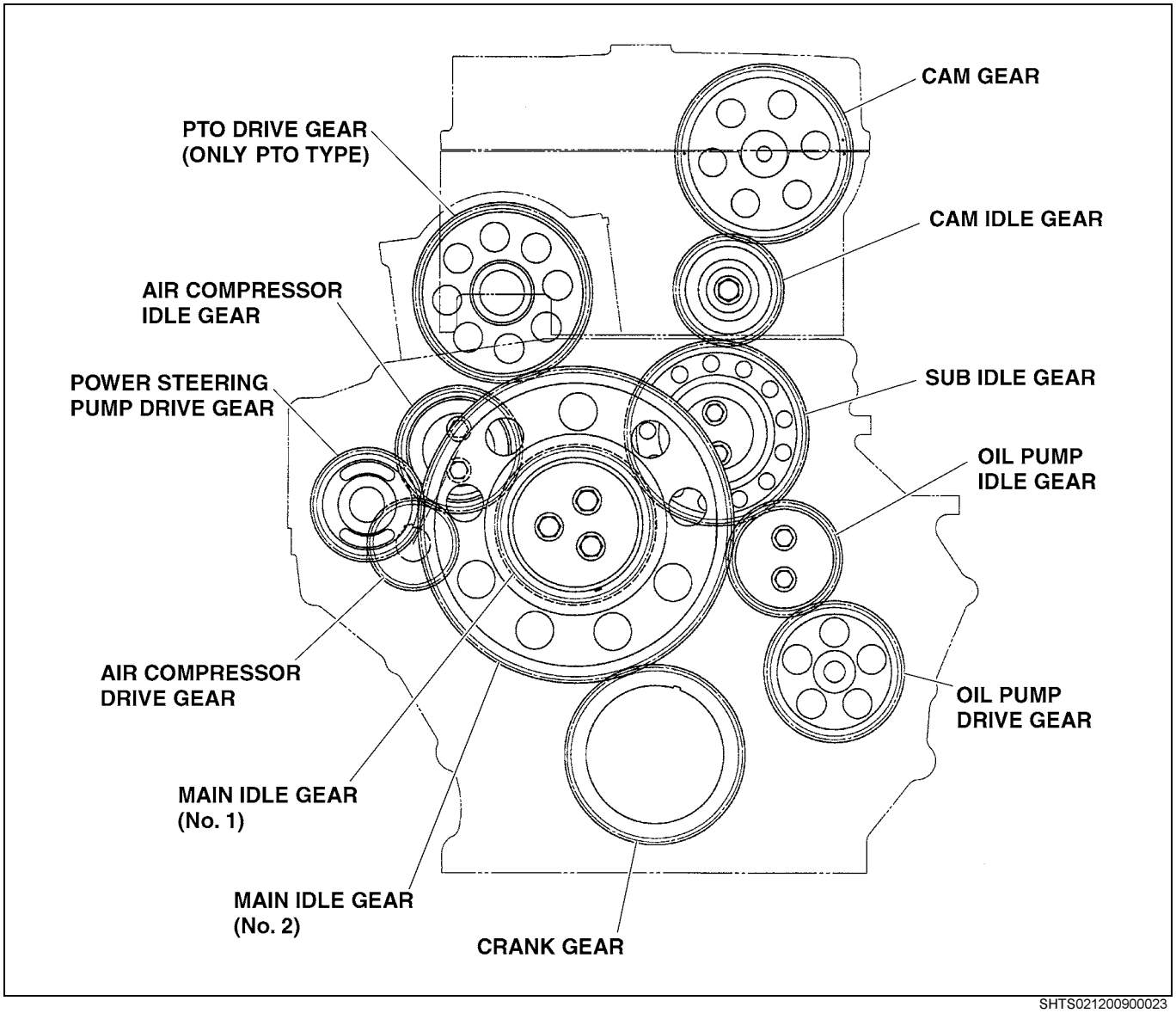
- The timing gear case is located between the rear end of a cylinder block and the flywheel housing. Laying out the timing gear case in the rearward location exposed to less torsional vibration increases the service life and reduces the gear rattling noise in sync with a helical gear of the timing gear.
- The injection pump drive gear is laid out at the front end of a cylinder block.
- The PTO (power take-off) is installed in the form that the main idle gear No.2 will engage with the PTO drive gear. The engine length remains unchanged after installation of the PTO. The PTO is oiled from external piping in order to increase the reliability.
- The PTO output shaft rotates counterclockwise as viewed from the rear side of the engine. The ratio of a rotational speed of the PTO output shaft to an engine speed is 1 to 1.



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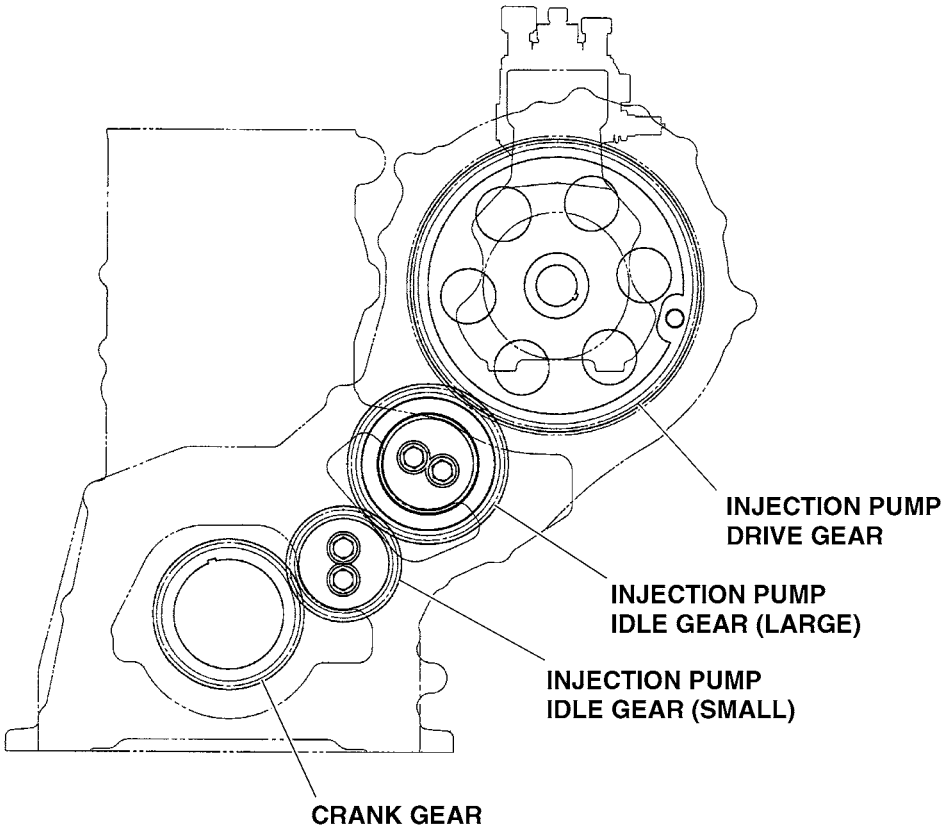


INJECTION PUMP (DRIVE GEAR SIDE)

SHTS021200900024

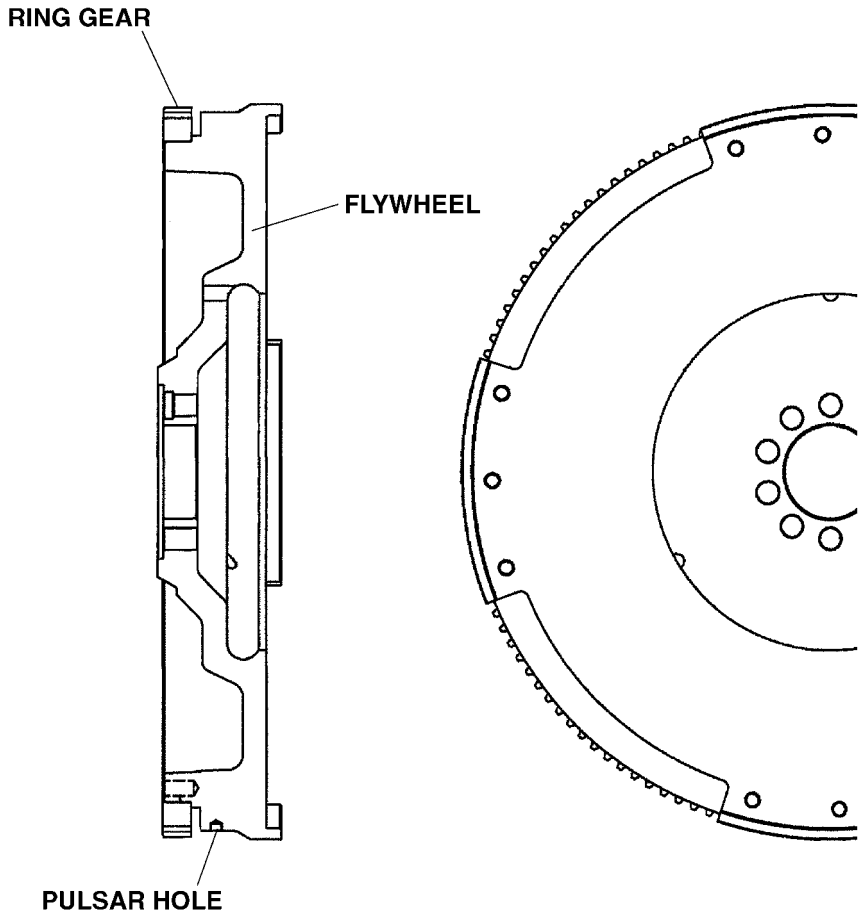
FLYWHEEL AND FLYWHEEL HOUSING

STRUCTURE

JP18117020301027

FLYWHEEL

- The flywheel is designed to transmit mechanical power from the crankshaft to the clutch and average out a rotational force varied by combustion in every two rotations of the crankshaft.
- When a rotational force of the crankshaft is increased by the combustion stroke, the flywheel will absorb such energy. When a rational force of the crankshaft is decreased by the strokes other than combustion stroke, inertia energy of the flywheel will keep the rotations and minimize a fluctuation in rotational speed of the crankshaft to maintain smooth rotations.
- The flywheel installed is made of alloy cast iron.
- To meet the common rail fuel injection system, fifty eight pulsar holes (diameter: 7 mm {0.27 in.}) for engine rotation sensor are located on the outer circumference of the flywheel.



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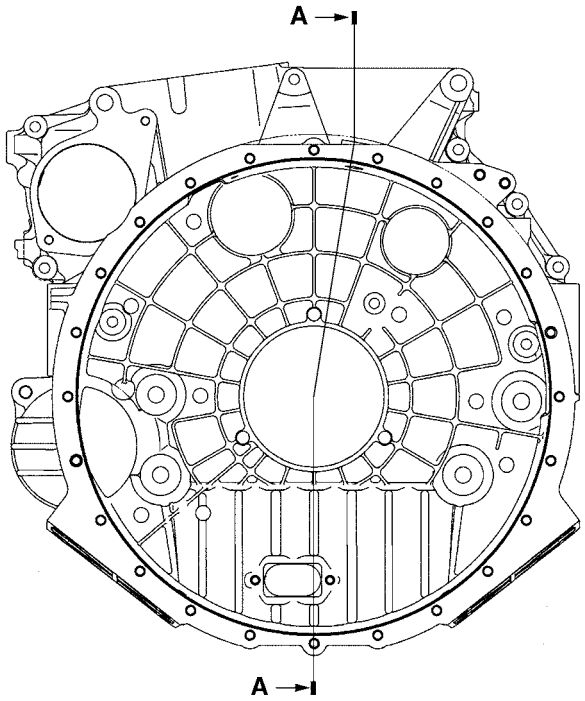
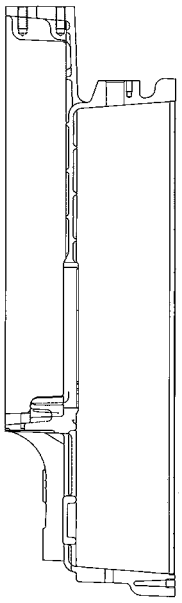
FLYWHEEL HOUSING

- The flywheel housing is installed at the rear end of a cylinder block.
- The flywheel housing is made of aluminum die-cast and is used both as a flywheel housing and as a timing gear case. This reduces an overall engine length.





SECTION A-A

SHTS021200900026

[A09C] EXHAUST SYSTEM

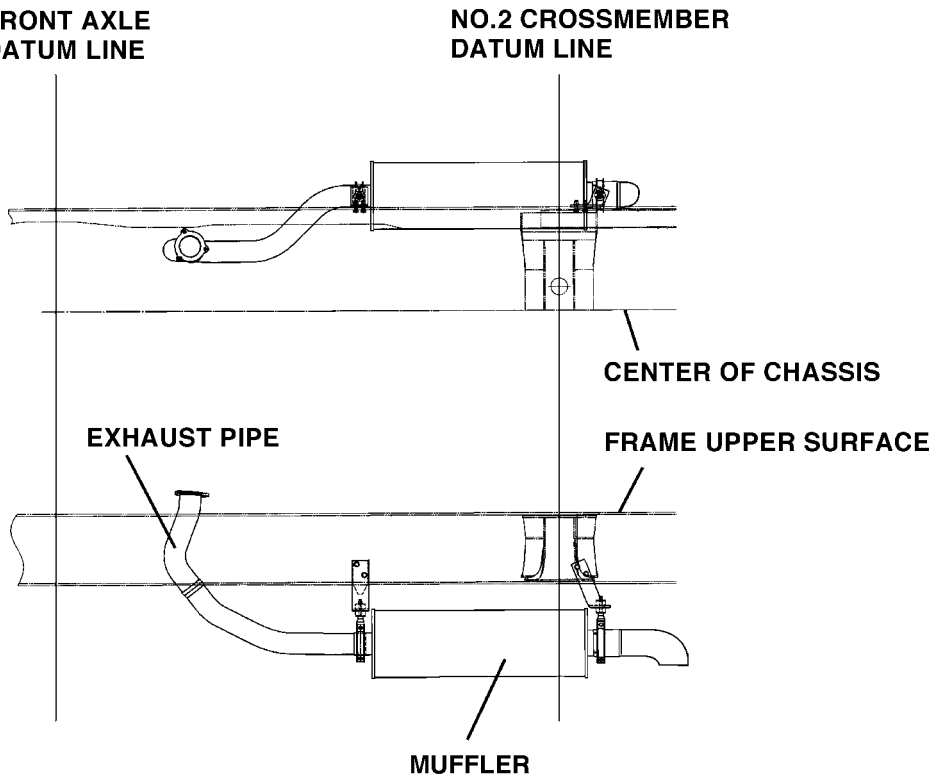
EXHAUST PIPE AND MUFFLER

SUMMARY

JP18117020301028

- The exhaust system consists of an exhaust pipe, a muffler and a tail pipe.

(EXAMPLE) SHORT TAIL TYPE



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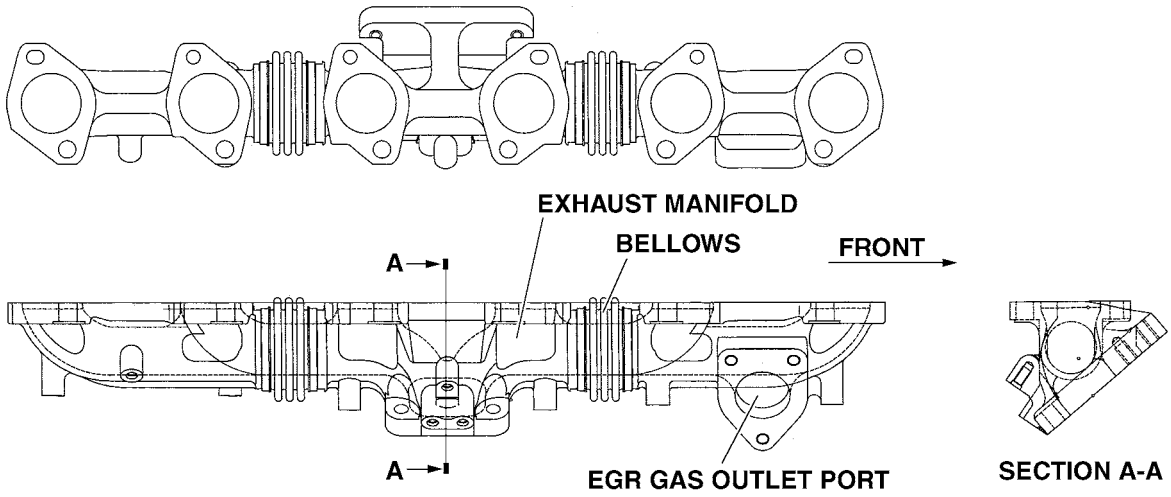
EXHAUST MANIFOLD

STRUCTURE

JP18117020301029

- The split type exhaust manifold has high durability as it is made of cast iron containing special compositions.
- The stainless steel gasket (steel plate) is attached to the flange surface to increase the gas sealing performance.
- The emission gas outlet port is formed for the EGR.



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[A09C] COOLING SYSTEM

COOLING SYSTEM

SPECIFICATION

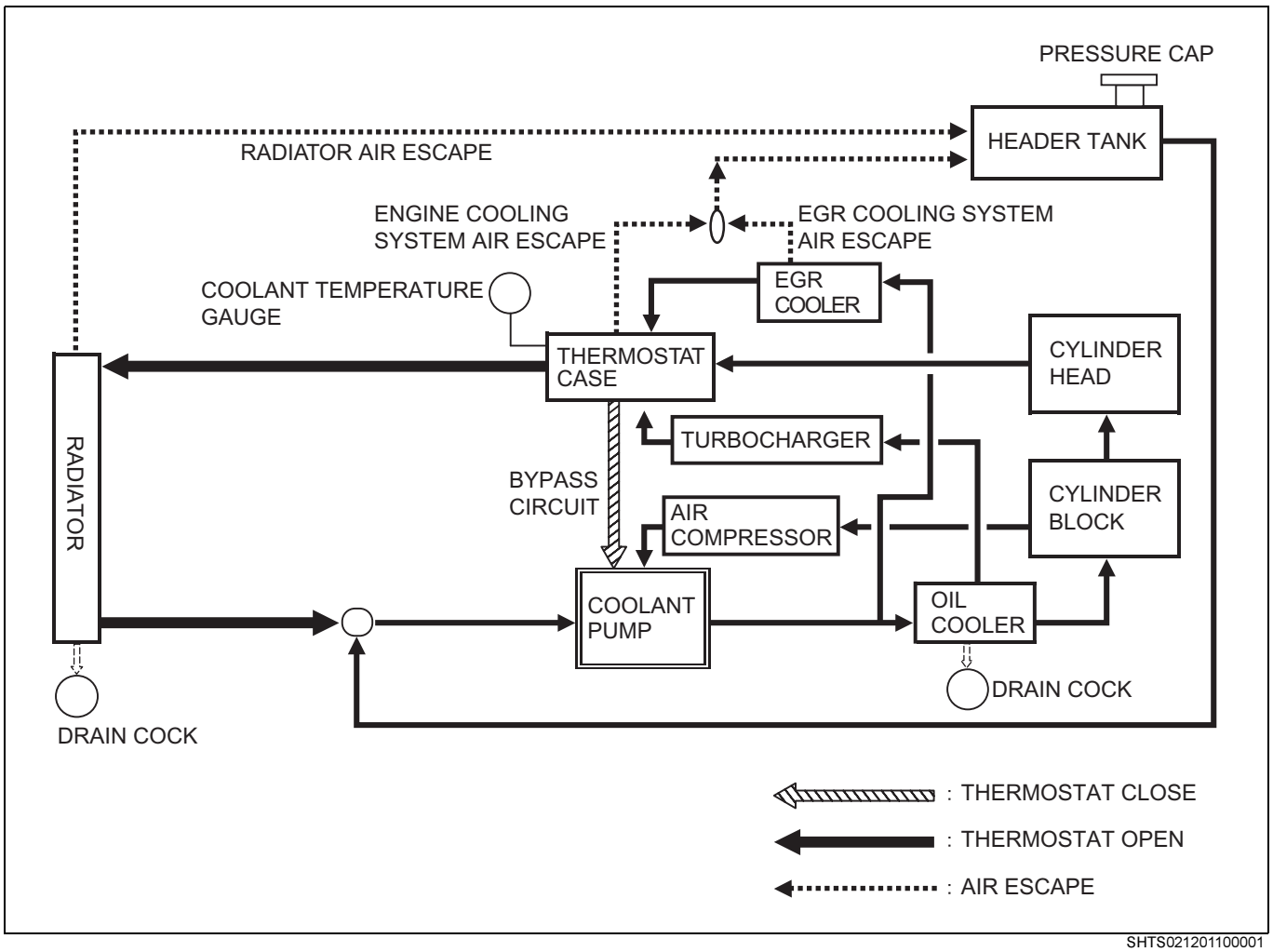
JP181170202010O4

Cooling method	Water cooling; force-feed circulation of coolant pump
Coolant pump	Centrifugal; belt drive
Thermostat	Wax type; bottom bypass type; valve opening temperature at 82°C {180°F}
Cooling fan	Resin; with fan clutch
Total coolant volume	30.0 L {6.60 UK.gal, 7.93 US.gal}

SUMMARY

JP18Z01020301038

- The engine is cooled by water cooling. The coolant pump force-feeds and circulates the coolant.
- The coolant cooled by the cooling fan in the radiator core flows into the coolant pump via a hose from the bottom of the radiator.
- The coolant discharged from the coolant pump flows into the oil cooler, cools each cylinder liner in the form of heat exchange and then flows up to the cylinder head.
- Some portion of coolant is delivered to a new EGR cooler, then cools the EGR gas and flows back to the thermostat case.
- In the cylinder head, the coolant flows through a water channel in the cylinder head, then goes through a thermostat and flows back to the radiator, after cooling the ports and between the valves.
- The abovementioned process is seen when a coolant temperature reaches is the thermostat valve opening temperature of 82°C {180°F} or higher. When a coolant temperature is below 82°C {180°F} and the thermostat valve is in its closed position (for example, immediately after engine startup), the coolant will bypass the radiator and will be directly delivered to the coolant pump and circulated within the engine. This prevents overcooling of the engine.



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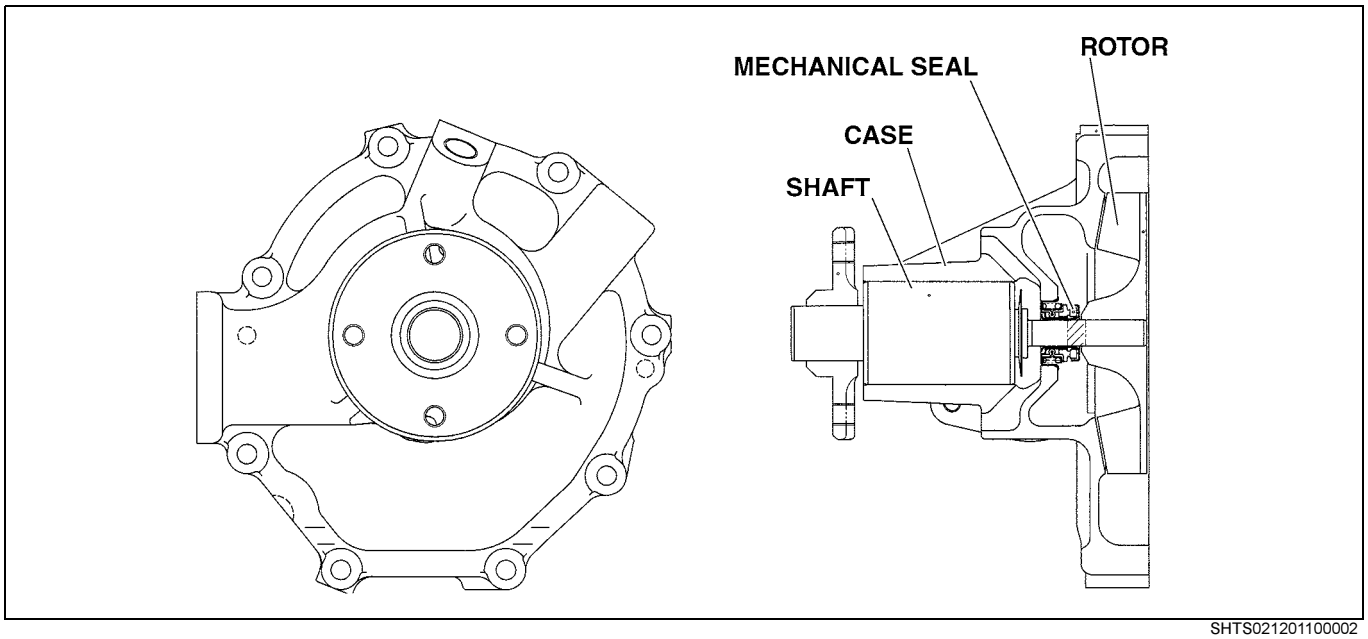
STRUCTURE

JP181170203010 32

COOLANT PUMP

- The coolant pump is installed at the front end of the cylinder block and is driven by the V-ribbed belt.
- The coolant leakage from the coolant pump is sealed off by the coolant seals mounted to the case and vanes. The coolant leakage is prevented by watertight contacts with the ceramic plate on the vane side and with the special carbon plate on the case side.



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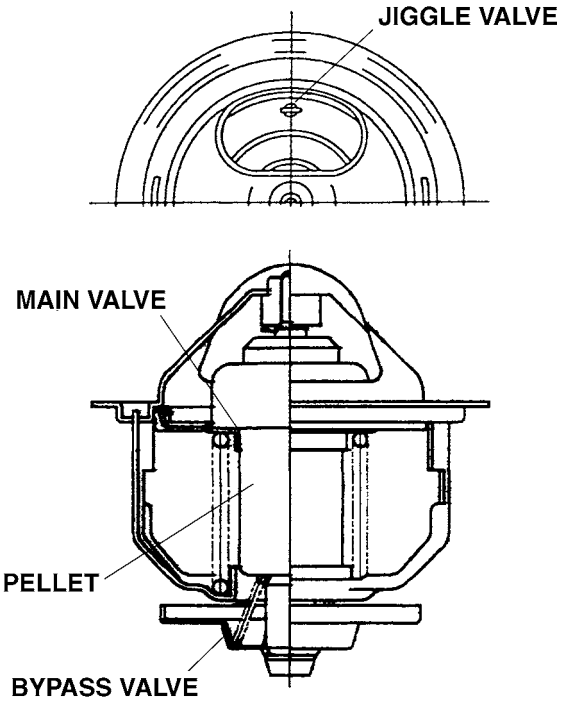
THERMOSTAT

- The wax type thermostat is installed. The special wax is enclosed in the pellet. When a coolant temperature reaches 82°C {180°F}, the wax in the pellet will start liquefying and expanding and the thermostat will open. The thermostat will be fully opened at a coolant temperature of 95°C {203°F}.
- After the thermostat is opened, a water channel from the radiator will be opened and the coolant will flow into the radiator for cooling.
- When a coolant temperature is below 82°C {180°F}, the coolant will flow through the bypassed circuit to the engine side (coolant pump.)
- The bottom bypass system is employed to increase the cooling performance. In addition, a jiggle valve is installed to have good warm-up characteristic.



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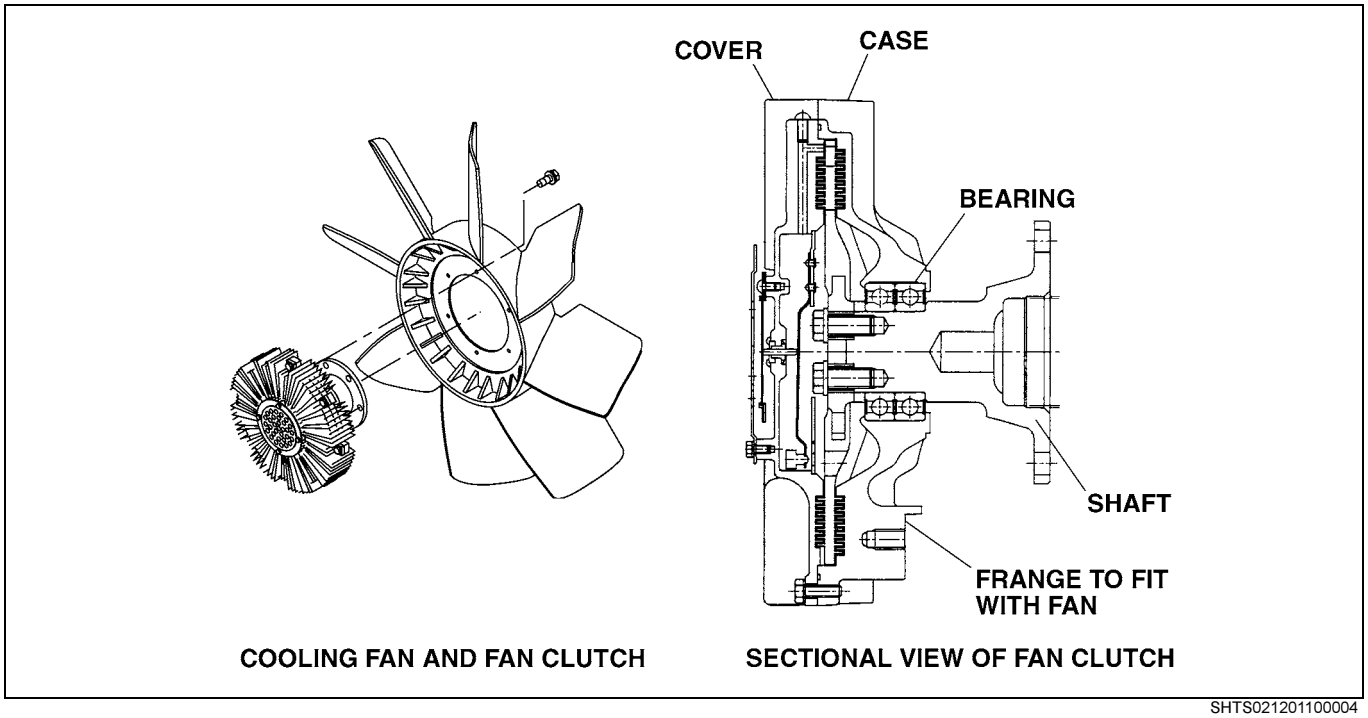
COOLING FAN

- The 8-vane nylon fan (glass-fibered nylon) is installed at the end of the crankshaft via a fan clutch.



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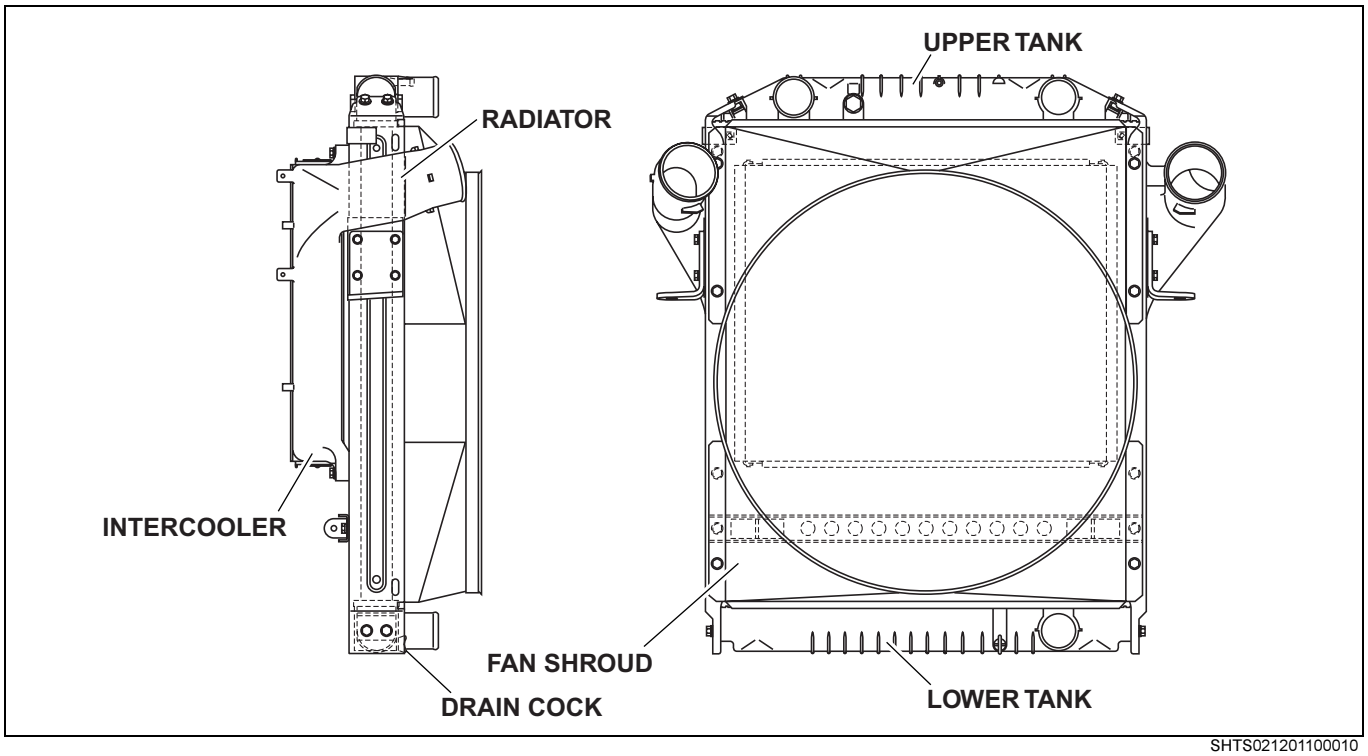
RADIATOR UNIT

- The pressure type radiator unit is installed and consists of a corrugated fin type radiator core, an upper tank and a lower tank.
- The upper tank and the lower tank are made of resin and are clinched to the core plate via O-ring.
- When the radiator coolant decreases, the coolant will be automatically refilled from a header tank.



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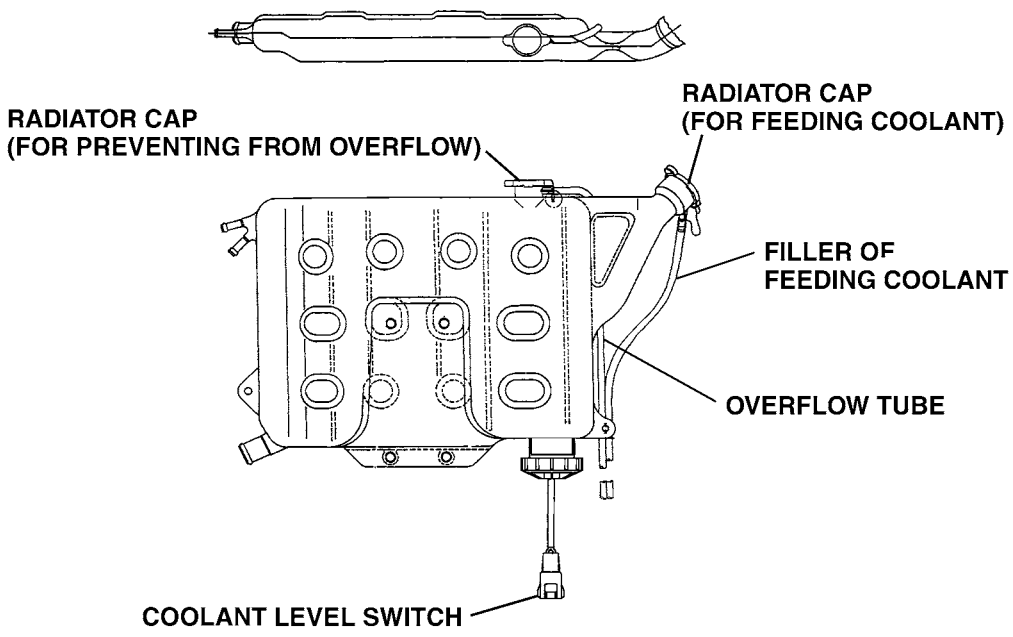
DRAIN COCK

- The drain cocks are installed to the lower tank and the engine unit.

HEADER TANK

- Header tank is installed on the upper part of rear arch, located at RH side of vehicle. Radiator caps with different types of injection-valve opening pressure, one at the upper part of header tank and another one at the filler of feeding coolant, are installed. And by securing expanded space in header tank due to a difference in injection-valve opening pressure, overflow of coolant into other part than the system can be prevented in structure wise.



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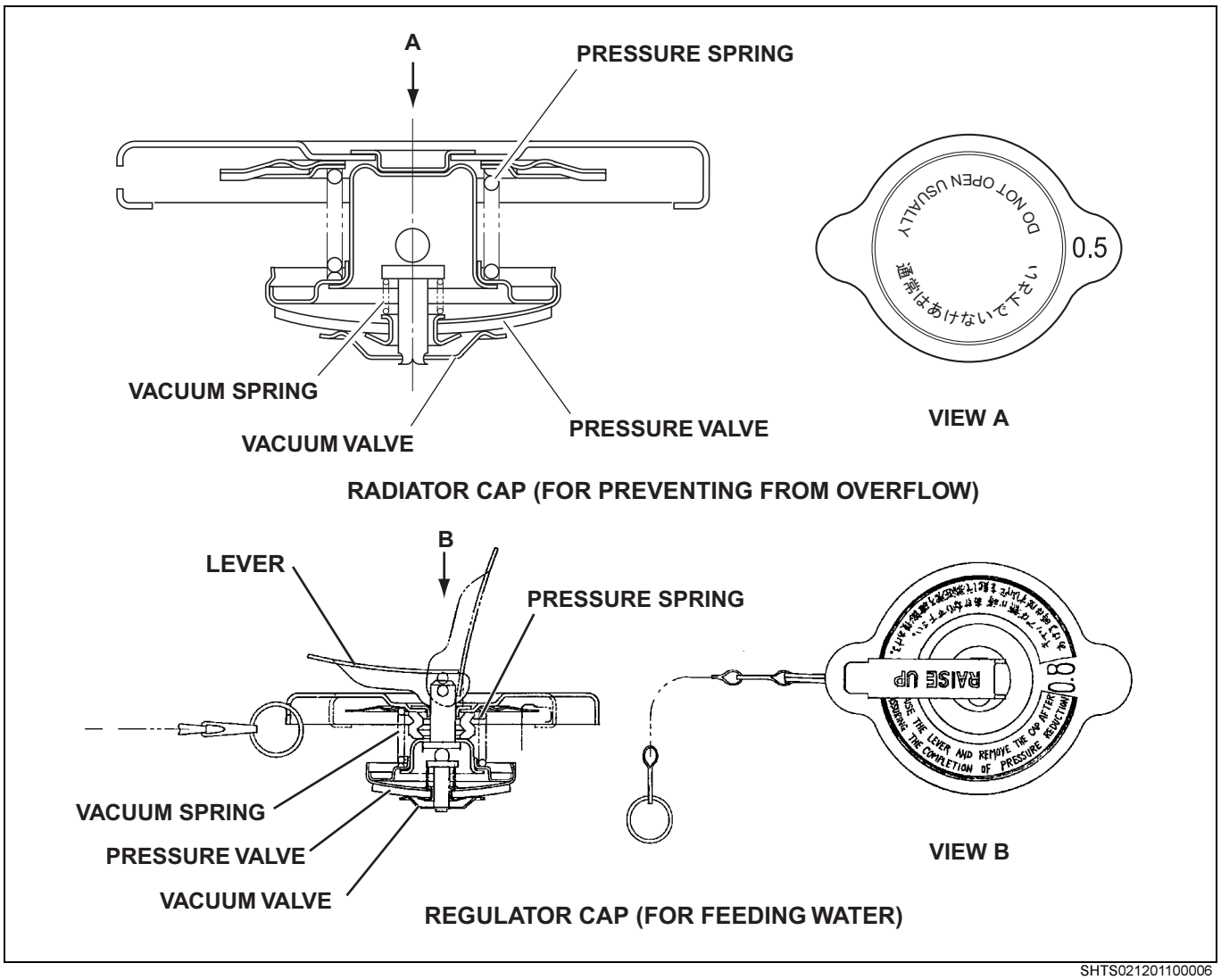
RADIATOR CAP

- The structure is that, due to installation of radiator caps which are different in injection-valve opening pressure and securing an expanded space in header tank with a difference in injection-valve opening pressure when feeding coolant, overflow of coolant can be prevented.
- In these radiator caps, pressure valve and vacuum valve are built-in respectively.
  1. PRESSURE VALVE
     - Pressure valve, by increasing pressure in cooling device [Atmospheric pressure +50 kPa {0.5 kgf/cm^2, 7.2 lbf/in.^{2}}], will raise boiling point of coolant [106°C {223°F}: in case of water, 117°C {243°F}: in case of LLC 30%, 121°C {250°F}: in case of LLC 50%] and will work to increase an efficiency and capacity of cooling system.
     - Pressure valve of radiator cap (for feeding coolant) will serve as a cap of feeding coolant and lever type pressure releasing mechanical contrivance is installed to prevent from hot water spout when removing the cap.
  2. VACUUM VALVE
     - Vacuum valve is built-in pressure valve and will work when inner pressure which became once high pressure becomes lower than ambient pressure due to temperature drop and will prevent air bubble from being generated by a drop of atmospheric pressure and also, from deterioration of cooling efficiency.
- It shall be used under pressure condition by turning fully radiator cap clock-wise.
- Radiator cap (for preventing the overflow) will not be necessary to be removed and be sealed to prevent from mistaking to feed coolant with a wire.



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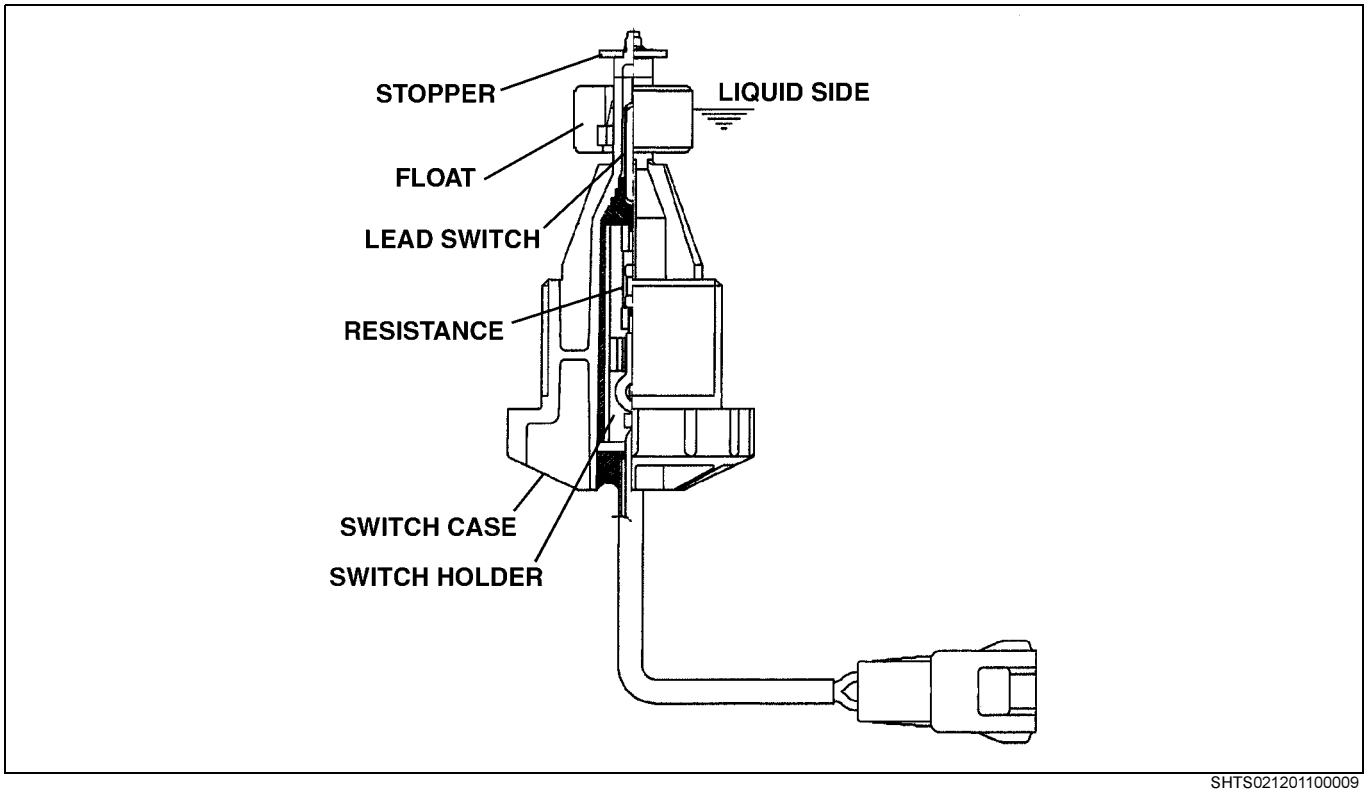
COOLANT LEVEL WARNING

- If a coolant level decreases to below the specified level during driving, the coolant level switch mounted to the header tank will trigger a buzzer to warn a driver of a decrease in the coolant level.



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[A09C] LUBRICATION SYSTEM

LUBRICATION SYSTEM

SPECIFICATION

JP18117020201005

Lubricating method	Pressure-feed of gear pump
Oil filter	Full-flow paper filter and bypass paper filter
Lubricant volume (L {UK.gal, US.gal})	Approximately 27.0 {5.94, 7.13} for oil pan; 1.7 {0.37, 0.45} for oil filter
Lubricant cooler	Multiplate water cooling

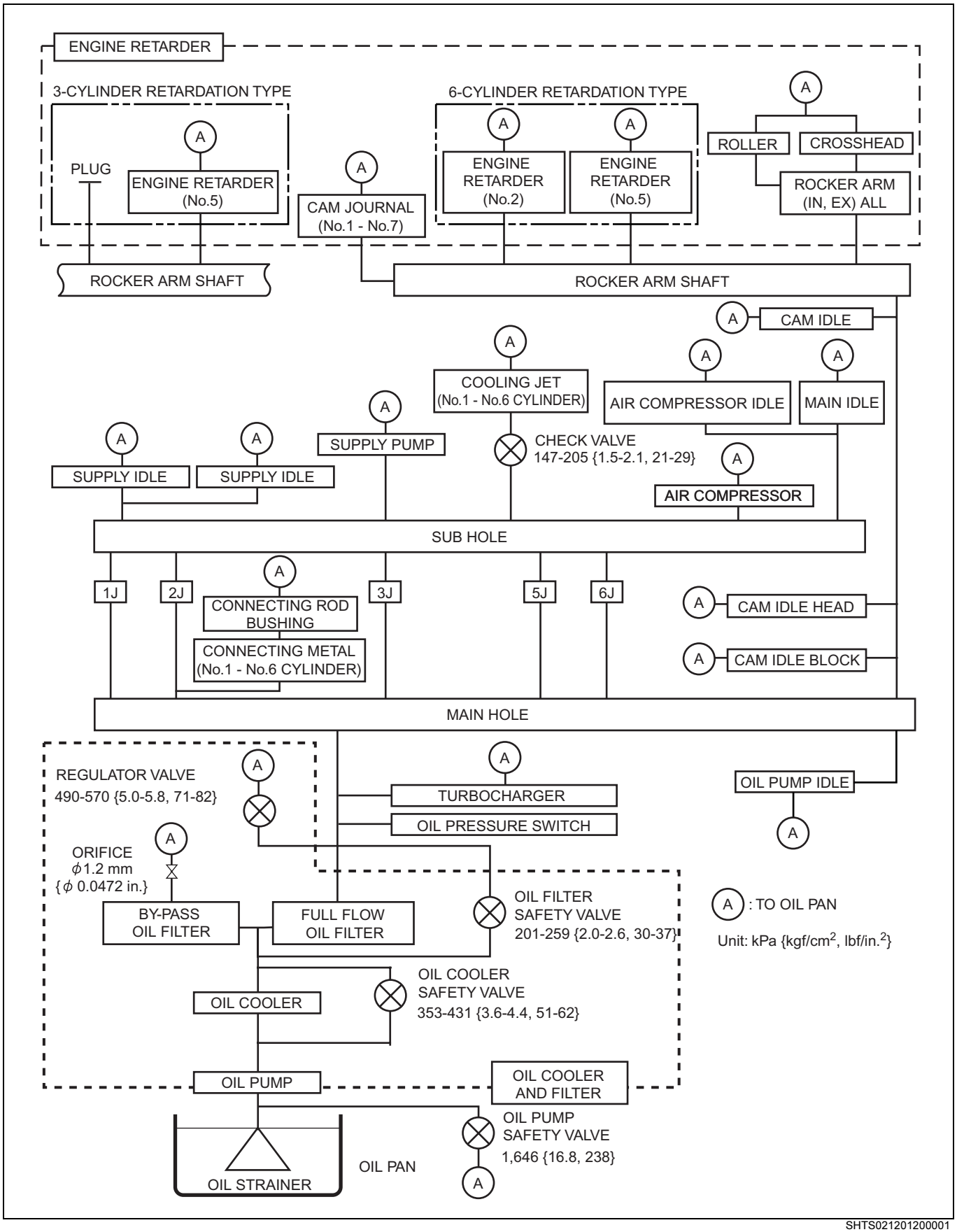
SUMMARY

JP18117020301038

- The oil in the oil pan is taken up through the strainer by the oil pump installed at the rear end of the cylinder block. Next, the oil goes through the oil cooler and undergoes heat exchange with coolant. Then, the oil is delivered to the main oil hole in the cylinder block after being filtered by the oil filer.
- After reaching the main oil hole, the oil will be delivered to and lubricate the crankshaft journal, camshaft and rocker arm shaft.
- After the oil lubricates each journal (main bearing) on the crankshaft, it will go through the oil hole in the crankshaft and reach the pin, then lubricate the large end of the connecting rod.
- In the meanwhile, some portion of the oil in each journal on the crankshaft reaches the sub oil hole and cools the piston from the piston cooling jet installed for each cylinder.
- The oil will branch off from the middle of an oil channel for the sub oil hole and lubricate the air compressor and the supply pump drive gear.
- The oil delivered to the rocker arm shaft will go through the oil hole in the rocker arm shaft and reach and lubricate each rocker arm bushing. The oil will be delivered from each rocker arm oil hole to the valves, rollers and roller pins and lubricate them.
- Some portion of oil delivered to the rocker arm shaft is utilized as hydraulic fluid for engine retarder and as lubricant for each journal on the camshaft.
- Each idle gear will be lubricated by the oil delivered from the main oil hole or sub oil hole.
- For adjusting an oil pressure in each area, the regulator valve will keep the maximum standard pressure at 530 ± 40 kPa {5.4 ± 0.4 kgf/cm^2, 76.9 ± 5.8 lbf/in.^{2}} If a pressure is high at a low temperature, the safety valve installed in the oil pump will start sending the oil back to the oil pan (valve opening pressure = 1,646 kPa {16.8 kgf/cm^2, 238.7 lbf/in.^{2}}).
- If the oil cooler and the oil filter are clogged, the safety valve installed in the middle will prevent insufficiency in oiling (valve opening pressure on the oil cooler side = 392 ± 39 kPa {4.0 ± 0.4 kgf/cm^2, 56.9 ± 5.6 lbf/in.^{2}}); valve opening pressure on the oil filter side = 230 ± 29 kPa {2.3 ± 0.3 kgf/cm^2, 33.3 ± 4.2 lbf/in.^{2}}).
- The pressure is taken by the oil pressure switch in the secondary side of the oil filter.
- Each piston cooling jet has a check valve (jet pressure = 176 kPa {1.8 kgf/cm^2, 25.5 lbf/in.^{2}}).

SYSTEM SCHEMATIC DIAGRAM

JP18Z01020301041



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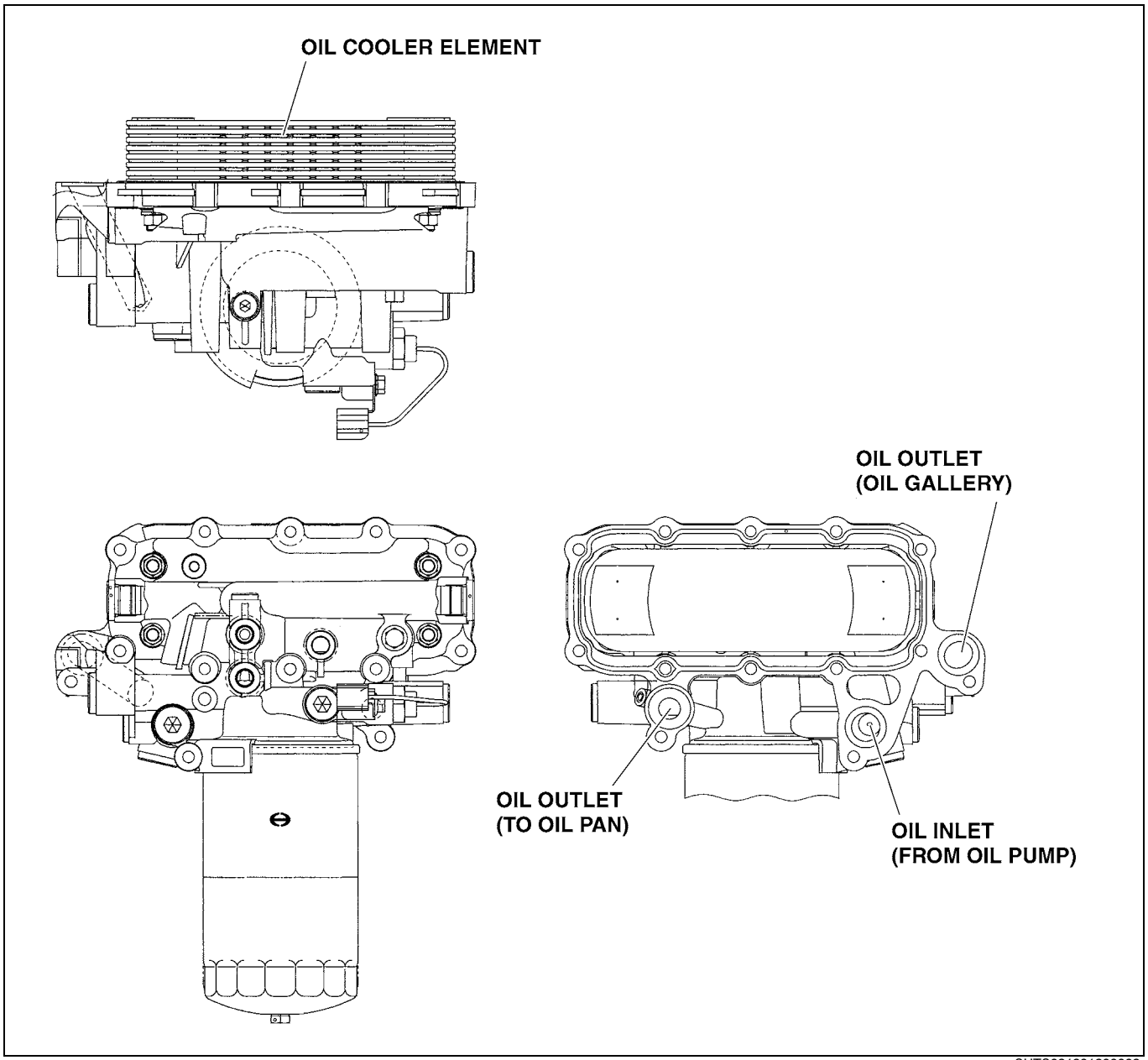
STRUCTURE

JP181170203010 39

OIL COOLER

- The oil cooler is of multiplate water-cooling type and is integrated with an oil filter. The oil cooler is designed to keep the oil supplied to each engine component at a proper temperature.
- The oil supplied from the oil pump goes through the inner side of the oil cooler, and the coolant cooled by the radiator goes through the outer side of the oil cooler. The oil cooler is designed to keep the oil at a proper temperature, to cool the oil when an oil temperature is high, and to warm the oil when an oil temperature is low.
- The safety valve is installed to bypass the oil cooler and deliver the oil supply directly to the oil filter. This prevents excessive pressure rise of the oil supplied from the oil pump if an oil temperature is low and the oil cooler passage resistance is high.
- The optimum number of rows of the oil cooler element increases the cooling efficiency and reduces the oil consumption.



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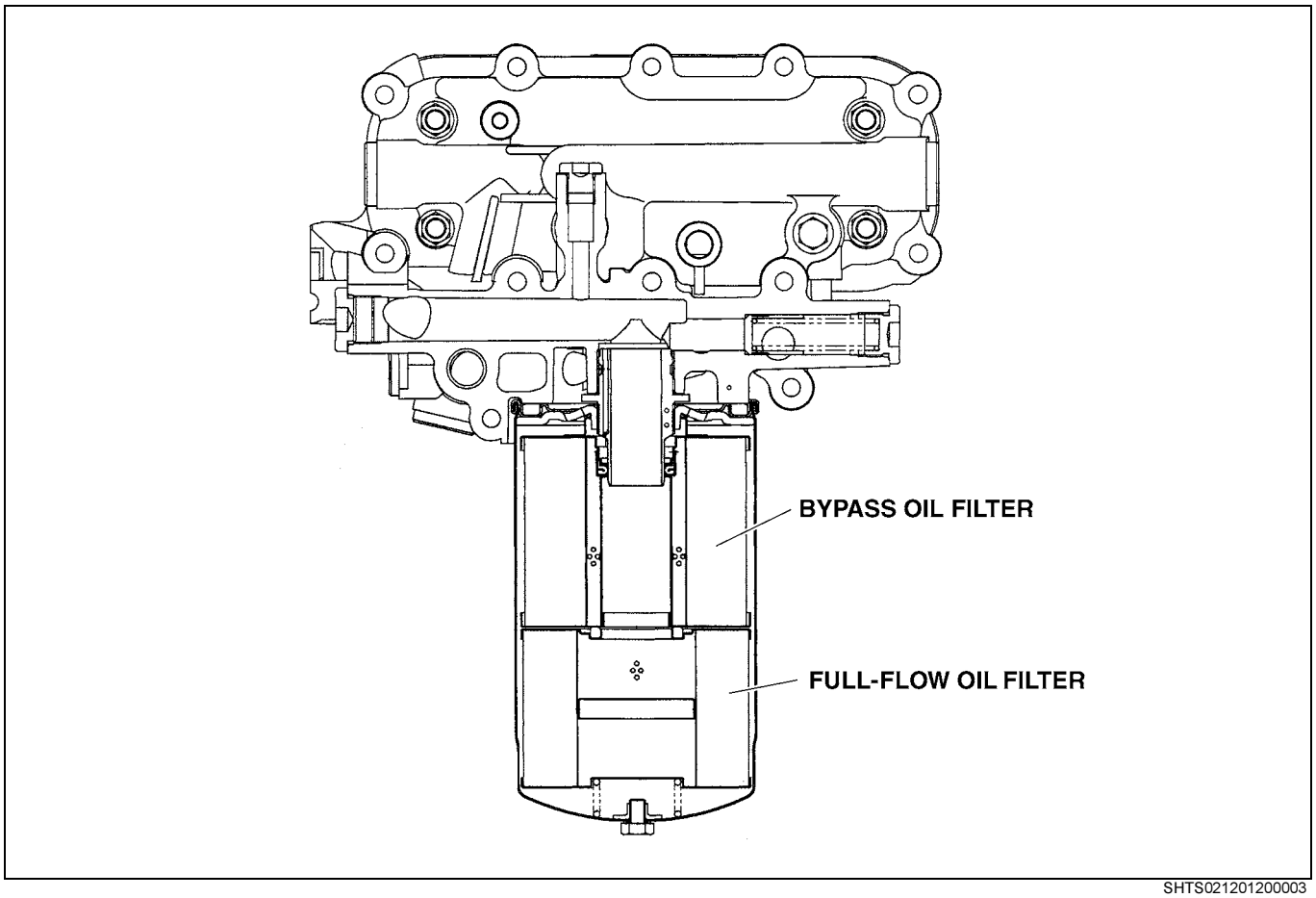
OIL FILTER

- As an oil filter, both a full-flow (paper filter) oil filter and a bypass (paper filter) oil filter are used.
- Some of oil flowing into the full-flow oil filter is filtered by the bypass oil filter and flows back to the oil pan.



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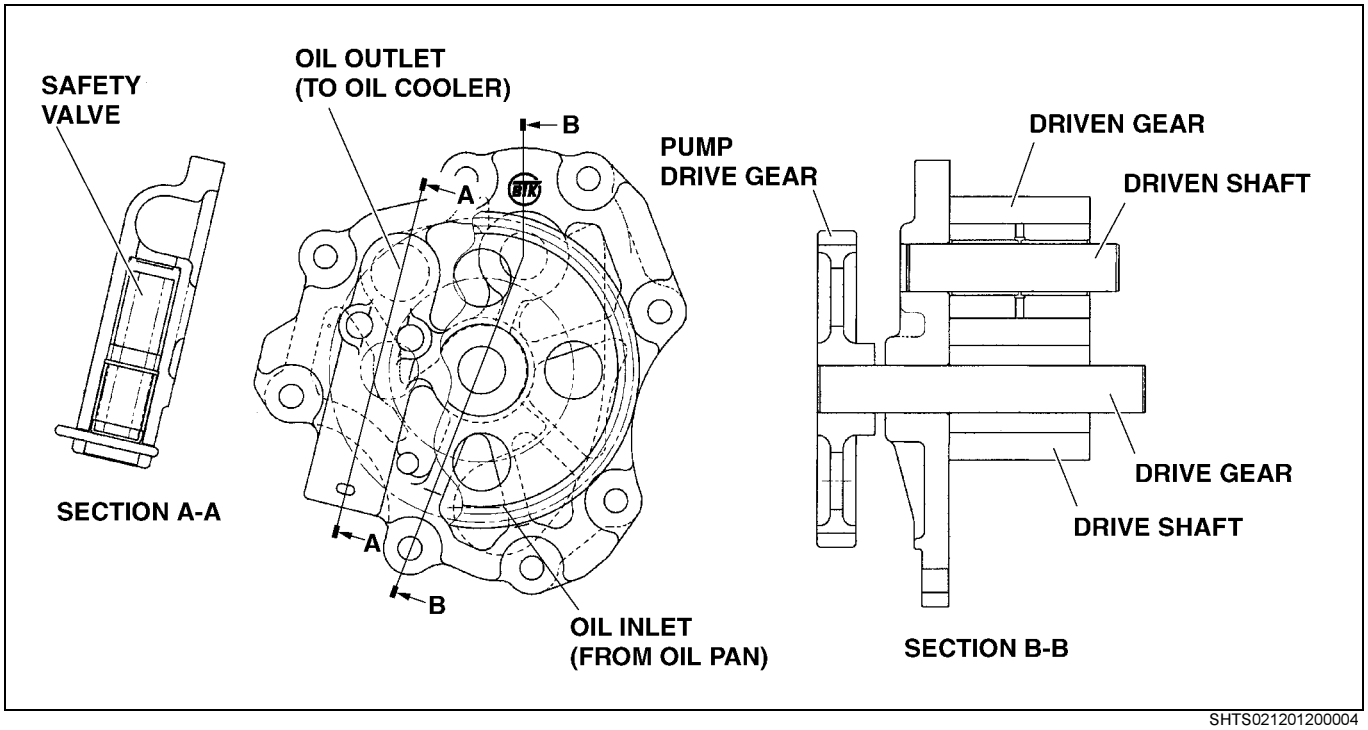
OIL PUMP

- The geared pump is installed as an oil pump. The oil pump is built in the rear wall of the cylinder block and is driven by the sub idle gear.



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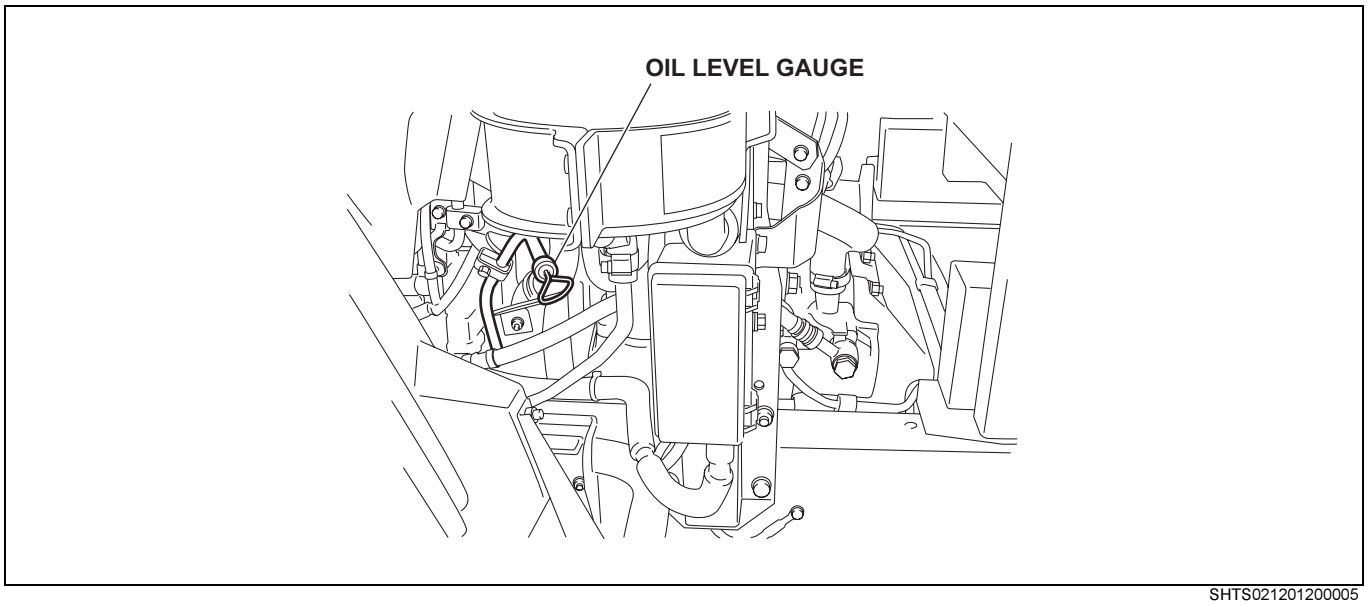
OIL LEVEL GAUGE

- The coil type oil level gauge is used so that a gauge can be attached/detached easily.



SHTS021201200005

[A09C] STARTING/CHARGING SYSTEM

STARTER

SPECIFICATION

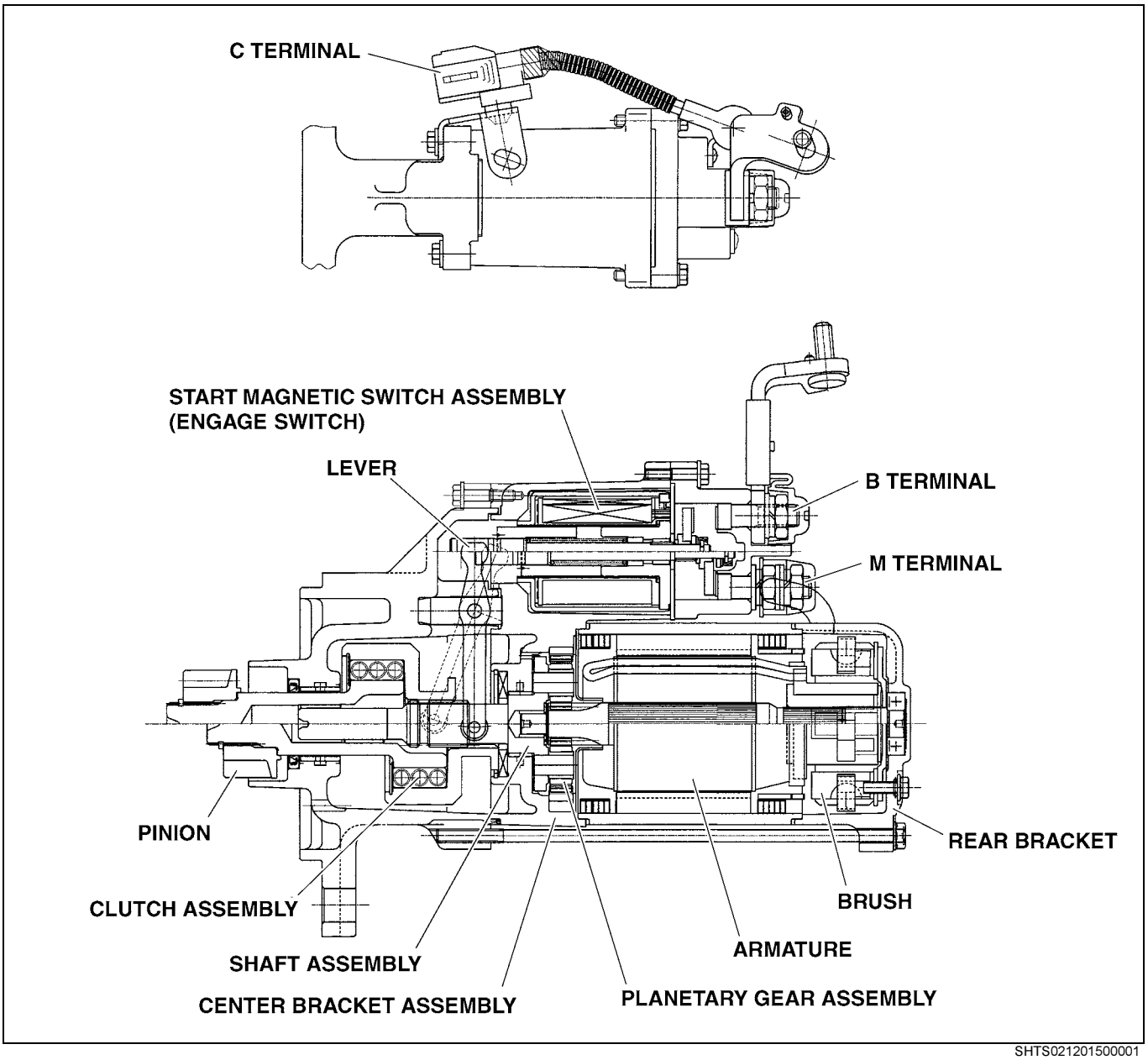
JP18117020201006

Power output	24V-6.0kW
Type of transfer	Magnetic pinion shift type
Pinion/ring gear number of teeth	11 teeth/137 teeth
Pinion travel	19.2 mm {0.76 in.}

SUMMARY

JP18117020301041

- The specification of 24 V, negative earth is standard for engine-related electrical systems.
- The 24 V- 6.0 kW, magnetic pinion shift type starter is installed and integrated with the main switch.
- This starter consists of a motor, a reduction gear, a pinion clutch and a start magnet, and is used in combination with a starter relay (accessory).
- The motor is a quadrupole, short-time rated, series-wound motor of high speed type. The armature is supported by individual bearings of a gear housing and a commutator end frame. The needle bearing is used as a front bearing and the metal bearing as a rear bearing. Four metal graphite brushes are installed and crimped to the commutator by the brush spring.
- The planetary gear is used as a reduction gear. The armature rotations are reduced to approximately one fifth via the planetary gear and transmitted to the pinion gear.
- The pinion clutch is designed to transmit motor rotations to the engine and prevent the engine power from being transmitted to the motor (armature) during startup. The roller clutch is used as a pinion clutch.
- The pinion gear is separated from the clutch. The pinion gear is connected to the inner sleeve in the straight spline and is secured by a retainer ring.
- The start magnetic switch opens and closes a main contact point. Engagement and disengagement between a pinion gear and a ring gear are performed via the lever.
- Integration of a moving contact point and a plunger increases the durability. Bolting of the resin cover increases the bonding strength between a cover and a yoke.
- To prevent abraded particles from a clutch from intruding into bearings, the dust seal is installed at the end of the start drive housing (pinion case).
- Introduction of a planetary one-axle starter contributes to downsizing.



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ALTERNATOR

SPECIFICATION

JP181170202201007S

☆: OPTION

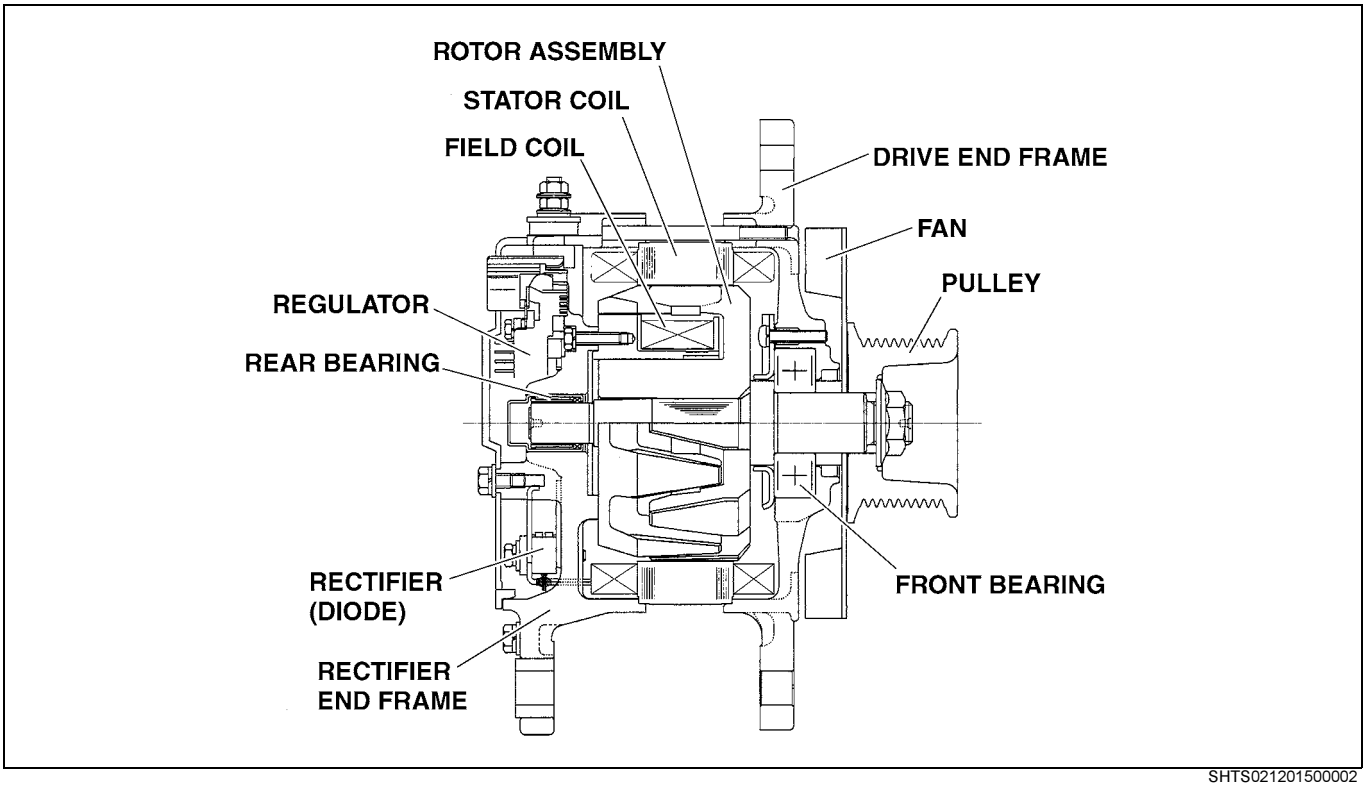
Alternator	Rated voltage	24V	
	Rated output	60A	90A☆
	Power generation	Three-phase, AC, self-rectifier	
Regulator	Type	IC regulator	
	Adjusting voltage	28.5 ± 0.5 V (light duty at ambient temperature)	

SUMMARY

JP18117020301042

- The 24 V, above the negative earth, is standard for engine-related electrical systems.
- The brushless AC alternator is installed and is driven by a belt at a speed of approximately two times higher than the engine speed. The alternator consists of a stator coil, a field coil, a rotor assembly, a rectifier, a rectifier end frame and a drive end frame.
- The rotor assembly is press-fit into the shaft and is supported by the ball bearing on the drive end frame side and by the roller bearing on the rectifier end frame side. This rotor assembly rotates between a field coil (excitation coil) and a stator coil (power generation coil) to induce a change to the magnetic field and generate AC voltage in the stator coil. The diode is used for rectification to obtain the direct current.
- The IC regulator is built in the alternator for weight-saving. Use of the IC improves the reliability and the accuracy of adjusting voltage.
- Installation of the belt auto tensioner separates the tension adjustment mechanism of the drive belt from the alternator mount. This increases the mounting/demounting workability and eliminates the necessity of belt tension adjustment.

ALTERNATOR (60A)



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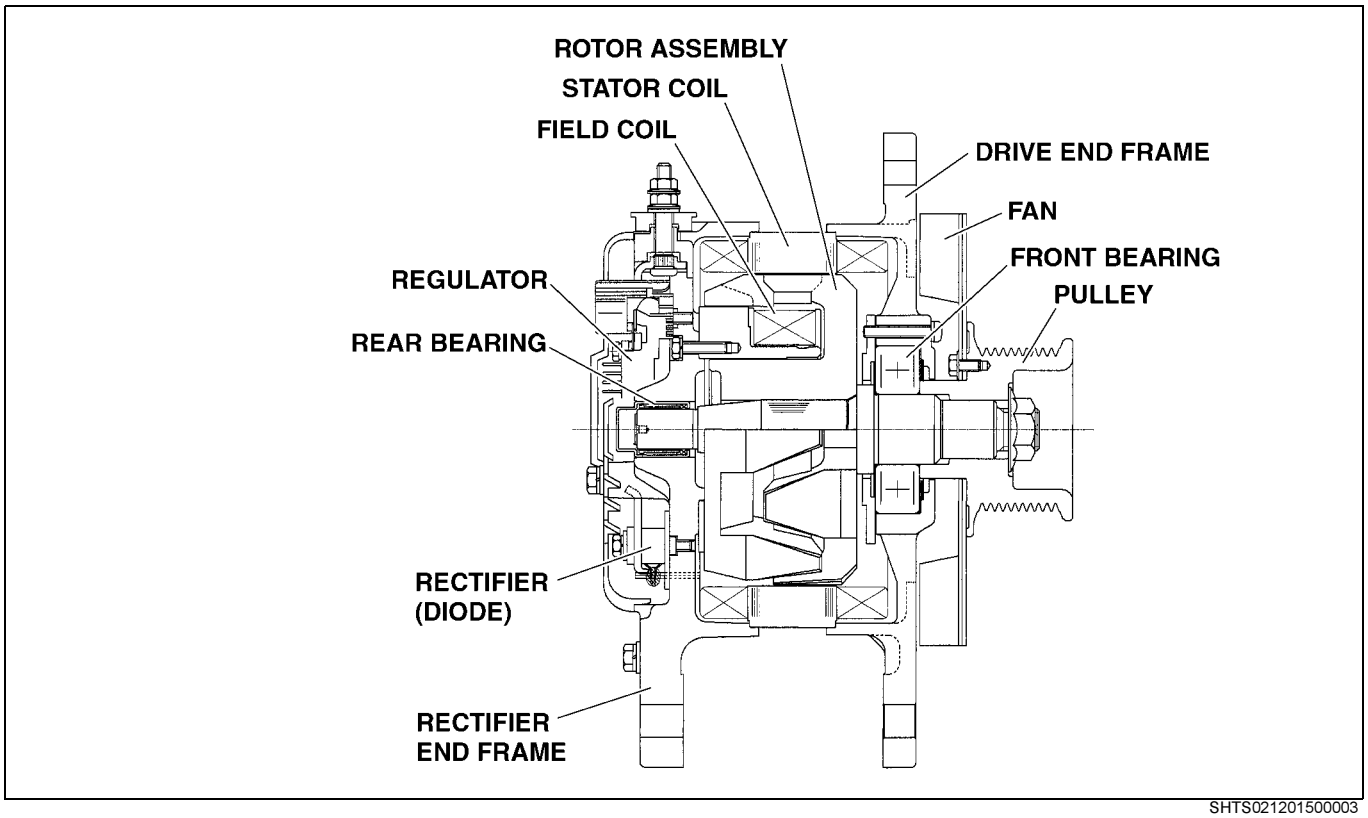
ALTERNATOR (90A)



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STRUCTURE

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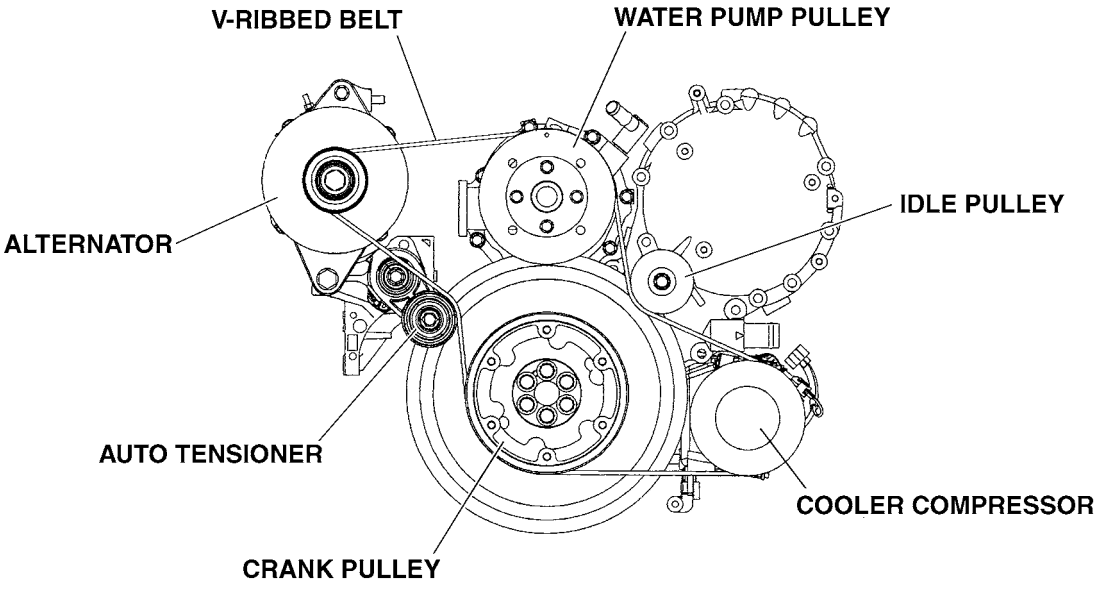
V-RIBBED BELT WITH AUTO TENSIONER

- Use of the auto tensioner eliminates the necessity of belt deflection adjustment.



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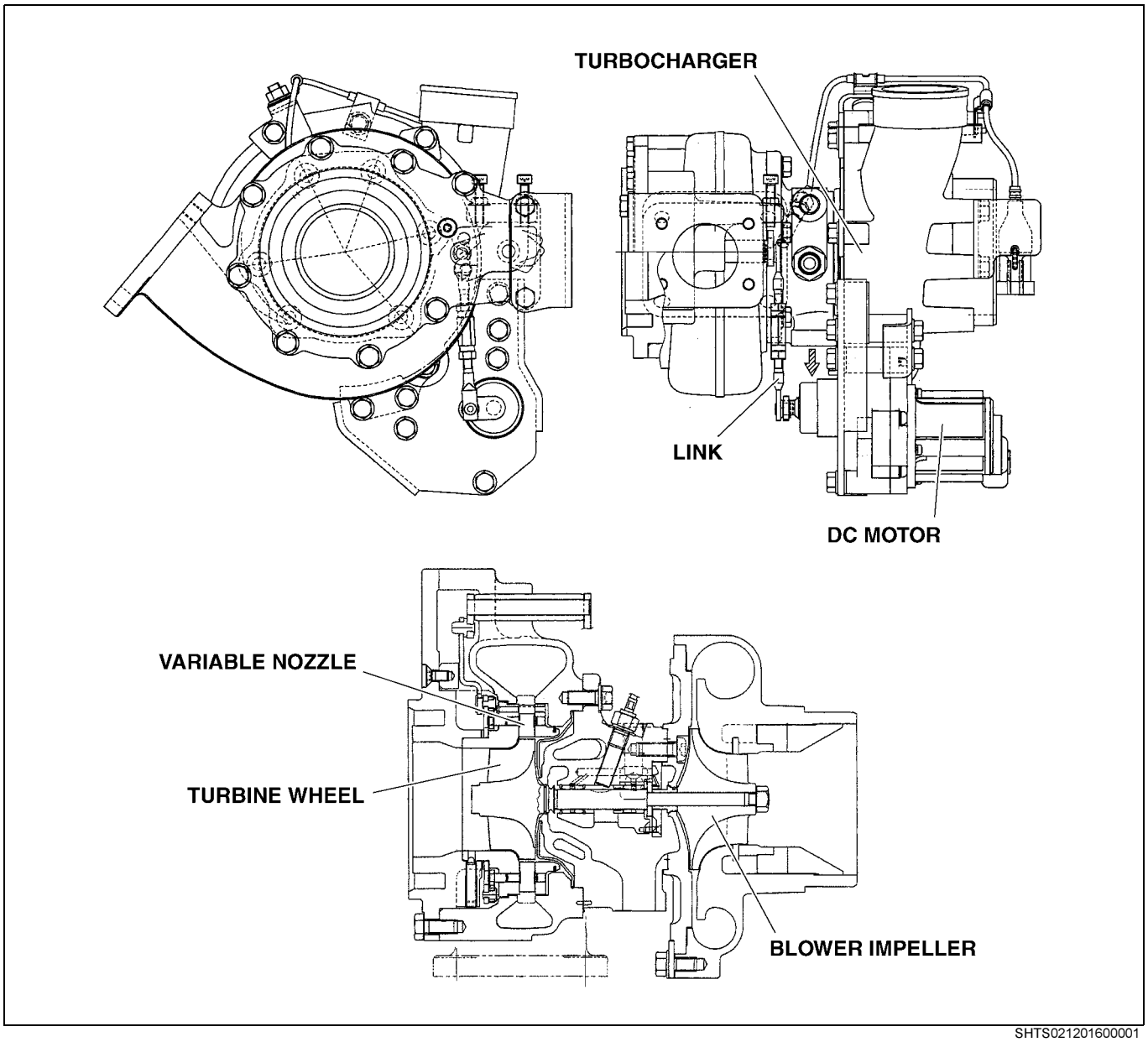
[A09C] TURBOCHARGER

TURBOCHARGER

SUMMARY

JP18Z01020301046

- The variable nozzle turbocharger is incorporated to optimize the air flow based on the engine speed and load and to increase the fuel efficiency in a whole range of engine speeds.
- The variable nozzle turbocharger has a variable nozzle that can change the turbine opening, and a DC motor and a link mechanism for nozzle control.
- The DC motor and the link mechanism change the variable nozzle opening to change the flow rate of incoming emission gas from the exhaust manifold for continuously variable control of the turbine wheel speed.
- The turbine wheel speed is equal to the blower impeller speed. This controls the air flow supplied to the intake manifold.
- The DC motor is controlled by the CAN communication signals from the engine ECU via a separately installed DC motor controller.
  The DC motor controller is installed in the engine.
- The DC motor precisely controls the turbine wheel speed based on the engine speed and load, to optimize the air flow. This improves the torque and fuel efficiency.
- The impeller of a new geometry is employed to increase the boost pressure and the fuel efficiency.
- To meet the increased boost pressure, the reliability was increased by changing a material for blower impeller, increasing the thrust metal capacity and using a spacer in the bearing area to reinforce the rotating area.
- The chamfered shape of a floating metal is optimized to enhance the rotational stability.
- The variable nozzle has a both-end-supported nozzle axis. This reduces the sliding resistance and improves the reliability.



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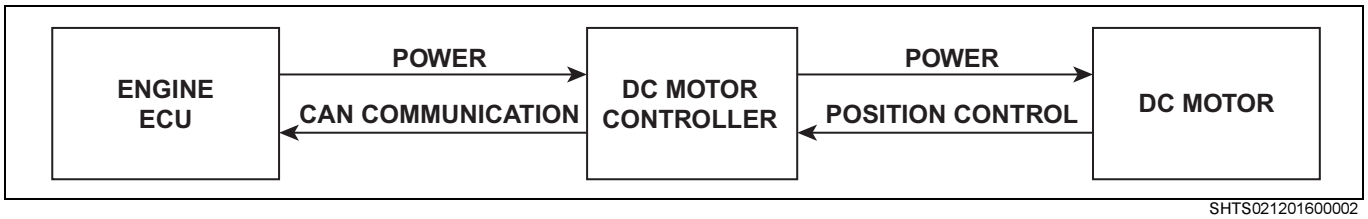
SYSTEM SCHEMATIC DIAGRAM

JP01D02120160405004001



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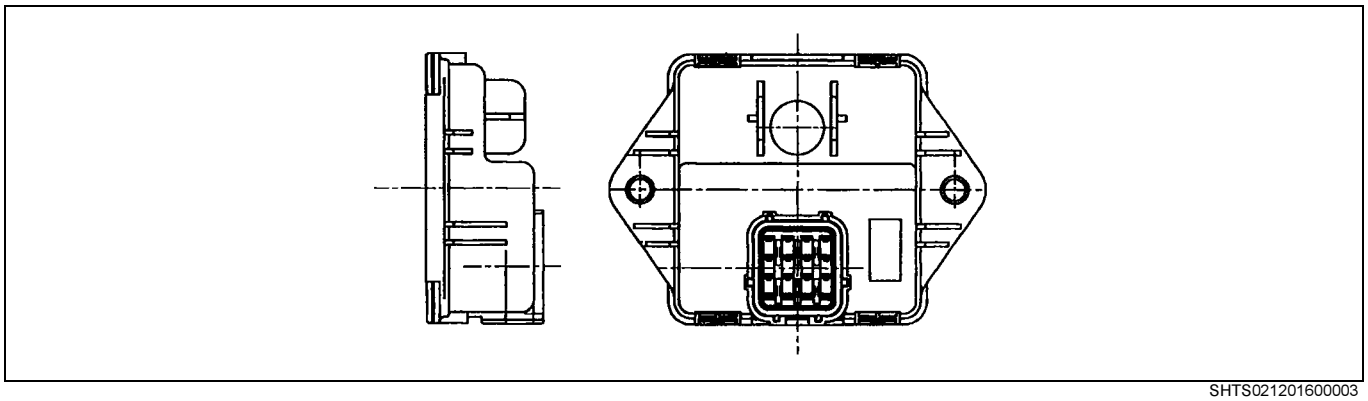
STRUCTURE

JP18Z01020301047

DC MOTOR CONTROLLER

- The DC motor controller receives the information through the CAN communication from the engine ECU and controls the DC motor.



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[A09C] AIR COMPRESSOR

AIR COMPRESSOR

SPECIFICATION

JP18117020201008

Type	Standard
Cylinder bore (mm {in.})	85 x 60 {3.3 x 2.3}
Discharge air flow (cm^3/rev {in^3/rev})	340 {20.7}
Operating pressure (MPa {kgf/cm^2, $lbf/in.^2$})	0.98 {10.0, 142.1} (Permissible maximum pressure)
Gear ratio	1.0

SUMMARY

JP18117020301044

- The air compressor is installed at the rear left of the engine and driven by the crankshaft via the air compressor idle gear and the air compressor drive gear.
- The air compressor is driven by the supply pump drive gear engaged with the idle gear, at a ratio to the engine speed of 1.0.
- When the crankshaft of the air compressor is driven, the pistons will start moving up and down to produce compressed air via the connecting rod linked to the crankshaft.
- The produced compressed air is delivered through a deliver valve in the air compressor head and pressure-fed to the air tank.

STRUCTURE

JP18117020301045

AIR COMPRESSOR UNIT

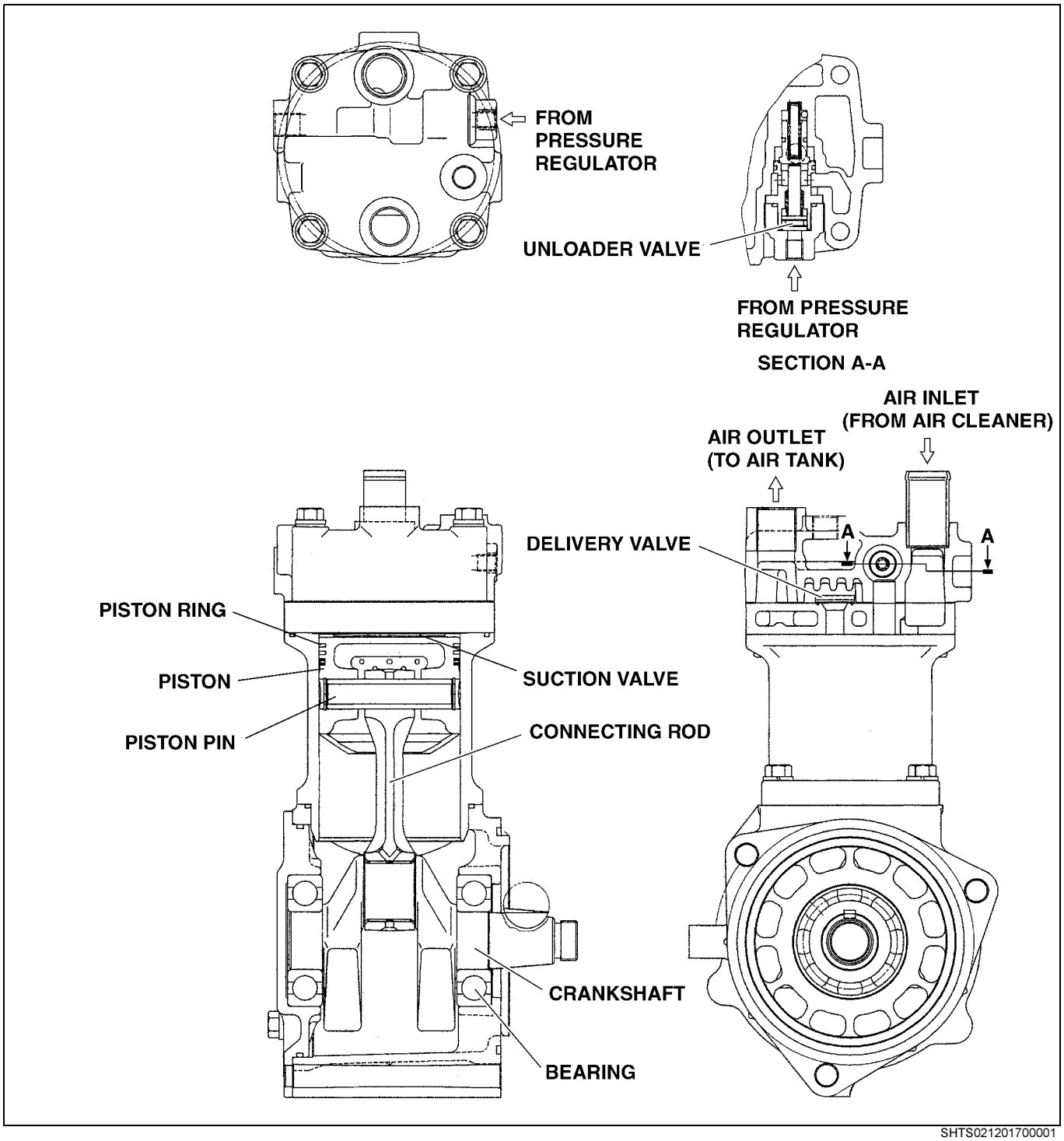
- Both ends of the crankshaft of the air compressor are supported by ball bearings.
- Two compression rings are assembled to the piston and one oil ring assembled to the lower area. Both ends of the piston pin are secured by retaining rings.
- The suction valve and the delivery valve are installed in the cylinder head of the compressor. The unloader valve is installed on the top of the inlet valve. These installed valves operate in sync with the pressure regulator to regulate a pressure in the air tank.
- The suction valve and the delivery valve are functioning in the form that a plate-shaped valve and a valve seat tightly contact with each other.

LUBRICATION

- The engine oil pressure-fed to the sub oil hole lubricates the area inside the air compressor.
- The engine oil returns to the gear case in the engine unit after lubricating.

COOLING

- The air compressor uses water cooling and has sufficient cooling.
- The coolant delivered from the cylinder block returns to the coolant pump inlet after cooling the air compressor.



SHTS021201700001

INSPECTION AND MAINTENANCE

HINO

INSPECTION AND MAINTENANCE

INDEX: INSPECTION AND MAINTENANCE GROUP 1/2

Hino Motors, Ltd.

INDEX: INSPECTION AND MAINTENANCE GROUP 2/2

GENERAL INTRODUCTION (A09C)

GN01-001

GENERAL INTRODUCTION

WARNING

EN00Z0001C100001

In order to ensure safety in work and avoid possible damage to vehicle, strictly observe the following precautions:
Audience of this manual is a qualified service engineer who has acquired expertise. In case an unqualified service engineer or a service engineer without appropriate training has performed maintenance, or in case maintenance is performed without using appropriate tools and units or in accordance with the method described in this manual, the vehicle under maintenance could be damaged as well as do harm to the service engineer and the people in the maintenance site.

- Appropriate maintenance and repairs are a must for assurance of safety of the service engineer as well as the safety and reliability of the vehicle. Replace parts of the vehicle with HINO genuine parts. Avoid using degraded parts.
- This manual contains the procedures to follow in performing maintenance and repairs. When performing maintenance and repairs in accordance with the procedures, use special tools designed to meet specific needs in a proper way.
- Never use a non-recommended work method or tool; this could impair the safety of the service engineer as well as the safety and reliability of your vehicle.
- This manual contains various items classified into DANGERS, WARNINGS, CAUTIONS and NOTICES in order to avoid accidents during maintenance and repairs or damage to the vehicle resulting in impairment of its safety and reliability.
  Note that these instructions described as DANGERS, WARNINGS, CAUTIONS and NOTICES are not the minimum requirements to observe in order to avoid possible dangers.

HOW TO USE THIS MANUAL

EN00Z0001C100002

1. REPAIR WORK

(1) The repair work is roughly classified into the three processes: "diagnosis", "mounting/dismounting, replacement, assembly/disassembly and inspection/adjustment work" and "final inspection".

(2) This manual describes the first process "diagnosis" and the second process "mounting/dismounting, replacement, assembly/disassembly and inspection/adjustment work". Description on the third process "final inspection" is omitted.

(3) While this manual does not describe the following element work, the work is to be performed in practical cases:

a. Jack work and lift work

b. Cleaning of removed parts as required

c. Visual inspection

2. TROUBLESHOOTING IN THIS MANUAL

(1) This manual describes the following steps 2 and 3.

(1) Interview	"Step 1"	Thoroughly listen to the conditions and environment for the trouble and confirm the fact.
(2) Pre-inspection (3) Replication method	"Step 2"	Perform diagnostic inspection, checkup of the symptom, function inspection and basic inspection to confirm the trouble. If the trouble hardly recurs, use the replication method.
(4) Troubleshooting by diagnosis code (5) Troubleshooting by trouble	"Step 3"	Classify the inspection results obtained in step 2 to systematically perform inspection accordance with the troubleshooting procedure by diagnosis code or trouble.
(6) Checkup test	"Step 4"	Check for the trouble after the trouble is removed. In case the trouble is hardly replicated, conduct a checkup test under the conditions and environment for the trouble.

(2) Pre-inspection

Pre-inspection	• Execute the following steps to perform pre-inspection. Diagnostic inspection → diagnosis code erasure → trouble check (If the trouble does not recur, use the replication method.) → Diagnosis code re-check • Assume the faulty system before the replication test. Connect a tester and determine a probable cause of trouble together with checkup of the trouble. For a probable cause of trouble, refer to the troubleshooting chart. • In case the trouble is momentary or in case an error code is displayed but no special trouble takes place, execute related troubleshooting procedures while using the replication method. • Trouble checkup In case the trouble recurs, follow steps 2, 3 and 4 in this order. Otherwise, use the replication method, that is, reproduce the external conditions, and inspect each wire harness and connector parts.

3. DESCRIPTION IN THIS MANUAL

(1) Component Locator

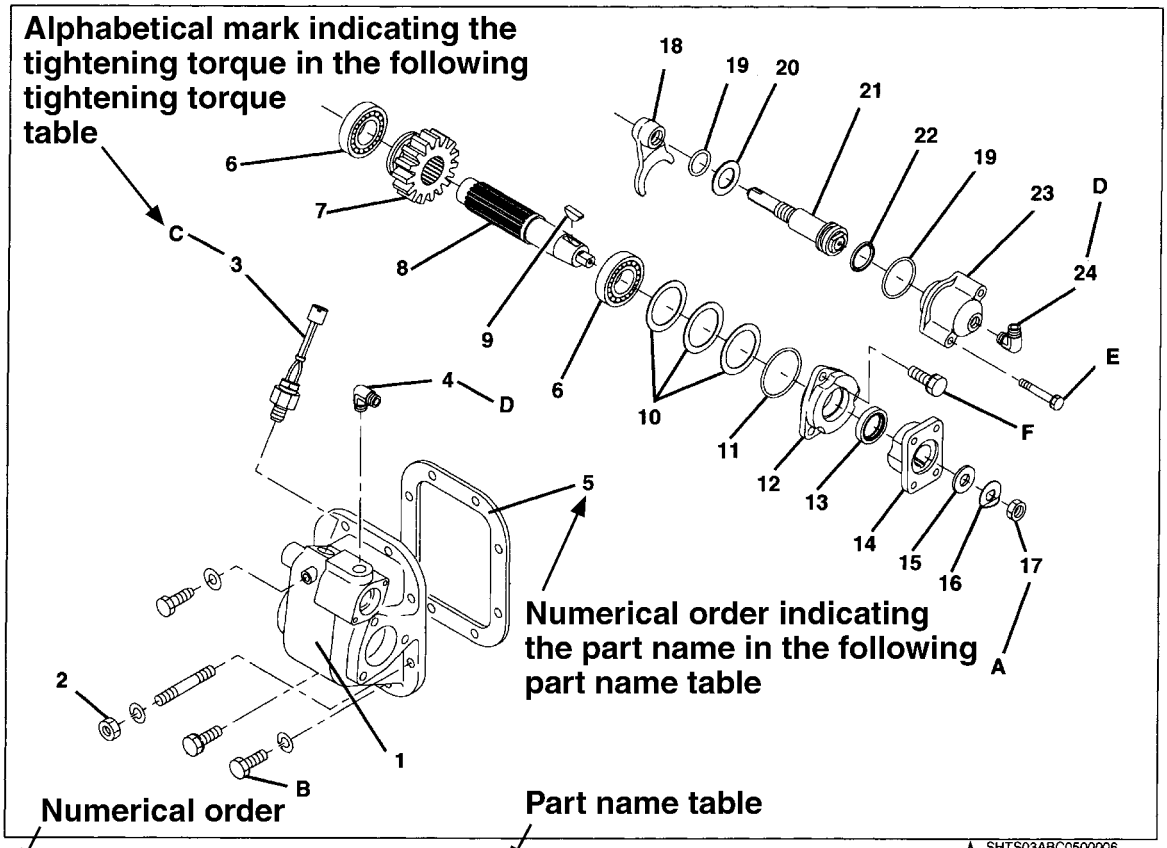
TR05–4 P.T.O. (POWER TAKE-OFF) (TRANSMISSION SERIES: HX07)

EXAMPLE

POWER TAKE-OFF UNIT

COMPONENT LOCATOR

☆ EN03ABC05D100001



☆ SHTS03ABC0500006

1	Power take-off case	13	Oil seal
2	Nut	14	Output shaft flange
3	Position switch	15	Plain washer
4	Connector	16	Lock washer
5	Power take-off case gasket	17	Lock nut
6	Taper roller bearing	18	Shift fork
7	Output gear	19	O-ring
8	Output shaft	20	Collar
9	Woodruff key	21	Shift shaft
10	Shim	22	Shift shaft piston cup
11	O-ring	23	Case cover
12	Seal cover	24	Elbow

Part name

Tightening torque table

Tightening torque — Unit: N·m {kgf·cm, lbf·ft}

A	39.2-47 {400-480, 29-34}	D	39.5-58.5 {400-600, 29-43}
B	44.5-53.5 {450-545, 33-39}	E	19-25 {200-250, 15-18}
C	48.5-67.5 {500-690, 36-49}	F	49-62 {500-630, 36-45}

Alphabetical mark — Tightening torque

SHTS00Z000100001

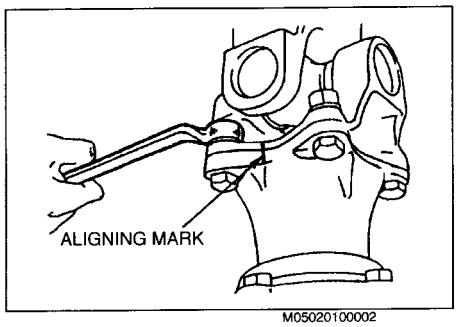
☆: This is the ID number of an item to be prepared for creating electronic data and is not necessary for repair work.

(2) Work item

EXAMPLE

OVERHAUL

M05020104BEH2004



M05020100002

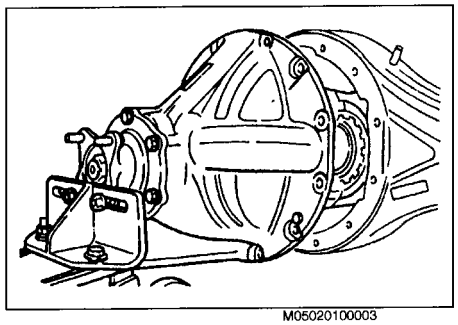
IMPORTANT POINTS - DISMOUNTING

1. DISCONNECT THE PROPELLER SHAFT.

NOTICE

Make aligning marks before disassembling.

Indicating the work sequence

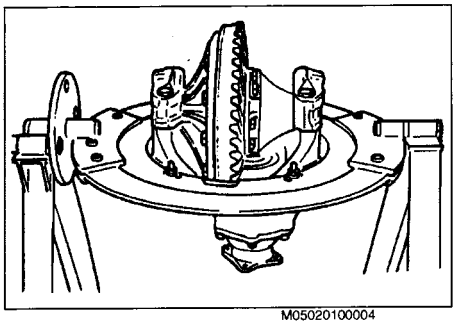

M05020100003

2. DISMOUNT THE DIFFERENTIAL CARRIER ASSEMBLY.

(1) Drain the gear oil and remove the axle shaft.

(2) Using a jack, dismount the differential carrier assembly.

Descriptive text: Indicating the work method which is gone into detail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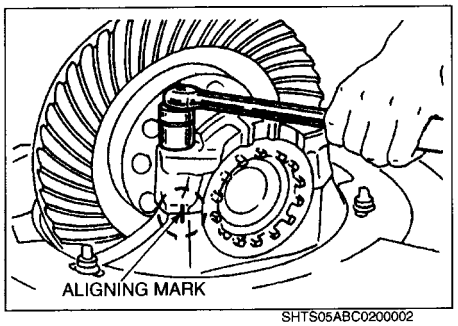
IMPORTANT POINTS - DISASSEMBLY

1. MOUNT THE DIFFERENTIAL CARRIER ASSEMBLY ON THE WORK STAND.



SHTS05ABC0200002

2. DIFFERENTIAL CASE

(1) Remove the bearing cap.

NOTICE

Make aligning marks before disassembling.

SST: Socket Wrench (S0983-93003)

(2) Using a puller, remove the taper roller bearing.

Indicating the part number of special tool required for work

SHTS00Z000100002

4. DEFINITION OF TERMS

This manual defines the terms used herein as follows:

(1) Direction

a. Chassis

- To-and-fro direction
  The direction of forward travel of the vehicle while mounted on the vehicle is forward direction; the direction of backward travel of the vehicle while mounted on the vehicle is backward direction.
- Direction of rotation
  The clockwise direction as seen from the rear of the vehicle is clockwise direction; the counterclockwise direction as seen from the rear of the vehicle is counterclockwise direction. (In case of engine, the clockwise direction as seen from the flywheel side is clockwise direction; the counterclockwise direction as seen from the flywheel side is counterclockwise direction.)
- Upward/Downward direction
  The upward direction while mounted on the vehicle is upward, and downward direction while mounted on the vehicle is downward.
- Right/Left direction
  The right direction as seen from the rear of the vehicle while mounted on the vehicle is right direction; the left direction as seen from the rear of the vehicle while mounted on the vehicle is left direction. (In case of engine, the right direction as seen from the flywheel side is right direction; the left direction as seen from the flywheel side is left direction.)

b. Standalone unit

- To-and-fro direction
  The direction of input of power is forward direction; the direction of output of power is backward direction.
- Direction of rotation
  The clockwise direction as seen from the rear of the unit is clockwise direction; the counterclockwise direction as seen from the rear of the unit is counterclockwise direction.
- Upward/Downward direction
  The upward direction while the unit is mounted on the vehicle (chassis) is upward, and downward direction while the unit is mounted on the vehicle (chassis) is downward.
- Right/Left direction
  The right direction as seen from the rear of the unit is right direction; the left direction as seen from the rear of the unit is left direction.

(2) Standard value (Assembly standard):
Indicates a basic dimension or including the tolerance and the clearance generated by the clearance of a combination of two parts

(3) Limit (Service limit):
Indicates a numeric value which requires correction or replacement.

5. DEFINITION OF SAFETY TERMS

⚠ DANGER	**Indicates an extremely hazardous situation if proper procedures would be not followed and could result in death or serious injury.**
⚠ WARNING	**Indicates a potential hazardous situation if proper procedures would be not followed and could result in death or serious injury.**
⚠ CAUTION	**Indicates a hazardous situation if proper procedures would be not followed and could result in serious injury or damage to parts/equipment.**
NOTICE	**Indicates the need to follow proper procedures and to pay attention to precautions so that efficient service is provided.**
HINT	**Provides additional information to help you to perform the repair efficiently.**

6. UNIT

(1) This manual uses the SI unit system. The SI unit is an international unit which is based on one unit per quantity unlike the conventional unit system which differs from country to country, in order to facilitate technology exchange.

(2) This manual writes the SI unit and a conventional unit side by side, the conventional unit enclosed in parentheses { }.

	SI unit	Conventional unit	Conversion value*1 (1[Conventional unit] = X [SI unit])		SI unit	Conventional unit	Conversion value*1 (1[Conventional unit] = X [SI unit])
Force	N	kgf	1 kgf=9.80665 N	Spring constant	N/mm	kgf/mm	1 kgf/mm= 9.80665 N/mm
Torque*2	N·m	kgf·cm	1 kgf·cm= 0.0980665 N·m	Volume	L	cc	1 cc=1 mL
Pressure	Pa	kgf/cm^2	1 kgf/cm^2= 98.0665 kPa= 0.0980665 MPa	Efficiency	W	PS	1 PS=0.735499 kW
		mmHg	1 mmHg= 0.133322 kPa	Quantity of heat	W·H	cal	1 kcal=1.13279 W·h
Rotation speed	r/min.	rpm	1 rpm=1 r/min.	Fuel consumption ratio	g/W·h	g/PS·h	1 g/PS·h= 1.3596 g/kW·h
	$min.^{-1}$		1 $rpm=1 min.^{-1}$				

*1: X is a value obtained by converting 1 [conventional unit] to an SI unit and is used as a conversion factor of the conventional unit and SI unit.

*2: The torque conversion value may depend on the unit. Follow the specific value described for each unit.

PRECAUTIONS FOR WORK

EN00Z0001C100003

GENERAL PRECAUTIONS

To assure safety in work and prevent possible danger, observe the following:

1. CLOTHES AND APPEARANCE

(1) Use safety glasses.
(2) To prevent injury, remove a watch, necktie, ring, bracelet and necklace.
(3) Bind long hair behind.
(4) Wear a cap and safety boots.

2. SAFETY WORK

(1) To prevent burns, never touch a radiator, muffler, exhaust pipe, and tail pipe just after the engine is turned off.
(2) While the engine is rotating, keep your clothes and tools off the rotating sections, in particular the cooling fan and V-belt.
(3) Remove the starter key except when starting the engine.
(4) Provide good ventilation to avoid excessive CO when starting the engine.
(5) The fuel/battery gas is flammable. Never make a spark or light a cigarette.
(6) Take utmost care when working on the battery. It contains corrosive sulfuric acid.
(7) Large electric current flows through the battery cable and starter cable. Be careful not to cause a short, which can result in personal injury and/or property damage.
(8) Leaving a tool or waste in the engine room causes the tool or waste to touch the rotating section of the engine and pop out, which could result in an injury.

3. TOWING

- When being towed, always place the gear shift lever in "Neutral" and release the parking brake completely. In order to protect the bumper, fit a protection bar against the lower edge of the bumper and put a wood block under the frame near the No.1 crossmember when attaching the towing chain. Never lift or tow the vehicle if the chain is in direct contact with the bumper.

(1) Towing procedures
   a. Make sure that the propeller shaft of the vehicle to be towed is removed. When the differential gear or rear axle shaft is defective, remove both right and left rear axle shafts, then cover the hub opening to prevent loss of axle lubricant and entry of dirt or foreign matter.
   b. Use a heavy duty cable or rope when towing the vehicle. Fasten the cable securely to the towing hook on the frame. The hook should be used only if the towed vehicle is not loaded.
   c. The angle of pulling direction of the cable fastened to the towing hook must not exceed 15° in horizontal and vertical directions from the straight ahead, level direction. Avoid using the hook in a way that subjects it to jerk, as in towing a vehicle trapped in a gutter.
   d. Keep the gear shift lever in "Neutral".
   e. Make sure that the starter switch is kept in the "ON" position.
   f. Make sure that the engine of the towed vehicle is kept running. If the engine is off, no compressed air/ no vacuum will be available for the brake. This is dangerous, as the brake system does not function if the engine is not running.
      In addition, the power steering system will not function. The steering wheel, therefore, will become unusually hard to turn, making it impossible to control the vehicle.
   g. Note that the engine brake and exhaust brake cannot be applied, if the propeller shaft is removed.
   h. Make a slow start to minimize shock. Towing speed should be less than 30 km/h {18 mile/h}.

(2) If the engine of the towed vehicle is defective, make sure that the vehicle is towed only by a tow truck designed for that purpose.
   a. Front end towing (with front wheels raised off the ground)
      When towing from the front end with the front wheels raised off the ground, remove the rear axle shafts to protect the transmission and differential gears from being damaged. The hub openings should be covered to prevent the loss of axle lubricant or the entry of dirt or foreign matter.
      The above-mentioned precautions should be observed for vehicles equipped with either automatic or manual transmission, and for even short distance towing. After being towed, check and refill the rear axle housing with lubricant if necessary.
   b. Rear end towing
      When being towed with the rear wheels raised off the ground, fasten and secure the steering wheel in a straight ahead position.

PRECAUTIONS ON MAINTENANCE

Observe following before maintenance:

1. PREPARATIONS FOR DISASSEMBLY

(1) Prepare general tools, special tools and instruments before work.
(2) Before disassembling complicated sections, make a fitting mark where functions are not affected to facilitate the assembly work. Before repair of the electrical system, remove the cable from the minus terminal of the battery.
(3) Follow the inspection procedure in this manual before disassembly

2. INSPECTION DURING DISASSEMBLY

(1) Each time you remove a part, inspect the state of the assembly of the part, deformation, damage, wear and flaws.

3. ARRANGEMENT OF DISASSEMBLED PARTS

(1) Arrange the disassembled parts in order. Discriminate parts to be reused from replacement parts.

4. CLEANING OF DISASSEMBLED PARTS

(1) Thoroughly clean the parts to be reused.

5. INSPECTION AND MEASUREMENT

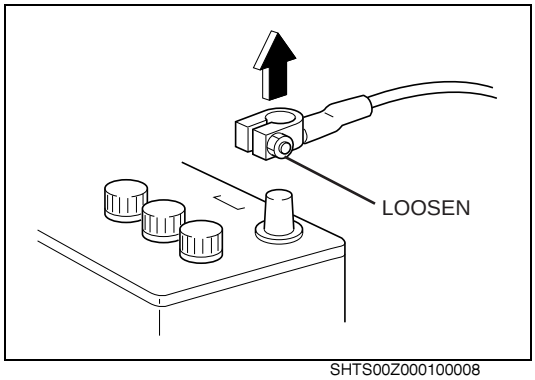
(1) Inspect and measure the parts to be reused as required.

6. ASSEMBLY

(1) Observe the specified values (tightening torque, adjustment value) to assemble conforming parts in a correct procedure.
(2) Use genuine parts for replacement.
(3) Use new packing, gasket, O-ring and cotter pin.
(4) Use a seal gasket depending on the location of gasket. Apply specified oil or grease to a sliding section where indicated. Apply specified grease to the lip of the oil seal.

7. ADJUSTMENT WORK CHECK

(1) Use a gauge and a tester to adjust to the specified maintenance value.



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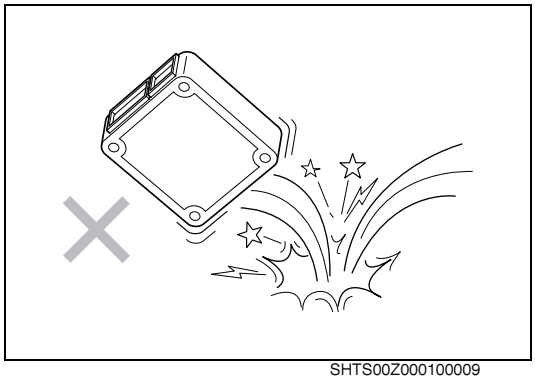
PRECAUTIONS FOR ELECTRICAL SYSTEM

1. REMOVING THE BATTERY CABLE

(1) Before electrical system work, remove the cable from the minus terminal of the battery in order to avoid burning caused by short-circuiting.

(2) To remove the battery cable, fully release the nut to avoid damage to the battery terminal. Never twist the terminal.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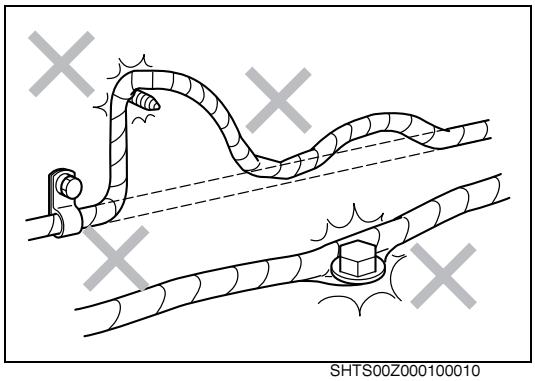
2. HANDLING OF ELECTRONIC PARTS

(1) Never give an impact to electronic parts of a computer or relay.

(2) Keep electronic parts away from high temperatures and humidity.

(3) Never splash water onto electronic parts in washing the vehicle.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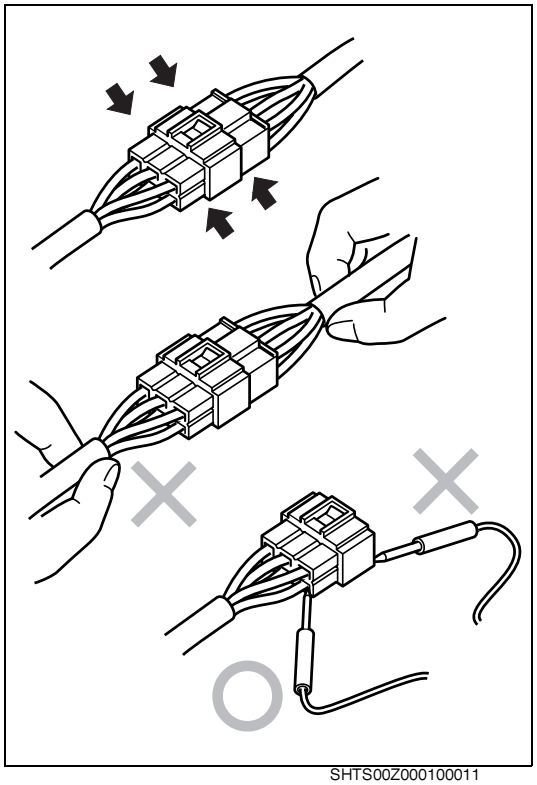
3. HANDLING OF WIRE HARNESS

(1) Perform marking on a clamp and a clip and secure then in original position so that the wire harness will not interfere with the end and acute angle section of the body and a bolt.

(2) To attach a part, take care not to bite the wire harness.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4. HANDLING OF CONNECTOR

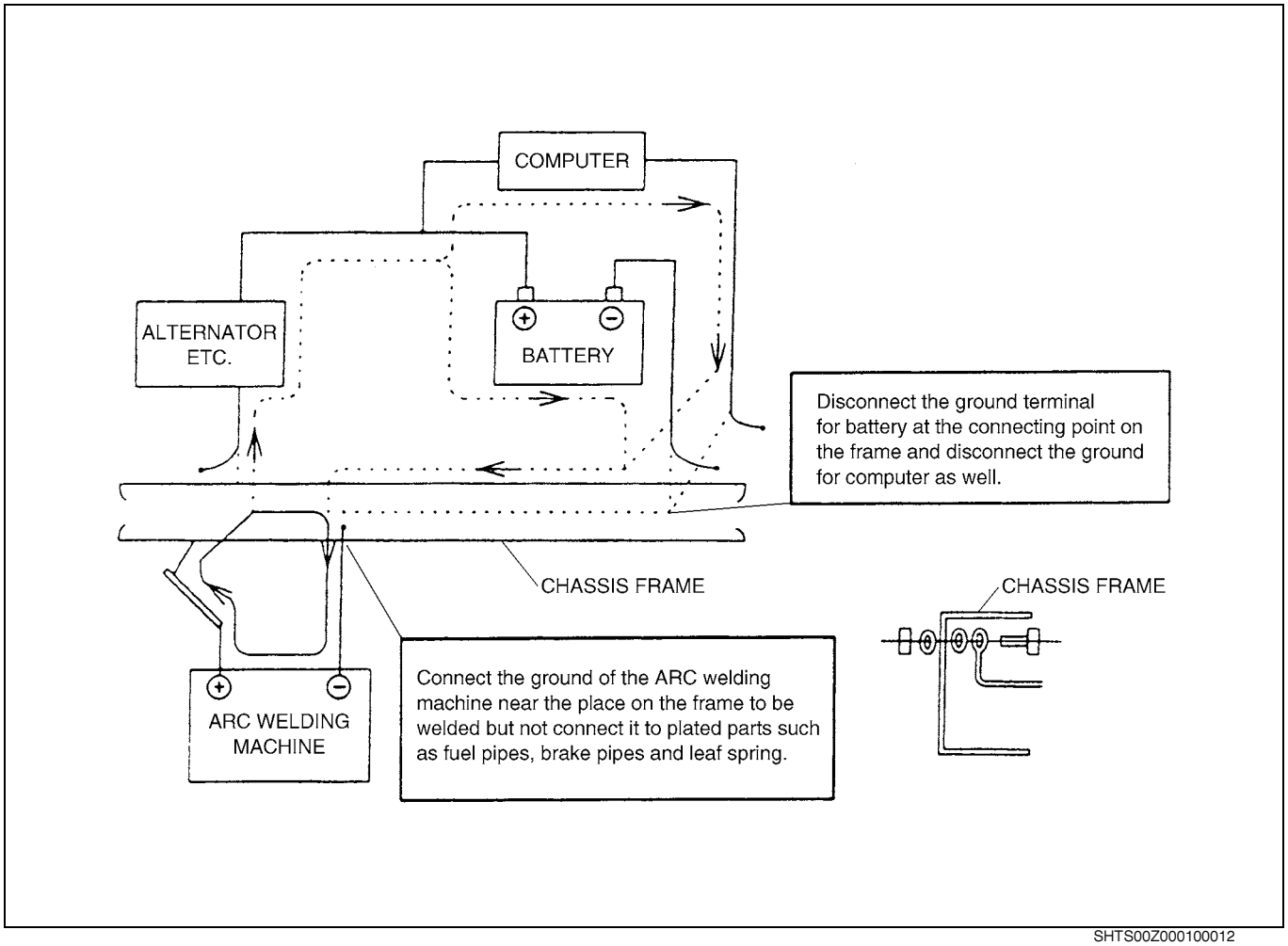
(1) To remove a connector, hold the connector (indicated by an arrow in the figure) to pull it out. Never pull the harness.
(2) To remove a connector with lock, release the lock then pull it out.
(3) To connect a connector with lock, insert it until it clicks.
(4) To insert a test lead into the connector, insert it from behind the connector.
(5) In case it is difficult to insert a test lead from behind the connector, prepare a harness for inspection and perform inspection.

PRECAUTIONS FOR ELECTRIC WELDING

1. PRECAUTION FOR ELECTRIC WELDING

Electrical components such as the alternator and tachograph are directly connected to the battery and one end is earthed to the chassis frame. Under these conditions, welding current will flow back along the earth circuit if electric welding is carried out and damage may be caused to the alternator, tachograph, electrical components, etc. Consequently, the following precautions are always to be taken during welding.

(1) Disconnect the earth terminal of the battery at the frame fitment and earth the welding equipment securely to the frame itself. (Do not fit the welding equipment earth to such things as the tire rims, brake pipes or fuel pipes and leaf spring, etc.)
   a. Turn the starter switch off.
   b. Disconnect the battery's negative terminal of the battery.
   c. Earth welding equipment securely, near to the area to be welded.



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(2) In order to prevent damage to ancillary equipment components from sparks during welding, take steps such as putting fire-resistant covers over things like the engine, meters, steering wheel, hoses, leaf spring and tires.

TIGHTENING OF BOLTS AND NUTS FOR ENGINE

EN00Z0001C100004

1. TIGHTENING TORQUE OF GENERAL STANDARD

(1) Washer based bolt

Unit: N·m {kgf·cm, lbf·ft}

Screw diameter x pitch	7T	9T
M8 x 1.25 (Coarse thread)	28.5 {290, 21}	36 {370, 27}
M10 x 1.25 (Fine thread)	60 {610, 44}	74.5 {760, 55}
M10 x 1.5 (Coarse thread)	55 {560, 40}	68.5 {700, 51}
M12 x 1.25 (Fine thread)	108 {1,100, 80}	136 {1,390, 101}
M12 x 1.75 (Coarse thread)	97 {990, 72}	125 {1,280, 93}
M14 x 1.5 (Fine thread)	171.5 {1,750, 127}	216 {2,210, 160}
M14 x 2 (Coarse thread)	154 {1,570, 114}	199 {2,030, 147}
Remarks	Bolt with the numeral "7" on its head	Bolt with the numeral "9" on its head

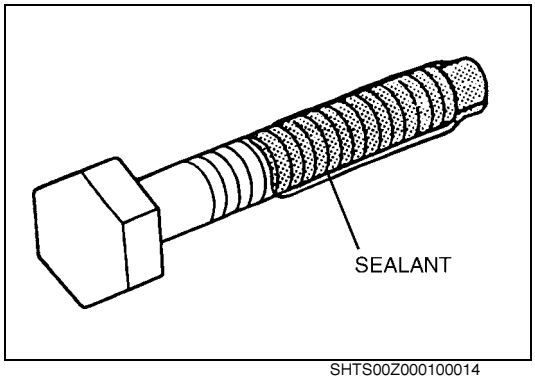
NOTICE
8T bolt conforms to the standard of 7T bolt.

(2) With washer

Unit: N·m {kgf·cm, lbf·ft}

Screw diameter x pitch	4T	7T	9T
M6 x 1 (Coarse thread)	6 {60, 4.3}	10 {100, 7.2}	13 {130, 9.4}
M8 x 1.25 (Coarse thread)	14 {140, 10}	25 {250, 18}	31 {320, 23}
M10 x 1.25 (Fine thread)	29 {300, 22}	51 {520, 38}	64 {650, 47}
M10 x 1.5 (Coarse thread)	26 {270, 20}	47 {480, 35}	59 {600, 43}
M12 x 1.25 (Fine thread)	54 {550, 40}	93 {950, 69}	118 {1,200, 87}
M12 x 1.75 (Coarse thread)	49 {500, 36}	83 {850, 61}	108 {1,100, 80}
M14 x 1.5 (Fine thread)	83 {850, 61}	147 {1,500, 108}	186 {1,900, 137}
M14 x 2 (Coarse thread)	74 {750, 54}	132 {1,350, 98}	172 {1,750, 127}
Remarks	Bolt with the numeral "4" on its head Projection bolt Stud with rounded free end face	Bolt with the numeral "7" on its head Stud with chamfered free end face	Bolt with the numeral "9" on its head

NOTICE
8T bolt conforms to the standard of 7T bolt.



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2. PRE-COATED BOLT

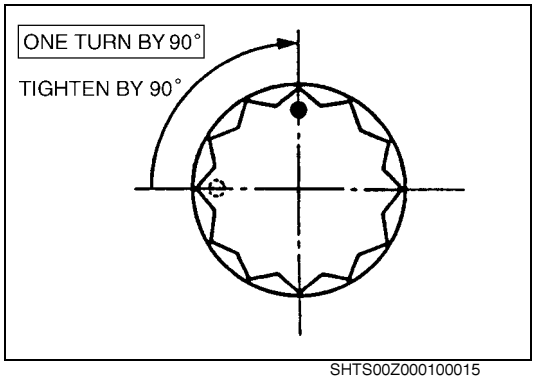
A pre-coated bolt is a bolt having a thread coated with sealant.

(1) Cases where sealant must be applied again
   a. Pre-coated bolt is removed
   b. Pre-coated bolt has moved during tightening torque inspection
      (Loosened or tightened)

HINT

Torque check is to be made using the lower limit value. In case the bolt has moved, retighten it in the following procedure:

(2) How to reuse pre-coated bolt
   a. Clean the bolt and the tapped hole (clean the tapped hole also when the bolt is to be replaced).
   b. Blow air to dry up the bolt.
   c. Apply a specified sealant to the thread of the bolt.



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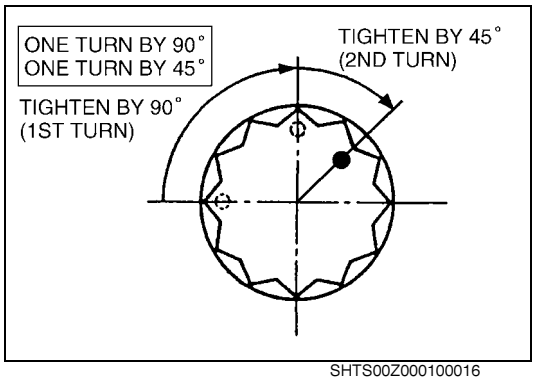
3. TENSION CONTROL WITH ANGULAR TORQUING METHOD IN PLASTIC REGION OF MATERIAL

(1) Precautions
Part of an engine uses the tension control with angular torquing method in plastic region of material.
This is different from the conventional tightening method. Follow the instructions in each chapter.



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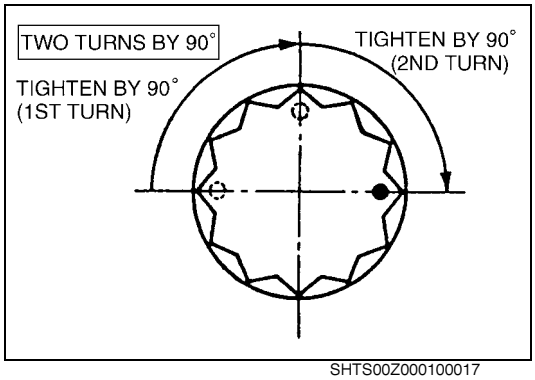
(2) Target region
Cylinder head bolt, crankshaft main bearing cap bolt, connecting rod bearing, cap bolt and so on.

⚠ CAUTION

Before assembly, measure the entire length of the bolt and if the use limit is exceeded, replace the bolt with new one.
Apply engine oil to the bolt seat face and bolt thread.



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(3) Tightening after tightening at the pre-set seating torque.
Further tighten by 90° or 135° (a turn by 90° and another by 45°) or 180° (two turns by 90°).

TIGHTENING OF BOLTS AND NUTS FOR CHASSIS

EN00Z0001C100005

1. TIGHTENING TORQUE OF GENERAL STANDARD BOLT/NUT

(1) Selection of tightening torque
   a. To select the tightening torque of a bolt, find the corresponding strength category in the table below. Select the corresponding value from the tightening torque table given later.
   b. To select the tightening torque of a nut, use the above method based on the mating bolt.

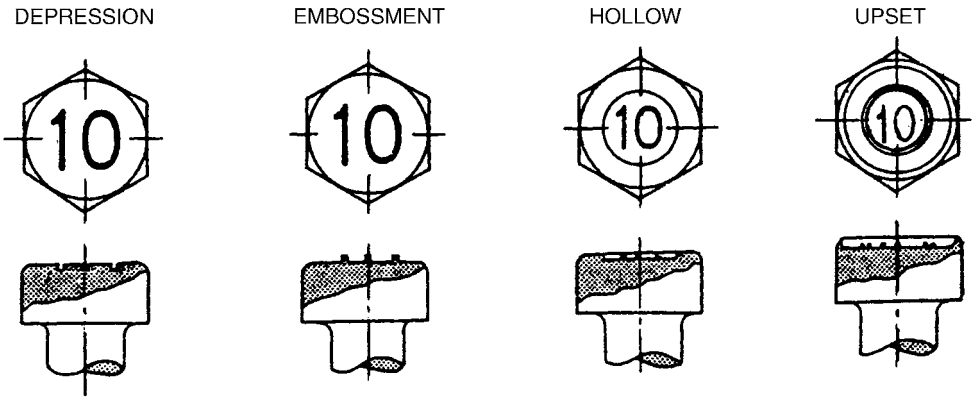
(2) Identification of bolt strength
   a. Identification on the part itself

HEXAGON BOLT

On the hexagon bolt, the strength category is generally indicated on the head of the bolt by way of depression, embossment, hollow and upset in accordance with the symbol in the table below.

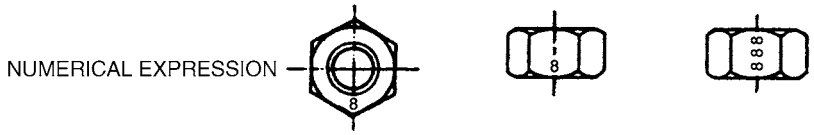
Strength category	6T	7T	8T	9T	10T	11T	12T
Symbol on the part	6	7	8	q*1	10	11	12

(*1): 9 is likely to be confused with 6 so that 9 is represented in q.

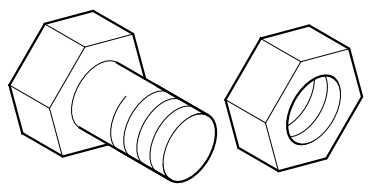
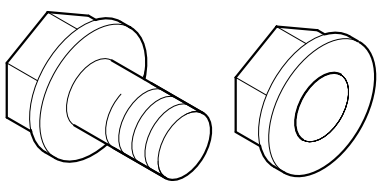
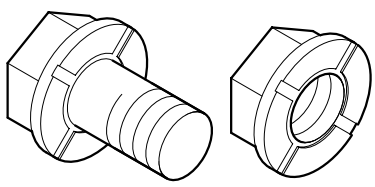


HEXAGON NUT

The following tables shows examples of symbols to identify the strength category of hexagon nut on the nut itself.



(3) Types of general standard bolt and nut

Standard seat face	Flanged seat face A	Flanged seat face B
		

(4) Table of tightening torque of general standard bolt and nut (Standard seat face is shown as a typical case)

Unit: N·m {kgf·cm, lbf·ft}

Strength category / Bolt diameter	4T	7T	9T
M6	4.5±1.8 {50±20, 3.6±1.4} (Cab) 5.5±1.1 {60±10, 4.4±0.7} (Chassis)	9.0±1.8 {90±20, 6.5±1.4}	11.5±2.0 {117±23, 8.5±1.6}
M8	14.0±3.5 {140±40, 10.1±2.8} (Cab) 17.0±3.0 {170±30, 12.3±2.1} (Chassis)	22.0±4.0 {220±40, 15.9±2.8}*2	29.0±5.5 {300±60, 21.7±4.3}*2
M10	27.0±5.0 {276±55, 20.0±3.9}	43.0±8.5 {440±90, 31.8±6.5}*2 (Cab) 51.5±10.0 {530±100, 38.3±7.2} (Chassis)	57.0±11.0 {580±110, 41.9±7.9}*2 (Cab) 68.5±13.5 {700±140, 51±10} (Chassis)
M12	48.0±9.5 {490±98, 35.4±7.0}	76.0±15.0 {776±150, 56±10}*2 (Cab) 91.0±18.0 {930±180, 67±13} (Chassis)	100.0±20.0 {1,020±200, 74±14}*2 (Cab) 120.0±24.0 {1,220±240, 88±17} (Chassis)
M14	77.0±15.0 {786±157, 57±11}	120.0±24.0 {1,220±240, 88±17}	160.0±32.0 {1,630±326, 118±23}
M16	120.0±24.0 {1,220±244, 88±17}	190.0±38.0 {1,940±390, 140±28}	250.0±50.0 {2,550±510, 184±37}
M18	165.0±33.0 {1,680±336, 121±24}	260.0±52.0 {2,650±530, 192±38}	345.0±69.0 {3,520±704, 255±50}
M20	235.0±47.0 {2,400±480, 174±34}	370.0±74.0 {3,770±750, 273±54}	490.0±98.0 {5,000±1,000, 362±72}
M22	320.0±64.0 {3,270±654, 236±47}	505.0±100.0 {5,150±1,030, 372±74}	670.0±130.0 {6,840±1,370, 495±99}
M24	405.0±81.0 {4,130±826, 299±59}	640.0±125.0 {6,530±1,310, 472±94}	845.0±165.0 {8,620±1,720, 623±124}

⚠ CAUTION

- **In case of tightening the bolt/nut with the flanged seat face A, the tightening torque value except *2 in the table is to be increased by 10% from the indicated tightening torque value.**
- **In case of tightening the bolt/nut with the flanged seat face B, the tightening torque value *2 in the table is to be increased by 20% from the indicated tightening torque value.**
  Note that for M8 the tightening torque value is constant for the flanged seat face B also.
- **The bolt/nut with flanged seat B which is marked *2 in the table is compatible with a standard seat face as a pair. Its tightening torque is the same as that of the standard seat face.**

TIGHTENING OF FLARE NUTS AND HOSES

EN00Z0001C100006

1. TIGHTENING TORQUE OF PIPE FLARE NUT

Unit: N·m {kgf·cm, lbf·ft}

Pipe outer diameter / Material	ϕ4.76	ϕ6.35	ϕ8	ϕ10	ϕ12	ϕ15
Steel pipe	15±5 {150±50, 10.8±3.6}	25±5 {250±50, 18.1±3.6}	36±5 {370±50, 26.8±3.6}	52±7 {530±70, 38.3±5.0}	67±7 {680±70, 49.2±5.0}	88±8 {900±80, 65.1±5.7}

2. TIGHTENING TORQUE OF HOSE

Unit: N·m {kgf·cm, lbf·ft}

	Hose outer diameter ϕ10.5 metal fitting	Hose outer diameter ϕ13, ϕ20, ϕ22 metal fitting for packing	Hose outer diameter PF3/8 metal fitting
Air hose	21.5±1.5 {215±15, 15.5±1.0} Meter gauge only 10 {100, 7.2}	41.5±2.5 {425±25, 30.7±1.8}	—
Brake hose	Packing 51.5±7.5 {525±75, 38.0±5.4}	—	—

3. TIGHTENING TORQUE OF FLARE JOINT FOR NYLON TUBE

Unit: N·m {kgf·cm, lbf·ft}

Nominal diameter of screw	M12	M16	M20
Tightening torque	14.7±2 {150±20, 10.8±1.4}	29.4±5 {300±50, 21.7±3.6}	51.9±5 {530±50, 38.3±3.6}

4. TIGHTENING TORQUE OF LOCK NUT FOR BRASS JOINT

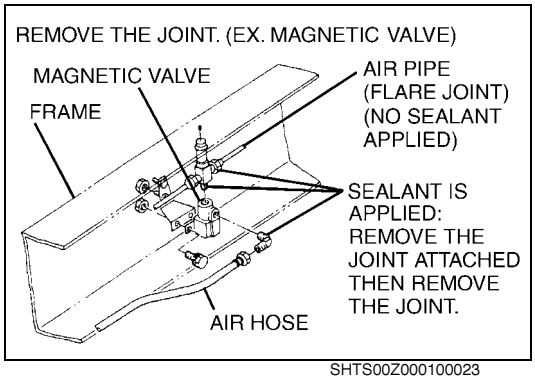
Unit: N·m {kgf·cm, lbf·ft}

Nominal diameter of screw	M12	M16	M20	M27
Tightening torque	15±2 {150±20, 10.8±1.4}	66±6 {670±60, 48.4±4.3}	97±9 {990±90, 71.6±6.5}	209±19 {2,130±190, 154±13}

SEALANT ON THE TAPERED SCREW FOR PIPING

EN00Z0001C100007

To the tapered thread of the air pipe joint is applied the sealant "LOCTITE #575". Follow the procedure below to remove/attach the piping.



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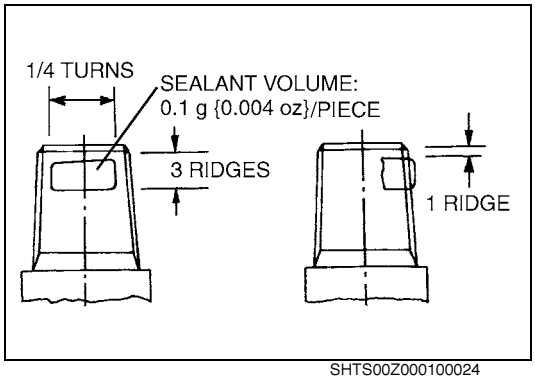
1. REMOVAL

(1) The sealant (LOCTITE #575) has a high sealing capability. The return torque of taper joint is about 1.5 times as high as the initial tightening torque. To remove the joint, use a longer wrench.

(2) For replacement of joint in a place with poor workability, remove the auxiliaries with the joint attached then remove the joint.



SHTS00Z000100024

2. ATTACHING

(1) To apply sealant (LOCTITE #575), use waste and thinner to wipe the dirt off the sealing section, directly apply the sealant by a quarter turn (three ridges) starting from the second ridge from the tip, then assemble in accordance with the tightening torque table below.
Wipe dirt off the mating part (female screw) before tightening it.

⚠ WARNING

In case the sealant has entered your eye or attached to your skin, wash it away in running water.

Tightening torque of tapered joint **Unit: N·m {kgf·cm, lbf·ft}**

Screw diameter / Material	1/4	3/8	1/2
Steel	49±10 {500±100, 36.2±7.2}	64±15 {650±150, 47±10}	
Aluminum, brass	25±5 {250±50, 18.1±3.6}	34±5 {350±50, 25.3±3.6}	44±5 {450±50, 32.5±3.6}

(2) To replace vulcanized tape with sealant, remove the tape beforehand, same as (1).

NOTICE

Take special care not to let dirt and foreign matters enter the piping.

(3) In the event of air leakage after sealant is applied and piping attached, retightening cannot check the air leakage. Follow the steps (1) and (2) to reassemble the piping.

NYLON TUBE

EN00Z0001C100008

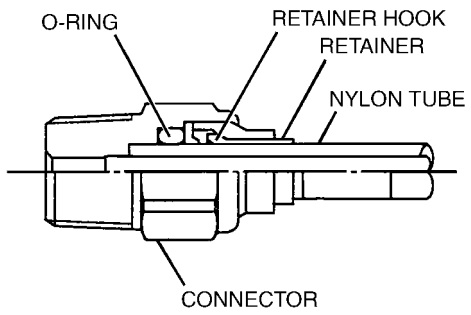
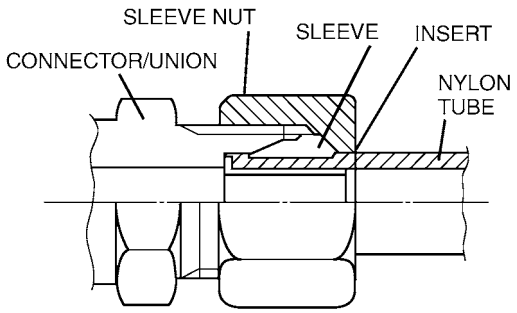
1. TYPES OF JOINT

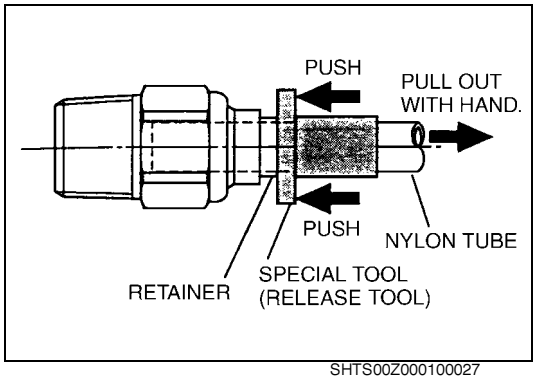
(1) Nylon tube joints have two types: one-touch connector joint and sleeve nut joint.

⚠ CAUTION

Function and quality of a nylon tube and each joint are guaranteed as a set. Use HINO genuine parts. Otherwise a burst or break may result.

Structure of joint and components

One-touch connector joint	Sleeve nut joint
	



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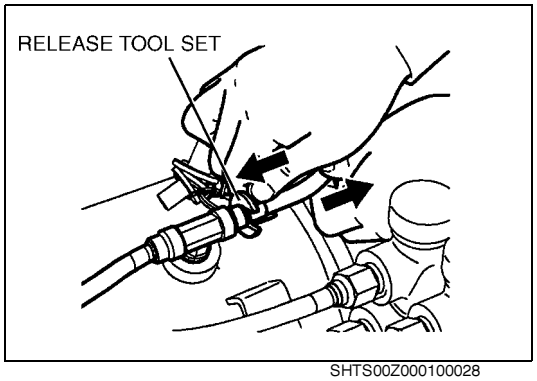
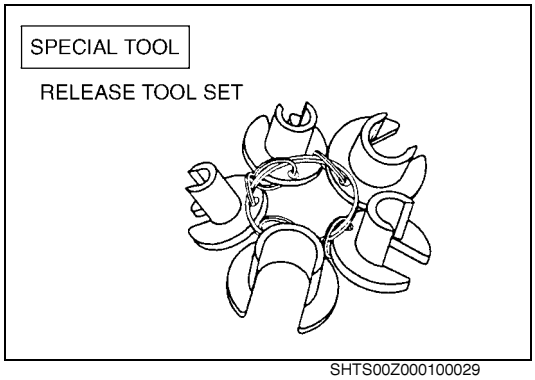
2. ONE-TOUCH CONNECTOR JOINT

(1) Remove the one-touch connector joint.



SHTS00Z000100028

a. Check that there is no dust or dirt in the proximity of the connector end. If any, use air blow to remove dust or dirt before removal.

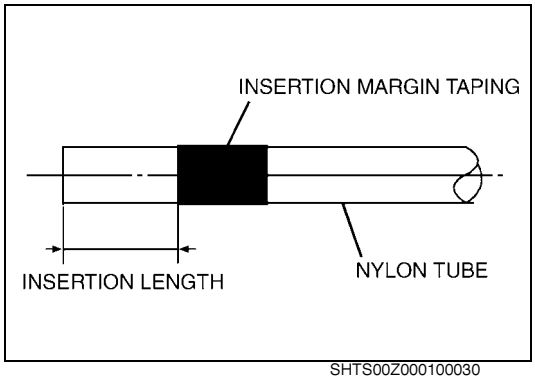


SHTS00Z000100029

b. To remove the connector, pull out the nylon tube at a stroke in the axial direction while holding down the retainer of the connector. Use a dedicated special tool to hold down the retainer of the connector.

Size of special tool

Tube outer diameter	Part No.	Name
ϕ6	S0942-11510	Release tool
ϕ8	S0942-11520	
ϕ10	S0942-11530	
ϕ12	S0942-11540	
ϕ15	S0942-11550	
Set in above five sizes	S0942-11560	Release tool set



SHTS00Z000100030

c. To connect the connector joint, give a mark such as taping at the tube insertion length and insert the tube to the position of the mark.

⚠ CAUTION
Fully insert the nylon tube to the position although shock is felt two times as the nylon tube passes through the retainer hook and O-ring.

Tube outer diameter	Tube insertion length (mm {in.})
ϕ6	21.5-22.5 {0.847-0.885}
ϕ8, ϕ10	22.0-23.0 {0.867-0.905}
ϕ12	22.5-23.5 {0.886-0.925}
ϕ15	24.0-25.0 {0.945-0.984}

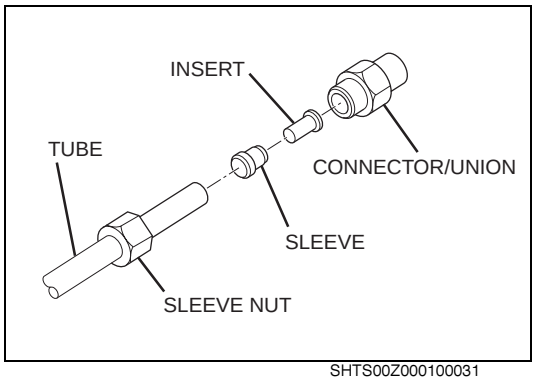
d. After connection, pull the tube and check that the distance from the connector end (retainer) to the taping at the insertion length position is 5 mm {0.197 in.} or less.

3. SLEEVE NUT JOINT

(1) Connection of sleeve nut

a. Thread the sleeve nut and sleeve in this order into the tube. Then push in the insert at the tip.

⚠ CAUTION
Take care of the assembling direction.



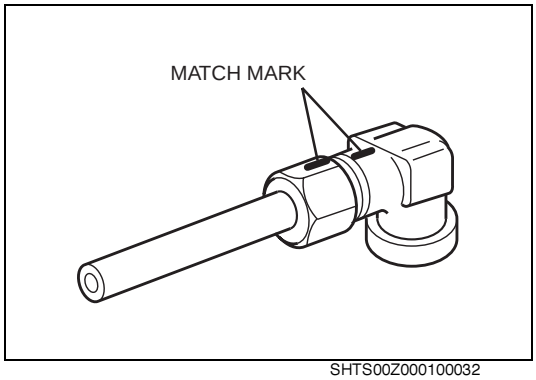
SHTS00Z000100031

b. For connection, push the insert until its end strikes the connector/union while taking care not to let the sleeve nut, sleeve and insert drop. In this state, fully tighten the sleeve nut with hand. The position of sleeve nut is referred to as the "hand-tightening position".

c. Hold down the tube so that it will not move (come loose) and tighten the sleeve nut in accordance with the torque in the table below.

Tightening torque of sleeve nut **Unit: N·m {kgf·cm, lbf·ft}**

Nominal diameter of screw x pitch	Tightening torque
M12 x 1 (ϕ6)	23±5 {230±50, 16.6±3.6}
M14 x 1.5 (ϕ8)	37±4 {380±40, 27.5±2.8}
M16 x 1.5 (ϕ10)	40±5 {410±50, 29.6±3.6}
M18 x 1.5 (ϕ12)	55±5 {560±50, 40.5±3.6}



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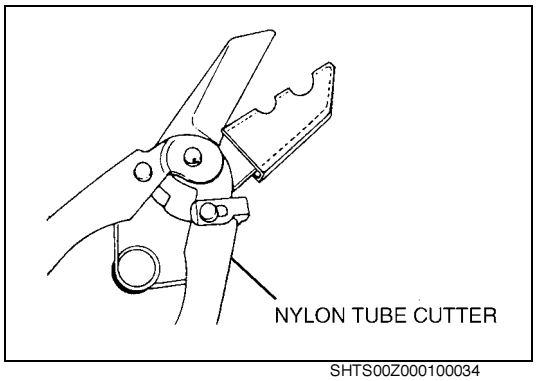
(2) Assembly of sleeve nut (removing the tube from the joint and re-attaching it in the same position)
   a. Give a match mark between the connector/union and the sleeve nut before loosening the sleeve nut so as to memorize the position.
   b. For reassembly, tighten the sleeve nut up to the previous position (match mark position). After that, retighten by 60°.
   c. After reassembly, check for air leakage, if any, retighten until the leakage stops.
   d. If the leakage persists, replace the tube, sleeve and insert with new ones. If this does not stop the leakage, replace the sleeve nut and connector/union as well.

4. HANDLING OF NYLON TUBE

(1) Types of nylon tube

	Tube indication	Tube outer diameter	Operating temperature range
DIN tube	DIN 74324 6X1 PA11PL NITTA MOORE YY123456789101112 JAPAN	**ϕ6, ϕ10, ϕ12**	**-40-90°C {-40-194°F}**

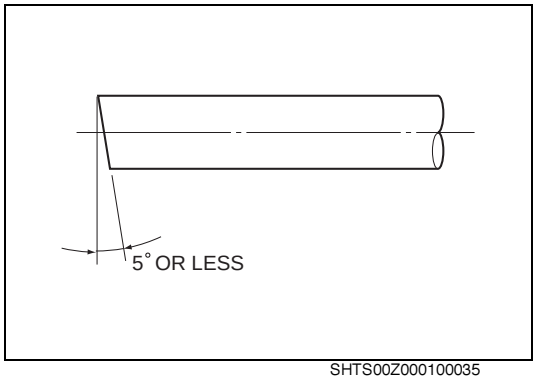


SHTS00Z000100034

(2) Cut the nylon tube.
   a. To cut a nylon tube in a predetermined length, use a dedicated special tool.
   SST: Nylon Tube Cutter (S0946-01020)

⚠ CAUTION

- **Cut a tube only when there is extra length or when using a new tube.**
- **When cutting a nylon tube, set the squareness of the tube end with respect to the axis core within 90±5°.**

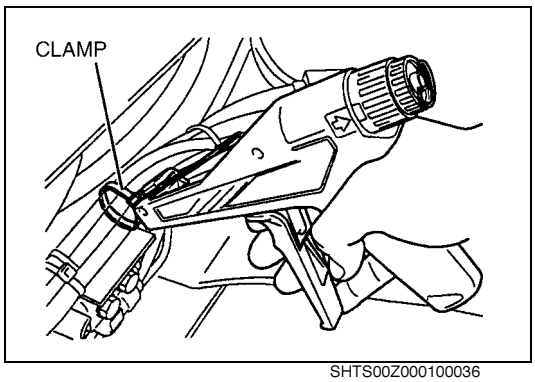


SHTS00Z000100035

⚠ CAUTION

- **Never repair a nylon tube under high temperatures exceeding the operating temperature range, in particular when drying the coating.**
- **For punching, welding and sanding, protect a nylon tube from tools, cutting, heat source or spark or remove the nylon tube.**
- **Never attach the clamp of the welder near the tube.**
- **Never splash acidic liquid such as battery liquid onto the tube.**
- **Never exceed the minimum bending radius R of the nylon tube listed in the table below. Avoid using a tube with trace of bending line.**

Tube outer diameter	Minimum bending radius in use: R (mm {in.})
ϕ6	30 {1.181}
ϕ8	50 {1.969}
ϕ10	65 {2.559}
ϕ12	70 {2.756}
ϕ15	80 {3.150}



SHTS00Z000100036

(3) Fixing the nylon tube

a. To fix the nylon tube to a vehicle, use a dedicated clamp and a dedicated special tool or clamping tool available on the market.

SST:
Clamp (S4783-71230)
Nylon Tube Tensioning Tool Assembly (S0962-01010)

Tool available on the market: Clamping tool (Tyton MK6)
Clamping torque (reference): 166.6 N {17 kgf, 37.5 lbf}

⚠ CAUTION

- **Set the tool clamping force to "3" on the dial.**
- **If the nylon tube is fixed with nonconforming clamping force, the nylon tube may be damaged.**

ASSEMBLY OF JOINT/GASKET FOR PIPING

EN00Z0001C100009

1. TIGHTENING TORQUE OF JOINT

Unit: N·m {kgf·cm, lbf·ft}

Seal system	Gasket seal system (aluminum+rubber or copper)	Metal seal system (Flare pipe system, nipple connector system)	
Tightening screw size		Type A	Type B
M8	13 {130, 9.4}		
M10	20 {200, 14}		11 {110, 8.0}
M12	25 {250, 18}	20 {200, 14}	
M14	25 {250, 18}	31 {320, 23}	
M16	29 {300, 22}	39 {400, 29}	
M18	39 {400, 29}	59 {600, 43}	
M20	*39 {400, 29}	64 {650, 47}	
M24	69 {700, 51}		20 {200, 14}
M28	*127 {1,300, 94}		

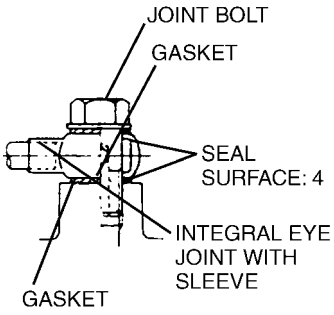
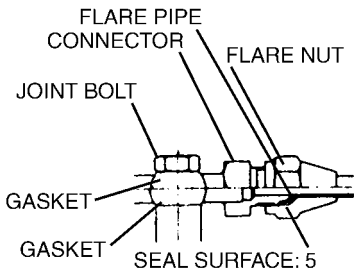
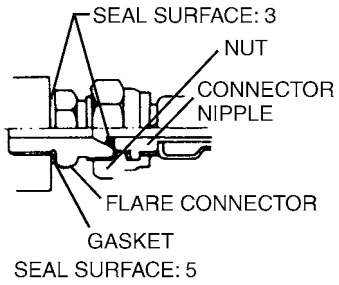
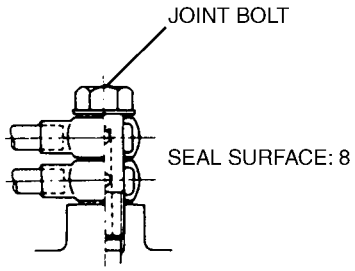
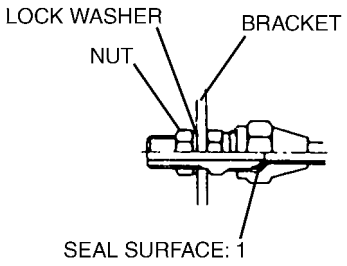
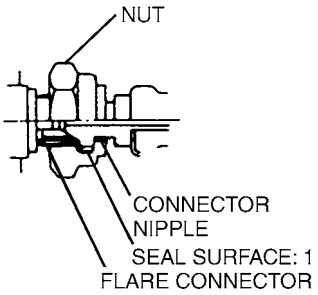
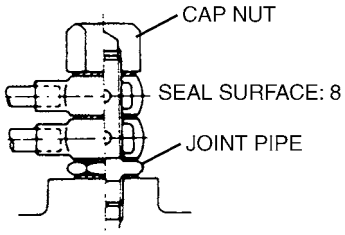
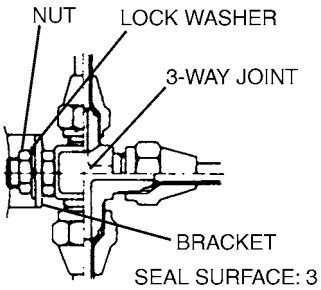
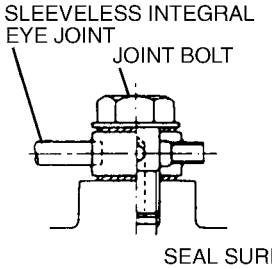
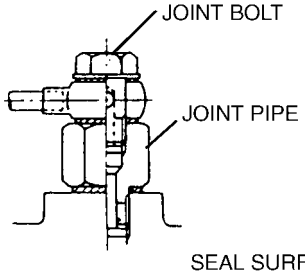
2. JOINT ASSEMBLY PROCEDURE AND POST-INSPECTION

(1) Before starting assembly, check that there is no dust or burr on each seat surface (mating part, pipe joint, gasket).
(2) Pipes are provided with the degree of freedom in assembly. The seat face is likely to be tilted. Temporarily tighten the pipe then perform final tightening in order to avoid leakage.
(3) When the tightening is complete, apply a regular pressure to each pipe joint and check that there is no leakage.
(4) Observe the above tightening torque values.

NOTICE

When a soft washer of the aluminum plus rubber carbon press-fitting type is once mounted then loosened or removed, replace it with a new one. This does not apply to normal retightening.

3. EXAMPLES OF JOINT SYSTEM FOR PIPING

Gasket seal system	Metal seal system	
	Type A (Flare pipe system)	Type B (Nipple connector system)
		
		
		
		
		

HANDLING OF LIQUID GASKET

EN00Z0001C100010

1. APPLICATION OF LIQUID GASKET AND ASSEMBLY OF PARTS

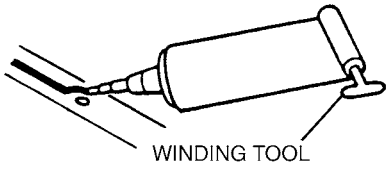
(1) Thoroughly remove the old liquid gasket on each part and mating part and clean the parts by using waste to wipe off oil, water and dust.
Overlap the coating at the beginning and end of coating.
(2) To assemble coated part, beware of any dislocation from the mating part. If any dislocation is found, coat the part again.
(3) Finish assembly within 20 minutes of completion of liquid gasket application.
If 20 minutes is exceeded, remove the liquid gasket and apply it again.
(4) Wait at least 15 minutes after assembly of parts before starting the engine.

2. REMOVING PARTS

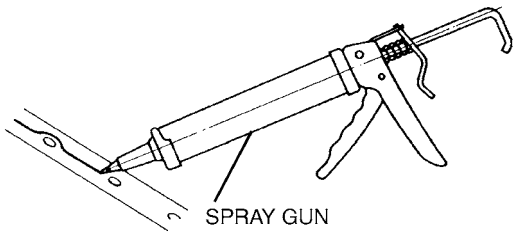
(1) To remove each part, never twist a single section but twist the part in alternate directions at the collar or clearance on the flange. When removing gasket, take care not to let the refuse of gasket enter the engine.

3. OTHER

(1) When the liquid gasket comes in a tube, use the supplied winding tool. When the gasket comes in a cartridge, use a spray gun.

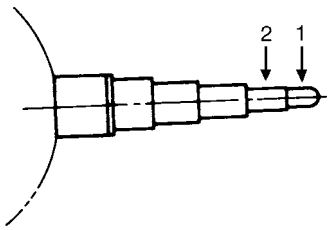


TUBE



CARTRIDGE TYPE

Note that the cutting position of the nozzle of the tube provides necessary width of application.



NOZZLE OF THE TUBE

1: Approx. 2 mm {0.079 in.} when cut at the first segment
2: Approx. 5 mm {0.197 in.} when cut at the second segment

TROUBLESHOOTING USING THE TROUBLE LIST

EN00Z0001F200001

EXAMPLE

ENGINE INTRODUCTION (E13C) EN01–3

TROUBLESHOOTING

A possible cause and remedy/prevention are indicated for every item, respectively.

EN01ABC01F300001

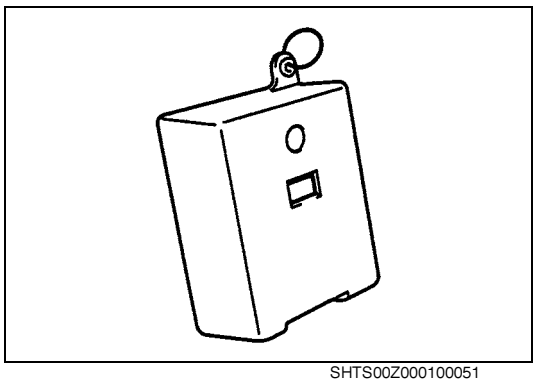
Engine overheating

Symptom	Possible cause	Remedy/Prevention
Engine overheating (Coolant)	Insufficient coolant	Add coolant.
	Defective thermostat	Replace thermostat.
	Overflow of coolant due to leakage of exhaust into cooling system	Repair.
	Damaged rubber hose	Replace rubber hose.
	Coolant leakage due to deteriorated rubber hose	Replace rubber hose.
	Coolant leakage from coolant pump	Replace the coolant pump.
	Coolant leakage from rubber hose connection	Retighten or replace clamp.
	Coolant leakage from cylinder head gasket	Replace gasket.
Engine overheating (Coolant pump)	Bearing seizure	Replace.
	Damaged (corroded) vane	Replace vane.
Engine overheating (Radiator)	Clogged with rust or scale	Clean radiator.
	Clogged with iron oxide due to leakage of exhaust into cooling system	Clean coolant passage and correct exhaust leakage.
	Coolant leakage	Repair or replace radiator.
	Damaged cooling fan	Replace cooling fan.
	Clogged radiator core due to mud or other debris	Clean radiator.
	Defective radiator cap pressure valve	Replace radiator cap.
Engine overheating (Abnormal combustion)	Poor fuel	Use good quality fuel.
	Breakdown of injector	Replace the injector.
Engine overheating (Other problems)	Defective or deteriorated engine oil	Change engine oil.
	Unsatisfactory operation of oil pump	Replace or repair.
	Insufficient oil	Add oil.
	Brake drag	Repair or adjust.
	Break water temperature sensor	Replace it.
Engine overheating (Severe operating condition)	Lugging the engine	Operate engine properly.

SHTS00Z000100050

TROUBLESHOOTING USING A DIAGNOSIS MONITOR

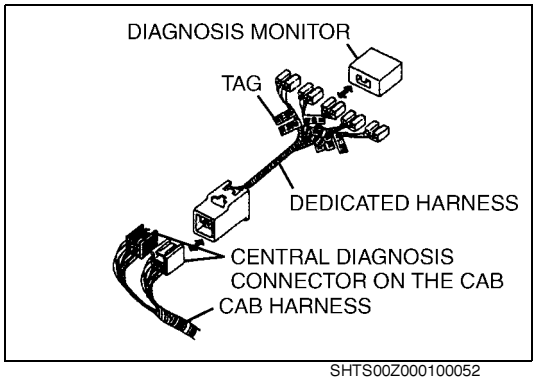
EN00Z0001F200002



SHTS00Z000100051

1. DIAGNOSIS MONITOR

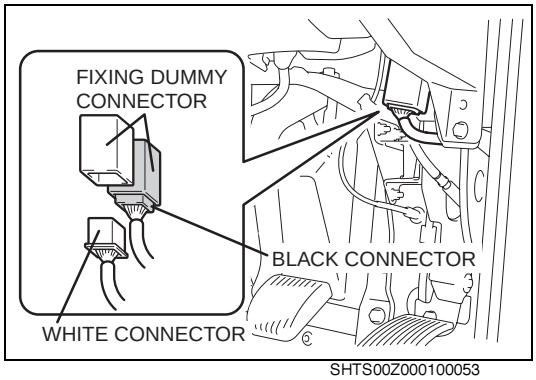
(1) When connected to the diagnosis connector dedicated to each system, the diagnosis monitor indicates a faulty section with sound and light.
SST: Diagnosis Monitor (S0963-01370)



SHTS00Z000100052

2. CONNECTION OF DIAGNOSIS MONITOR

(1) Turn "ON" the starter switch.
(2) Connect a dedicated harness to the black (or white) connector out of the central diagnosis connectors (total 2) at the lower right section of the instrumental panel at the driver's seat, and connect the diagnosis monitor to the connector having the tag of "each system name".
SST: Dedicated Harness (S0963-02300)



SHTS00Z000100053

⚠ CAUTION

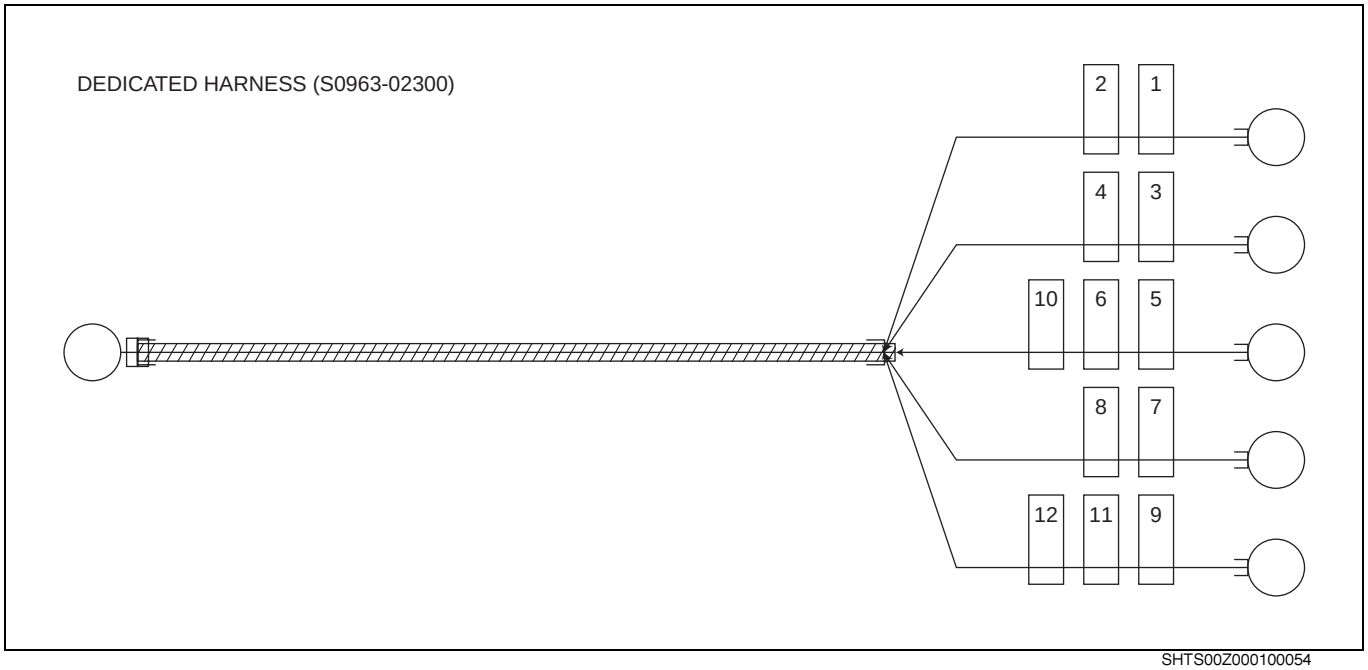
The central diagnosis connectors are normally connected to the fixing dummy connectors. Remove the central diagnosis connectors from the dummy connectors before using them. When the central diagnosis connectors are not used, they should be engaged into the fixing dummy connectors.

HINT

- **Turning "ON" the starter switch with the diagnosis monitor connected causes the diagnosis monitor to keep sounding without outputting diagnosis monitor codes. First turn "ON" the starter switch, wait at least ten seconds, and connect the diagnosis monitor.**
- **The method for outputting diagnosis monitor codes differs from system to system. Follow the instruction in the chapter for each system.**

TAG AND SYSTEM NAME OF DEDICATED HARNESS

	Tag name	Name of system to be diagnosed
1	STD: ENG	Common rail
3	STD: AIR BAG	Not used
5	STD: ABS/ASR	ABS
7	STD: ES START	Not used
10	STD: VSC	Not used
11	STD: TIRE	Not used
2	OPT: RTD/4WD	Not used
4	OPT: SHAKAN	Not used
6	OPT: AIR SUS	Not used
8	OPT: IDL STOP	Not used
9	OPT: ATM	Not used
12	OPT: PRO SHIFT	Not used



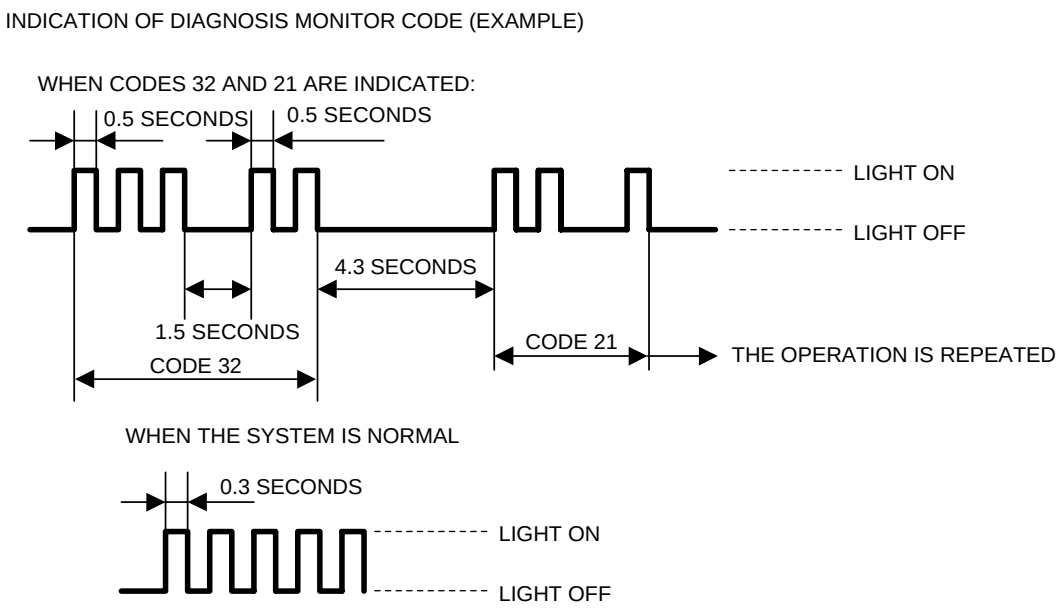
SHTS00Z000100054

3. INDICATION OF DIAGNOSIS MONITOR CODE

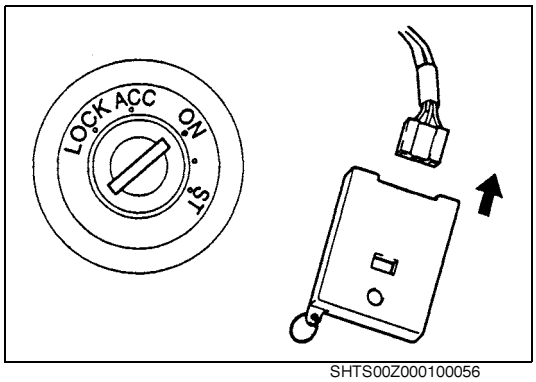
(1) Diagnosis code can be checked on the diagnosis monitor and check engine light. For example, diagnosis codes 32 and 21 are indicated as described below. The indication method uses the blinking interval of light. For the first code, "3" in the ten place illuminates for 0.5 seconds three times and twice after 1.5 seconds. For the second code, the light illuminates twice and once for the same period as the first code after an interval of 4.3 seconds; this operation is repeated. In case there is no fault in the system, light repeats blinking for 3 seconds.

HINT

Indication of a diagnosis code in the figure below is a typical example. For details, refer to chapter on each system.



SHTS00Z000100055



SHTS00Z000100056

4. ERASURE OF PAST FAULTS

(1) Record the first output diagnosis monitor code.

(2) Remove the diagnosis monitor with the starter key in the "ON" position.

⚠ CAUTION

- **If the starter key is placed in "LOCK" position, the past faults are not erased. Keep the starter key "ON".**
- **Erase the malfunction code memory using the PC DIAGNOSIS TOOL (Hino DX).**

(3) Wait at least 5 seconds. Connect the diagnosis monitor to output the current fault information.

5. HOW TO USE TROUBLESHOOTING BY DIAGNOSIS MONITOR CODE

(1) The "diagnosis code table" and "Troubleshooting by code" are shown for each system which outputs diagnosis codes. In case the diagnosis code is identified, troubleshooting may be initiated referring to the code list.

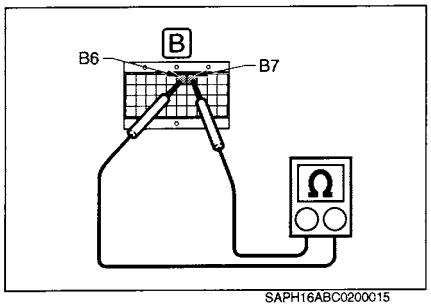
EXAMPLE

DN02–32 FUEL CONTROL (E13C)

ENGINE SPEED MAIN SENSOR

EN16ABC02F200008

MC No.	13	DTC No.	P0335	Engine speed main sensor circuit malfunction



SAPH16ABC0200015

1. CHECK THE RESISTANCE BETWEEN TERMINALS.

(1) Set the starter switch to "LOCK" and connect the signal check harness.

(2) Disconnect the signal check harness connector on the ECU side.

(3) Measure the resistance between NE1+ (B6) and NE1- (B7) terminals.

Standard: APPROX. 108.5 — 142.5 Ω at 20°C {68°F}

Working description

NO → Proceed to 3

YES

2. RECHECK THE MC or DTC.

(1) Connect the signal check harness connector on the ECU side.

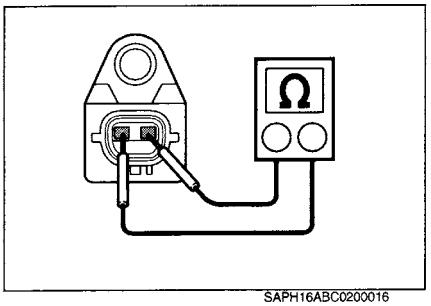
(2) Erase the MC or DTC memory.

(3) Check the MC or DTC.

NO →
- Bad contact of ECU connectors
- Malfunction of ECU
- Malfunction of harness (Short circuit)

YES

Normal



SAPH16ABC0200016

3. CHECK THE ENGINE SPEED MAIN SENSOR.

(1) Disconnect the connectors of engine speed main sensor.

(2) Measure the resistance between terminals of engine speed main sensor.

Standard: APPROX. 108.5 — 142.5 Ω at 20°C {68°F}

Indicating the need for replacement of the engine speed main sensor.

NO → Malfunction of engine speed main sensor

YES

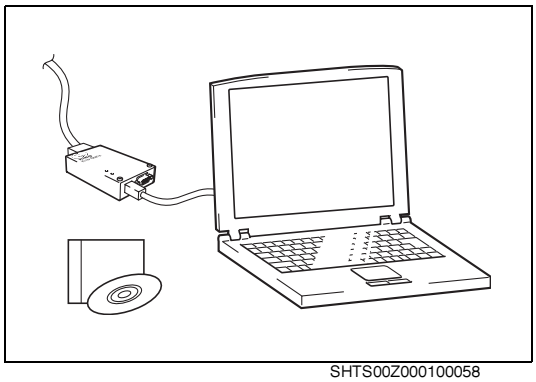
Check the harness of related circuit and repair the defective section.

- Harness disconnection
- Bad contact of connectors

SHTS00Z000100057

DIAGNOSIS USING THE PC (PERSONAL COMPUTER) DIAGNOSIS TOOL WITH INTERFACE

EN00Z0001F200003



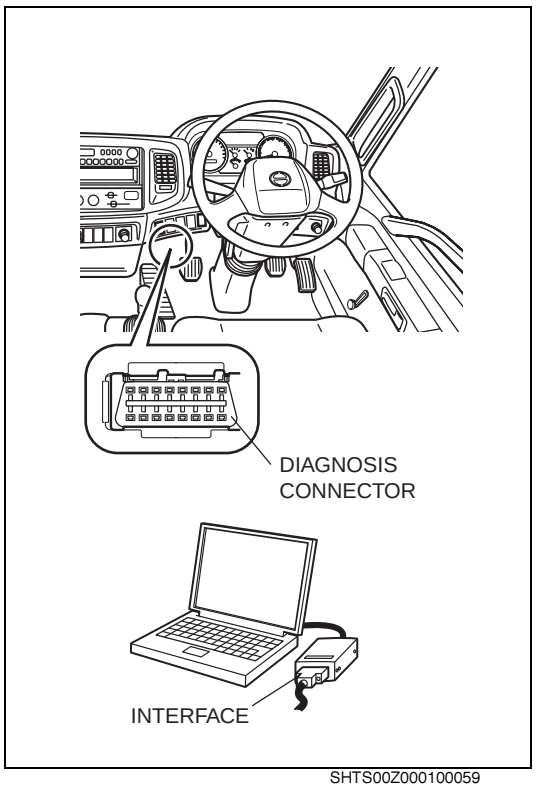
SHTS00Z000100058

1. DIAGNOSIS TOOL

- Trouble diagnosis can be performed using the PC diagnosis tool. By connection to the diagnosis connector, the trouble location is indicated.

SST:
Interface Box (Hino-Bowie) (09993-E9070)
Cable between vehicle & Hino-Bowie (S0904-21220)
Diagnosis software: HINO Diagnostic explorer (DX)
Reprogramming software: HINO Reprog Manager

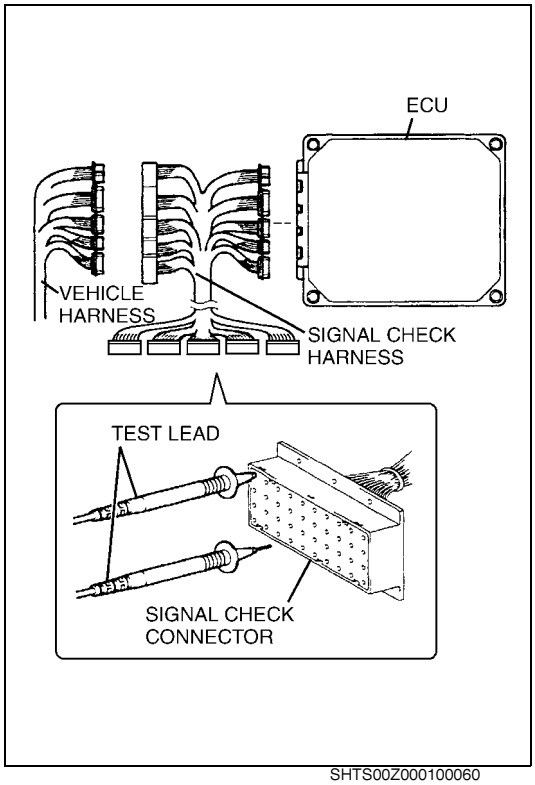
NOTICE
Only ECU reprogramming can be performed by authorized HINO dealer.



SHTS00Z000100059

2. CONNECT THE PC DIAGNOSIS TOOL

(1) Turn the starter switch to the "LOCK" position.
(2) Connect the diagnosis cable between diagnosis connector and interface.
(3) Connect the interface to the PC.
(4) Turn the starter switch to the "ON" position.
(5) The opening menu will be displayed on the PC screen.



SHTS00Z000100060

3. CONNECTION OF SIGNAL CHECK HARNESS

(1) To prevent damage to ECU connector and improve workability, connect a signal check harness. Perform measurement while placing the test lead on the signal check connector of the signal check harness.

a. Remove the connector from ECU.

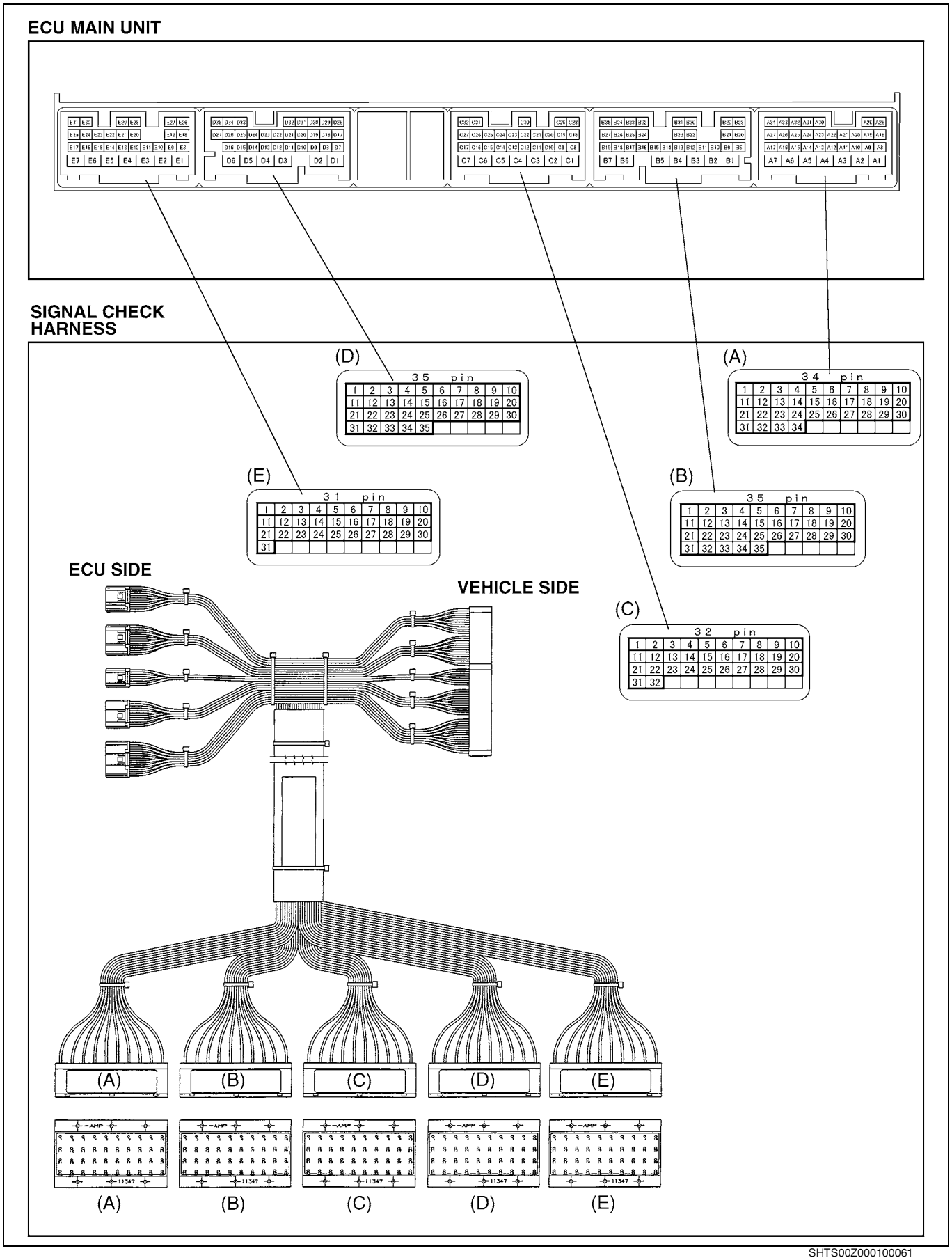
⚠ CAUTION

Take care not to snap off the lock lug of the connector.

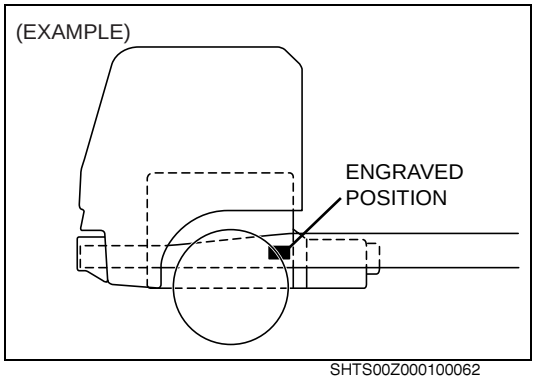
b. Connect a signal check harness to the vehicle harness and ECU.

SST: Signal Check Harness (for common rail type fuel injection system) (S0904-91080)

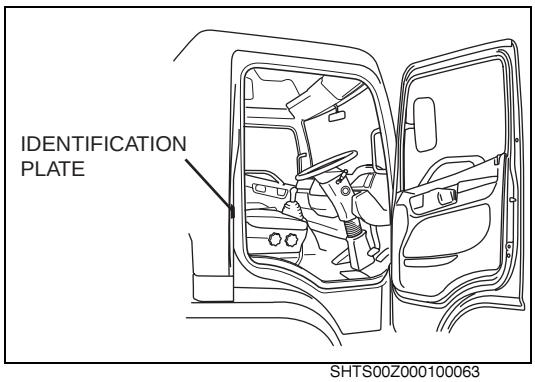
(2) Terminal number
ECU terminal numbers in the text correspond to connectors of signal check harness as shown below.



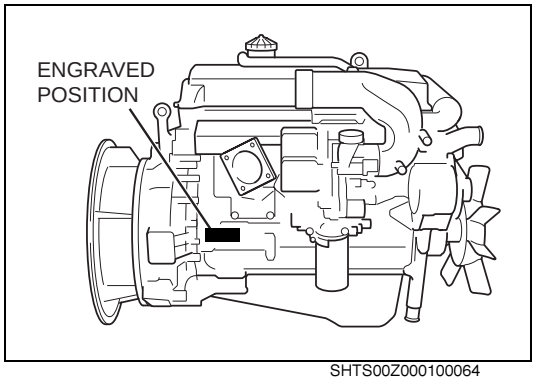
SHTS00Z000100061



SHTS00Z000100062



SHTS00Z000100063



SHTS00Z000100064

CHASSIS SERIAL NUMBER, VEHICLE IDENTIFICATION NUMBER AND ENGINE SERIAL NUMBER

EN00Z0001C100011

1. VEHICLE MODEL AND CHASSIS SERIAL NUMBER OR VEHICLE IDENTIFICATION NUMBER

(1) Vehicle model and chassis serial number or vehicle identification number are engraved near the front wheel of the right or left frame of the vehicle. When ordering parts, notify us of these numbers for quick support.

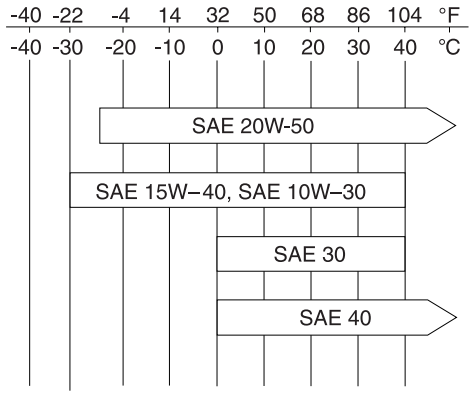
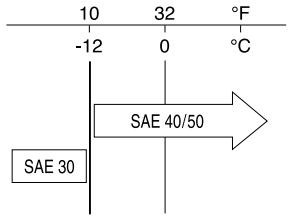
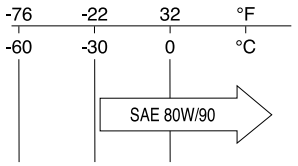
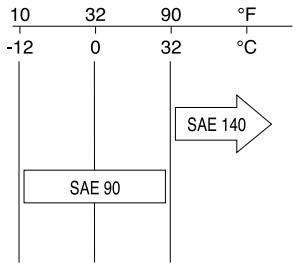
(2) At the step inside the right door of the cab is attached an identification plate stamped the vehicle model and chassis serial number or vehicle identification number.

2. ENGINE MODEL AND ENGINE SERIAL NUMBER

(1) Engine model and engine serial number are engraved on the right side of the cylinder block.
When ordering parts, notify us of these numbers for quick support.

RECOMMENDED LUBRICANTS

EN00Z0001C100012

No.	LUBRICANTS	POSITIONS	VISCOSITY RECOMENDATIONS (SAE)
1	**Engine oil** **(JASO: DH-1, DH-2*1)** **(API: CD*2, CE*2, CF, CH-4, CI-4, CJ-4)** **(ACEA: E-3, E-4, E-5*1, E-6)** ***1: HINO recommends these oil to the EURO4/EPA07 regulation countries, and use ultra-low sulfur fuel only.** ***2: These oil grades do not comply with the latest exhaust emission (EURO4/EPA07 etc.) regulations, and HINO cannot recommend the use of these oil grades.**	**Cylinder block**	
2	**Gear oil** **[API: CD (Mineral oil)]**	**Transmission:** **FULLER** **RTO11909ALL**	
	Gear oil **(API: GL-4)**		
	Eaton Approved Synthetic oil **Eaton Approved Semi-Synthetic oil**		**—**
3	**Hypoid gear oil** **(API: GL-5)**	**Differential (Rear):** **THD17**	
4	**Gear oil** **(API: GL-4)**	**Steering**	

No.	LUBRICANTS	POSITIONS
5	**Power steering fluid (ATF DEXRON)**	**Integral power steering gear**
6	**Clutch fluid (DOT-3) or (DOT-4)**	**Clutch**
7	**Wheel bearing grease** **Lithium base wheel bearing grease NLGI No.2 LITHIUM-SOAP**	**Wheel hub**
8	**Chassis grease** **Lithium base multipurpose grease No.2**	**Steering, suspension, etc.**

ENGINE INTRODUCTION (A09C)

EN01-001

ENGINE ASSEMBLY

DATA AND SPECIFICATIONS

EN0111201I200001

ENGINE SERIES: A09C-TK/ -TJ

Type		**Diesel, 4 cycle, vertical, 6 cylinder, in-line overhead camshaft, water-cooled, direct injection**
Aspiration		**Turbocharged with intercooler**
Bore and stroke		**112x150 mm {4.409x5.906 in.}**
Piston displacement		**8.866 L {541.0 cu.in.}**
Compression ratio		**17.0: 1**
Firing order		**1-4-2-6-3-5 (The cylinder numbers are counted in order from the crankshaft pulley side)**
Direction of rotation		**Counterclockwise viewed from flywheel**
Compression pressure		**3.3 MPa {34 kgf/cm^2, 479 lbf/in.^{2}} at 200 r/min.**
Maximum revolution (at full load)		**2,100 r/min.**
Idling revolution		**500 r/min.**
Dry weight		**Approximately 850 kg {1,874 lbf}**
Valve seat angle	**Intake**	**30°**
	Exhaust	**45°**
Valve face angle	**Intake**	**30°**
	Exhaust	**45°**
Valve timing (flywheel travel)	**Intake opens**	**14° before top dead center**
	Intake closes	**30° after bottom dead center**
	Exhaust opens	**44° before bottom dead center**
	Exhaust closes	**13° after top dead center**
Valve clearance (when cold)	**Intake**	**0.21 mm {0.0083 in.}**
	Exhaust	**0.39 mm {0.0154 in.}**
Engine oil pump	**Type**	**Full forced pressure feed by gear pump**
	Drive	**By gear**
Engine oil cooler		**Multi-plate type, water cooled**
Injection nozzle	**Type**	**Multi-hole nozzle type**
	Valve opening pressure	**25 MPa {255 kgf/cm^2, 3,626 lbf/in.^{2}}**
Coolant pump	**Type**	**Forced circulation by volute pump**
	Drive	**By V-belt**
Thermostat type		**Wax.type, bottom bypass system**
Injection timing (flywheel travel)		**0° at top dead center for No.1 cylinder of the compression stroke**

TROUBLESHOOTING

EN0111201F300001

Symptom	Possible cause	Remedy/Prevention
Engine overheating (Coolant)	Insufficient coolant	Add coolant.
	Defective thermostat	Replace thermostat.
	Overflow of coolant due to leakage of exhaust into cooling system	Repair.
	Coolant leakage from EGR cooler	Replace EGR cooler.
	Coolant leakage from coolant pump	Replace the coolant pump.
	Coolant leakage from cylinder head gasket	Replace gasket.
Engine overheating (Radiator)	Clogged radiator core due to mud or other debris	Clean radiator core.
	Clogged with iron oxide due to leakage of exhaust into cooling system	Clean coolant passage and correct exhaust leakage.
	Clogged front surface of radiator core due to mud or other debris	Clean radiator.
	Defective radiator cap pressure valve	Replace radiator cap.
	Clogged front surface of intercooler core	Clean intercooler.
Engine overheating (Compression pressure)	Incorrect injection timing	Inspect engine ECU.
	Poor fuel	Use good quality fuel.
	Breakdown of injector	Replace the injector.
Engine overheating (Oil system)	Defective or deteriorated engine oil	Change engine oil.
	Unsatisfactory operation of oil pump	Replace or repair.
	Insufficient oil	Add oil.
Excessive oil consumption (Pistons, cylinder liners, and piston rings)	Wear of piston ring and cylinder liner	Replace piston rings and cylinder liner.
	Worn, sticking or broken piston rings	Replace piston rings and cylinder liner.
	Insufficient tension on piston rings	Replace piston rings and cylinder liner.
	Unsatisfactory installation in of piston rings	Reassemble piston rings.
	Unsuitable oil (viscosity too low)	Change oil as required and replace piston rings and cylinder liners.
	Gaps of piston rings in cell with each other	Reassemble piston rings.
Excessive oil consumption (Valve and valve guides)	Worn valve stem and valve guide	Replace valve and valve guide.
	Incorrectly fitted valve stem seal	Replace the stem seal.
	Excessive lubricant on rocker arm	Check clearance of rocker arm and shaft.
Excessive oil consumption (Other problems)	Oil level too high	Drain excess oil.
	Oil leakage from miscellaneous parts	Repair or replace.
	Damaged closed-ventilator	Replace.
Piston seizure (Operation)	Abrupt stoppage of engine after running at high speed	Operate engine properly.
Piston seizure (Oil system)	Insufficient oil	Add oil.
	Dirty oil	Change oil.
	Poor quality oil	Replace with proper engine oil.
	Low oil pressure	Repair.
	Defective oil pump	Repair oil pump.
Piston seizure (Other problems)	Abnormal combustion	See Symptom: "**Engine overheating**"
	Damaged cooling system	See Symptom: "**Engine overheating**"

Symptom	Possible cause	Remedy/Prevention
Lack of power (Air cleaner)	Clogged air cleaner	Clean or replace element.
Lack of power (Fuel and injector)	Breakdown of injector	Replace the injector.
	Air in fuel system	Repair and bleed air from fuel system
	Clogged fuel filter	Replace element.
	Use of poor fuel	Use good quality fuel.
Lack of power (Other problems)	Engine overheating	See Symptom: "**Engine overheating**"
	Abnormal compression pressure	See Symptom: "**Engine overheating**"
	Worn or broken piston rings, piston and cylinder liner	Replace piston rings, piston and liner.
Difficulty starting engine (Electrical system)	Discharged battery	Charge battery.
	Defective wiring in starter circuit	Repair wiring of starter.
	Loose or open-circuit battery cable	Tighten battery terminal connections or replace battery cable.
	Defective starter	Replace.
	Defective starting aids	Inspect and replace.
	Defective harness circuit	Replace ECU main relay, PCV main relay, fuse about engine.
Difficulty starting engine (Air cleaner)	Clogged element	Replace the element.
Difficulty starting engine (Fuel system)	No fuel in tank	Supply fuel and air bleed.
	Clogged fuel line	Clean fuel line, replace fuel filter.
	Air sucked into fuel system through fuel line connections	Tighten fuel line connections.
	Clogged fuel filter	Replace.
	Loose connection in high-pressure line	Tighten sleeve nut of high-pressure line.
	Seized injector	Replace.
Difficulty starting engine (Oil system)	Oil viscosity too high	Use proper viscosity oil, or install an oil immersion heater and warm up oil.
Difficulty starting engine (Other problems)	Seized piston	Replace piston, piston rings, and liner.
	Seized bearing	Replace bearing and/or crankshaft.
	Reduced compression pressure	Overhaul engine.
	Ring gear damaged or worn	Replace the ring gear and/or starter pinion.
Rough idling (Injector)	Improper spray pattern	Inspect and replace.
Rough idling (Valve system)	Improper valve clearance	Adjust valve clearance.
	Improper contact of valve seat	Replace or repair valve and valve seat.
Rough idling (Other problems)	Coolant temperature too low	Warm up engine.
	Compression pressure of cylinders markedly different from one another	Overhaul engine.
Leakage of exhaust (Head gasket)	Damage	Replace gasket.
	Improper installation	Replace gasket.
Leakage of exhaust (Head bolts)	Improper tightening torque or tightening sequence	Tighten properly.
	Loose bolts	Tighten bolts.
	Elongated bolts	Replace bolts.
Leakage of exhaust (Cylinder head)	Cracking	Replace cylinder head.
	Under surface distortion	Repair or replace.

Symptom	Possible cause	Remedy/Prevention
Leakage of exhaust (Cylinder block)	Cracking	Replace cylinder block.
	Surface distortion	Repair or replace.
	Fretting of cylinder liner insertion portion (insufficient projection of cylinder liner)	Replace cylinder liner and/or block.
Leakage of exhaust (Cylinder liners)	Cracking	Replace cylinder liner.
	Corrosion	Replace cylinder liner.
	Insufficient projection of cylinder liner	Replace cylinder liner.

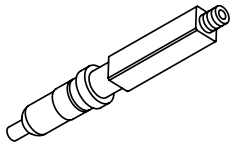
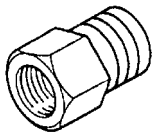
NOTICE
If oil consumption is excessive, the problems above will occur. Complaints from the customer are often related to such problems.

1. **White smoke is emitted continuously when the engine is run at high speed.**
2. **White smoke is emitted only immediately after the engine speed is abruptly raised when idling.**
3. **The tail pipe is blackened with oil.**
4. **Oil leaks from the flanges of the exhaust manifold.**
5. **Lack of power.**
6. **Excessive blow-by gas.**

SPECIAL TOOL

EN0111201K100001

Prior to starting an engine overhaul, it is necessary to have these special tools.

Illustration	Part number	Tool name	Remarks
	09203-E1020	COMPRESSION GAUGE ADAPTER (A)	
	S0955-21030	COMPRESSION GAUGE ADAPTER (B)	
	S0955-21060		

MEASUREMENT OF COMPRESSION PRESSURE

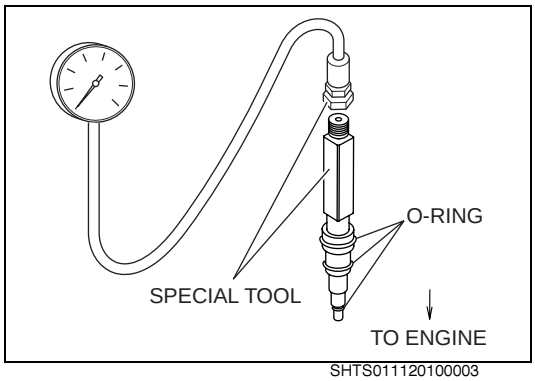
EN0111201H300001

HINT
Before disassembling the engine, measure and record a compression pressure. Periodical compression pressure measurements will be a great aid in knowing the engine conditions.

1. PREPARATION OF CHECKING AND ADJUSTMENT
(1) Charge the battery completely.
(2) Set the valve clearance to the correct value.
(3) Idle the engine (Coolant temperature at 80°C {176°F}).
(4) Remove the air cleaner.
Refer to the section **"AIR CLEANER"** in the chapter **"AIR INTAKE SYSTEM"**.
(5) Remove the head cover.
Refer to the section **"HEAD COVER"** in the chapter **"ENGINE MECHANICAL"**.
(6) Remove all injectors.
Refer to the section **"INJECTOR"** in the chapter **"FUEL SYSTEM"**.
(7) Cut a head cover into half (enough to cover the camshaft) to make a jig for avoiding spatter of engine oil. Attach this jig.

2. VALVE CLEARANCE CHECKING
(1) Install new O-rings to the grooves of the compression gauge adapter (A).

SST: Compression gauge adapter (A) (09203-E1020)



SHTS011120100003

(2) Insert the compression gauge adapter with injector clamp.
(3) Tighten the injector clamp installation bolt.
Tightening Torque:
34 N·m {350 kgf·cm, 25 lbf·ft}

(4) Connect the pressure gauge using the compression gauge adapter (B).
SST:
Compression gauge adapter (B) (S0955-21030)
Compression gauge adapter (B) (S0955-21060)

NOTICE
For details, refer to the section "INJECTOR" in the chapter "FUEL SYSTEM".

(5) Run the engine with the starter and measure the compression pressure.

NOTICE
- **Do not operate the starter for more than 15 seconds.**
- **Since the air cleaner is removed, take a special care not to breathe in any contaminants.**

(6) Measure the compression pressure of each cylinder.

Standard	Limit
3.3 MPa {34 kgf/cm^2, 479 lbf/in.^{2}}	3.0 MPa {31 kgf/cm^2, 435 lbf/in.^{2}}
Engine revolution 200 r/min.	

(7) If a compression pressure is below the permissible limit or if a variance between cylinders exceeds the standard value, overhaul the engine.
(8) Reassemble the removed parts.

VALVE CLEARANCE ADJUSTMENT

EN0111201H300002

NOTICE

- **Before start of adjustment works, check that the head bolt and the rocker support bolt have been tightened to the specified torque.**
- **Check that the crosshead and the valve stem head are free of dusts or other contaminants.**

1. VALVE CLEARANCE ADJUSTMENT

(1) Set the cylinder to the top dead center on the compression stroke for making adjustment by rotating the crankshaft in the positive direction.

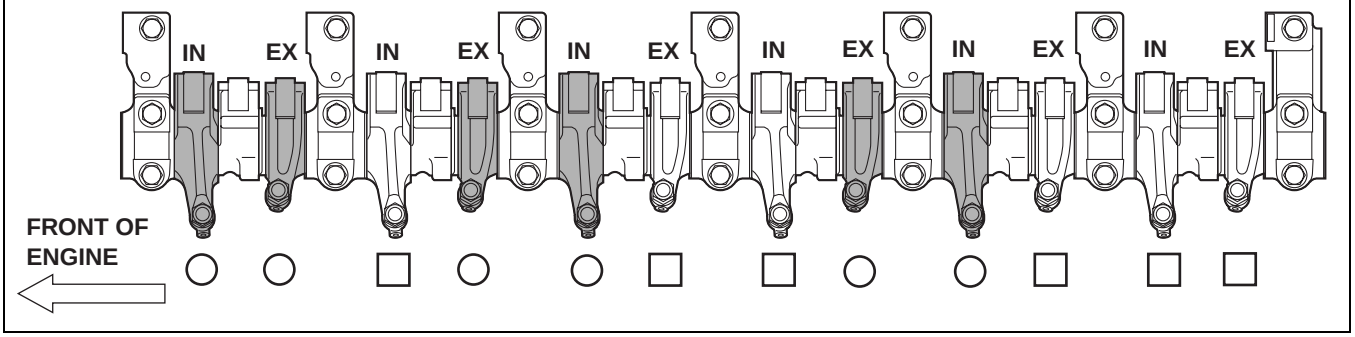
NOTICE

Check that the rocker arms to be adjusted are not lifted by the cam on the camshaft.

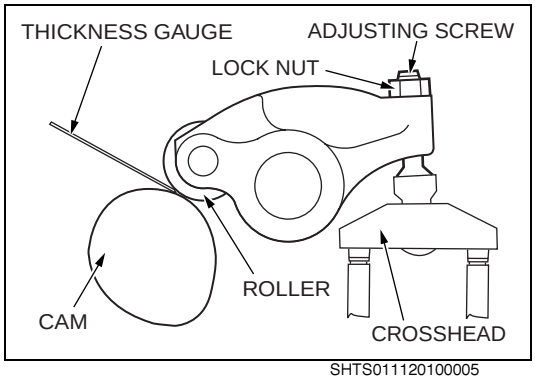
HINT

- **When the cylinder No.1 is set to the top dead center on the compression stroke, the valve clearances shown with a circle marked in the table below can be adjusted. When the cylinder No.6 is set to the top dead center on the compression stroke, the cylinders shown with a square marked in the table below can be adjusted.**
- **"IN" means Intake and "EX" means Exhaust.**

Cylinder No.	1		2		3		4		5		6	
Valve	IN	EX	IN	EX	IN	EX	IN	EX	IN	EX	IN	EX
With No.1 cylinder at T.D.C. on compression stroke	○	○		○	○			○	○			
With No.6 cylinder at T.D.C. on compression stroke			□			□	□			□	□	



- **T.D.C: Top Dead Center**



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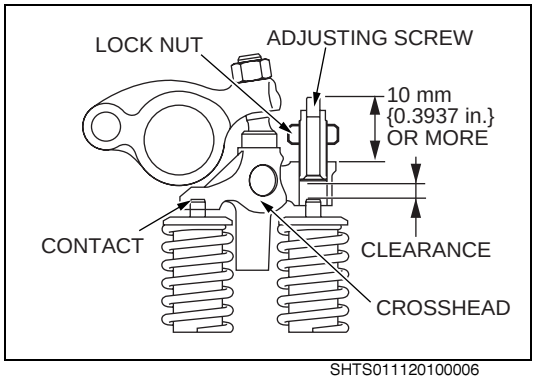
(2) Adjustment of intake side

a. Insert a thickness gauge of the specified thickness as below between the roller of the rocker arm and the cam to check the valve clearance. Tighten the lock nut.
Standard value (at cold): 0.21 mm {0.0083 in.}
Tightening Torque:
44 N·m {450 kgf·cm, 32 lbf·ft}

HINT
It will be appropriate if you feel somewhat tight insertion of a thickness gauge and observe slightly frictional but smooth movements of an inserted gauge.

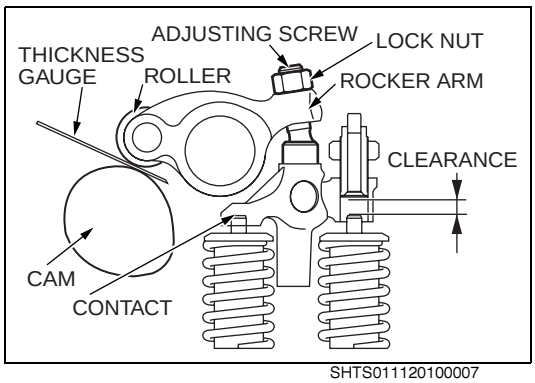


SHTS011120100006

(3) Adjustment of exhaust side

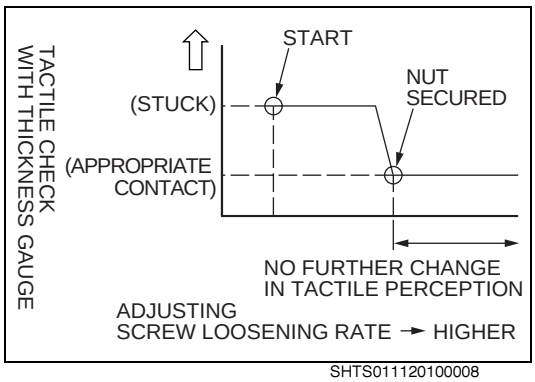
a. Loosen the adjusting screw and the lock nut of the crosshead fully.

NOTICE
Make sure that the top surface of an adjusting screw is at a height of 10 mm {0.3937 in.} above the crosshead top surface. Proper adjustments can be made only when the adjusting screw is completely apart (having a clearance) from the valve stem.



SHTS011120100007

b. Insert a thickness gauge of the specified thickness as below between the roller of the rocker arm and the cam to check the valve clearance. Tighten the lock nut.
Standard value (at cold): 0.39 mm {0.0154 in.}
Tightening Torque:
44 N·m {450 kgf·cm, 32 lbf·ft}



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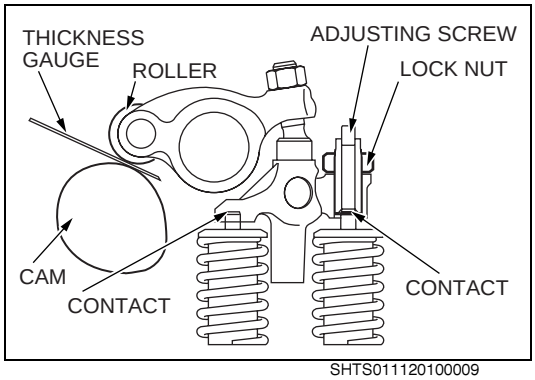
c. With a thickness gauge inserted, loosen the adjusting screw on the crosshead and feel that contact remains unchanged through a thickness gauge.

NOTICE
If less contact would be felt through a gauge, restart the procedures.



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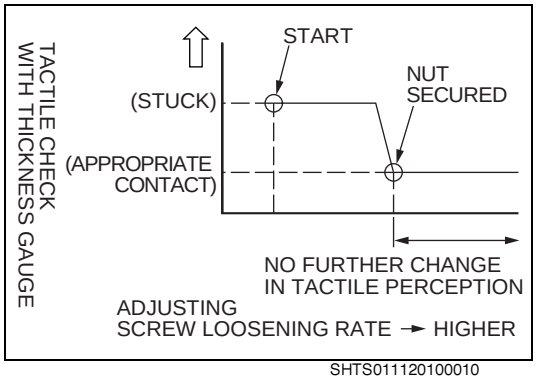
d. Tighten the adjusting screw on the crosshead until a thickness gauge can be no longer moved.



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e. While gradually loosening the adjusting screw on the crosshead, determine appropriate contact through a thickness gauge and tighten the lock nut on the crosshead.

Tightening Torque:
28 N·m {286 kgf·cm, 21 lbf·ft}

NOTICE
Do not excessively loosen the adjusting screw. Excessive loosening of the adjusting screw will bring the condition back to the original state. The tactile feel with a thickness gauge will be appropriate contact, but there will actually be a clearance between the valve and the adjusting screw on the crosshead and no correct adjustment can be made.

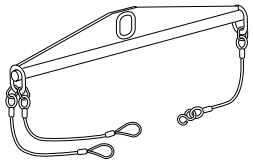
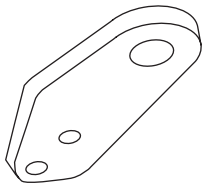
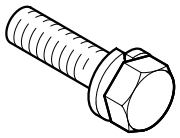
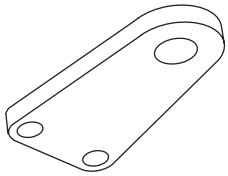
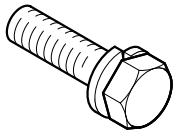
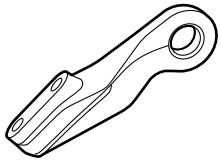
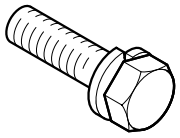
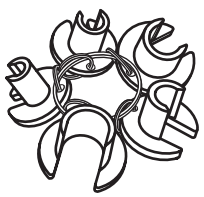
HINT
It will be appropriate if you feel somewhat tight insertion of a thickness gauge and observe slightly frictional but smooth movements of an inserted gauge.

DISMOUNTING AND MOUNTING

SPECIAL TOOL

EN0111201K100002

Prior to starting an engine dismounting and mounting, it is necessary to have these special tools.

Illustration	Part number	Tool name	Remarks
	S0940-51190	ENGINE HANGER	
	09205-E1010	ENGINE HANGER	For front side
	SH782-41235	BOLT	For front side
	09205-E1040	ENGINE HANGER	For rear left side
	SZ119-14014	BOLT	For rear left side
	09205-E1030	ENGINE HANGER	For rear right side
	SZ119-14018	BOLT	For rear right side
	S0942-11560	RELEASE TOOL SET	

DISMOUNTING AND MOUNTING

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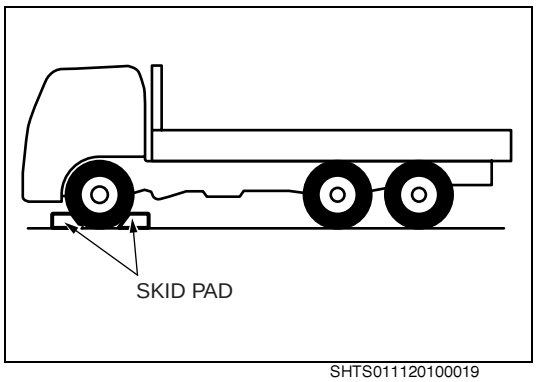


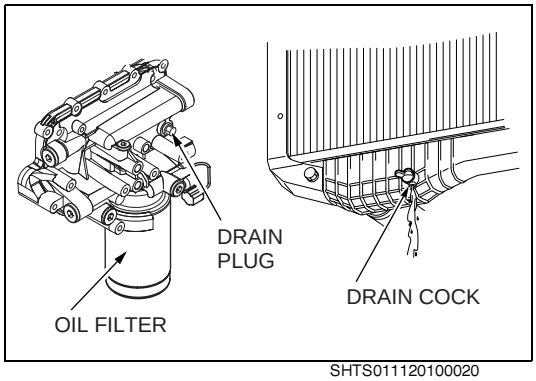
SHTS011120100019

DISMOUNT THE ENGINE ASSEMBLY.

1. PREPARATION OF DISMOUNTING

(1) Park the vehicle on level ground and then block the wheels.

(2) Disconnect the battery cable from negative (–) pole of the batterry.



SHTS011120100020

2. DRAIN COOLANT AND ENGINE OIL.

(1) Drain coolant from the radiator and oil cooler.

⚠ CAUTION

To avoid the danger of burns, do not drain the coolant and engine oil while the engine and radiator are still hot.

NOTICE

Disposal of engine oil must comply with specified procedures (waste disposal) or other environmentally-conscious procedures.

HINT

- **Coolant can be drained quicker by removing the radiator cap.**
- **Connection of a reasonable hose to the oil cooler drain pipe will aid in avoiding spatters of coolant during drainage.**

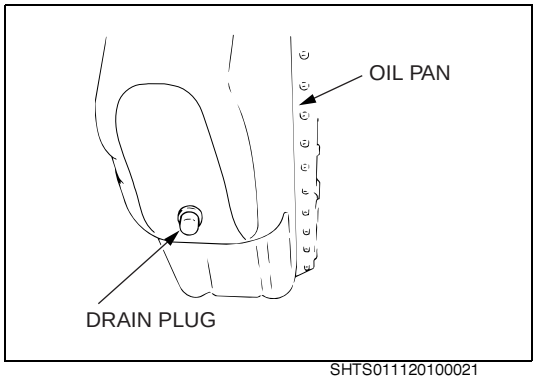
(2) Drain engine oil from the oil pan.

⚠ CAUTION

To avoid the danger of burns, do not drain the coolant and engine oil while the engine and radiator are still hot.

NOTICE

Disposal of engine oil must comply with specified procedures (waste disposal) or other environmentally-conscious procedures.



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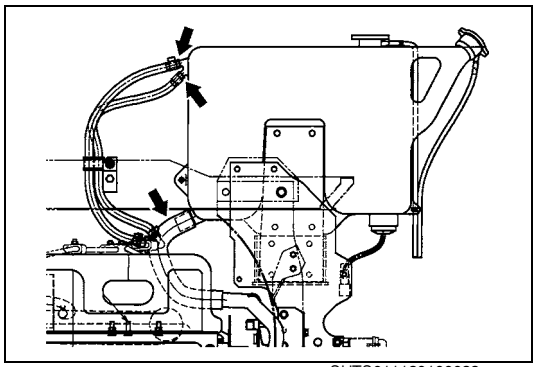


SHTS011120100022

3. REMOVE THE REAR CAB MOUNTING.

(1) Remove the clips to disconnect the engine coolant hoses from the header tank.

NOTICE

Before disconnection, check that a mark is indicated on each hose. If a mark is fading, re-indicate a mark before disconnection.

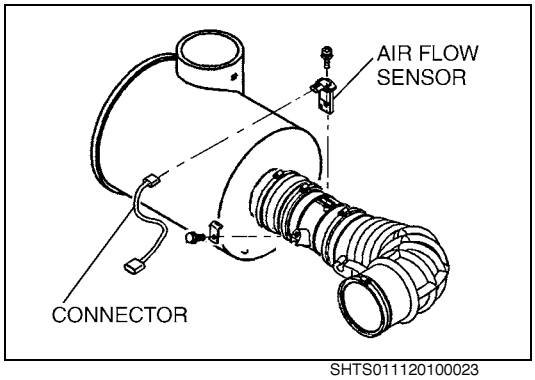
HINT

Use a container and a waste as coolant might drop off from the header tank during disconnection of engine coolant pipes.

(2) Disconnect the connector of the water level switch.

(3) Remove the bolt to remove the header tank bracket from the cab mounting.

(4) Remove the air cleaner.
Refer to the section **"AIR CLEANER"** in the chapter **"AIR INTAKE SYSTEM"**.



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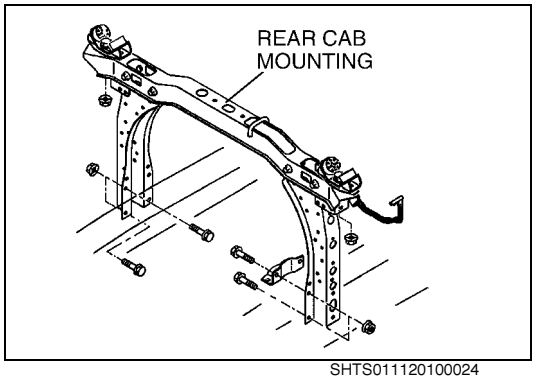
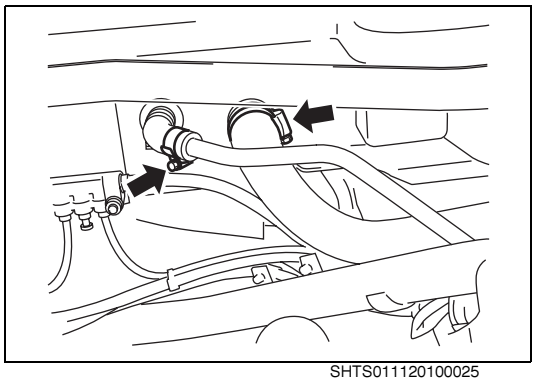
(5) Disconnect the connector of the air flow sensor.



SHTS011120100024

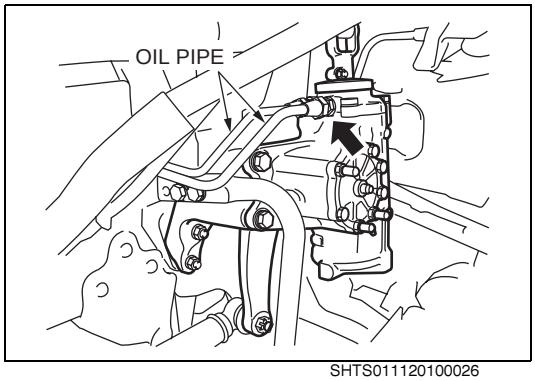
(6) Disconnect the connector from chassis harness.
(7) Remove the bolts. Using a hoist crane, remove the rear cab mounting from the frame.

⚠ CAUTION
The rear cab mounting is a heavy component. Handle it carefully.


SHTS011120100025

4. DISCONNECT THE POWER STEERING OIL HOSE.
(1) Disconnect the power steering oil hoses.

NOTICE
- **Use a container as oil might drop off. Use a cover to protect the hose against incoming dust.**
- **Disposal of engine oil must comply with specified procedures (waste disposal) or other environmentally-conscious procedures.**



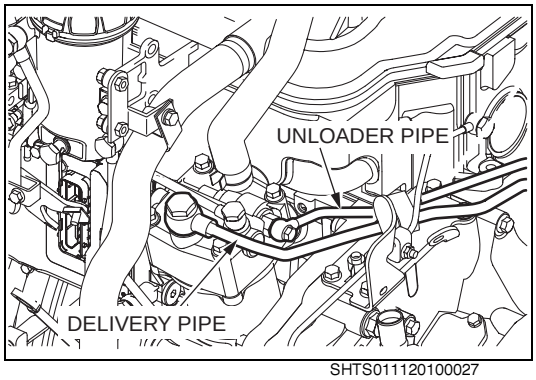
SHTS011120100026

5. DISCONNECT THE POWER STEERING OIL PIPE.
(1) Disconnect the power steering oil pipes from the power steering gear.

NOTICE
- **Before disconnection of the power steering oil pipes, clean the power steering gear and the pipes. Use a cover to protect the pipe against incoming dust.**
- **Use a container as power steering oil might drop off.**
- **Disposal of engine oil must comply with specified procedures (waste disposal) or other environmentally-conscious procedures.**

6. REMOVE THE RADIATOR.
(1) Remove the radiator.
Refer to the section **"RADIATOR"** in the chapter **"COOLING SYSTEM"**.

7. REMOVE THE FAN SHROUD RING SEAL RING (RUBBER).
(1) Remove the fan shroud ring seal ring (rubber).
Refer to the section **"COOLING FAN AND FAN CLUTCH"** in the chapter **"COOLING SYSTEM"**.



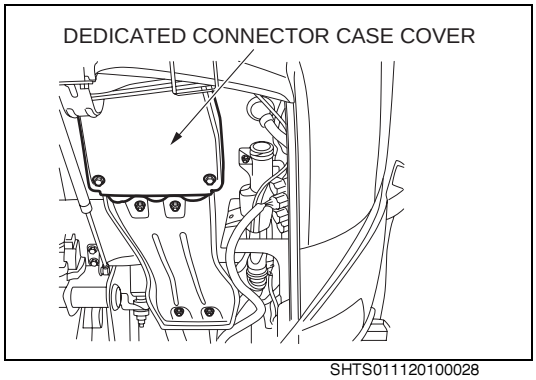
SHTS011120100027

8. DISCONNECT THE AIR PIPE.

(1) Remove two union bolts and four gaskets to disconnect the delivery pipe and unloader pipe for air compressor.

HINT

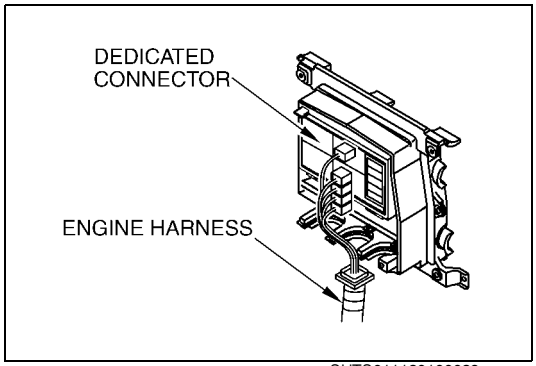
A union bolt securing the unloader pipe has a dodecagonal head.



SHTS011120100028

9. DISCONNECT THE HARNESSES.

(1) Remove two bolts to remove the dedicated connector case cover (cab side).



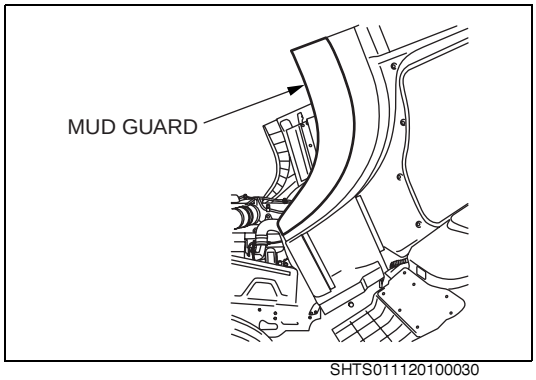
SHTS011120100029

(2) Disconnect the engine harness from the dedicated connector. Use a vinyl cover to protect the engine harness connector.

(3) Disconnect the connector of the engine ECU.
Refer to the section **"ENGINE ECU AND ENGINE ECU COOLER"** in the chapter **"ENGINE CONTROL"**.

(4) Disconnect the alternator earth.
Refer to the section **"ALTERNATOR"** in the chapter **"ALTERNATOR"**.

(5) Disconnect the starter cable.
Refer to the section **"STARTER"** in the chapter **"STARTER"**.



SHTS011120100030

10. REMOVE THE MUD GUARD.

(1) Remove the mud guard (right side only).

11. REMOVE THE COVER (ON THE UNDERSIDE OF ENGINE).

(1) Remove the cover from the frame on the underside of engine.

12. REMOVE THE EXHAUST PIPE AND INTER COOLER HOSE.

(1) Remove the exhaust pipe and inter cooler hose.

NOTICE

Cover open ends of the engine to prevent entry of dirt.

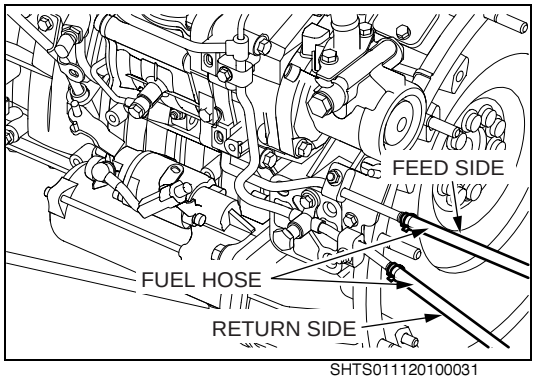
Refer to the section **"EXHAUST PIPE"** in the chapter **"EXHAUST SYSTEM"**.
Refer to the section **"INTER COOLER"** in the chapter **"COOLING SYSTEM"**.

13. DISCONNECT THE FUEL HOSE.

(1) Disconnect the fuel hose from the fuel pipe on the flywheel housing.

HINT

Use a container as a fuel might drop off during disconnection of fuel hose.



SHTS011120100031

14. REMOVE THE PROPELLER SHAFT.

(1) Remove the propeller shaft.
Refer to the section **"PROPELLER SHAFT ASSEMBLY"** in the chapter **"PROPELLER SHAFT"** in the workshop manual (chassis).

15. REMOVE THE TRANSMISSION.

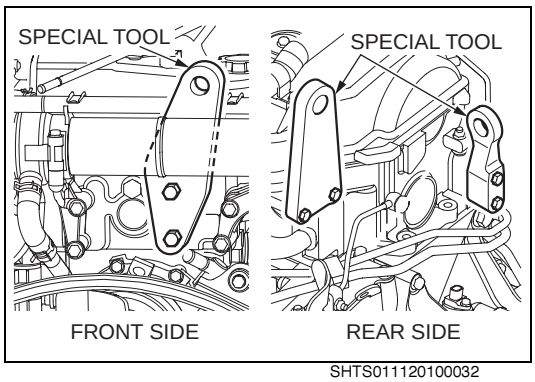
(1) Remove the transmission.
Refer to the section **"TRANSMISSION ASSEMBLY"** in the chapter **"TRANSMISSION MAIN UNIT"** in the workshop manual (chassis).

16. LIFT THE ENGINE.

(1) Install the special tool to the engine.
In this step, position a mark "BOLT SIDE" engraved on the special tool to the front side.
Tightening Torque:
M12: 108 N·m {1,101 kgf·cm, 80 lbf·ft}
M14: 172 N·m {1,754 kgf·cm, 127 lbf·ft}

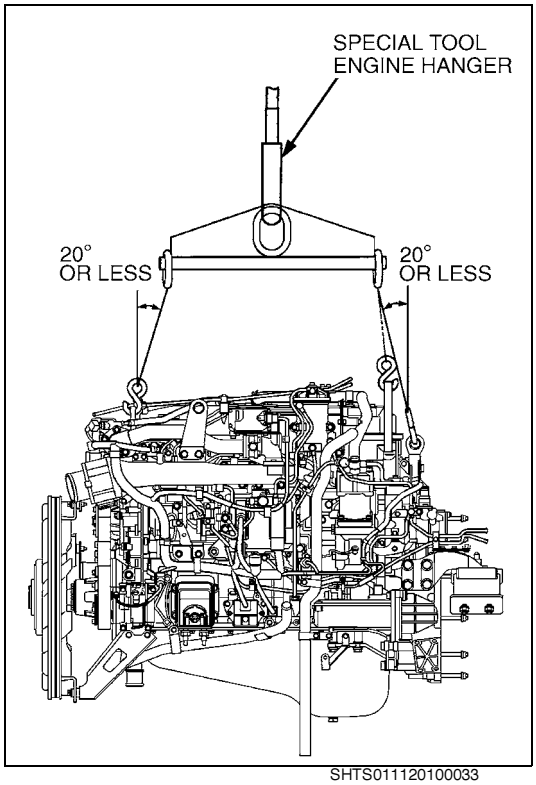
SST

	Engine hanger	Bolt
Engine front side	**09205-E1010**	**SH782-41235**
Engine rear left side	**09205-E1040**	**SZ119-14014**



SHTS011120100032

(2) Remove the engine mounting installation bolt (front and rear) to cut out engine mounting from the frame.



SHTS011120100033

(3) Lift the engine hanger so that the cables are fully tightened, then, after checking that the cables are securely, lift gently and remove the engine from the vehicle.

(4) When the bottom of the engine goes past the frame, rotate the engine clockwise to remove the engine from the right side of a vehicle.

⚠ CAUTION

- **Proceed with this work step with a care not to allow the engine to contact with the frame or cab.**
- **The engine is a heavy component. Handle it carefully.**

SST: Engine hanger (S0940-51190)

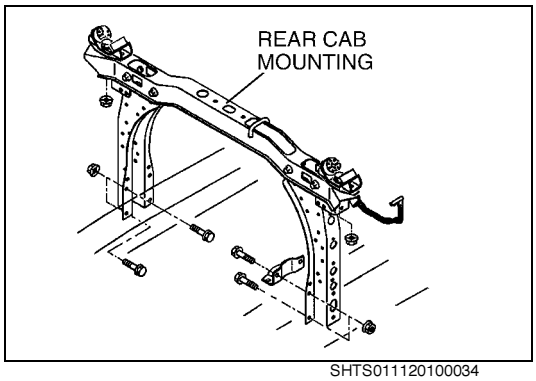
MOUNT THE ENGINE ASSEMBLY.

1. MOUNT THE ENGINE ASSEMBLY.

(1) Lift the engine assembly as with dismounting and align the engine on the frame.

(2) If bolts on the engine mounting do not meet with mounting holes, adjust the engine mounting position with a tire lever or the like.

(3) Tighten the engine mounting installation bolts.
Tightening Torque:
Front side: 166-224 N·m {1,692-2,284 kgf·cm, 122-165 lbf·ft}
Rear side: 166-224 N·m {1,692-2,284 kgf·cm, 122-165 lbf·ft}



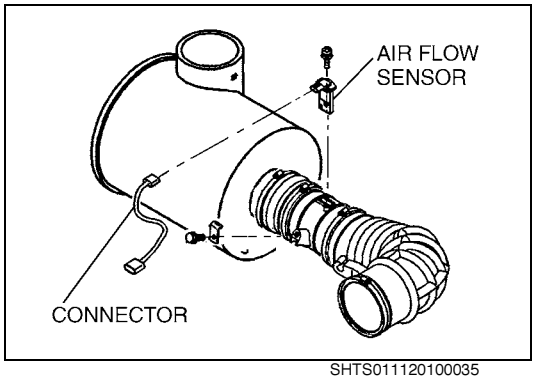
SHTS011120100034

2. INSTALL THE REAR CAB MOUNTING.

(1) Install the rear cab mounting to the frame, and tighten the bolts.
Tightening Torque:
Standerd cab: 55-82 N·m {561-836 kgf·cm, 41-60 lbf·ft}
Wide cab: 96-144 N·m {979-1,468 kgf·cm, 71-106 lbf·ft}

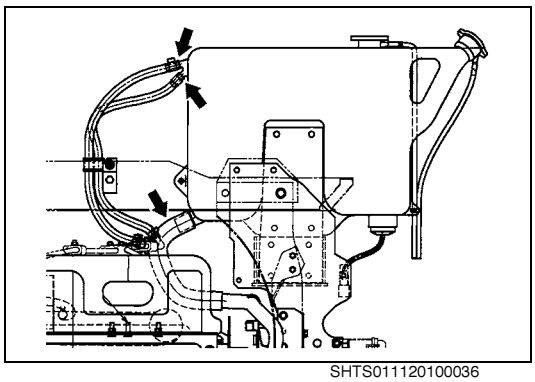
(2) Connect the connector of the chassis harness.

(3) Install the air cleaner case.
Refer to the section **"AIR CLEANER"** in the chapter **"AIR INTAKE SYSTEM"**.

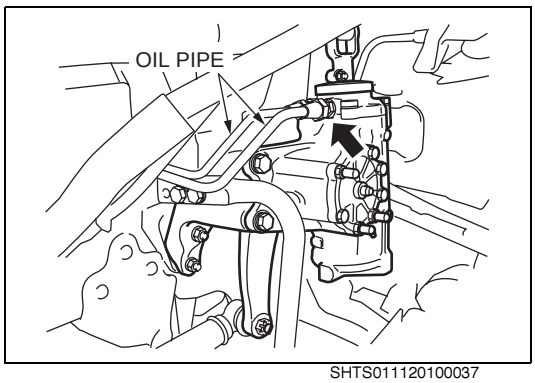


SHTS011120100035

(4) Connect the connector of the air flow sensor.


SHTS011120100036

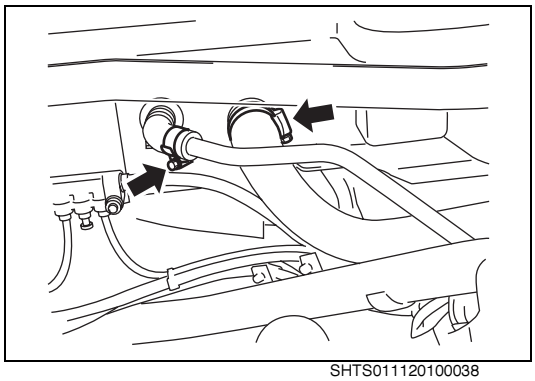
(5) Install the header tank bracket to the cab mounting.
(6) Connect the connector of the water level switch.
(7) Connect the coolant hose to the header tank in alignment with a mark indicated before disconnection, and fasten clips.



SHTS011120100037

3. CONNECT THE POWER STEERING OIL PIPE.
(1) Connect the power steering oil pipe to the power steering gear.

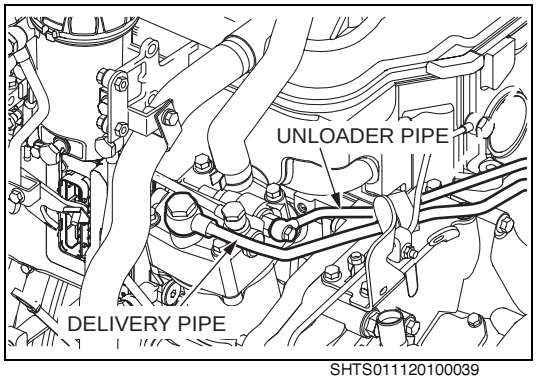
NOTICE
Connect the tapered thread portion securely to avoid oil leakage.


SHTS011120100038

4. CONNECT THE POWER STEERING OIL HOSE.
(1) Connect the power steering oil hose.

5. INSTALL THE RADIATOR.
(1) Install the radiator.
Refer to the section **"RADIATOR"** in the chapter **"COOLING SYSTEM"**.

6. INSTALL THE FAN SHROUD RING SEAL RING (RUBBER).
(1) Install the fan shroud ring seal ring (rubber).
Refer to the section **"COOLING FAN AND FAN CLUTCH"** in the chapter **"COOLING SYSTEM"**.



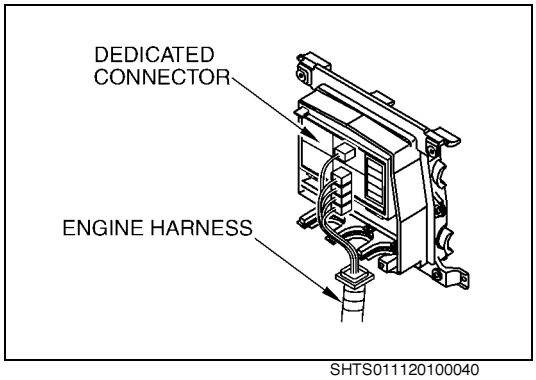
SHTS011120100039

7. CONNECT THE AIR PIPE.

(1) Replace the gasket with new one. Connect the delivery pipe and unloader pipe for air compressor, and tighten union bolts.

HINT

A union bolt securing the unloader pipe has a dodecagonal head.

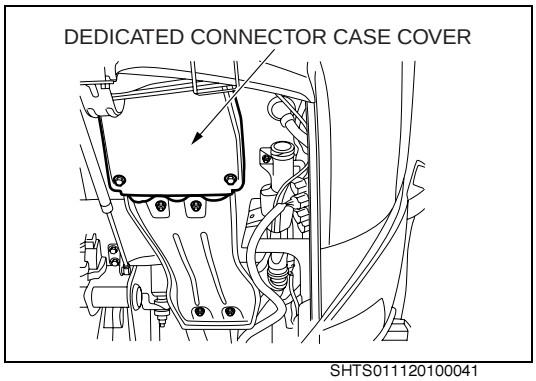


SHTS011120100040

8. CONNECT THE HARNESSES.

(1) Connect the connector of the engine harness and install the engine harness to the clips.
Refer to the section **"ENGINE ECU AND ENGINE ECU COOLER"** in the chapter **"ENGINE CONTROL"**.

(2) Connect the engine harness to the dedicated connector.

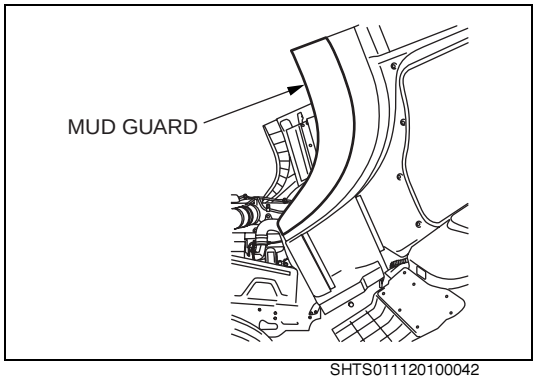


SHTS011120100041

(3) Install the dedicated connector case cover (cab side), and tighten two bolts.

(4) Install the alternator earth.
Refer to the section **"ALTERNATOR"** in the chapter **"ALTERNATOR"**.

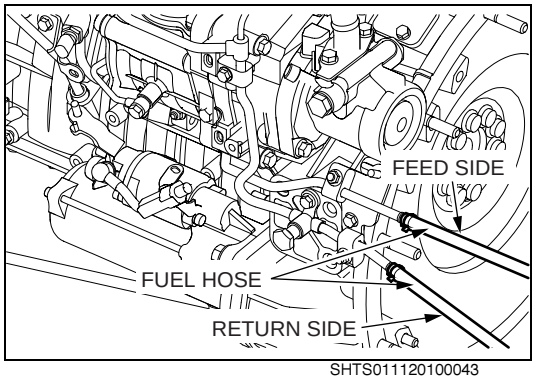
(5) Connect the starter cable.
Refer to the section **"STARTER"** in the chapter **"STARTER"**.



SHTS011120100042

9. INSTALL THE MUD GUARD.

(1) Install the mud guard.



SHTS011120100043

10. INSTALL THE FUEL HOSE.

(1) Install the fuel hoses and fix them with clamps.

11. INSTALL THE EXHAUST PIPE AND THE INTER COOLER HOSE.

(1) Install the exhaust pipe and the inter cooler hose.
Refer to the section **"EXHAUST PIPE"** in the chapter **"EXHAUST SYSTEM"**.

12. INSTALL THE COVER (ON THE UNDERSIDE OF ENGINE).

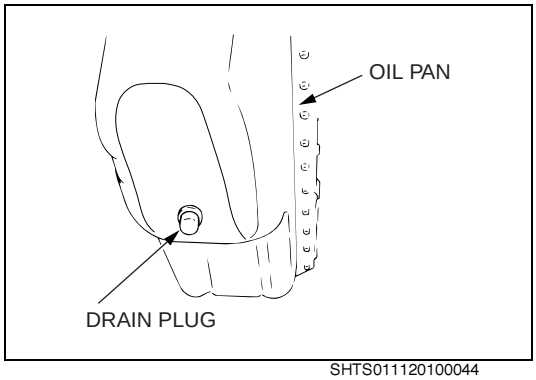
(1) Install the cover (on the underside of engine).

13. INSTALL THE TRANSMISSION.

(1) Install the transmission.
Refer to the section **"TRANSMISSION ASSEMBLY"** in the chapter **"TRANSMISSION MAIN UNIT"** in the workshop manual (chassis).

14. INSTALL THE PROPELLER SHAFT.

(1) Install the propeller shaft.
Refer to the section **"PROPELLER SHAFT ASSEMBLY"** in the chapter **"PROPELLER SHAFT"** in the workshop manual (chassis).

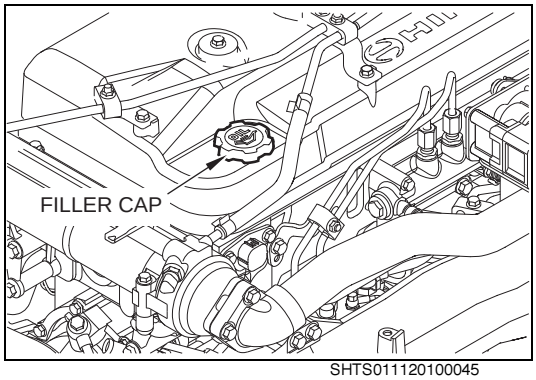


SHTS011120100044

WORK AFTER MOUNTING

1. POUR ENGINE OIL.

(1) Replace the gasket with new one. Install the drain plug to the oil pan.
Tightening Torque:
44 N·m {450 kgf·cm, 32 lbf·ft}



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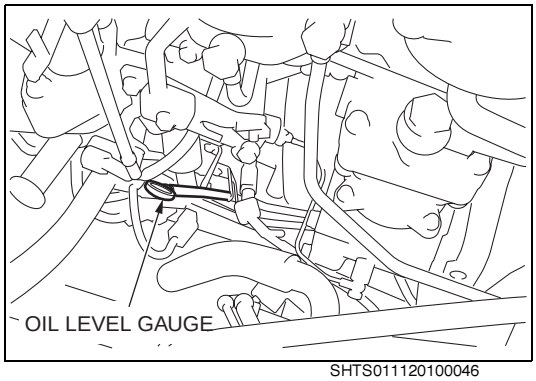
(2) Fill engine oil to a certain level through the filler cap on the engine head cover.



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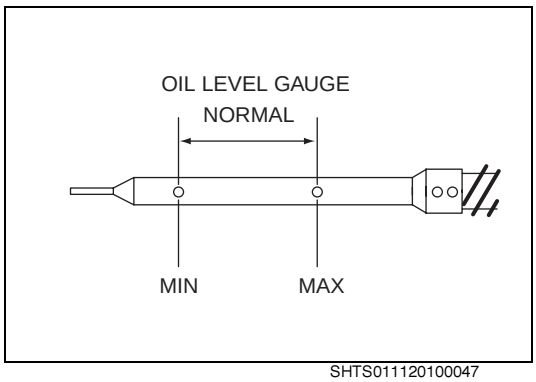
(3) Fill engine oil through the filler cap on the head cover while observing the oil level gauge on the left side of the engine to check a level of remaining engine oil.

ENGINE OIL

Oil pan	Oil filter
Approximately 27 L	Approximately 1.7 L

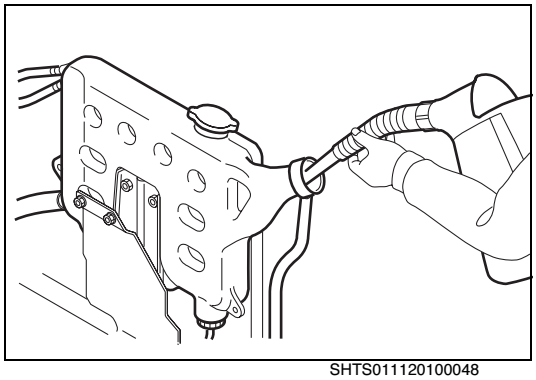
- SAE #10W-30 or SAE #30



SHTS011120100047

2. AIR BLEEDING

(1) Apply the priming pump and bleed air.
Refer to the section **"FUEL FILTER AND CASE"** in the chapter **"FUEL SYSTEM"**.


SHTS011120100048

3. FILL THE COOLANT.

(1) Gradually fill coolant through the coolant inlet in the header tank.

NOTICE

Rapid filling will obstruct smooth air vent in the cooling piping and increase the filling time.

Coolant volume: 33.5 L

(2) Fill coolant in the header tank to the "FULL" level.
(3) Fully close the radiator cap.
(4) Set an engine speed slightly higher than a regular idling speed.
(5) Increase a cooalnt temperature to the extent that the coolant temperature gauge indicates a middle level by racing the engine three to five times (idle to 1,800 r/min or higher). Keep running the engine for additional 10 min. to purge air from the radiator and from inside the engine.
(6) Stop the engine and wail until the engine cools down. Check the coolant levels in the header tank. Fill coolant to make up for a decrease in coolant (used for air purge).

NOTICE

- **A substantial drop in the coolant level in the header tank will obstruct the coolant in the reservoir tank to be taken up. Refill coolant from time to time when such substantial drop is detected.**
- **An excessive increase of the engine speed will cause breakdown of engine components or shorten the service life.**
- **Air-contained coolant will cause overheat or leakage from the coolant pump.**
- **Before removing the radiator cap, wait until the coolant temperature gauge indicates an appropriate or lower temperature. If the radiator cap is removed at an improper timing, hot coolant or vapor will spurt out, resulting in a potential risk of burn injury.**
- **Check that no leakage (engine oil, etc.) or noise is observed from the fuel system and/or the cooling system.**

4. FILL POWER STEERING FLUID.

(1) Fill power steering fluid.

NOTICE

- **Use only specified fluid.**
- **Do not overfill the oil reservoir.**
- **Specified fluid....Refer to recommended lubricant list.**

LIQUID GASKET AND APPLICATION POINTS

EN0111201H200001

- Following liquid gaskets are used for the A09C series engine.

Liquid gasket specification:
Three Bond TB1207B: Black
Liquid gasket specification:
Three Bond TB1207C: Red
Liquid gasket specification:
Three Bond TB1207D: Silver

1. LIQUID GASKET APPLICATION AND PART ASSEMBLY PROCEDURE.

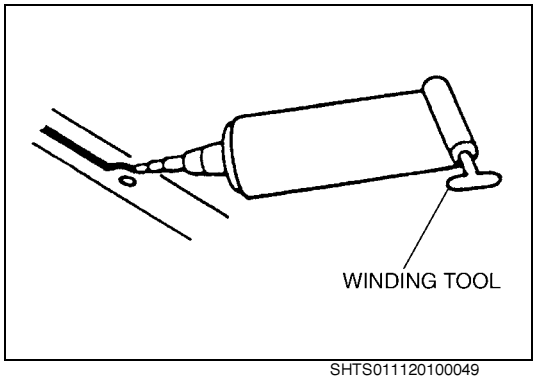
(1) Remove old liquid gasket from each part and matching parts and wipe off oil, moisture or dirt with a rag.
(2) Overlap the liquid gasket at the start and end of application.
(3) Be careful of misalignment when assembling parts with liquid gasket. If they are misaligned, reapply the liquid gasket.
(4) Assemble parts within 20 minutes of application.
If more than 20 minutes have passed, remove and reapply the liquid gasket.
(5) Wait for at least 15 minutes or more after assembly of parts before starting the engine.

2. REMOVE PARTS.

(1) When removing parts, do not use a tool for removal at one location only. Use the tool at various locations such as a flange step or gap for removal. When removing the gasket, be careful that gasket residue does not enter the engine.

3. OTHERS

(1) For tube-type liquid gasket, use the winding tool that comes with the liquid gasket.



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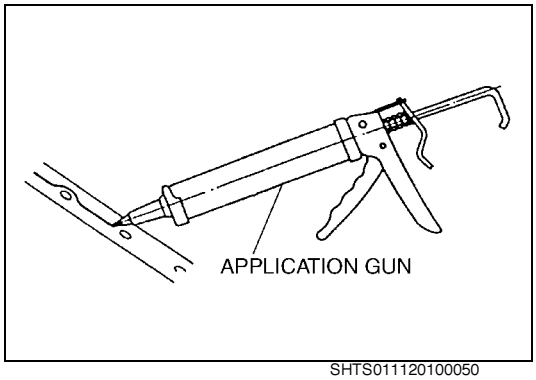
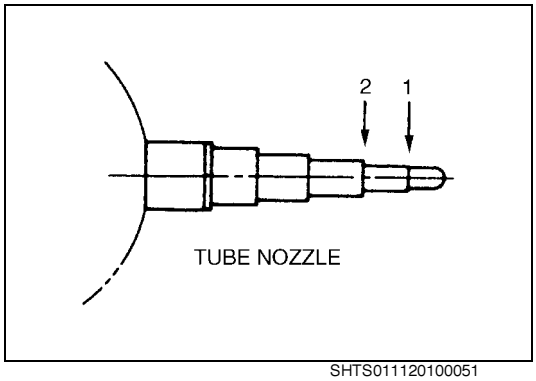
(2) For cartridge-type gasket, use an application gun.



SHTS011120100050

(3) For tube-type liquid gasket, required width of application can be obtained by cutting the nozzle to suit.

1: Approximately 2 mm {0.079 in.} width when cut at the first step
2: Approximately 5 mm {0.197 in.} width when cut at the second step

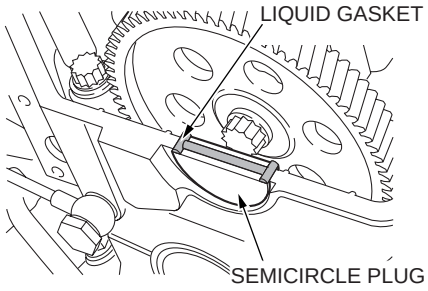
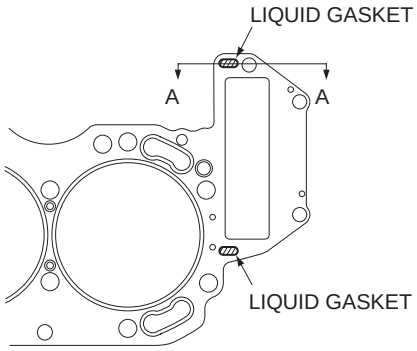
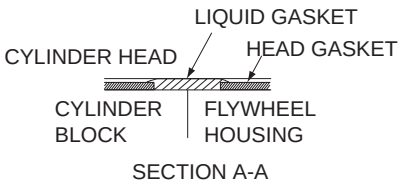
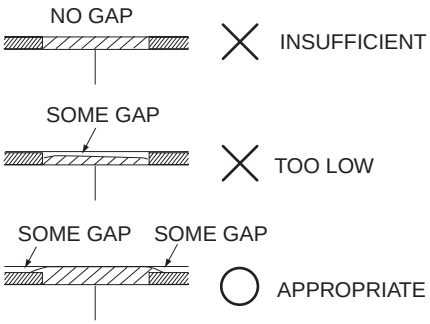


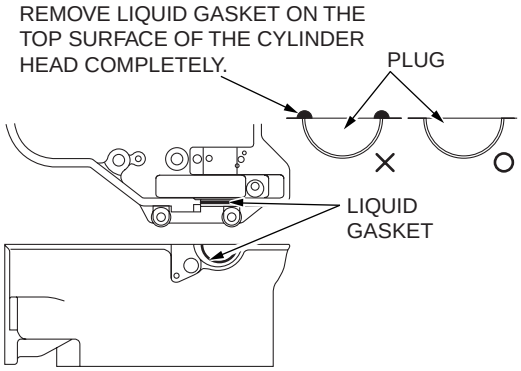
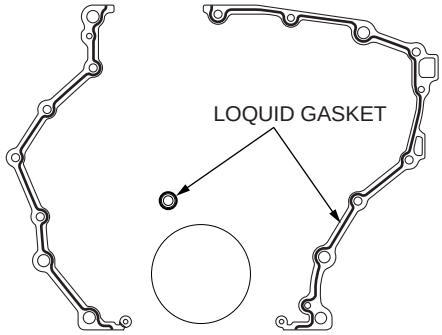
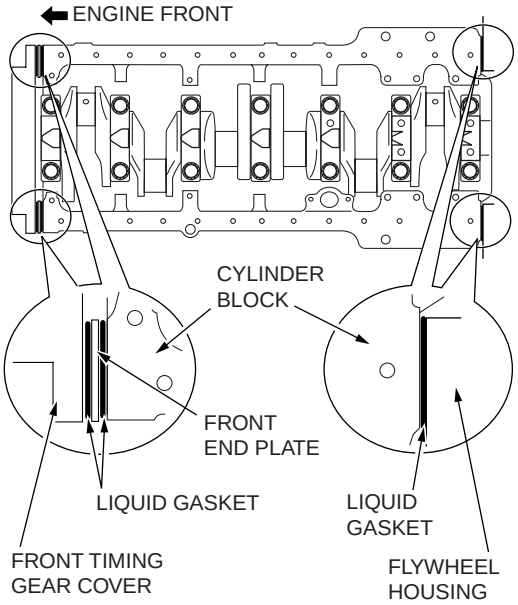
SHTS011120100051

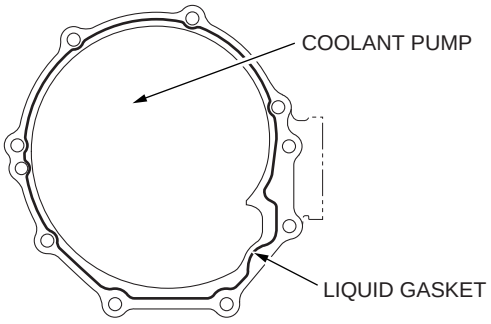
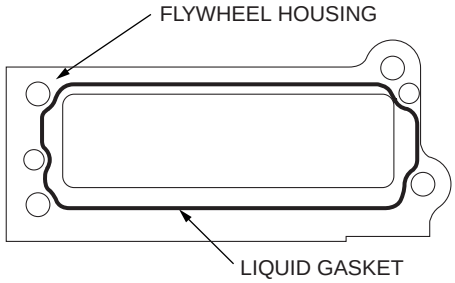
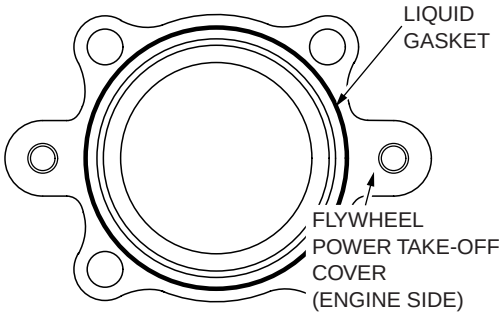
4. PARTS AND POSITIONS FOR LIQUID GASKET

(1) Apply liquid gasket to positions and types of gasket according to the table shown below.
Follow the application pattern at each position shown in the figures.

Unit: mm {in.}

No.	Part name	Application position and pattern	Application width	Gasket to be used	Remarks
1	**Head cover**	**Matching surface of the semicircle plugs on the top of the cylinder head (one at the front end, the other at the rear end)**  **NOTICE** **Apply liquid gasket without intermittence.**	**1.5-2.5 {0.0591-0.0984}**	**Black**	
2	**Cylinder head assembly**	**The head gasket matching surface (two location) between the flywheel housing and the top rear end surface of the cylinder block**   SECTION A-A  HEAP UP LIQUID GASKET OVER THE TOP SURFACE **NOTICE** **Heap up liquid gasket over the top surface.**	**—**	**Red**	

No.	Part name	Application position and pattern	Application width	Gasket to be used	Remarks
2	Cylinder head assembly	**The semicircle plug mounting surface on the cylinder head**  	1.5-2.5 {0.0591-0.0984}	Black	
3	Flywheel housing	**Matching surface of the flywheel housing**  **NOTICE** **Apply liquid gasket without intermittence.**	1.5-2.5 {0.0591-0.0984}	Silver	
4	Oil pan	**The cylinder block and the front end plate at the frontmost bottom surface and to the cylinder block and the flywheel housing at the rearmost bottom surface.**  **NOTICE** **Apply liquid gasket without intermittence.**	1.5-2.5 {0.0591-0.0984}	Red and Silver	

No.	Part name	Application position and pattern	Application width	Gasket to be used	Remarks
5	Coolant pump	**Coolant pump**  **NOTICE** **Apply liquid gasket without intermittence.**	1.5 {0.0591}	Black	
6	Flywheel power take-off	**Matching surface of the flywheel housing**  **NOTICE** **Apply liquid gasket without intermittence.**	1.5-2.5 {0.0591-0.0984}	Silver	
		Matching surface of the flywheel power take-off cover (engine side) on the gear case  **NOTICE** **Apply liquid gasket without intermittence.**	1.5-2.5 {0.0591-0.0984}	Silver	

NOTICE
Figure on the right shows application "pattern" of the liquid gasket.
Apply the liquid gasket to the center of seal flange inside whenever possible.

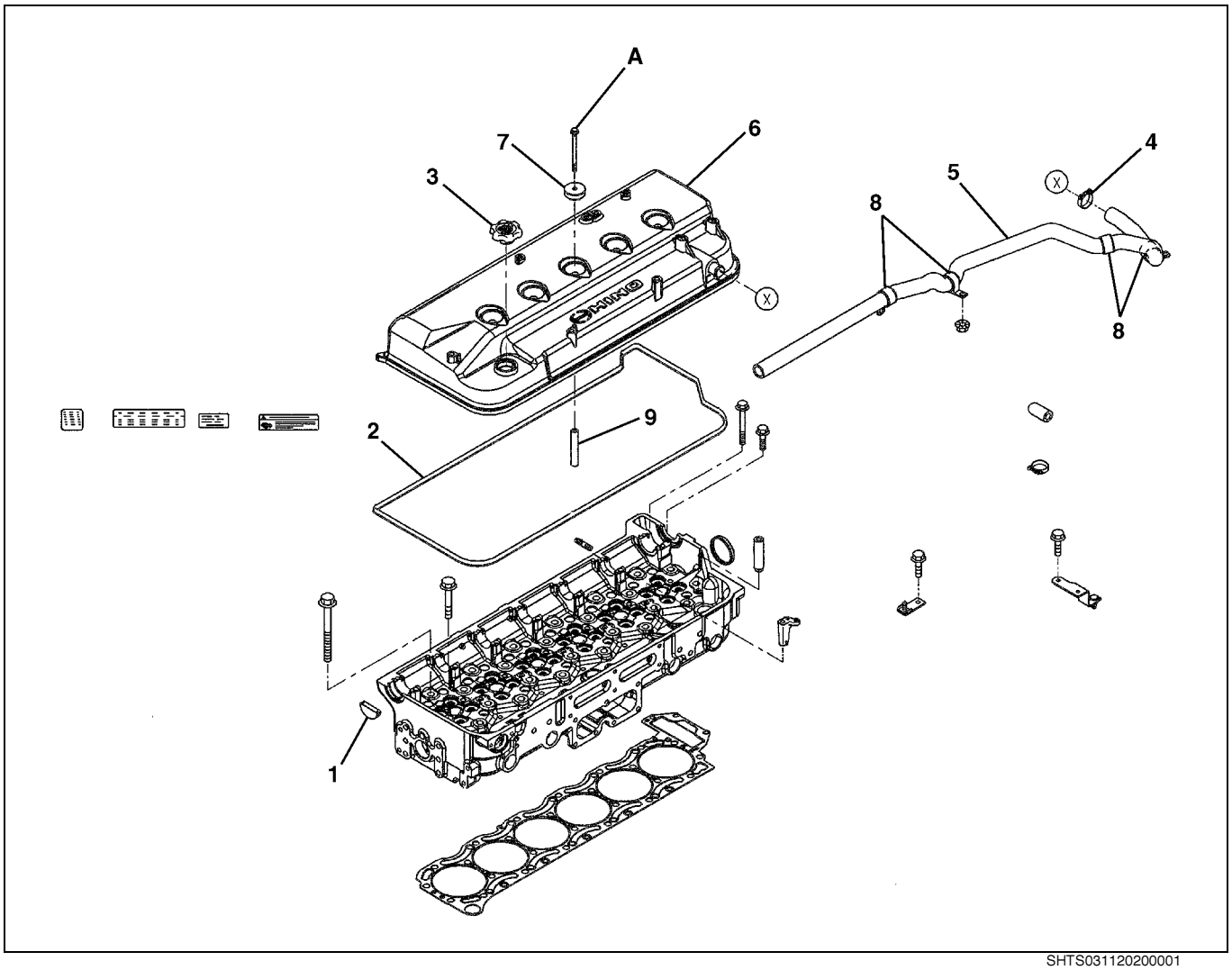
ENGINE MECHANICAL (A09C)

EN02-001

HEAD COVER

COMPONENT LOCATOR

EN0311202D100001



SHTS031120200001

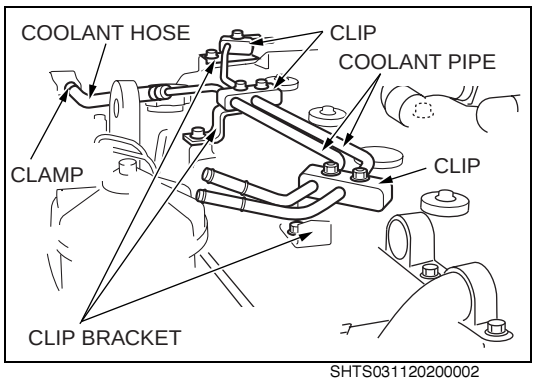
1	Semicircle plug	6	Head cover
2	Gasket	7	Cushion
3	Oil filler cap	8	Clip
4	Clamp	9	Spacer
5	Vent hose		

Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

A	36 {367, 27}		

REPLACEMENT

EN0311202H300001

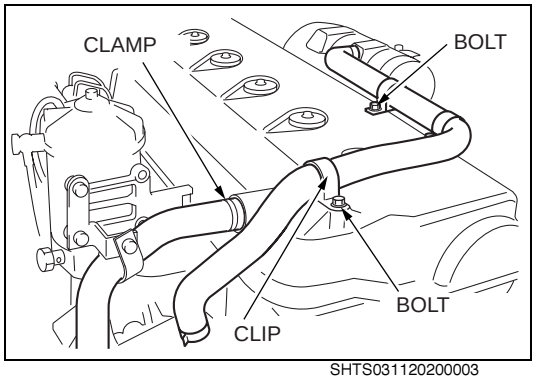


SHTS031120200002

REMOVE THE HEAD COVER.

1. DISCONNECT THE COOLANT PIPES ON THE HEAD COVER.

(1) Remove the clamp brackets and disconnect the coolant pipes for the purpose of facilitating the replacement works.

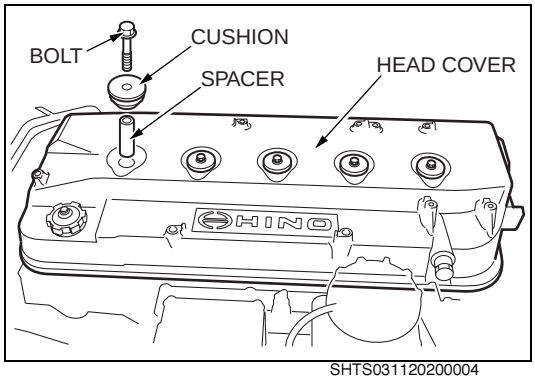


SHTS031120200003

2. DISCONNECT THE HOSES ON THE HEAD COVER.

(1) Remove clamps securing the vent hose and the air compressor suction hose on the head cover.

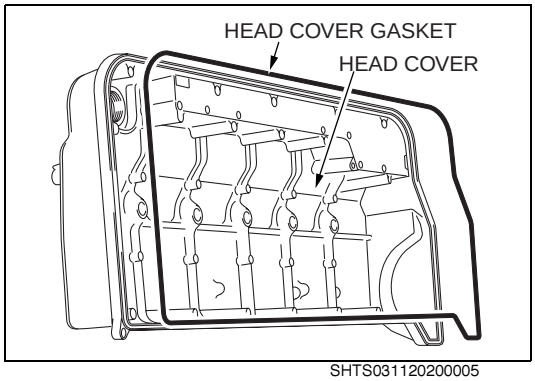
(2) Remove the bolts to remove the vent hose, the air compressor suction hose and clips.



SHTS031120200004

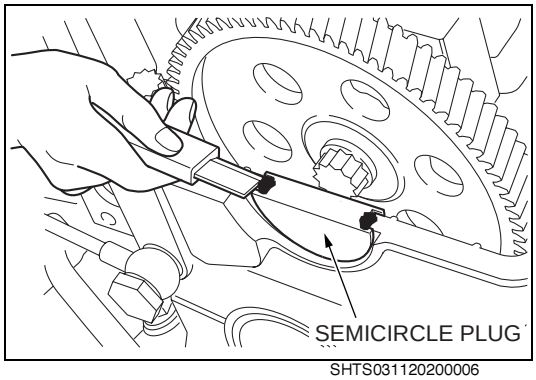
3. REMOVE THE HEAD COVER.

(1) Remove five bolts to remove the cushions, the spacers and the head cover.



SHTS031120200005

(2) Remove the head cover gasket from the head cover.

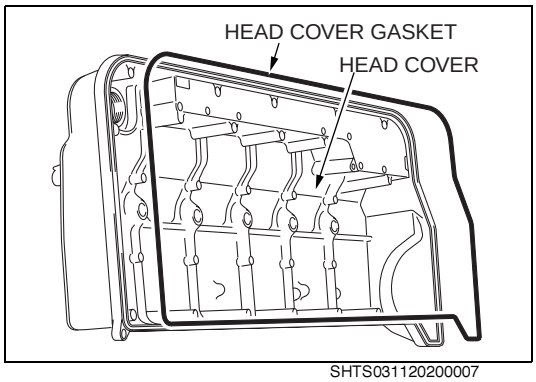


SHTS031120200006

(3) Use a scraper to remove liquid gasket from semicircle plugs on the top of the cylinder head (one at the front end, the other at the rear end).

NOTICE

Do not remove the semicircle plugs unless oil leak is found from the semicircle plugs.



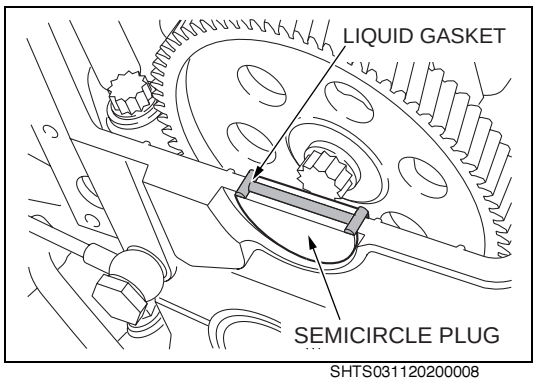
SHTS031120200007

INSTALL THE HEAD COVER.

1. INSTALL THE HEAD COVER.

(1) Remove dirt (including liquid gasket) and oil from the mating surfaces of the head cover and the cylinder head.

(2) Install a new head cover gasket into a groove in the head cover.

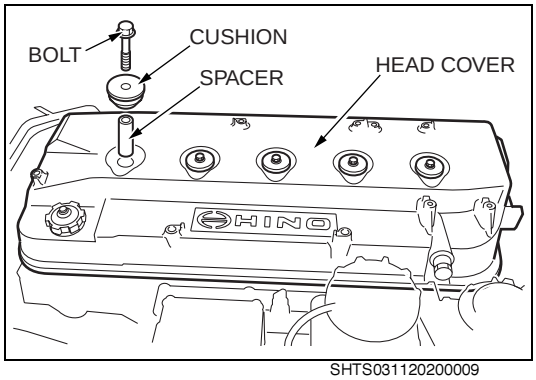


SHTS031120200008

(3) Apply liquid gasket (ThreeBond TB1207B, black) to the mating surfaces of the semicircle plugs on the top of the cylinder head (one at the front end, the other at the rear end).

NOTICE

- **Apply liquid gasket at a width of 1.5 to 2.5 mm {0.0591 to 0.0984 in.}.**
- **Apply liquid gasket without intermittence.**
- **Proceed with a next step within 20 min. after applying liquid gasket.**



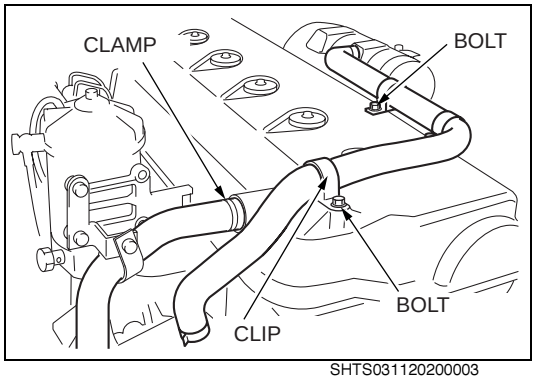
SHTS031120200009

(4) Align the head cover with the installation position on the cylinder head. Attach a spacer and a cushion, and tighten a bolt.
Tightening Torque:
36 N·m {367 kgf·cm, 27 lbf·ft}

NOTICE

- **Note that the head cover is of floating mount type. Do not excessively tighten a bolt.**
- **Gradually install the head cover without applying an excessive force so that there will be no interference nor excessive contact with other components/parts in the cylinder head such as engine retarder harness.**

(5) Remove excessive liquid gasket thoroughly.



SHTS031120200003

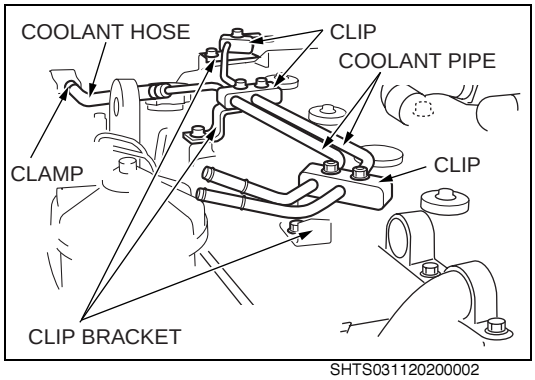
2. CONNECT THE HOSES ON THE HEAD COVER.

(1) Insert the vent hose and the air compressor suction hose, and secure the clamps.

NOTICE

Do not twist the vent hose.

(2) Install the clips with the bolts to secure the vent hose and the air compressor suction hose.



SHTS031120200002

3. CONNECT THE COOLANT PIPES ON THE HEAD COVER.

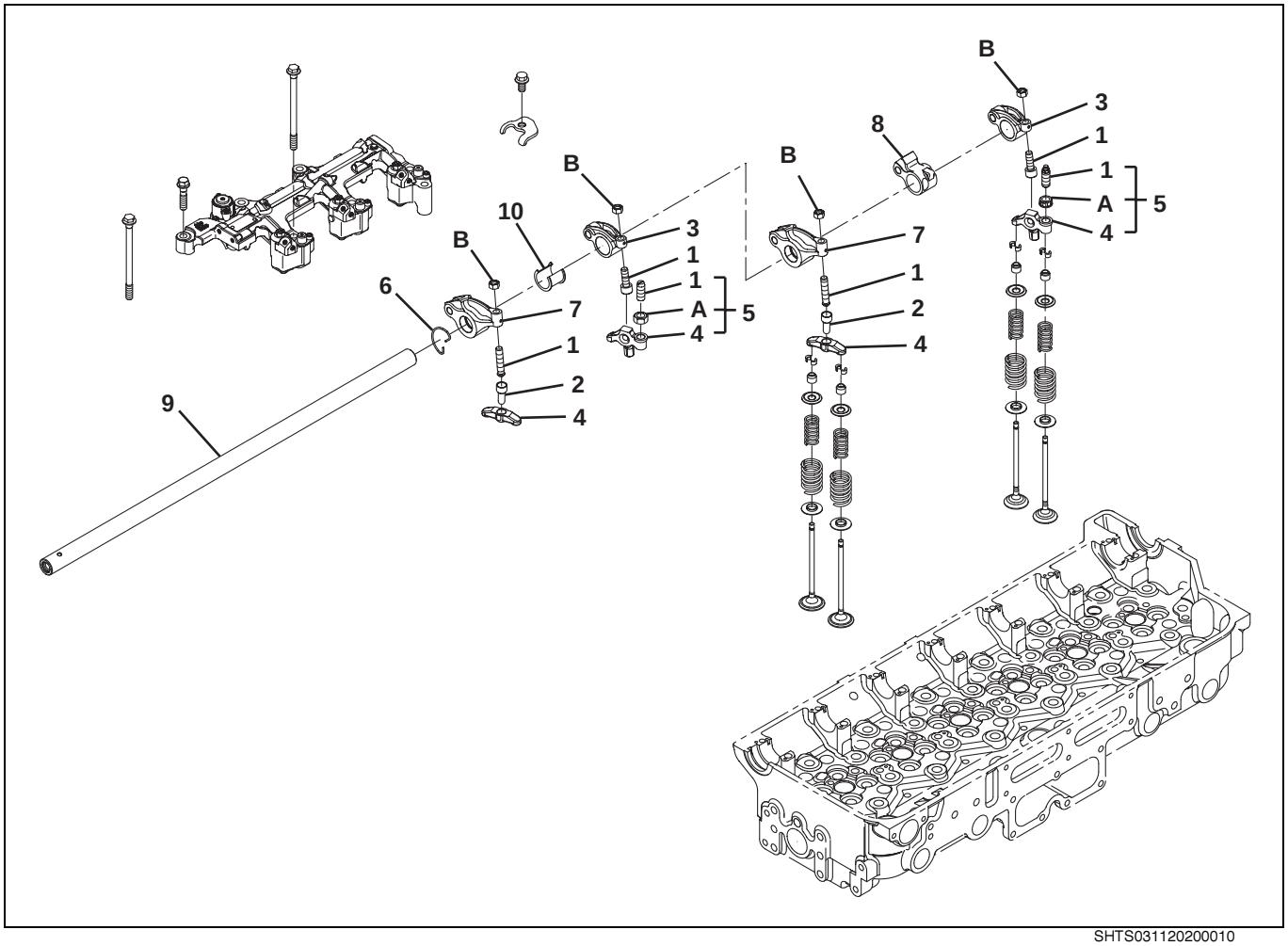
(1) Install the clip bracket to the head cover with the bolt.

ROCKER ARM ASSEMBLY

COMPONENT LOCATOR

EN0311202D100002

WITH 3-CYLINDER RETARDATION TYPE OF ENGINE RETARDER



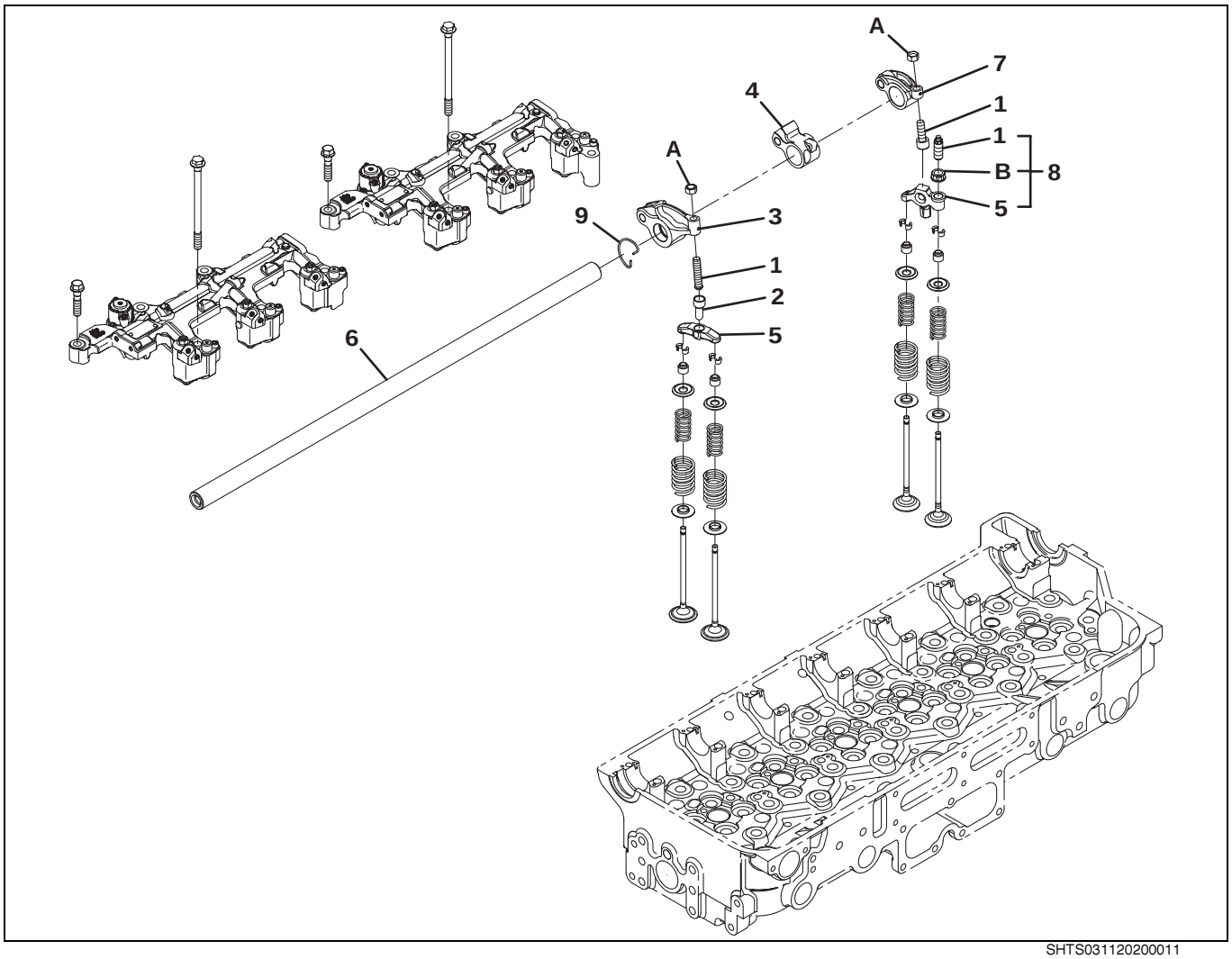
SHTS031120200010

1	Adjusting screw	6	Torsion spring
2	Push rod	7	Rocker arm (Intake)
3	Rocker arm (Exhaust)	8	Rocker arm (Retarder)
4	Crosshead	9	Rocker arm shaft
5	Crosshead assembly	10	Spacer

Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

A	28 {286, 21}	B	44 {450, 32}

WITH 6-CYLINDER RETARDATION TYPE OF ENGINE RETARDER



SHTS031120200011

1	Adjusting screw	6	Rocker arm shaft
2	Push rod	7	Rocker arm (Exhaust)
3	Rocker arm (Intake)	8	Crosshead assembly
4	Rocker arm (Retarder)	9	Torsion spring
5	Crosshead		

Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

A	44 {450, 32}	B	28 {286, 21}

OVERHAUL

EN0311202H200001

REMOVE THE ROCKER ARM ASSEMBLY.

1. REMOVE THE HEAD COVER.

(1) Remove the head cover.
Refer to the section **"HEAD COVER"**.

2. REMOVE THE INJECTOR HARNESS.

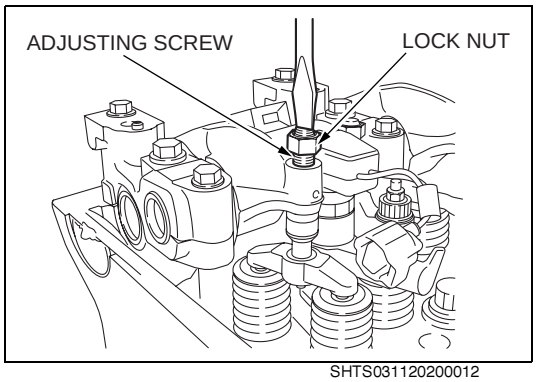
(1) Disconnect the terminal of the engine retarder and the connector of the injector and remove the injector harness.
Refer to the section **"INJECTOR"** in the chapter **"FUEL SYSTEM"**.

3. REMOVE THE ENGINE RETARDER.

(1) Remove the engine retarder.
Refer to the section **"ENGINE RETARDER"** in the chapter **"ENGINE RETARDER"**.

4. REMOVE THE ROCKER ARM ASSEMBLY.

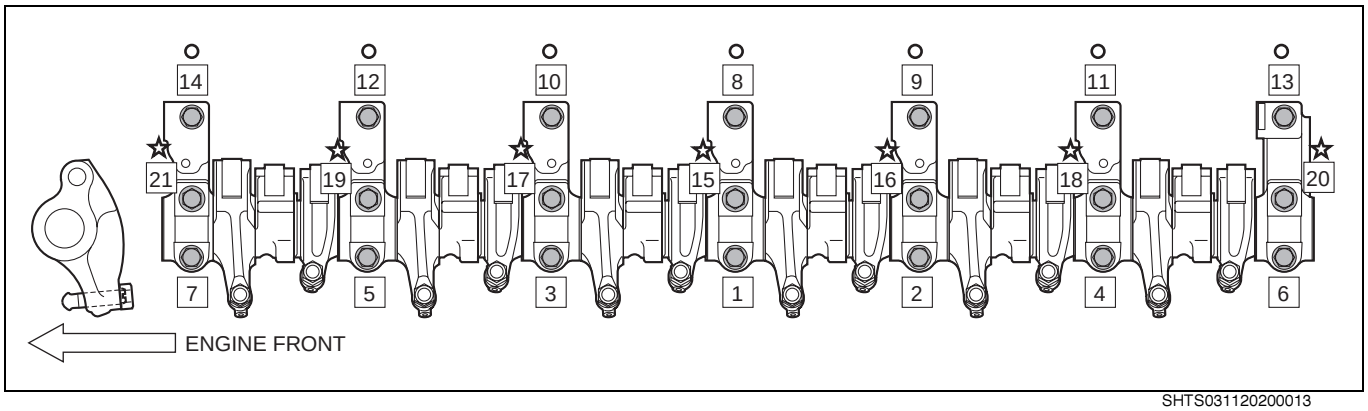
(1) Loosen the lock nut and turn the adjusting screw counterclockwise completely.



SHTS031120200012

⚠ CAUTION
Not untightening the adjusting screw may result in a bent rocker arm shaft.

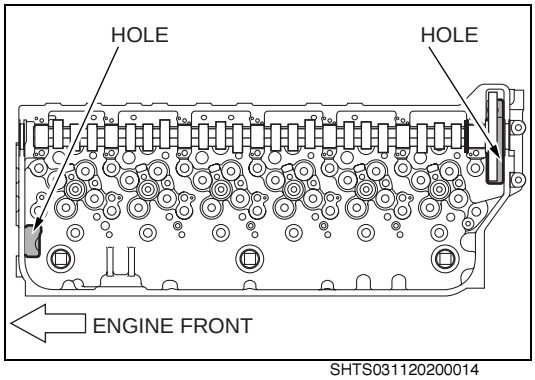
(2) Gradually loosen the rocker support bolt (turn approximately 90° at each time) in the order shown in the figure.



SHTS031120200013

⚠ CAUTION

- **The bolts shown with a star in the figure have a thin head. Take care not to cause damage with a tool.**
- **Make sure to gradually loosen a rocker support bolt. Otherwise the rocker arm shaft might be bent.**

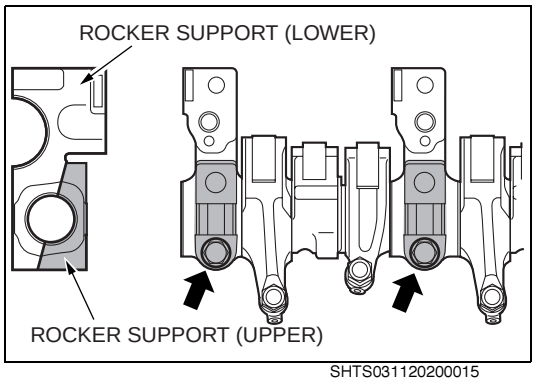


SHTS031120200014

(3) Remove the bolts No.8 to No.21 shown in the figure and remove the rocker arm assembly.

NOTICE

- **Note that the cam bearing (top) mounted on the rocker support (lower) might drop off due to some impacts.**
- **Take care not to allow the bearing and the push rod of the crosshead to drop onto the holes shown in the figure.**

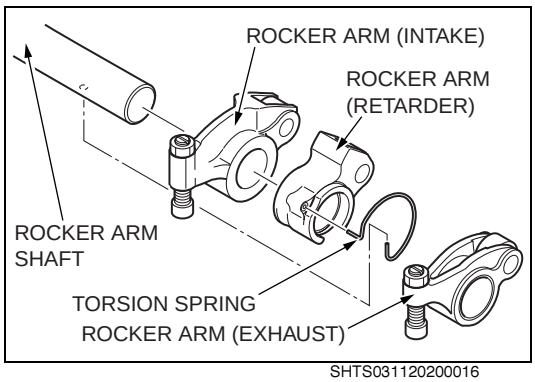


SHTS031120200015

DISASSEMBLE THE ROCKER ARM ASSEMBLY.

1. REMOVE THE ROCKER SUPPORT.

(1) Remove the rocker support bolt to remove the rocker support (upper and lower) from the rocker arm shaft.



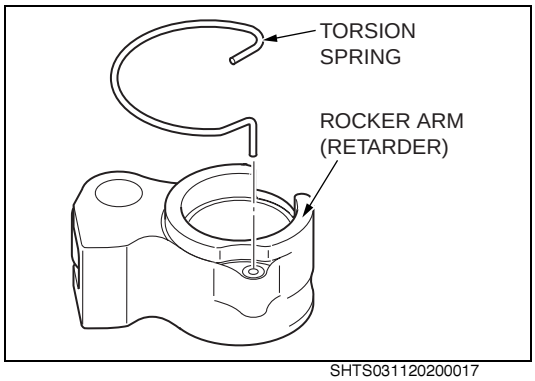
SHTS031120200016

2. REMOVE THE ROCKER ARM.

(1) With retarder

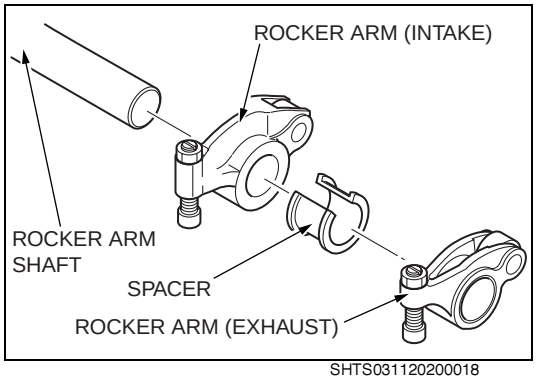
a. Remove the rocker arm (exhaust), the rocker arm (retarder) and the rocker arm (intake) from the rocker arm shaft in this sequential order.

⚠ CAUTION
Take care not to cut your hand with a sharp edge.



SHTS031120200017

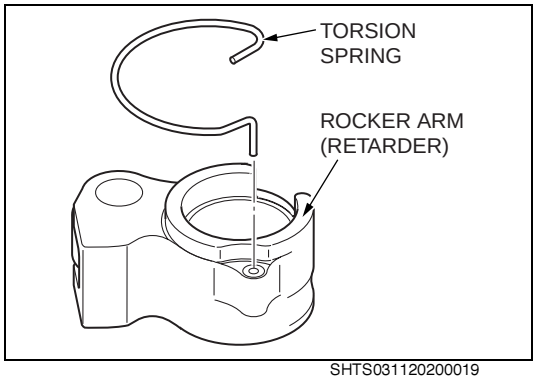
b. Remove the torsion spring from the rocker arm (retarder).



SHTS031120200018

(2) With no retarder
   a. Remove the rocker arm (exhaust), the spacer and the rocker arm (intake) from the rocker arm shaft in this sequential order.

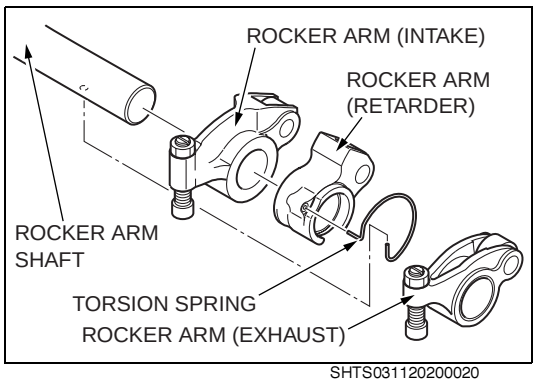
⚠ CAUTION
Take care not to cut your hand with a sharp edge.



SHTS031120200019

ASSEMBLE THE ROCKER ARM ASSEMBLY.

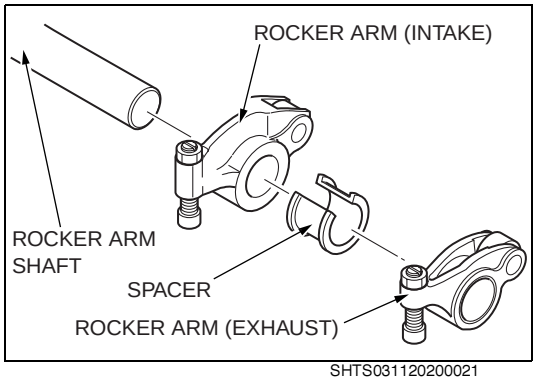
1. INSTALL THE ROCKER ARM.
(1) With retarder
   a. Insert the torsion spring into a hole in the side face of the rocker arm (retarder).
   b. Apply engine oil to the rocker arm shaft and the axes of the rocker arms (exhaust, retarder and intake).



SHTS031120200020

   c. Insert and install the rocker arm (exhaust), the rocker arm (retarder) and the rocker arm (intake) into the rocker arm shaft. Then insert the torsion spring of the rocker arm (retarder) into the hole of the rocker arm shaft.

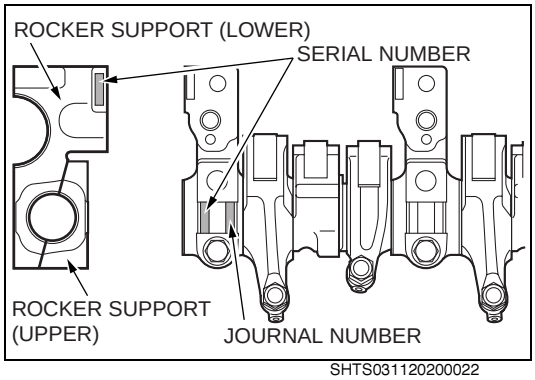
⚠ CAUTION
Take care not to cut your hand with a sharp edge.



SHTS031120200021

(2) With no retarder
   a. Apply engine oil to the rocker arm shaft and the axes of the rocker arms (exhaust), the spacer and the rocker arm (intake).
   b. Insert and install the rocker arm (exhaust), the spacer and the rocker arm (intake) into the rocker arm shaft.

⚠ CAUTION
Take care not to cut your hand with a sharp edge.

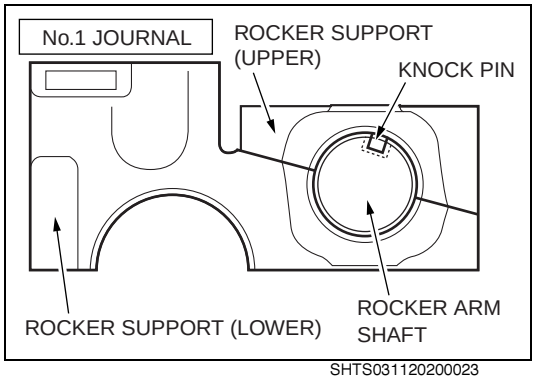


SHTS031120200022

2. INSTALL THE ROCKER SUPPORT.

(1) Check that upper and lower rocker supports have the same serial number.

(2) Check the installation position with a journal number on the upper rocker support.



SHTS031120200023

(3) Set the knock pin on the upper rocker support in the journal No.1, into the knock hole in the rocker arm shaft. Fit the lower rocker support to sandwich the rocker arm shaft.

HINT

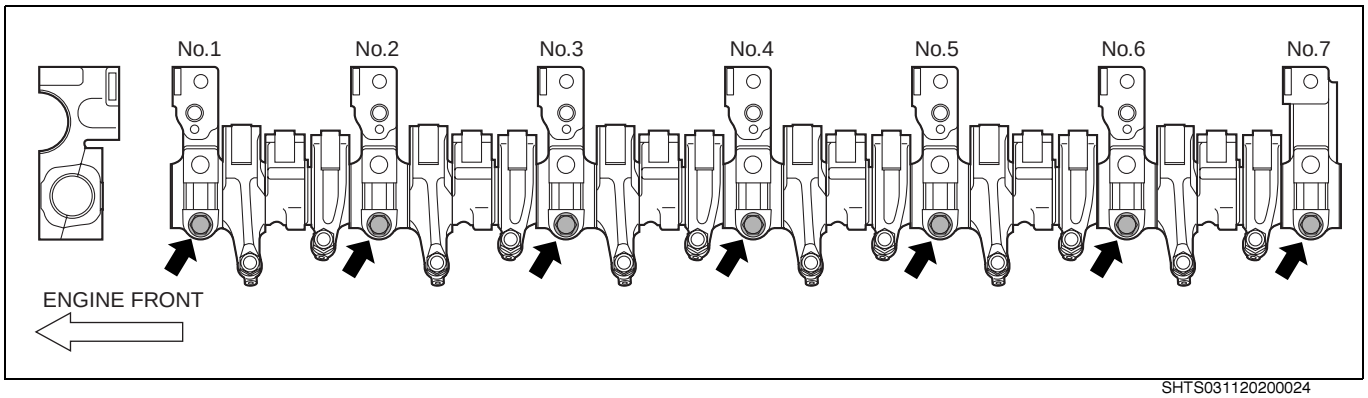
- **The knock pin exists only in the journal No.1. Install other rocker supports (upper and lower) by referencing to the journal No.1.**
- **Pretighten a bolt on the upper rocker support until it is fully seated, in order to prevent the knock pin from coming off.**

(4) Insert a bolt into the installation hole in the upper rocker support, and apply engine oil to the bolt seat surface and thread.

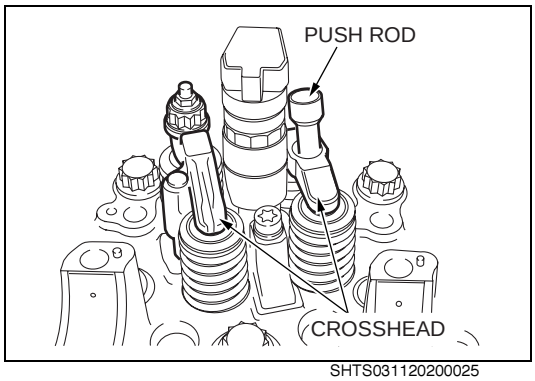
(5) Pretighten a bolt on the upper rocker support.

HINT

Just pretighten a bolt on the rocker support in this step. Fully tighten it to the specified torque in a later stage when installing the rocker arm assembly.



SHTS031120200024



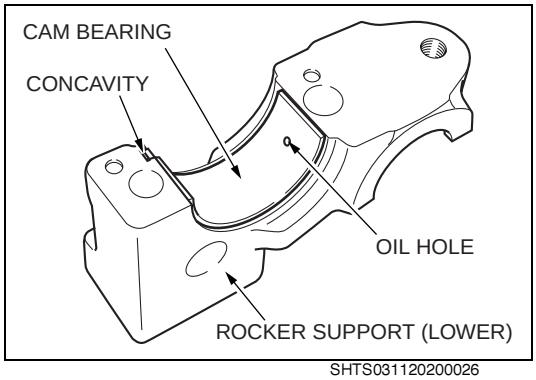
SHTS031120200025

INSTALL THE ROCKER ARM ASSEMBLY.

1. PRIOR CHECK

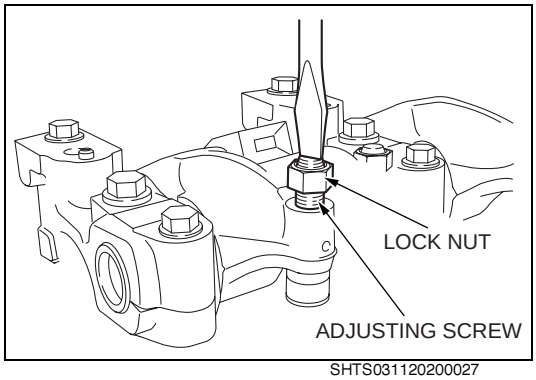
(1) Check that the crosshead and the push rod are property placed (sitting) on each valve.

(2) Check that the rocker arms are properly assembled to the rocker shaft.



SHTS031120200026

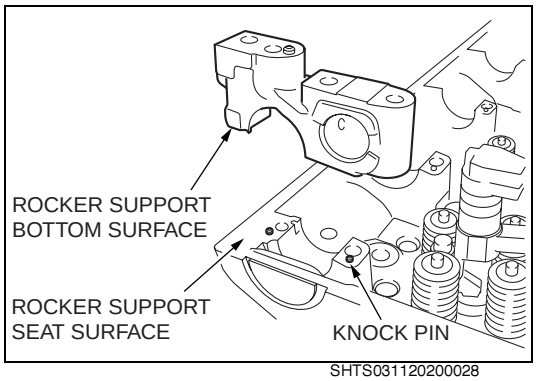
(3) Check that the cam bearing (upper) is properly installed to the lower rocker support.



SHTS031120200027

(4) Check that the adjusting screw on the rocker arm is fully lifted.

⚠ CAUTION
If the adjusting screw is not fully lifted, the shaft might bend during tightening of the rocker support bolt.

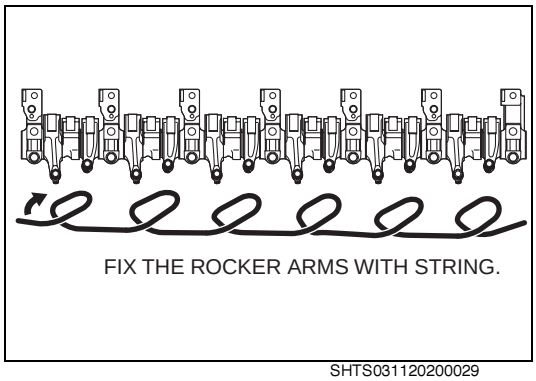


SHTS031120200028

2. INSTALL THE ROCKER ARM ASSEMBLY.

(1) Check that no dusts or shavings remain on the rocker support bottom surface and the rocker support seat surface on the top of the cylinder head. Set the rocker arm assembly to the installation position.

HINT
Make sure that the knock pin on the cylinder head mates with the knock hole in the lower rocker support.



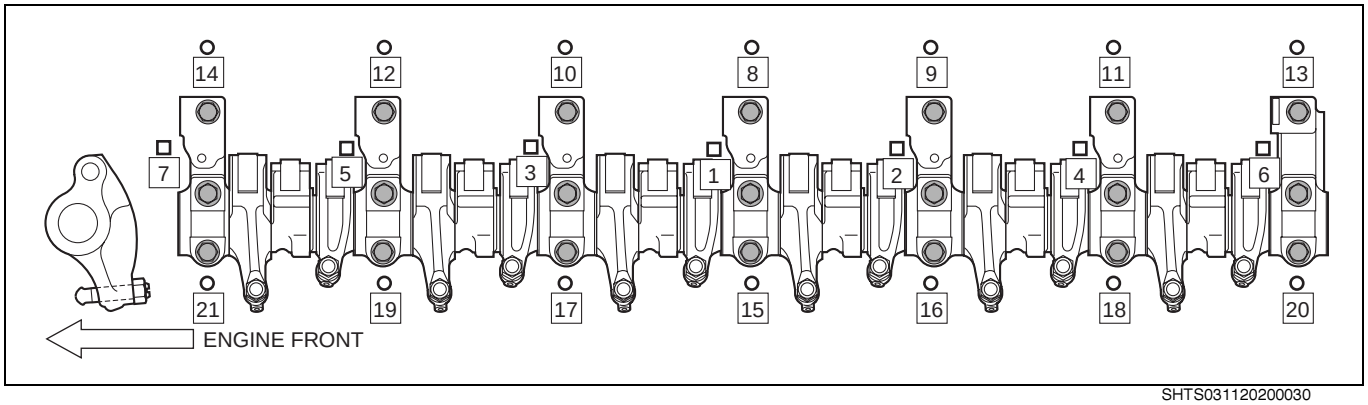
SHTS031120200029

HINT
Fix the rocker arms with string to facilitate installation.

(2) Apply engine oil to the rocker arm mounting bolt seats and threads. Finger-tighten the bolts until one or two threads go in for the purpose of positioning.

(3) Pretighten the rocker arm support bolts in the order shown in the figure.

Mark in figure	Tightening method	Pretightening
□	Plastic-region angle control method	Seating torque 60 N·m {610 kgf·cm, 44 lbf·ft}
○	Torque method	Before seating



SHTS031120200030

(4) Make sure that the crosshead and the push rod are positioned in place and do not come off after pretightening.

(5) Tighten the rocker arm support bolts in the order shown in the figure to the specified torque.

Mark in figure	Tightening method	Final tightening
□	Plastic-region angle control method	Rotational angle 120°
○	Torque method	Tightening torque 26 N·m {265 kgf·cm, 19 lbf·ft}

NOTICE

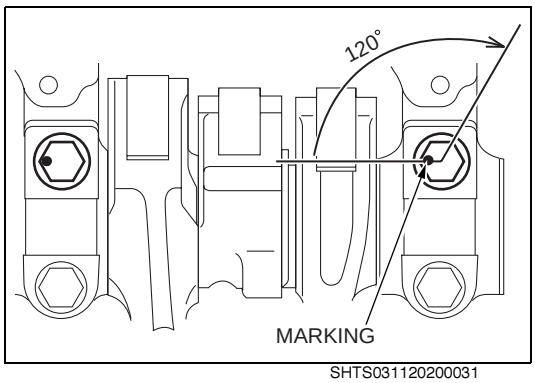
- **When adding torque, never untighten the bolts, even if they have been overtightened.**
- **The bolts shown with a square marked in the figure have a thin head. Take care not to cause damage with a tool.**

HINT

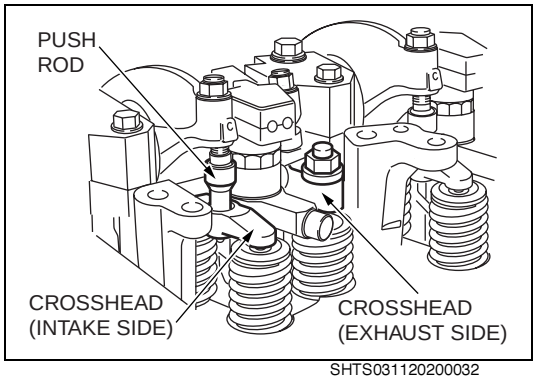
- **PROCEDURE OF THE ANGLE CONTROL METHOD**

a. Mark the bolts (shown with a square marked in the figure) with paint to indicate the same directions.

b. Turn the bolts 120° (1/3 turn) and make sure that all paint marks face the same direction.



SHTS031120200031



SHTS031120200032

(6) Make sure that the crosshead and the push rod are positioned in place and do not come off.

(7) Adjust the valve clearance.
Refer to the section **"VALVE CLEARANCE ADJUSTMENT"** in the chapter **"ENGINE INTRODUCTION"**.

3. INSTALL THE ENGINE RETARDER.

(1) Install the engine retarder.
Refer to the section **"ENGINE RETARDER"** in the chapter **"ENGINE RETARDER"**.

4. INSTALL THE INJECTOR HARNESS.

(1) Install the injector harness and connect the terminal of the engine retarder and the connector of the injector.
Refer to the section **"INJECTOR"** in the chapter **"FUEL SYSTEM"**.

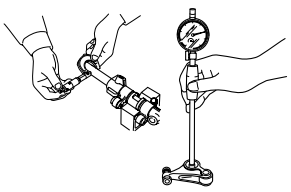
5. INSTALL THE HEAD COVER.

(1) Install the head cover.
Refer to the section **"HEAD COVER"**.

INSPECTION AND REPAIR

EN0311202H300002

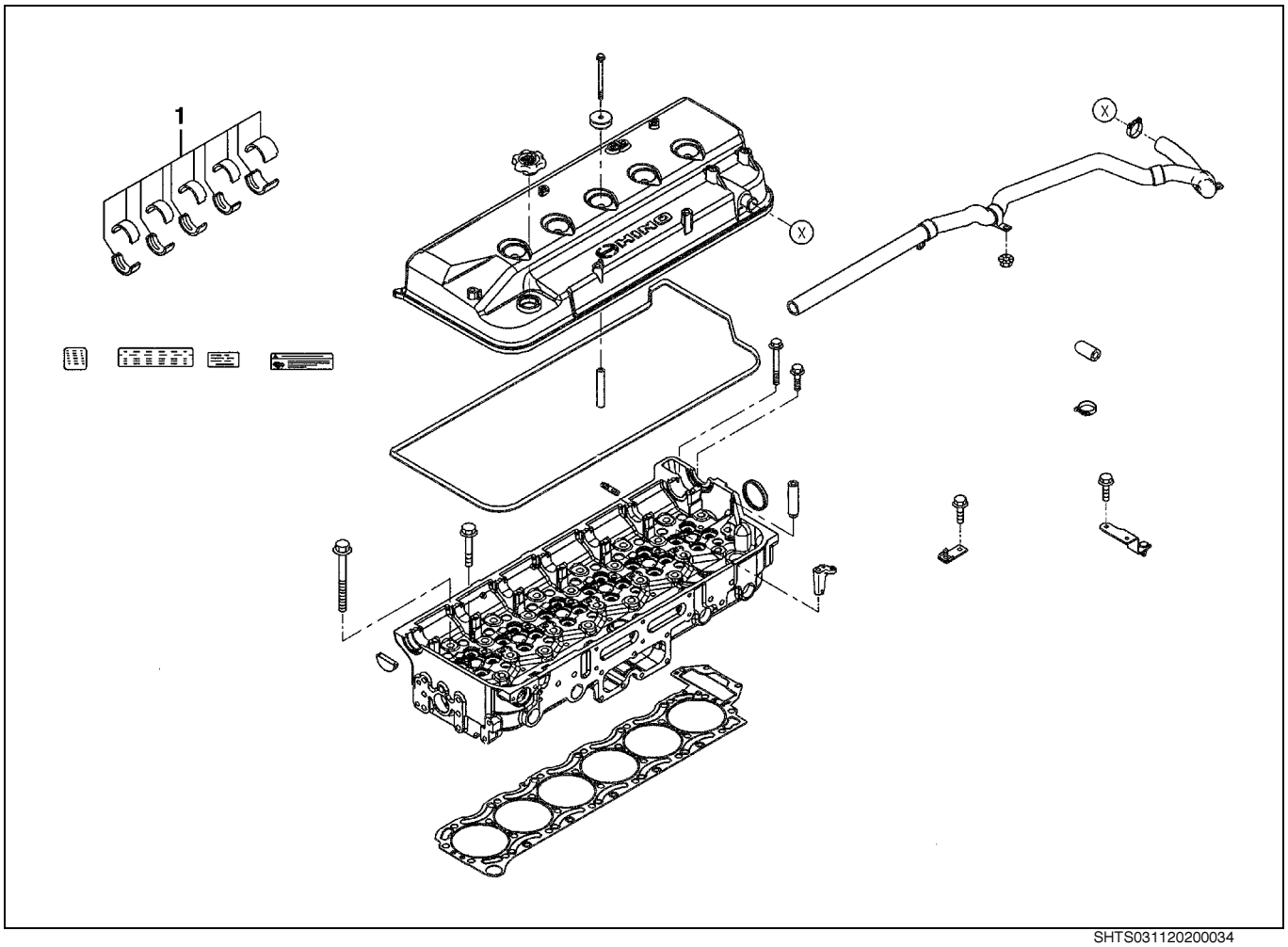
Unit: mm {in.}

Inspection item		Standard	Limit	Remedy	Inspection procedure
Rocker shaft outside diameter		27 {1.062}	26.92 {1.0590}	Replace rocker shaft.	Measure 
Rocker arm bushing inside diameter	Exhaust, Retarder	27	27.08 {1.0661}	Replace rocker arm bushing.	
	Intake	27	27.05 {1.0649}		
Clearance between rocker shaft and rocker arm bushing	Exhaust, Retarder	0.020-0.092 {0.0007-0.0036}	0.16 {0.0062}	Replace rocker arm bushing and/ or rocker shaft.	
	Intake	0.020-0.092 {0.0007-0.0036}	0.13 {0.0051}		
Rocker support bolt		90 {3.543}	91.5 {3.602}	Replace rocker support bolt.	Measure

CAMSHAFT ASSEMBLY

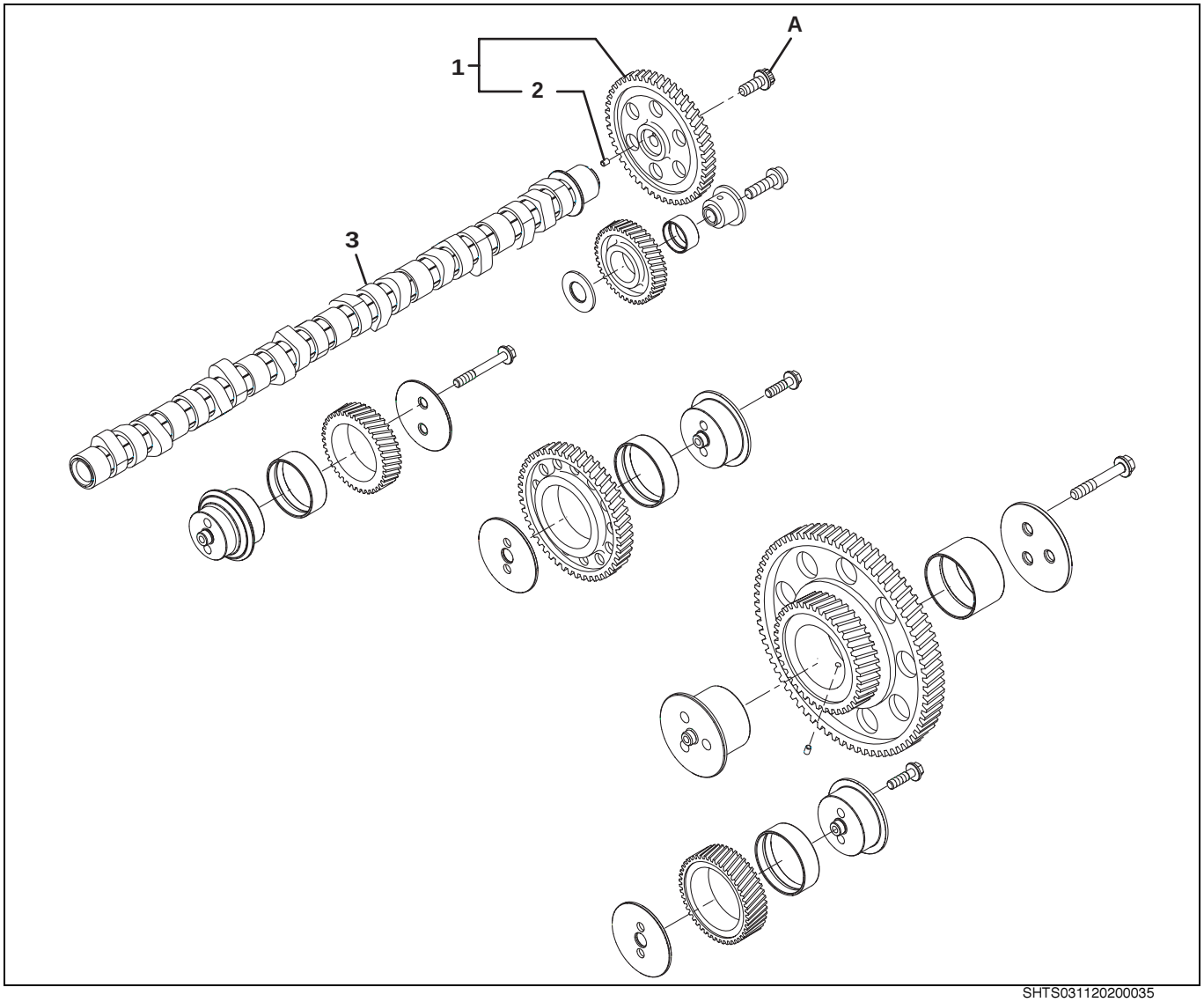
COMPONENT LOCATOR

EN0311202D100003



SHTS031120200034

1 Cam bearing	



SHTS031120200035

1	Camshaft gear	3	Camshaft
2	Knock pin		

Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

A	60 {610, 44} + 90°		

OVERHAUL

EN0311202H200002

REMOVE THE CAMSHAFT ASSEMBLY.

1. REMOVE THE HEAD COVER.

(1) Remove the head cover.
Refer to the section **"HEAD COVER"**.

2. REMOVE THE INJECTOR HARNESS.

(1) Disconnect the terminal of the engine retarder and the connector of the injector and remove the injector harness.
Refer to the section **"INJECTOR"** in the chapter **"FUEL SYSTEM"**.

3. REMOVE THE ENGINE RETARDER.

(1) Remove the engine retarder.
Refer to the section **"ENGINE RETARDER"** in the chapter **"ENGINE RETARDER"**.

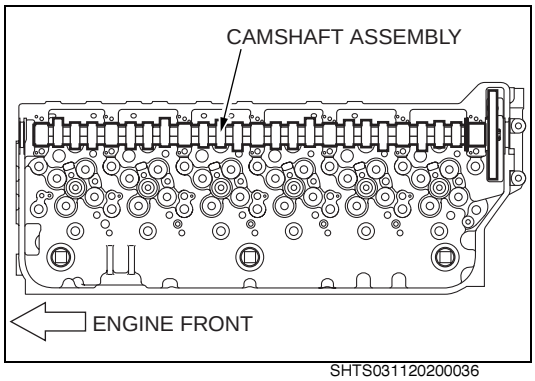
4. REMOVE THE ROCKER ARM ASSEMBLY.

(1) Loosen the lock nut and turn the adjusting screw counterclockwise completely. Remove the rocker arm assembly.
Refer to the section **"ROCKER ARM ASSEMBLY"**.

5. REMOVE THE CAMSHAFT ASSEMBLY.

(1) Hold the camshaft gear and the camshaft journal with your hands, and remove the camshaft assembly.

⚠ CAUTION
Take care as the cam bearing attached to the cylinder head might drop off concurrently.

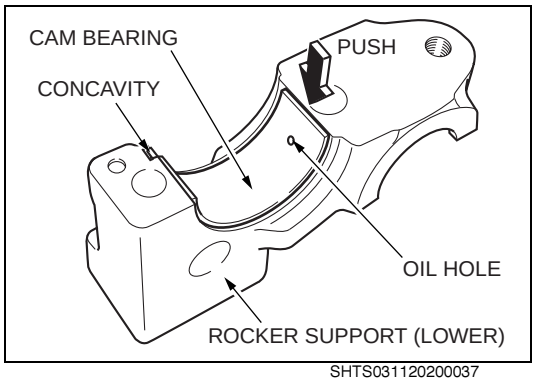


SHTS031120200036

6. REMOVE THE CAM BEARING.

(1) Remove the cam bearing from the lower rocker arm support.

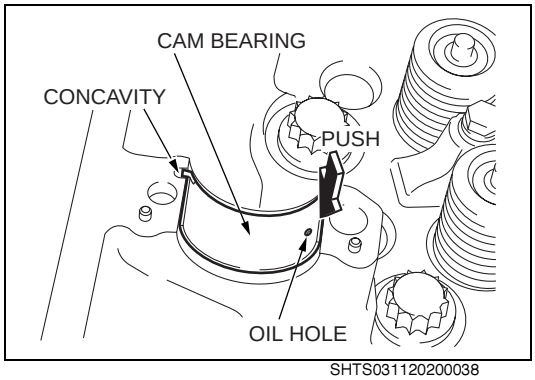
HINT
For easier works in this step, push the end of the cam bearing on the opposite side from a concavity.



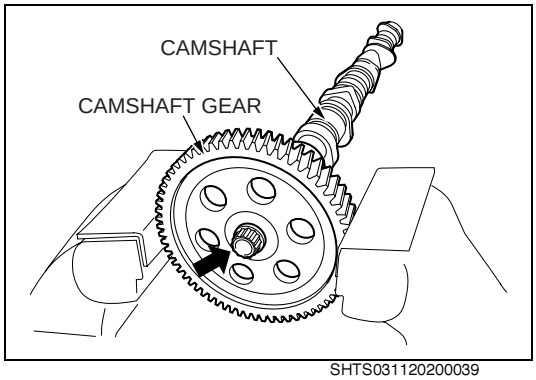
SHTS031120200037

(2) Remove the cam bearing from the cylinder head.

HINT
For easier works in this step, push the end of the cam bearing on the opposite side from a concavity.



SHTS031120200038



SHTS031120200039

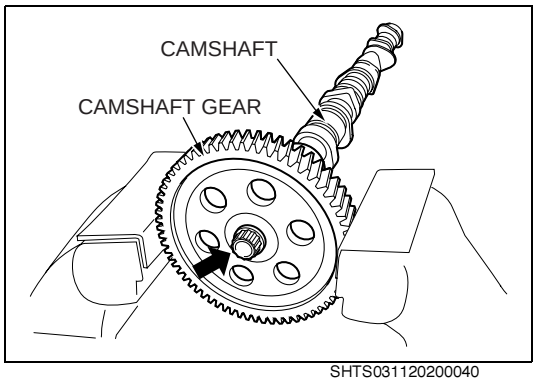
DISASSEMBLE THE CAMSHAFT ASSEMBLY.

1. REMOVE THE CAMSHAFT ASSEMBLY.

(1) Using a vise, fix the camshaft gear.

⚠ CAUTION
Take care not to deform or scratch the gear.

(2) Remove the bolt to remove the camshaft gear.



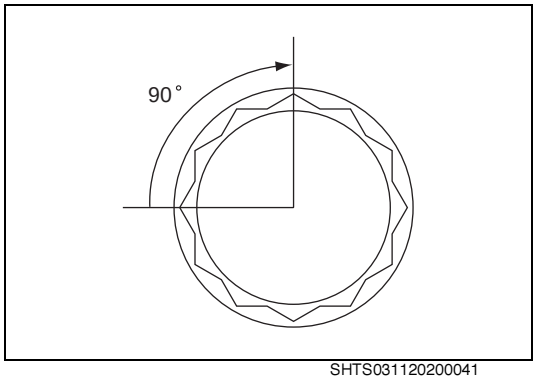
SHTS031120200040

ASSEMBLE THE CAMSHAFT.

1. INSTALL THE CAMSHAFT GEAR.

(1) Using a vise, fix the camshaft gear. Apply engine oil to the seat surface and thread of the camshaft installation bolt.

(2) Fit the knock pin to the camshaft and camshaft gear, and tighten the camshaft gear installation bolt.
Seating torque:
60 N·m {610 kgf·cm, 44 lbf·ft}



SHTS031120200041

(3) Retighten the bolt 90° (1/4 turn).

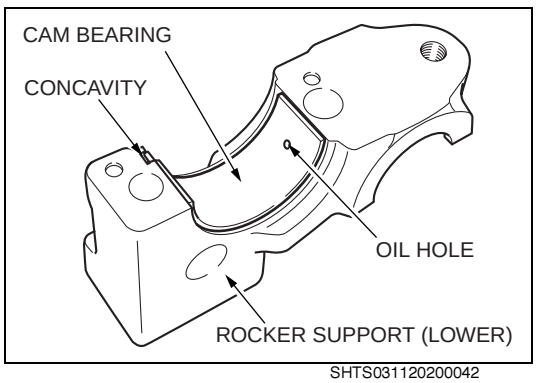
NOTICE
When adding torque, never untighten the bolt, even if they have been overtightened.

⚠ CAUTION
Take care not to deform or scratch the gear.

INSTALL THE CAMSHAFT ASSEMBLY.

1. SET THE TOP DEAD CENTER ON THE COMPRESSION STROKE OF THE No.1 CYLINDER.

(1) Set the top dead center on the compression stroke of the No.1 cylinder.
Refer to the section **"SUPPLY PUMP"** in the chapter **"FUEL SYSTEM"**.



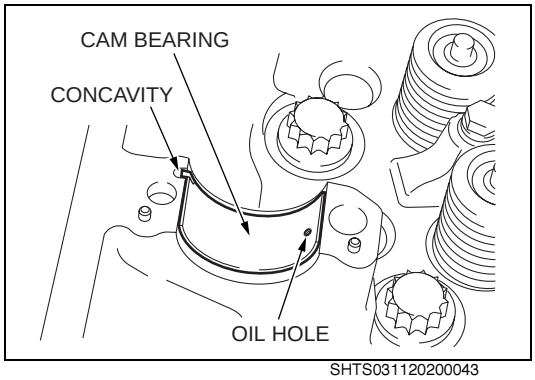
SHTS031120200042

2. INSALL THE CAM BEARING.

(1) Install the cam bearing in alignment with a concavity in the lower rocker arm support, and apply engine oil.

NOTICE

- **Make sure that oil holes are aligned with each other.**
- **Misaligned oil holes will cause insufficient oiling, resulting in seizure.**

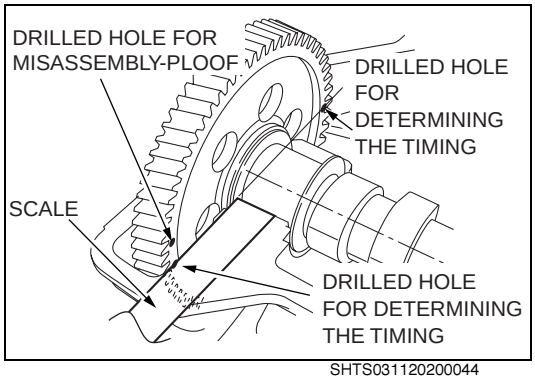


SHTS031120200043

(2) Install the cam bearing in alignment with a concavity in the cylinder head, and apply engine oil.

NOTICE

- **Make sure that oil holes are aligned with each other.**
- **Misaligned oil holes will cause insufficient oiling, resulting in seizure.**



SHTS031120200044

3. INSTALL THE CAMSHAFT ASSEMBLY.

(1) Position two drilled holes located at an angle of 180° (drilled holes for determining the timing) to be parallel to the top surface of the cylinder head.

NOTICE

Place a transparent plastic scale or an edged scale on the top face of the cylinder head and on the side face of the camshaft gear, and check that drilled holes for misassembly-proof lie at a height above the scale.

(2) Check that end play of the camshaft falls within the standard value.

4. INSTALL THE ROCKER ARM ASSEMBLY.

(1) Loosen the lock nut and turn the adjusting screw counterclockwise completely. Install the rocker arm assembly.
Refer to the section **"ROCKER ARM ASSEMBLY"**.

5. INSTALL THE ENGINE RETARDER.

(1) Install the engine retarder.
Refer to the section **"ENGINE RETARDER"** in the chapter **"ENGINE RETARDER"**.

6. INSTALL THE INJECTOR HARNESS.

(1) Install the injector harness and connect the terminal of the engine retarder and the connector of the injector.
Refer to the section **"INJECTOR"** in the chapter **"FUEL SYSTEM"**.

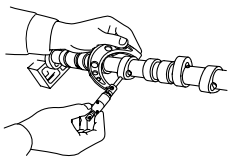
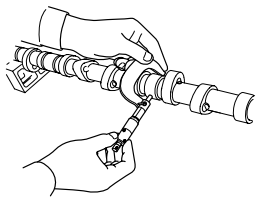
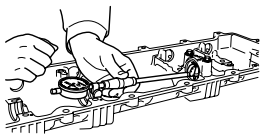
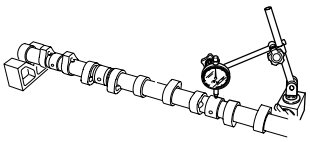
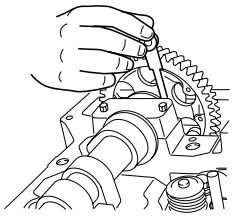
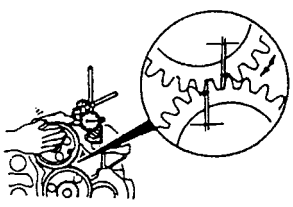
7. INSTALL THE HEAD COVER.

(1) Install the head cover.
Refer to the section **"HEAD COVER"**.

INSPECTION AND REPAIR

EN0311202H300003

Unit: mm {in.}

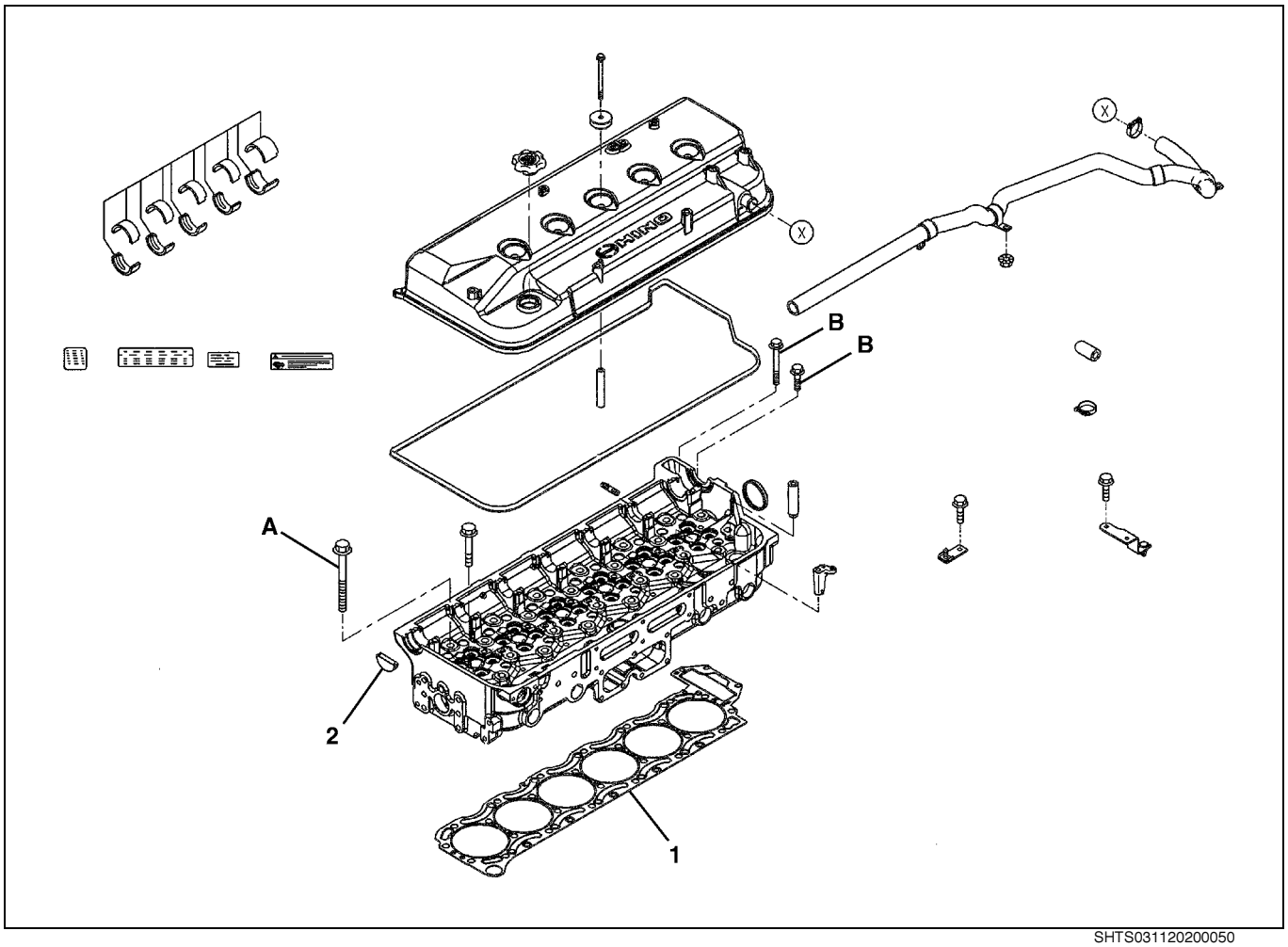
Inspection item		Standard	Limit	Remedy	Inspection procedure
Cam height	IN	50.067 {1.9711}	49.987 {1.9679}	Replace camshaft.	Measure 
	EX	52.104 {2.0513}	52.024 {2.0481}		
	RE	49.788 {1.9601}	49.708 {1.9570}		
Cam lift	IN	8.067 {0.3175}	—	Replace camshaft.	
	EX	10.104 {0.3977}	—		
	RE	5.788 {0.2278}	—		
Camshaft journal outside diameter		40 {1.5748}	39.85 {1.5689}	Replace camshaft.	Measure  
Camshaft bearing inside diameter		40 {1.5748}	40.15 {1.5807}	Replace camshaft bearing.	
Clearance between camshaft journal and camshaft bearing		0.020-0.063 {0.0008-0.0024}	0.3 {0.0118}	Replace camshaft and/or cam bearing.	
Camshaft deflection		0.04 {0.0016}	0.1 {0.0039}	Replace camshaft.	Measure 
Camshaft end play		0.100-0.380 {0.0040-0.0149}	—	Replace camshaft.	Measure 
Timing gear backlash	Cam idle-Camshaft	0.040-0.151 {0.0015-0.0059}	0.3 {0.0118}	Replace gear.	Measure 

Inspection item	Standard	Limit	Remedy	Inspection procedure
Camshaft gear bolt	**30 {1.1811}**	**31 {1.2204}**	**Replace camshaft gear bolt.**	**Measure**

CYLINDER HEAD ASSEMBLY

COMPONENT LOCATOR

EN0311202D100004

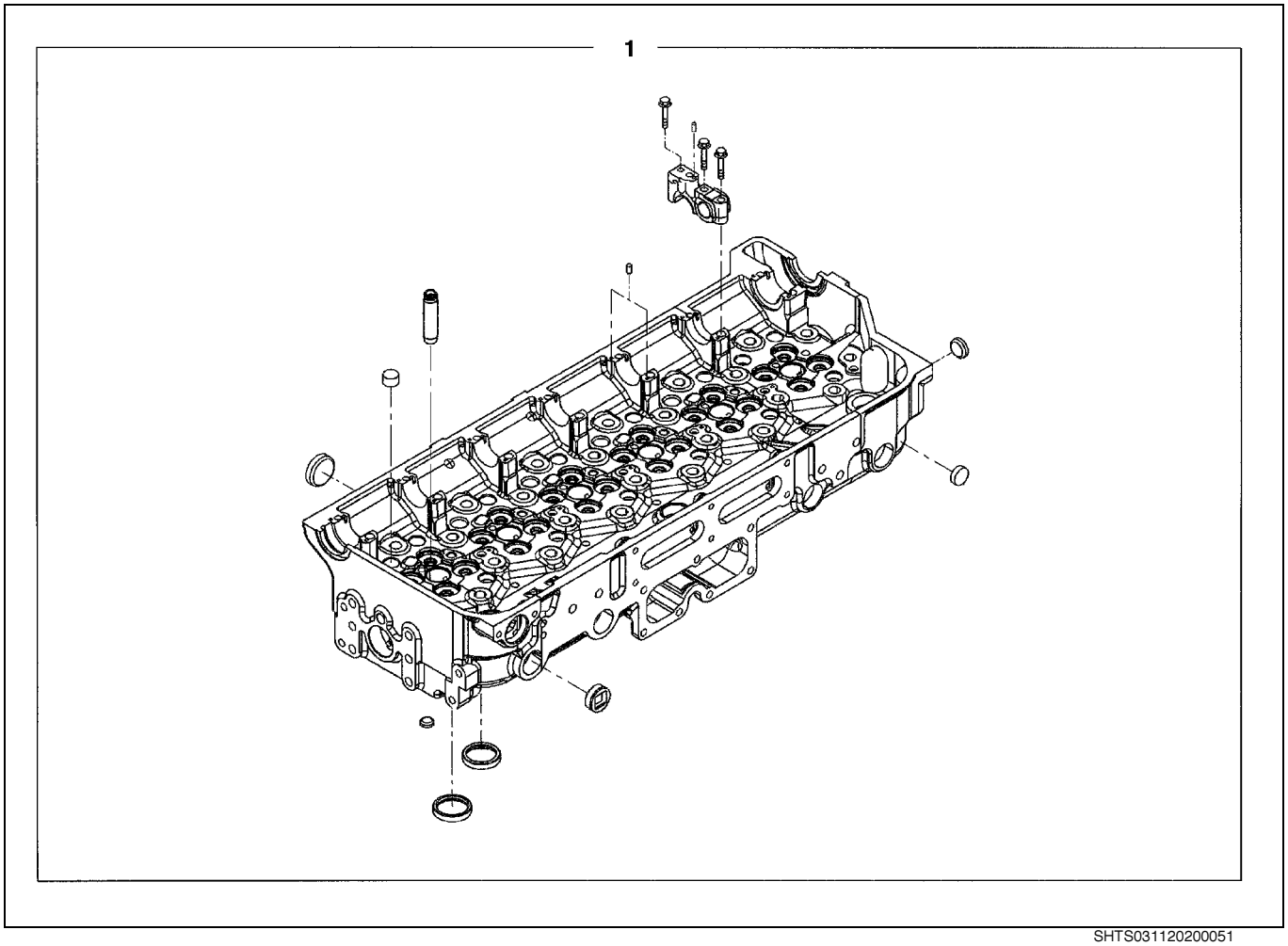


SHTS031120200050

1	Head gasket	2	Semicircle plug

Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

A	100 {1,020, 74} + 135° + 90°	B	59 {600, 44}



SHTS031120200051

1 Cylinder head assembly	

REPLACEMENT

EN0311202H100001

REMOVE THE PERIPHERAL COMPONENTS/PARTS OF CYLINDER HEAD ASSEMBLY.

1. DISCONNECT THE HARNESS.

(1) Disconnect the connector from the cylinder head.
Refer to the section **"ENGINE HARNESS"** in the chapter **"ENGINE CONTROL"**.

2. REMOVE THE INTAKE PIPE (EXHAUST SIDE).

(1) Remove the intake pipe (exhaust side).
Refer to the section **"INTAKE PIPE (EXHAUST SIDE)"** in the chapter **"AIR INTAKE SYSTEM"**.

3. REMOVE THE TURBOCHARGER PIPES.

(1) Remove the oil pipes (upper and lower) and the coolant pipes (upper and side) from the turbocharger.
Refer to the section **"TURBOCHARGER"** in the chapter **"TURBOCHARGER"**.

4. REMOVE THE ALTERNATOR.

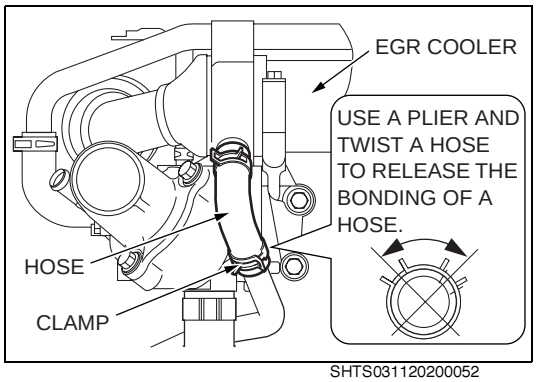
(1) Remove the alternator assembly.
Refer to the section **"ALTERNATOR"** in the chapter **"ALTERMATOR"**.

5. DISCONNECT THE COOLANT HOSE FROM THE EGR COOLER.

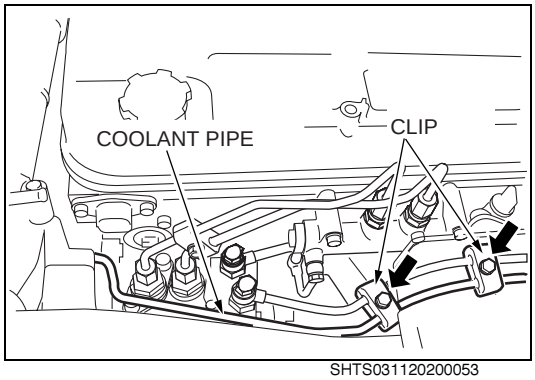
(1) Remove a clamp. Use a plier and slightly twist a hose to release the bonding of a hose.

HINT

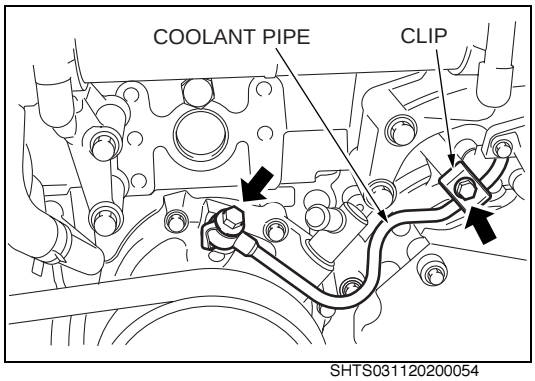
Do not pull off a hose in this step as the hose will be pulled off automatically when the cylinder head assembly is lifted.



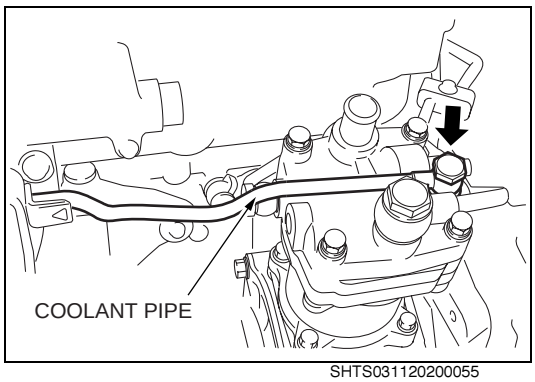
SHTS031120200052



SHTS031120200053



SHTS031120200054

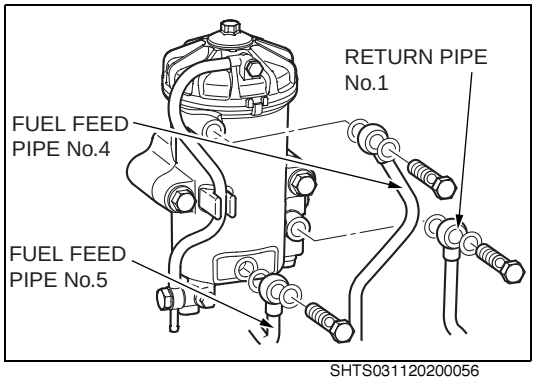


SHTS031120200055

6. DISCONNECT THE COOLANT PIPE.

(1) Remove three clips securing the coolant pipe between the coolant pump and the air compressor.

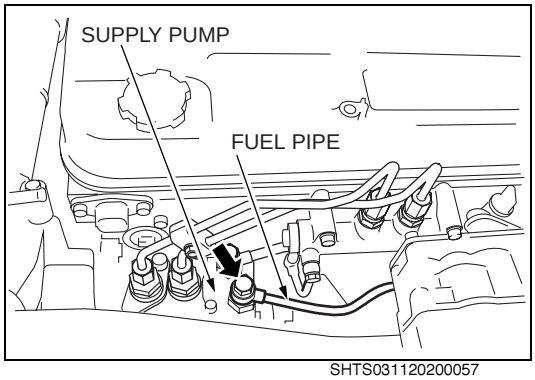
(2) Remove a union bolt to disconnect one coolant pipe between the coolant pump and the air compressor.



SHTS031120200056

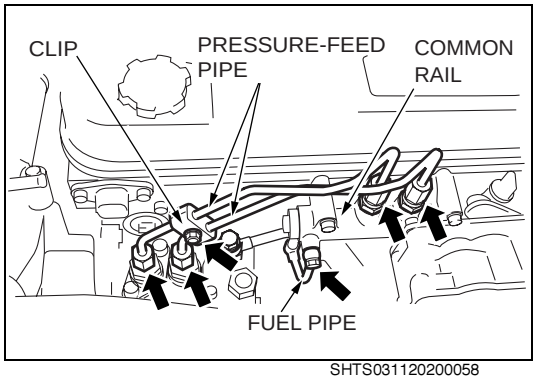
7. DISCONNECT THE FUEL PIPE.

(1) Remove the union bolt to disconnect three fuel pipes from the fuel filter case.



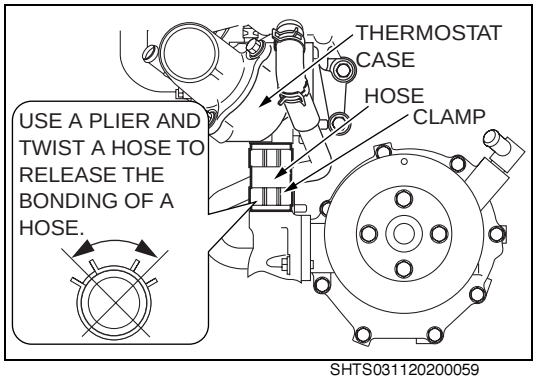
SHTS031120200057

(2) Remove the union bolt to disconnect the fuel pipe between fuel filter case and the supply pump.



SHTS031120200058

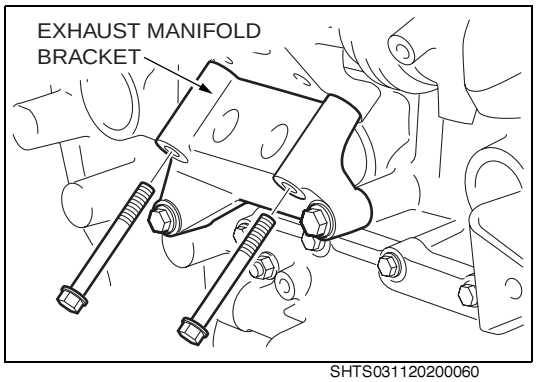
(3) Remove the clip to remove two pressure-feed pipes from the common rail.
(4) Remove the union bolt to disconnect the fuel pipe from the common rail.



SHTS031120200059

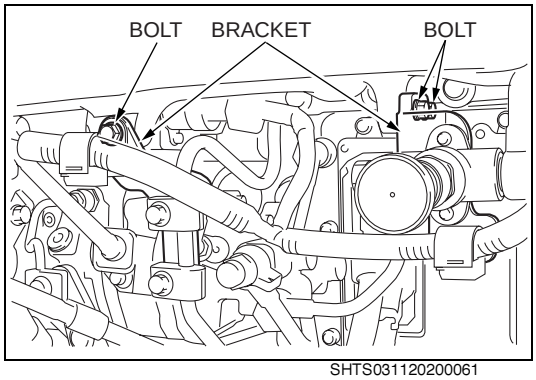
8. DISCONNECT THE COOLANT HOSE UNDER THE THERMOSTAT CASE.
(1) Remove a clamp. Use a plier and slightly twist a hose to release the bonding of a hose.

HINT
Do not pull off a hose in this step as the hose will be pulled off automatically when the cylinder head assembly is lifted.



SHTS031120200060

9. REMOVE THE EXHAUST MANIFOLD BRACKET.
(1) Remove the bolts to remove the exhaust manifold bracket.



SHTS031120200061

10. REMOVE THE CONNECTING PARTS UNDER THE INTAKE PIPE (INTAKE SIDE).
(1) Remove the bolts to remove the fuel pipe bracket and priming pump bracket.

REMOVE THE CYLINDER HEAD ASSEMBLY.

1. REMOVE THE HEAD COVER.

(1) Remove the head cover.
Refer to the section **"HEAD COVER"**.

2. REMOVE THE INJECTOR HARNESS.

(1) Disconnect the terminal of the engine retarder and the connector of the injector and remove the injector harness.
Refer to the section **"INJECTOR"** in the chapter **"FUEL SYSTEM"**.

3. REMOVE THE ENGINE RETARDER.

(1) Remove the engine retarder.
Refer to the section **"ENGINE RETARDER"** in the chapter **"ENGINE RETARDER"**.

4. REMOVE THE ROCKER ARM ASSEMBLY.

(1) Loosen the lock nut and turn the adjusting screw counterclockwise completely. Remove the rocker arm assembly.
Refer to the section **"ROCKER ARM ASSEMBLY"**.

5. REMOVE THE CAMSHAFT ASSEMBLY.

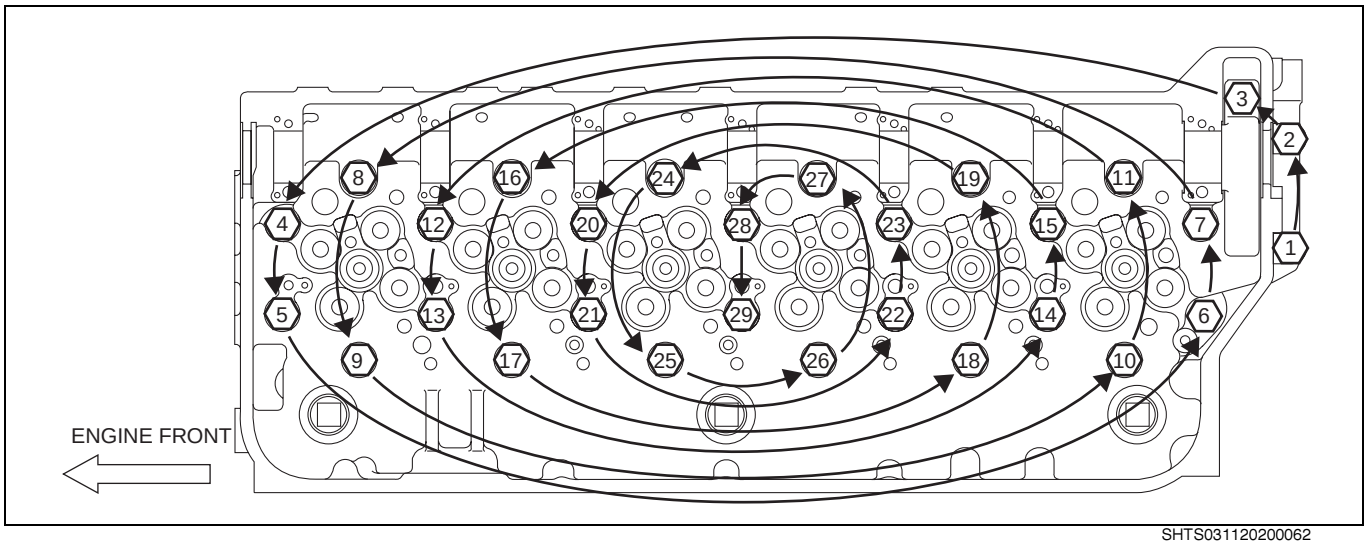
(1) Remove the camshaft.
Refer to the section **"CAMSHAFT ASSEMBLY"**.

6. REMOVE THE INJECTOR.

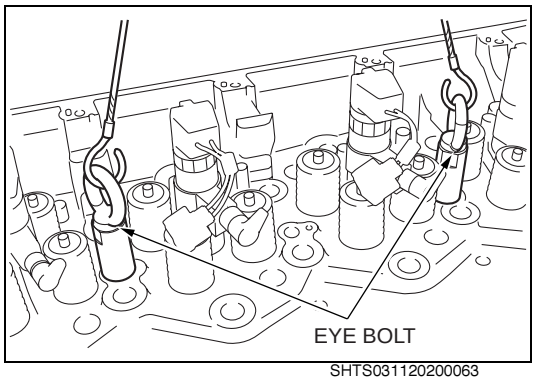
(1) Remove the injector and six injection pipes.
Refer to the section **"INJECTOR"** in the chapter **"FUEL SYSTEM"**.

7. REMOVE THE CYLINDER HEAD ASSEMBLY.

(1) Gradually loosen the bolts (turn approximately 90° at each time) and remove them in the order shown in the figure.



SHTS031120200062

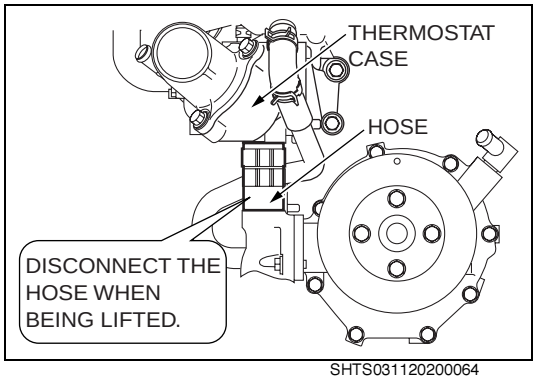


SHTS031120200063

(2) Install the eye bolts to the cylinder head.
(3) Lift and remove the cylinder head assembly using a hoist.

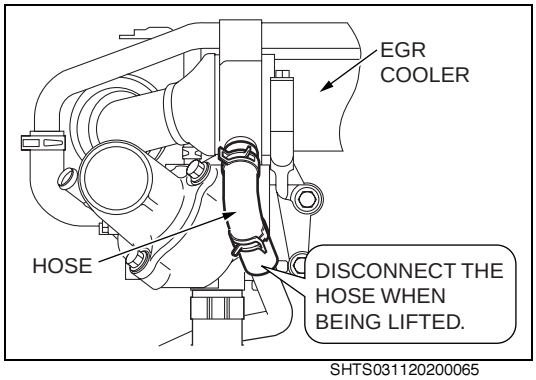
HINT

If the cylinder head would be too tight to be separated off, use a plastic hammer to apply some impacts to the surrounding area of the cylinder head being slightly lifted by a hoist.



SHTS031120200064

a. Disconnect the coolant hose under the thermostat case when being lifted.



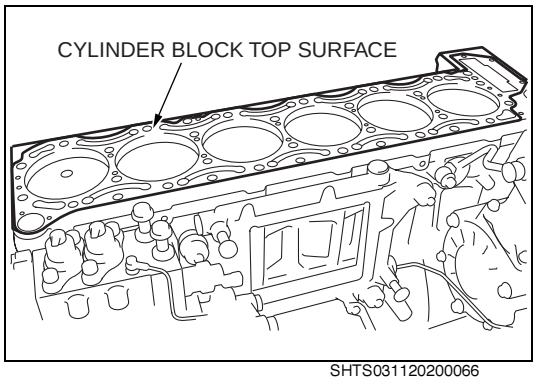
SHTS031120200065

b. Disconnect the coolant hose for the EGR cooler when being lifted.

(4) Use some blocks to prepare a reasonable bed so that peripheral components such as an intake pipe will not undergo any loads when the cylinder head assembly is placed on the work bench.

⚠ CAUTION
With injector installed, take care not to damage the nozzle tips.

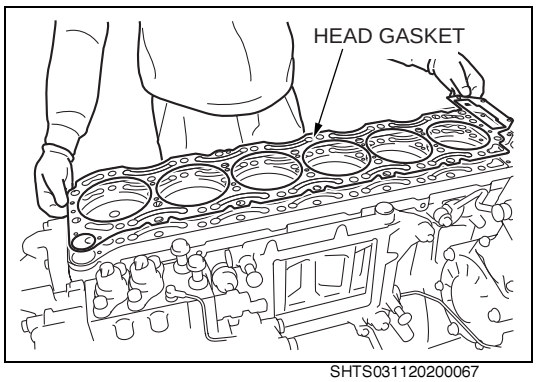
INSTALL THE CYLINDER HEAD ASSEMBLY.



SHTS031120200066

1. INSTALL THE HEAD GASKET.
(1) Clean the cylinder block top surface.

NOTICE
Before start of works, remove dusts, moisture or oil from the mounting surfaces of the cylinder head and the cylinder block.



SHTS031120200067

(2) Place a new head gasket on the top surface of the cylinder block in alignment with the knock pin.

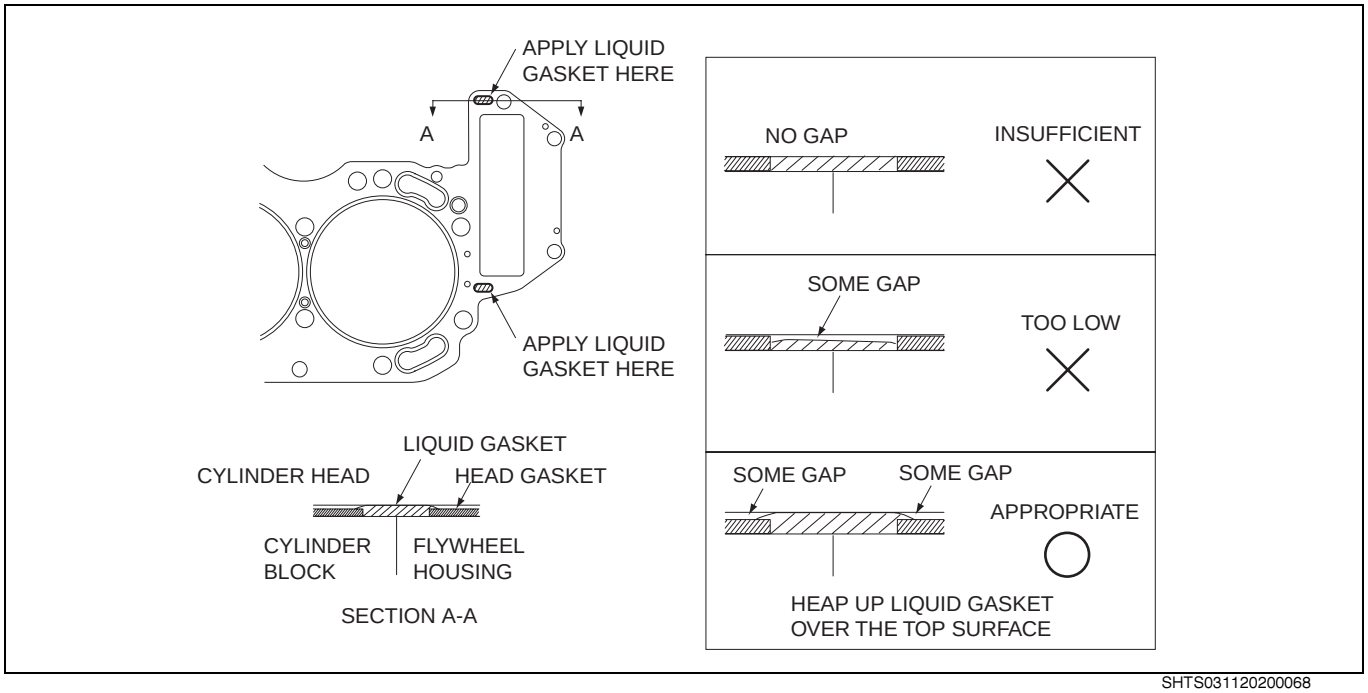
⚠ CAUTION
Do not reuse an old gasket. Otherwise, the engine will be damaged.

NOTICE
Before mounting the head gasket, make sure of no scratches in or coming-off of the seal ring.

(3) Apply liquid gasket (ThreeBond TB1207C, red) to the head gasket mating surfaces (two locations) between the flywheel housing and the top rear end surface of the cylinder block.

NOTICE

- **Apply enough liquid gasket to the extent that a raise of liquid gasket is seen on the head gasket surface.**
- **Proceed with a mounting work within 20 min. after applying liquid gasket.**



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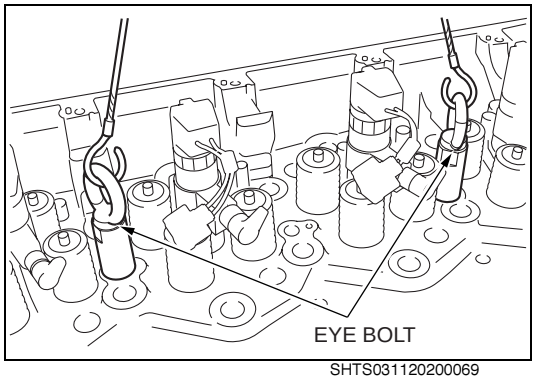


SHTS031120200069

2. INSTALL THE CYLINDER HEAD ASSEMBLY.

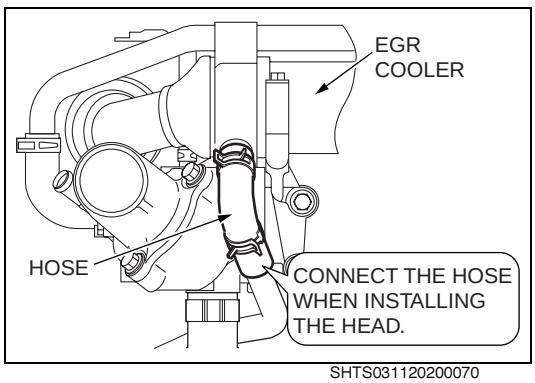
(1) Clean the cylinder head bottom surface and the head bolt seat surface on the top of the cylinder head.

(2) Install eye bolts and use a hoist to lift the cylinder head assembly.

(3) Install some guide bolts to the cylinder block. Align the knock pin and place the cylinder head assembly on the cylinder block.

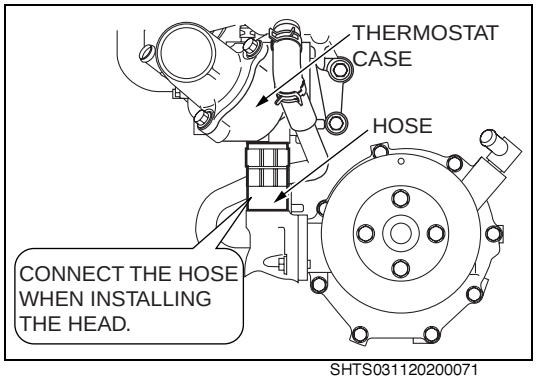
NOTICE

Before placing onto the cylinder block, make sure that no contaminants remain in the cylinders.



SHTS031120200070

a. Connect the coolant hose to the EGR cooler when installing the cylinder head assembly.

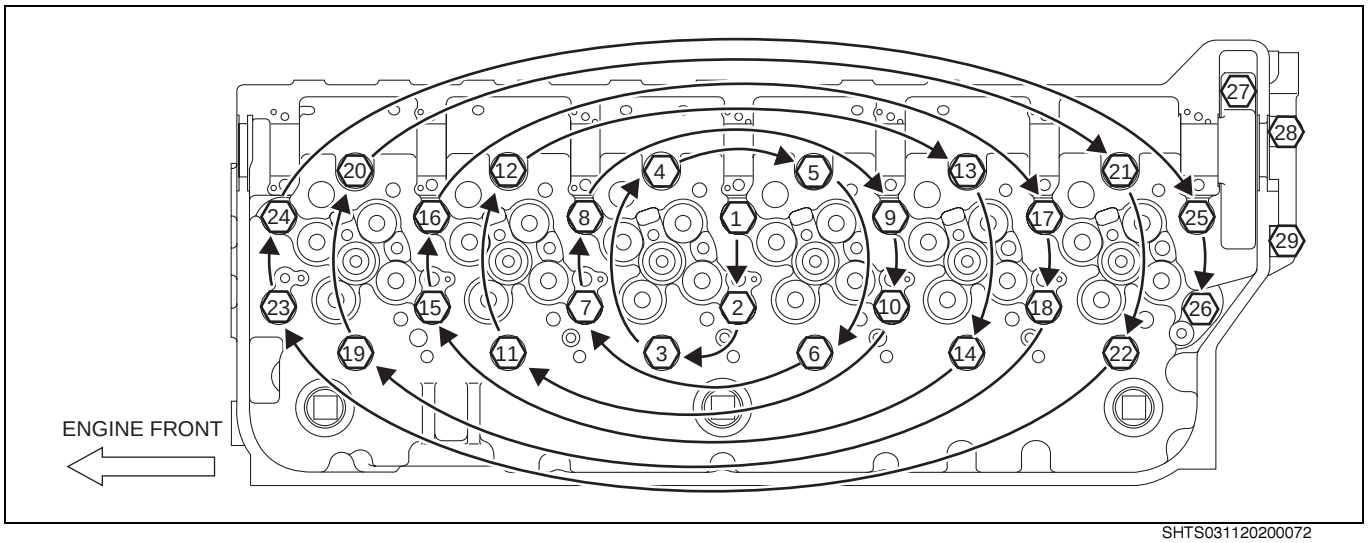


SHTS031120200071

b. Connect the coolant hose under the thermostat case when installing the cylinder head assembly.

(4) Apply engine oil to the bolt seat surfaces and bolt threads of the head bolt.

(5) Tighten No.1-No.26 head bolts in order shown in the figure to the specified torque.
Seating torque:
100 N·m {1,020 kgf·cm, 74 lbf·ft}



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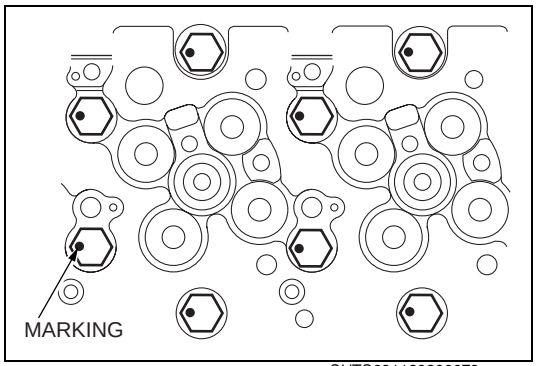
(6) Mark the head bolts with paint to indicate the same directions.



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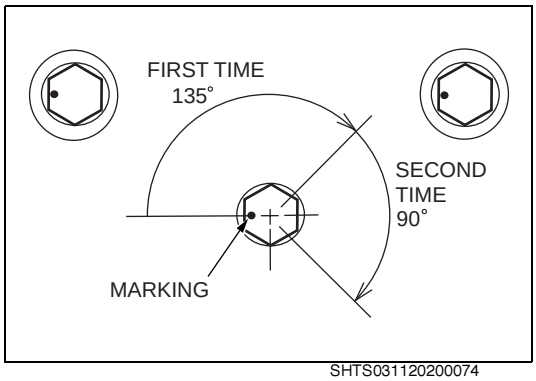

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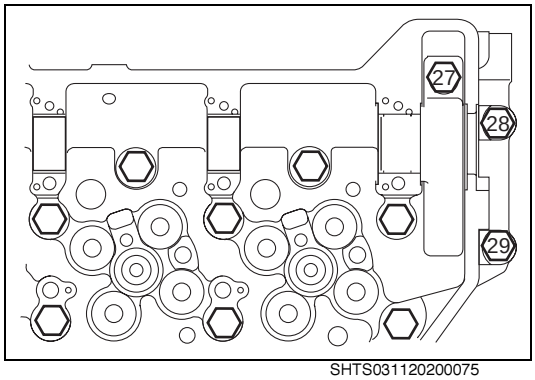
(7) Turn No.1-No.26 head bolts 135° (3/8 turn) in the same order as in (5) and make sure that all paint marks face the same direction. Additionally, turn No.1-No.26 head bolts 90° (1/4 turn) in the same order as in (5) and make sure that all paint marks face the same direction.

NOTICE
When adding torque, never untighten the bolts, even if they have been overtightened.



SHTS031120200075

(8) Tighten No.27-No.29 in the order shown in the figure to the specified torque below.
Tightening Torque:
59 N·m {600 kgf·cm, 43 lbf·ft}

3. INSTALL THE INJECTOR.
(1) Install the injector and six injection pipes to the cylinder head.
Refer to the section **"INJECTOR"** in the chapter **"FUEL SYSTEM"**.

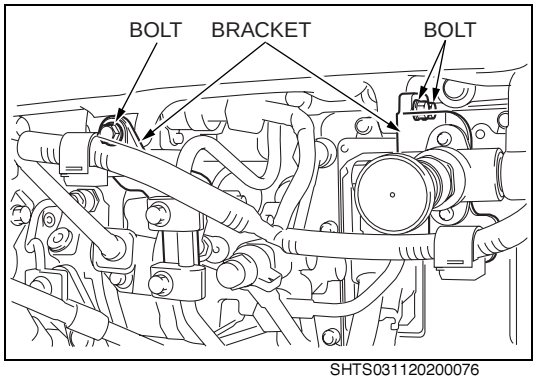
4. INSTALL THE CAMSHAFT ASSEMBLY.
(1) Install the camshaft assembly.
Refer to the section **"CAMSHAFT ASSEMBLY"**.

5. INSTALL THE ROCKER ARM ASSEMBLY.
(1) Loosen the lock nut and turn the adjusting screw counterclockwise completely. Install the rocker arm assembly.
Refer to the section **"ROCKER ARM ASSEMBLY"**.

6. INSTALL THE ENGINE RETARDER.
(1) Install the engine retarder.
Refer to the section **"ENGINE RETARDER"** in the chapter **"ENGINE RETARDER"**.

7. INSTALL THE INJECTOR HARNESS.
(1) Install the injector harness and connect the terminal of the engine retarder and the connector of the injector.
Refer to the section **"INJECTOR"** in the chapter **"FUEL SYSTEM"**.

8. INSTALL THE HEAD COVER.
(1) Install the head cover.
Refer to the section **"HEAD COVER"**.

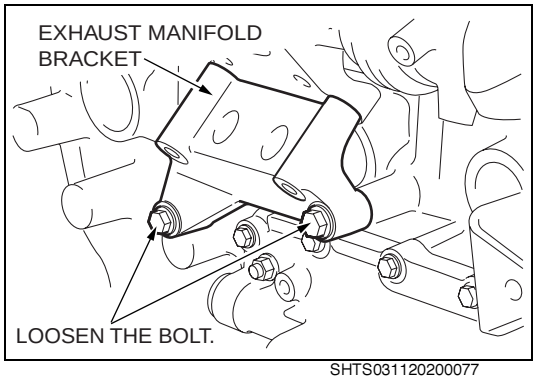


SHTS031120200076

INSTALL THE PERIPHERAL COMPONENTS/PARTS OF CYLINDER HEAD ASSEMBLY.

1. INSTALL THE CONNECTING PARTS UNDER THE INTAKE PIPE (INTAKE SIDE).

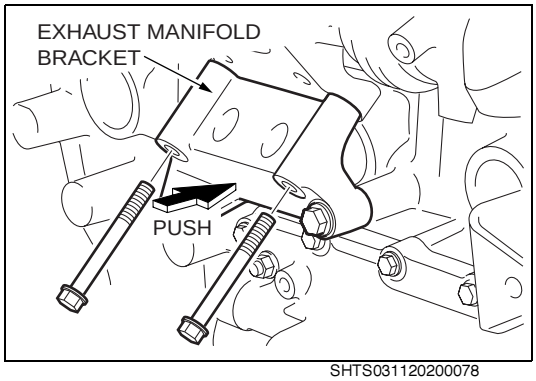
(1) Install the fuel pipe bracket and the priming pump bracket to under the intake pipe (intake side), and tighten bolts.



SHTS031120200077

2. INSTALL THE EXHAUST MANIFOLD BRACKET.

(1) Loosen bolts in the lower area of the exhaust manifold bracket on the cylinder block side.



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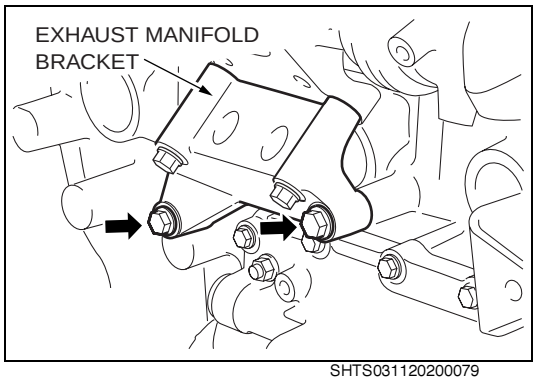
(2) Hold the exhaust manifold bracket against the cylinder block, and tighten the bolts on the exhaust manifold side.
Tightening Torque:
68.5 N·m {700 kgf·cm, 51 lbf·ft}



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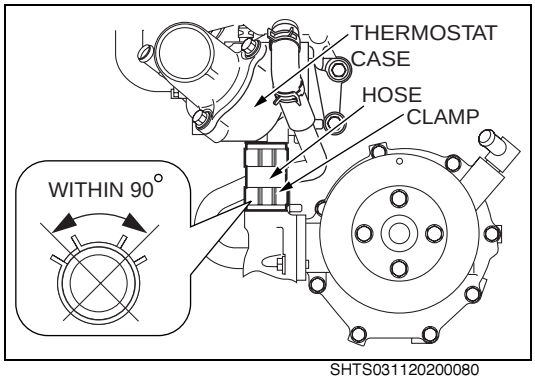
(3) Tighten the loosened bolts in the lower area of the exhaust manifold bracket on the cylinder block side.
Tightening Torque:
68.5 N·m {700 kgf·cm, 51 lbf·ft}



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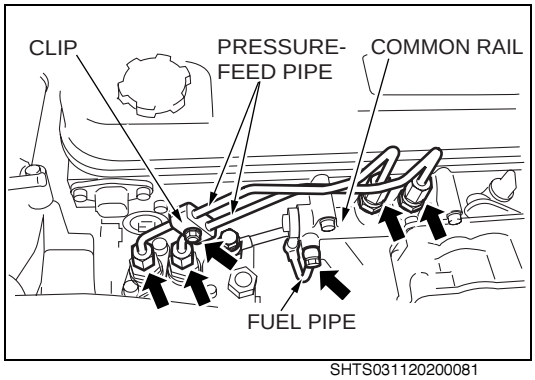
3. CONNECT THE COOLANT HOSE UNDER THE THERMOSTAT CASE.

(1) Fix the coolant hose under the thermostat case with a clamp.



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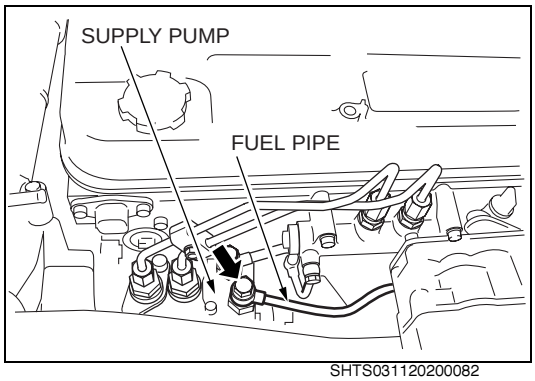
4. CONNECT THE FUEL PIPE.

(1) Replace old gasket with a new one. Connect the fuel pipe to the common rail, and tighten a union bolt.
Tightening Torque:
12.5 N·m {128 kgf·cm, 9 lbf·ft}

(2) connect new pressure-feed pipes, and fasten clips.
Tightening Torque:
32 N·m {330 kgf·cm, 24 lbf·ft}

⚠ CAUTION
Note that the pressure-feed pipe must be replaced with a new one. Otherwise fuel might leak out when a high pressure is applied.



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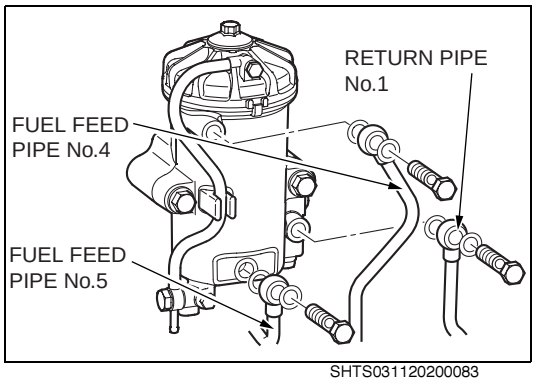
(3) Replace the gasket with a new one. Connect the fuel pipe (supply pump side) between the fuel filter case and the supply pump.
Tightening Torque:
27 N·m {275 kgf·cm, 20 lbf·ft}



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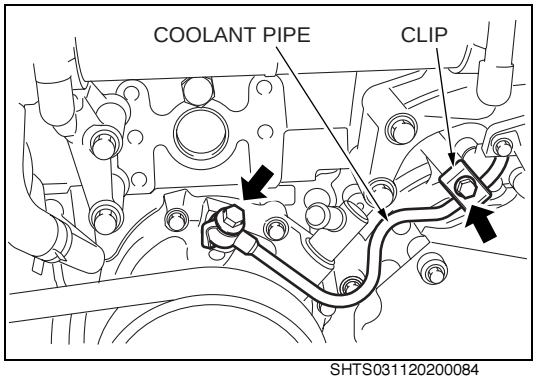
(4) Replace the gasket with a new one. Connect three fuel pipes to the fuel filter case, and fasten union bolts.



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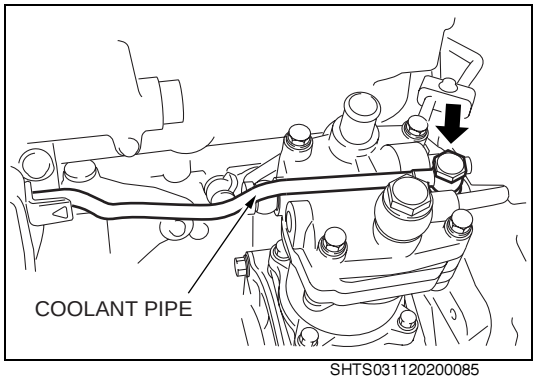

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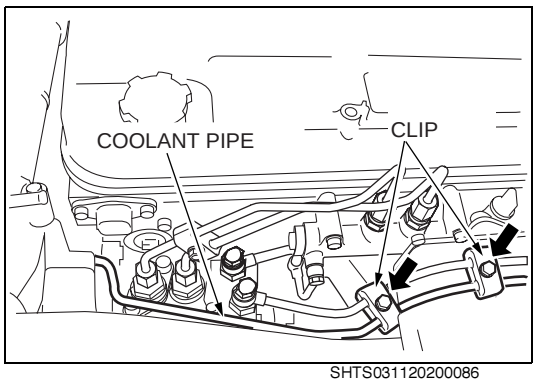

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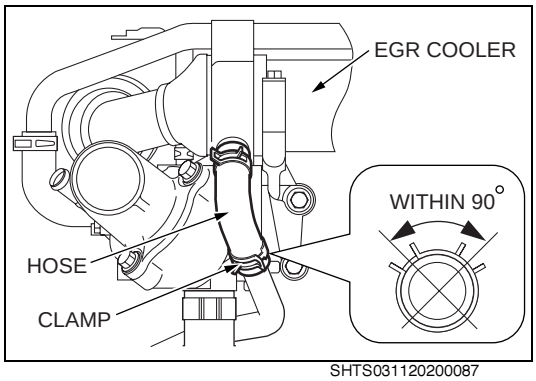
5. INSTALL THE COOLANT PIPE.

(1) Replace the gasket with a new one. Connect the coolant pipe between the coolant pump and the air compressor, and fasten union bolts.

(2) Fix the coolant pipe and fuel pipe on the intake pipe (intake side) with three clips.



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6. CONNECT THE COOLANT HOSE FOR THE EGR COOLER.

(1) Fix the coolant hose for the EGR cooler with the clamps.

7. INSTALL THE ALTERNATOR.

(1) Install the alternator assembly.
Refer to the section **"ALTERNATOR"** in the chapter **"ALTERNATOR"**.

8. INSTALL THE TURBOCHARGER PIPES.

(1) Install the oil pipes (upper and lower) and the coolant pipes (upper and side) to the turbocharger.
Refer to the section **"TURBOCHARGER"** in the chapter **"TURBOCHARGER"**.

9. INSTALL THE INTAKE PIPE (EXHAUST SIDE).
(1) Install the intake pipe (exhaust side).
Refer to the section **"INTAKE PIPE (EXHAUST SIDE)"** in the chapter **"AIR INTAKE SYSTEM"**.

10. CONNECT THE HARNESS.
(1) Connect the connector to the cylinder head.
Refer to the section **"ENGINE HARNESS"** in the chapter **"ENGINE CONTROL"**.

OVERHAUL

EN0311202H200003

REMOVE THE CYLINDER HEAD ASSEMBLY.

1. DISCONNECT THE HARNESS.
(1) Disconnect the connector from the cylinder head.
Refer to the section **"ENGINE HARNESS"** in the chapter **"ENGINE CONTROL"**.

2. REMOVE THE INTAKE PIPE (EXHAUST SIDE).
(1) Remove the intake pipe (exhaust side).
Refer to the section **"INTAKE PIPE (EXHAUST SIDE)"** in the chapter **"AIR INTAKE SYSTEM"**.

3. REMOVE THE FUEL FILTER AND THE CASE.
(1) Remove the fuel filter and the case.
Refer to the section **"FUEL FILTER AND CASE"** in the chapter **"FUEL SYSTEM"**.

4. REMOVE THE EGR VALVE AND THE COOLER.
(1) Remove the EGR valve and the cooler.
Refer to the section **"EGR VALVE AND COOLER"** in the chapter **"EMISSION CONTROL"**.

5. REMOVE THE COMMON RAIL.
(1) Remove the common rail.
Refer to the section **"COMMON RAIL"** in the chapter **"FUEL SYSTEM"**.

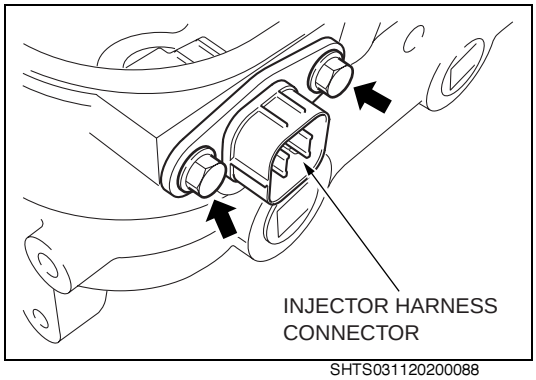
6. REMOVE THE TURBOCHARGER.
(1) Remove the turbocharger.
Refer to the section **"TURBOCHARGER"** in the chapter **"TURBOCHARGER"**.

7. REMOVE THE ALTERNATOR.
(1) Remove the alternator assembly.
Refer to the section **"ALTERNATOR"** in the chapter **"ALTERNATOR"**.

8. REMOVE THE THERMOSTAT CASE.
(1) Remove the thermostat case.
Refer to the section **"THERMOSTAT CASE AND THERMOSTAT"** in the chapter **"COOLING SYSTEM"**.

9. REMOVE THE EXHAUST MANIFOLD.
(1) Remove the exhaust manifold.
Refer to the section **"EXHAUST MANIFOLD"** in the chapter **"EXHAUST SYSTEM"**.

10. REMOVE THE CYLINDER HEAD ASSEMBLY.
(1) Remove the cylinder head assembly.
Refer to the section **"CYLINDER HEAD ASSEMBLY"**.



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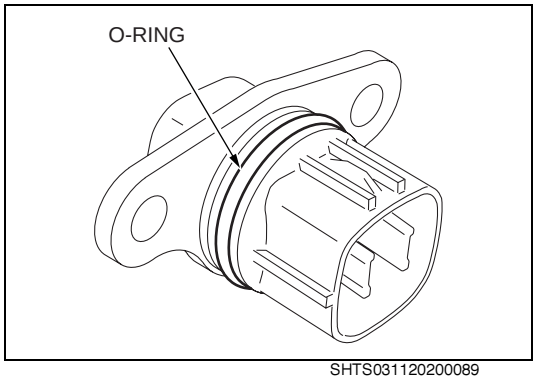
DISASSEMBLE THE CYLINDER HEAD ASSEMBLY.

1. REMOVE THE INJECTOR HARNESS CONNECTOR.

(1) Remove the bolts to remove the injector harness connector.



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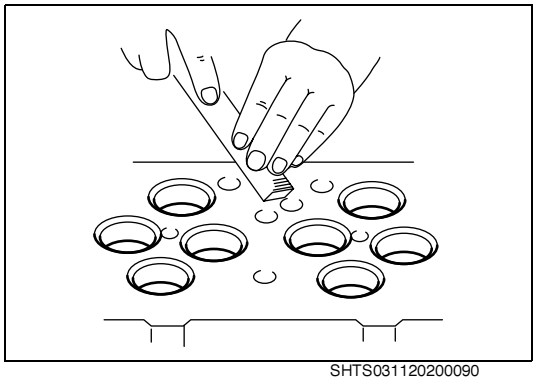
(2) Remove the O-ring from the injector harness connector.


SHTS031120200090

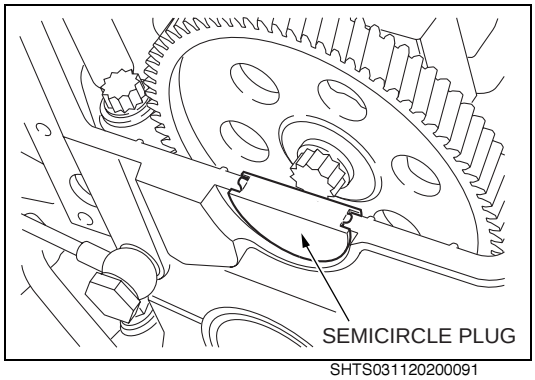
2. CLEAN THE CYLINDER HEAD.

(1) Using a scraper, remove carbon deposits or foreign particles.

(2) Clean the cylinder head.

⚠ CAUTION

Be careful not to damage the cylinder head lower surface when removing carbon deposits or foreign particles.



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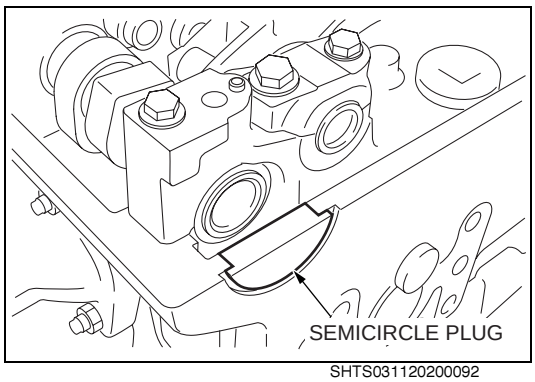


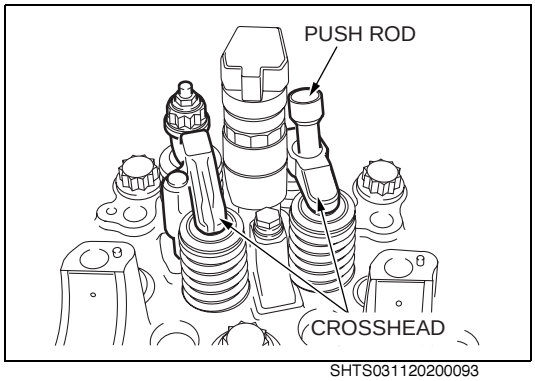
SHTS031120200092

3. REMOVE THE SEMICIRCLE PLUG.

(1) Remove two semicircle plugs (one each at the front and rear on the top surface of the cylinder head) fitted by liquid gasket if oil leaks from the semicircle plugs.

NOTICE

Remove semicircle plugs only if oil leakage is found.



SHTS031120200093

4. REMOVE THE CROSSHEAD.

(1) Remove the crosshead and the push rod.

HINT

Identify the corresponding cylinder number and intake side or exhaust side in storage.

5. REMOVE THE VALVE AND THE VALVE SPRING.

(1) Using the special tool, compress the valve spring and remove the valve and the valve spring.
Refer to the section **"VALVE SYSTEM"**.

6. REMOVE THE VALVE STEM SEAL.

(1) Using a plier, pull off the valve stem seal while waggling it.
Refer to the section **"VALVE SYSTEM"**.

7. REMOVE THE VALVE GUIDE.

(1) Using a press or the like, press out the valve guide.
Refer to the section **"VALVE SYSTEM"**.

8. REMOVE THE VALVE SEAT.

(1) Weld the valve to the valve seat and strike out to remove it.
Refer to the section **"VALVE SYSTEM"**.

9. REMOVE THE CAM IDLE GEAR.

(1) Remove the cam idle gear.
Refer to the section **"REAR TIMING GEAR AND CAM IDLE GEAR"**.

ASSEMBLE THE CYLINDER HEAD ASSEMBLY.

1. INSTALL THE CAM IDLE GEAR.

(1) Install the cam idle gear.
Refer to the section **"REAR TIMING GEAR AND CAM IDLE GEAR"**.

2. INSTALL THE VALVE SEAT.

(1) Insert new valve seat.
Refer to the section **"VALVE SYSTEM"**.

3. INSTALL THE VALVE GUIDE.

(1) Using a press or the like, press into new valve guide.
Refer to the section **"VALVE SYSTEM"**.

4. INSTALL THE VALVE STEM SEAL.

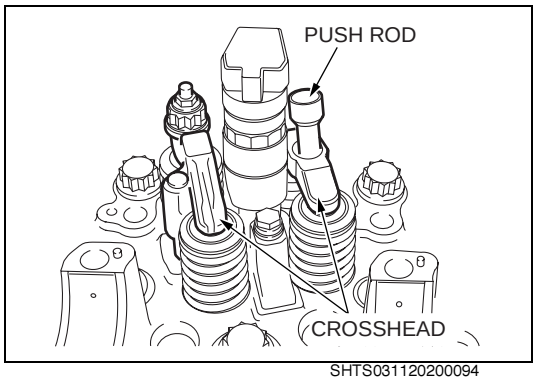
(1) Using the special tool, press new valve stem seal.

5. INSTALL THE VALVE AND THE VALVE SPRING.

(1) Using the special tool, compress the valve spring and install the valve spring and the valve.
Refer to the section **"VALVE SYSTEM"**.

6. INSTALL THE CROSSHEAD.

(1) Install the crosshead and make sure that the crosshead and push rod are on each valves.



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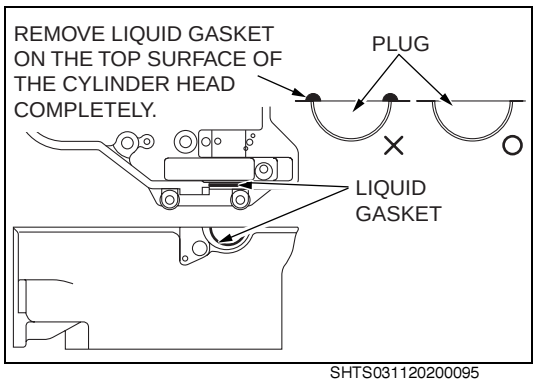
7. INSTALL THE SEMICIRCLE PLUG.

(1) Remove oil or dust thoroughly from the semicircle plug mounting surfaces on the cylinder head (one each at front and rear).

(2) Apply liquid gasket (ThreeBond TB1207B, black) to the semicircle plug installation surfaces on the cylinder head as shown in the figure.



SHTS031120200095

NOTICE

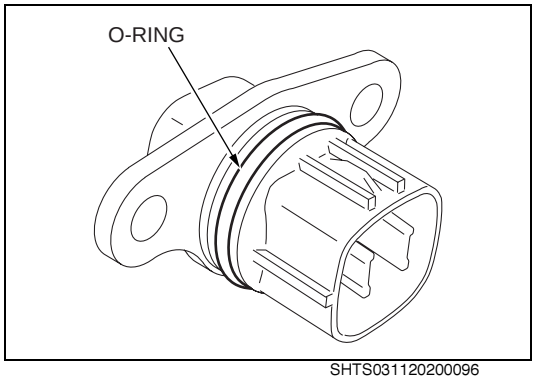
- **Apply liquid gasket at a width of 1.5 to 2.5 mm {0.0591 to 0.0984 in.}.**
- **Proceed with remounting works within 20 min. after applying the liquid gasket.**

(3) Attach the semicircle plugs in parallel on the top of the cylinder head. Make sure that the bottom of a semicircle plug contacts with the head.

(4) After attaching the semicircle plugs, immediately remove excessive liquid gasket on the top surface of the cylinder head.

NOTICE

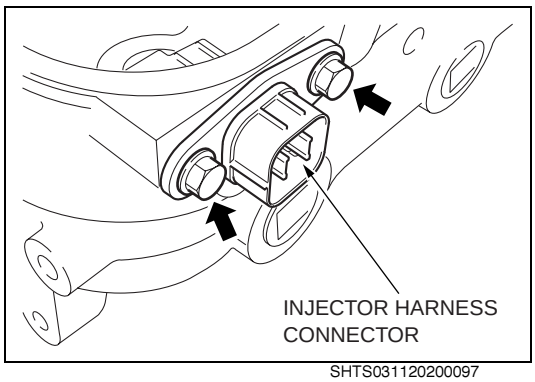
In this step, do not wobble or tilt the semicircle plugs.



SHTS031120200096

8. INSTALL THE INJECTOR HARNESS CONNECTOR.

(1) Install new O-ring to the injector harness connector.



SHTS031120200097

(2) Install the injector harness connector to the cylinder head with the bolts.

INSTALL THE CYLINDER HEAD ASSEMBLY.

1. INSTALL THE CYLINDER HEAD ASSEMBLY.

(1) Install the cylinder head assembly.
Refer to the section **"CYLINDER HEAD ASSEMBLY"**.

2. INSTALL THE EXHAUST MANIFOLD.

(1) Replace the gasket with a new one and install the exhaust manifold.
Refer to the section **"EXHAUST MANIFOLD"** in the chapter **"EXHAUST SYSTEM"**.

3. INSTALL THE THERMOSTAT CASE.

(1) Replace the gasket with a new one and install the thermostat case.
Refer to the section **"THERMOSTAT CASE AND THERMOSTAT"** in the chapter **"COOLING SYSTEM"**.

4. INSTALL THE ALTERNATOR.

(1) Install the alternator assembly.
Refer to the section **"ALTERNATOR"** in the chapter **"ALTERNATOR"**.

5. INSTALL THE TURBOCHARGER.

(1) Replace the gasket with a new one and install the turbocharger.
Refer to the section **"TURBOCHARGER"** in the chapter **"TURBOCHARGER"**.

6. INSTALL THE COMMON RAIL.

(1) Replace the gasket with a new one and install the common rail.
Refer to the section **"COMMON RAIL"** in the chapter **"FUEL SYSTEM"**.

7. INSTALL THE EGR VALVE AND THE COOLER.

(1) Replace the gasket with a new one and install the EGR valve and the cooler.
Refer to the section **"EGR VALVE AND COOLER"** in the chapter **"EMISSION CONTROL"**.

8. INSTALL THE FUEL FILTER AND THE CASE.

(1) Install the fuel filter and the case.
Refer to the section **"FUEL FILTER AND CASE"** in the chapter **"FUEL SYSTEM"**.

9. INSTALL THE INTAKE PIPE (EXHAUST SIDE).

(1) Install the intake pipe (exhaust side).
Refer to the section **"INTAKE PIPE (EXHAUST SIDE)"** in the chapter **"AIR INTAKE SYSTEM"**.

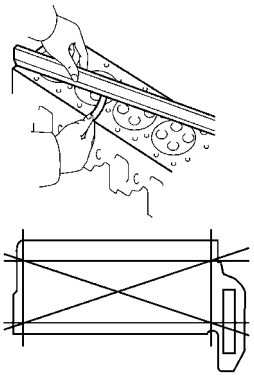
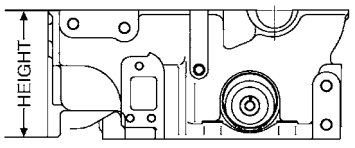
10. CONNECT THE HARNESS.

(1) Connect the connector to the cylinder head.
Refer to the section **"ENGINE HARNESS"** in the chapter **"ENGINE CONTROL"**.

INSPECTION AND REPAIR

EN0311202H300004

Unit: mm {in.}

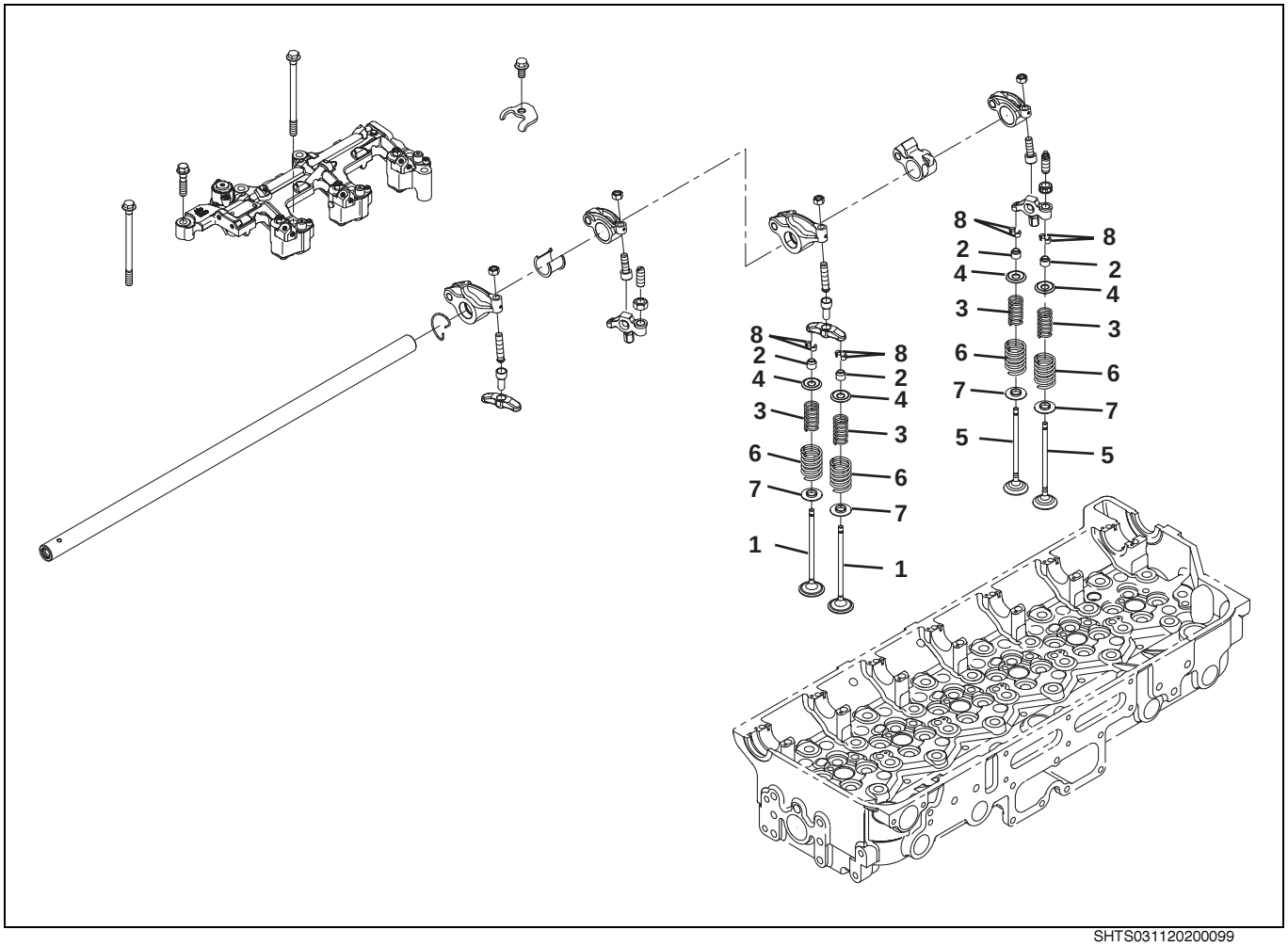
Inspection item	Standard	Limit	Remedy	Inspection procedure
Cylinder head bolt	**146.5 {5.7677}**	**147.5 {5.8070}**	**Replace cylinder head bolt.**	**Measure**
Cylinder head lower surface flatness	**0.05 {0.0019}**	**0.20 {0.0078}**	**Regrind or replace.**	**Measure** 
Cylinder head height	**155.5-155.7 {6.1220-6.1299}**	**155.3 {6.1142}**	**Replace.**	**Measure** 

VALVE SYSTEM

COMPONENT LOCATOR

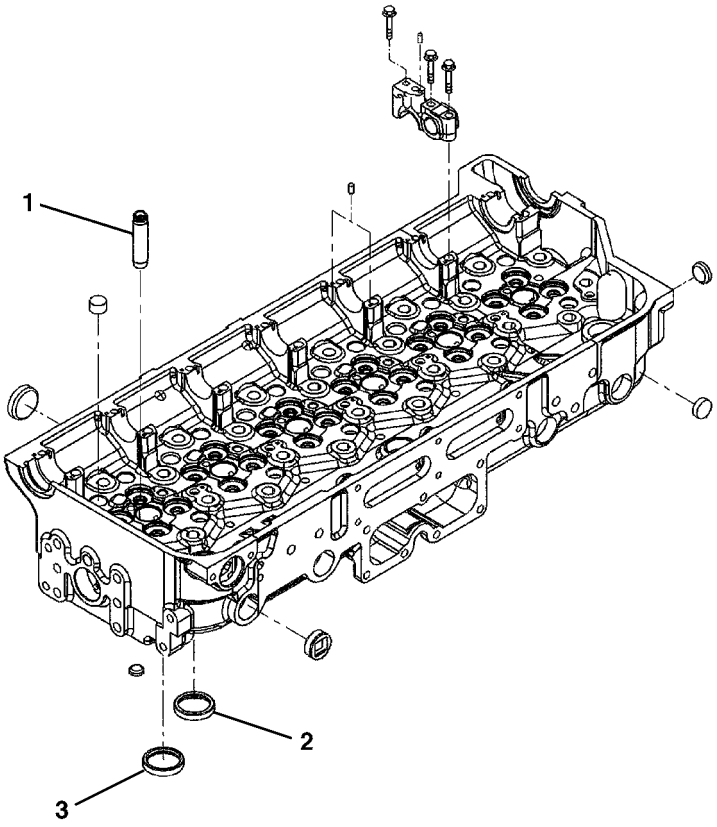
EN0311202D100005

WITH 3-CYLINDER RETARDATION TYPE OF ENGINE RETARDER



SHTS031120200099

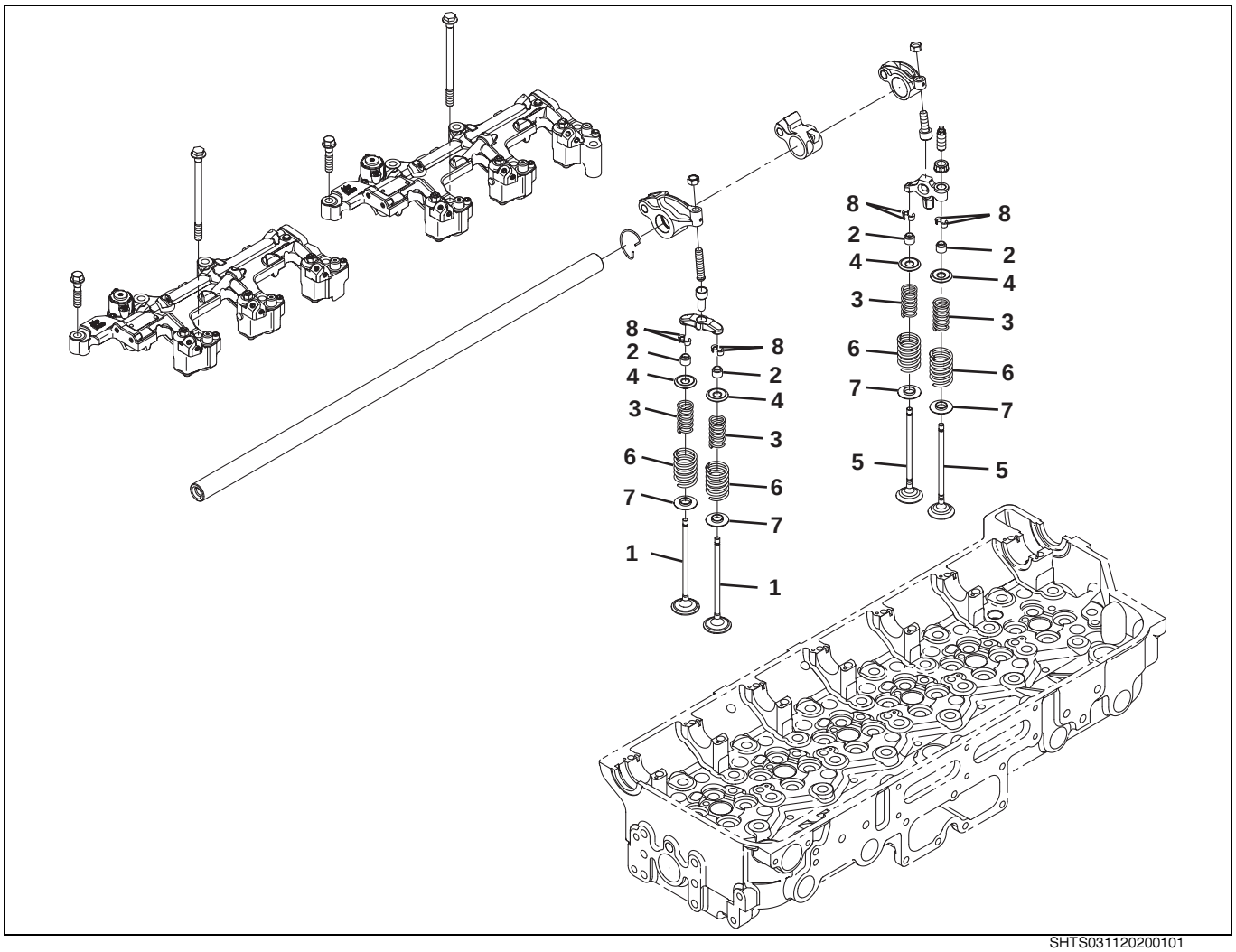
1	Intake valve	5	Exhaust valve
2	Valve stem seal	6	Valve spring (Outer)
3	Valve spring (Inner)	7	Spring seat (Lower)
4	Spring seat (Upper)	8	Valve spring retainer



SHTS031120200100

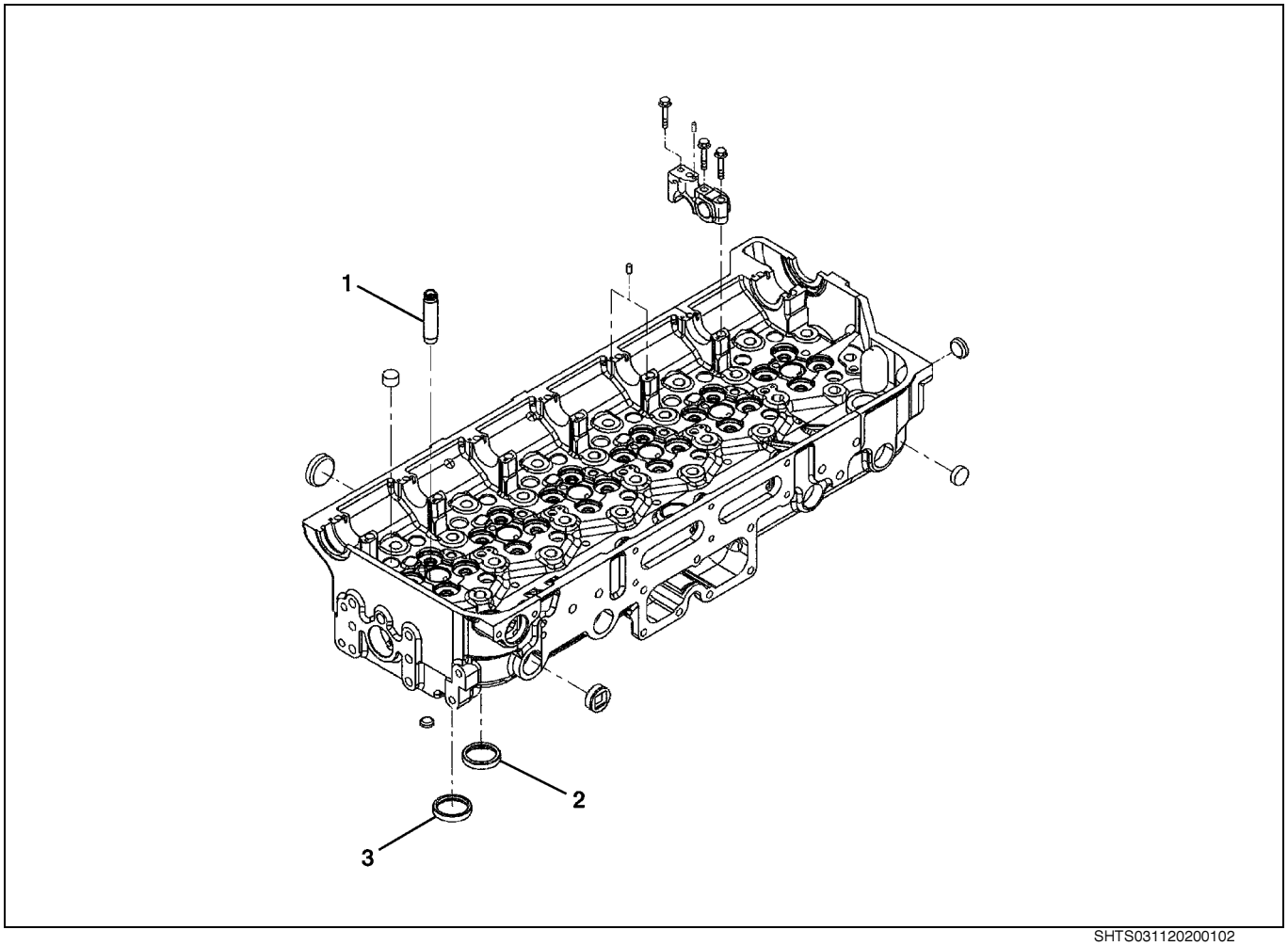
1	Valve guide	3	Spring seat (Intake)
2	Spring seat (Exhaust)		

WITH 6-CYLINDER RETARDATION TYPE OF ENGINE RETARDER



SHTS031120200101

1	Intake valve	5	Exhaust valve
2	Valve stem seal	6	Valve spring (Outer)
3	Valve spring (Inner)	7	Spring seat (Lower)
4	Spring seat (Upper)	8	Valve spring retainer



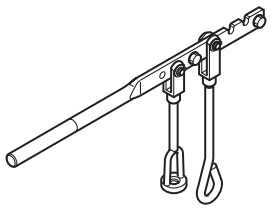
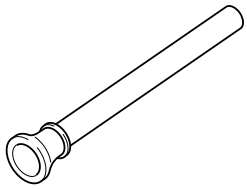
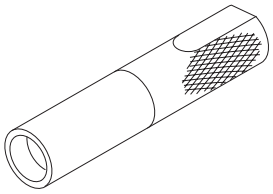
SHTS031120200102

1	Valve guide	3	Spring seat (Intake)
2	Spring seat (Exhaust)		

SPECIAL TOOL

EN0311202K100001

Prior to starting an engine overhaul, it is necessary to have these special tools.

Illustration	Part number	Tool name	Remarks
	S0947-01170	VALVE SPRING PRESS	
	S0943-11020	VALVE LAPPING TOOL	
	09201-E1011	VALVE STEM SEAL PRESS	

OVERHAUL

EN0311202H200004

DISASSEMBLE THE VALVE SYSTEM.

1. REMOVE THE CYLINDER HEAD ASSEMBLY.

(1) Remove the cylinder head assembly.
Refer to the section **"CYLINDER HEAD ASSEMBLY"**.

2. PRIOR PREPARATION

(1) Place a wooden board on the work bench and then place the cylinder head assembly thereon.

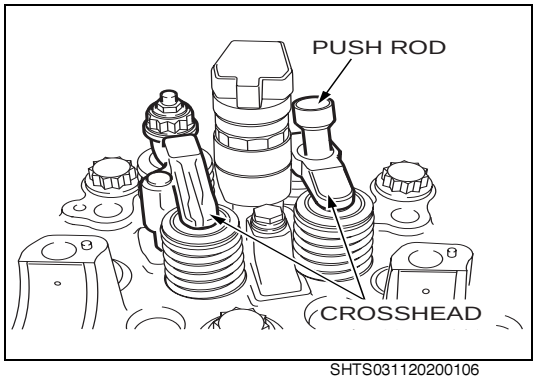
⚠ CAUTION
With injectors mounted, take care not to damage the nozzle tips.

HINT
Place the cylinder head assembly laterally so that the valve will not be lowered when the valve spring is compressed.

3. REMOVE THE CROSSHEAD.

(1) Remove the crosshead and the push rod.

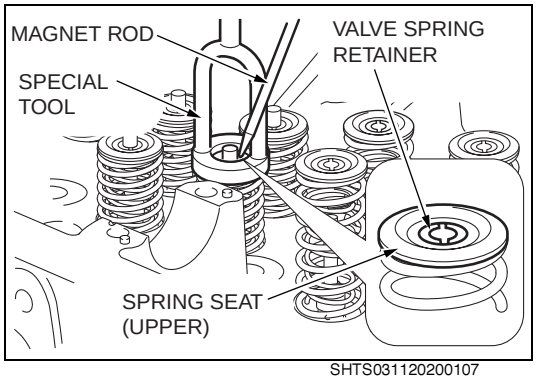
HINT
Identify the corresponding cylinder number and intake side or exhaust side in storage.



SHTS031120200106

4. REMOVE THE VALVE AND THE VALVE SPRING.

(1) Remove the valve spring retainer using the special tool and remove the spring seat (upper) and the valve spring.
SST: Valve spring press (S0947-01170)



SHTS031120200107

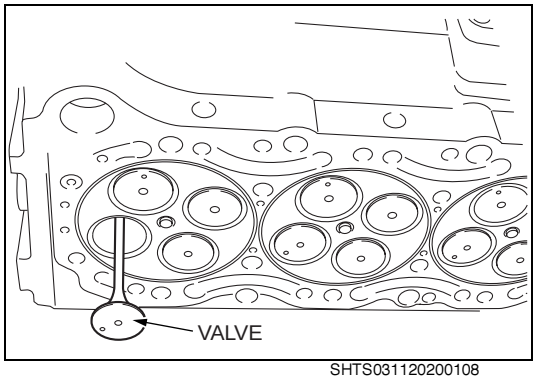
⚠ CAUTION
If eye bolts are used, attach a washer in between so that the cylinder head top surface will not be damaged.

HINT

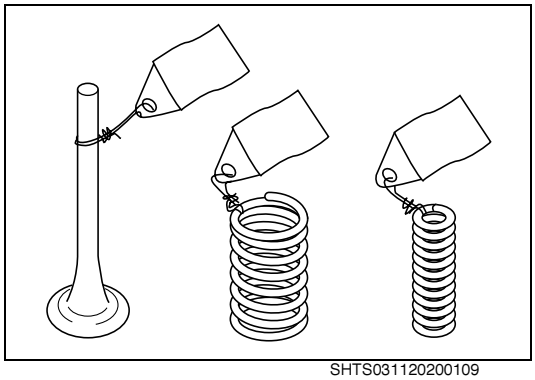
- **For easier works in this step, use a magnet rod to remove the valve spring retainer.**
- **Use a plastic hammer to slightly hammer the spring seat (upper) before start of this work step. This will release bonding and ease a removal work.**
- **If the spring seat (lower) needs to be replaced, proceed with replacement works after removing the valve stem seal.**

(2) Position the cylinder head assembly on its one side face down, and remove the intake and exhaust valves.

HINT
The engraved letters "I" for intake and "E" for exhaust are indicated in the center of the bottom of the valve.

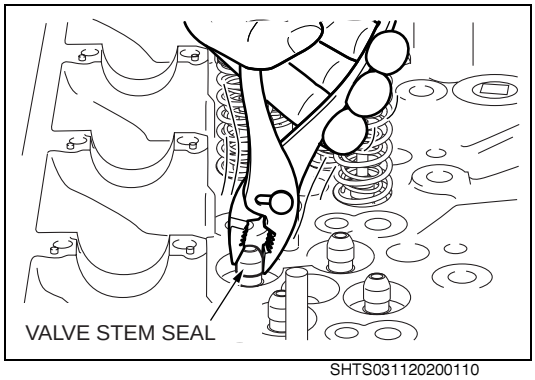


SHTS031120200108


SHTS031120200109

NOTICE

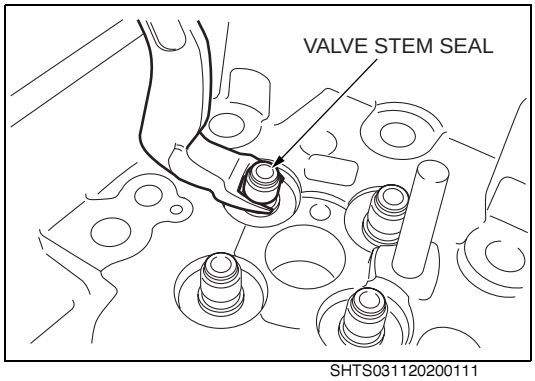
- **The cylinder head assembly is a heavy component but can be manually positioned on its one side face down. Handle the cylinder head assembly carefully.**
- **Prepare the labels indicating a corresponding cylinder number. Attach the labels to the valve and the valve spring in order to prevent misassembly of the valves and the cylinder head.**



SHTS031120200110

5. REMOVE THE VALVE STEM SEAL.

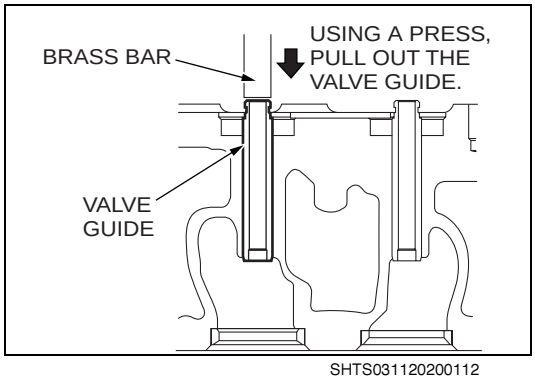
(1) Use a plier to pull off the valve stem seal while waggling it.



SHTS031120200111

HINT

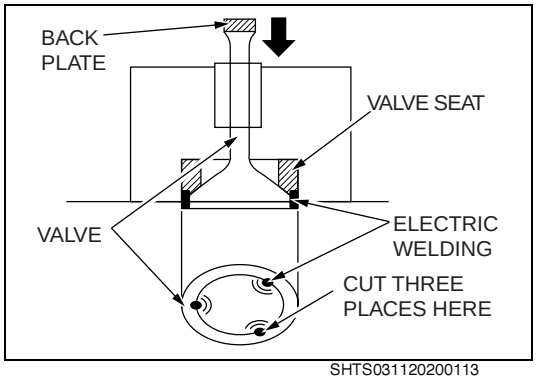
For easier works in this step, use a crowbar to pull off with leverage.



SHTS031120200112

6. REMOVE THE VALVE GUIDE.

(1) Pull out the valve guide using a brass bar and a press or the like.



SHTS031120200113

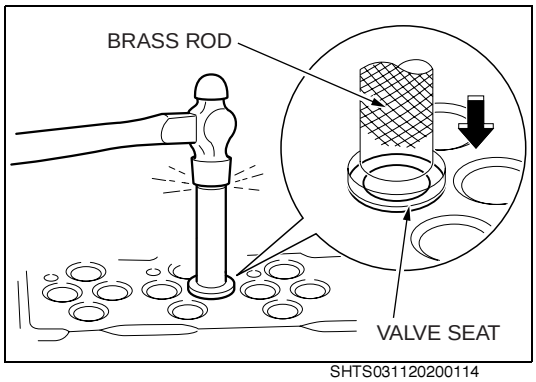
7. REMOVE THE VALVE SEAT.

(1) When replacing the valve seat, cut three places on the circumference of an unwanted valve and weld it to the valve seat.

NOTICE

To protect the lower surface of the cylinder head from welding spatter, be sure to apply grease before welding.

(2) Place a (brass) back plate at the top of the valve system and strike it with a hammer to remove the valve seat.



SHTS031120200114

ASSEMBLE THE VALVE SYSTEM.

1. INSTALL THE VALVE SEAT.

(1) Remove the welding spatter and dirt from the valve seat flange.

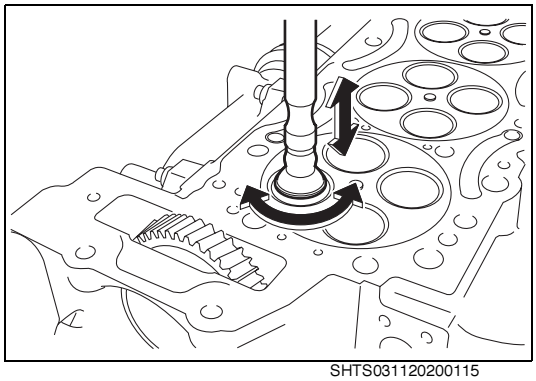
(2) Heat the cylinder head to 80 - 100°C {176 - 212°F} in hot water. After cooling the valve seat, insert it into the cylinder head.

⚠ CAUTION

Handle this work carefully not to crack sintered parts.

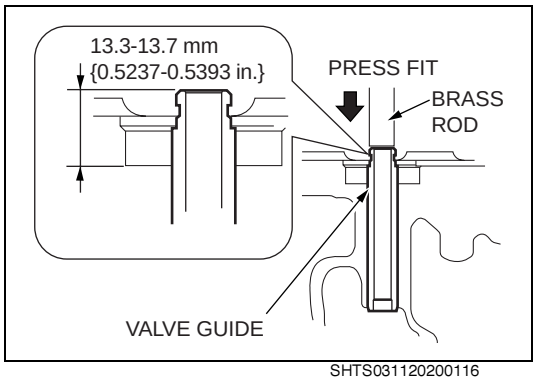
HINT

The valve seat of 41 mm {1.6142 in.} in outer diameter is designed for intake and 39 mm {0.5354 in.} in outer diameter for exhaust.


SHTS031120200115

(3) Apply a small amount of lapping compound to the contact surfaces of the valve and the valve seat.

(4) Turn the valve using the special tool and tap it lightly to lap.
SST: Valve lapping tool (S0943-11020)



SHTS031120200116

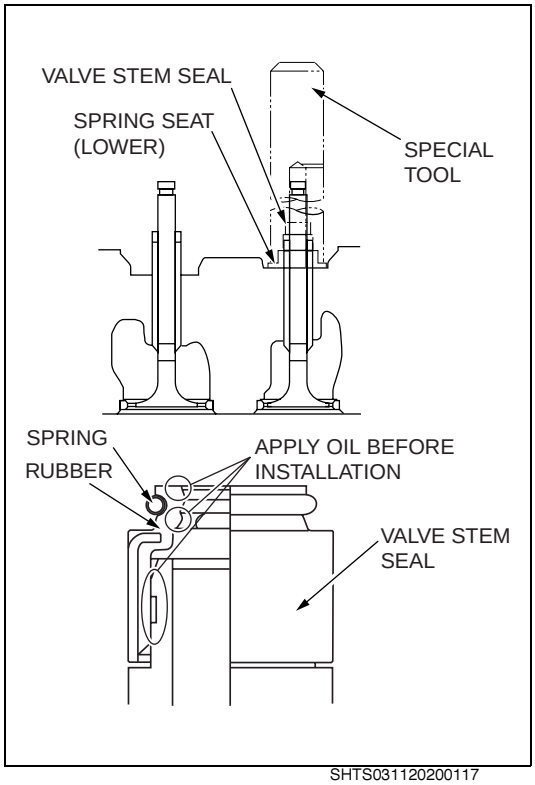
2. INSTALL THE VALVE GUIDE.

(1) Apply engine oil to the new valve guide periphery.

(2) Using a brass rod, press fit the valve guide into the cylinder head.
Standard value: 13.3-13.7 mm {0.5237-0.5393 in.}

⚠ CAUTION

- **Be careful not to damage the valve stem at the upper or lower end of the guide during press-fitting.**
- **Do not wobble the valve guide tip during press-fitting.**



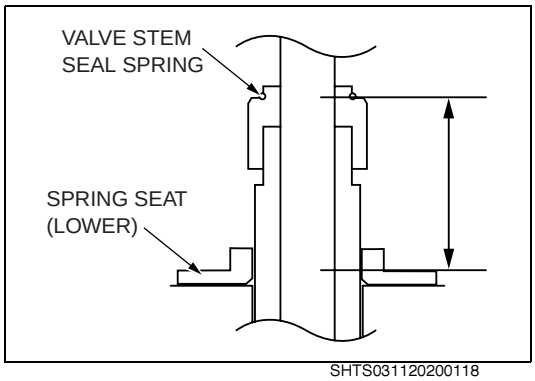
SHTS031120200117

3. INSTALL THE VALVE STEM SEAL.

(1) Install the valve spring seat (lower) before installing the valve stem seal.

(2) Apply engine oil to the inner surface and the lip of the valve stem seal. Use a special tool to press the valve stem seal down until a special tool contacts with the valve spring seat (lower).
SST: Valve stem seal press (09201-E1011)

NOTICE
After assembly of the oil seal, check for deformation or cracking of the rubber or incline.

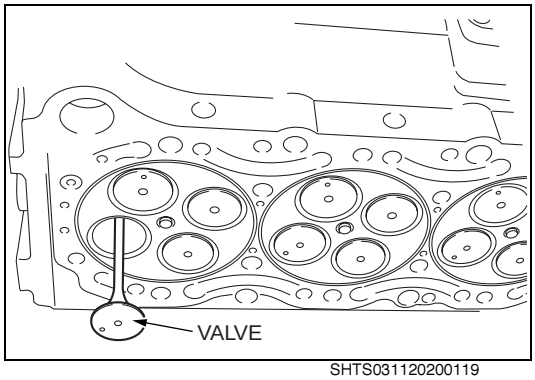


SHTS031120200118

(3) Measure the height between spring seat (lower) and the valve stem seal spring.
Standard value: 15.0-15.5 mm {0.5906-0.6102 in.}

4. INSTALL THE VALVE AND THE VALVE SPRING.

NOTICE
Before start of reassembling works, apply engine oil to contact surfaces of individual parts.
Make sure to mount each valve to its original position on the cylinder.



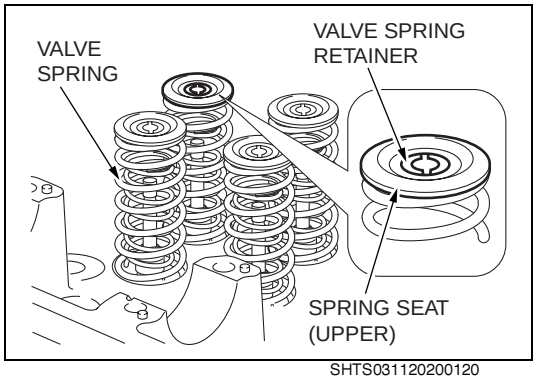
SHTS031120200119

(1) Position the cylinder head assembly on its one side face down, and install the intake and exhaust valves to the valve guide.

NOTICE

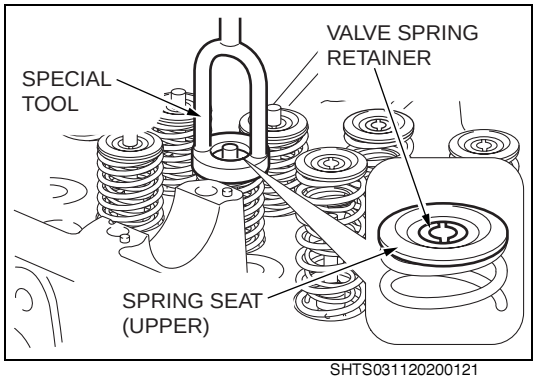
- **The cylinder head assembly is a heavy component but can be manually positioned on its one side face down. Handle the cylinder head assembly carefully.**
- **If reuse the valves, check the valve stem for damage.**

HINT
The engraved letters "I" for intake and "E" for exhaust are indicated in the center of the bottom of the valve.



SHTS031120200120

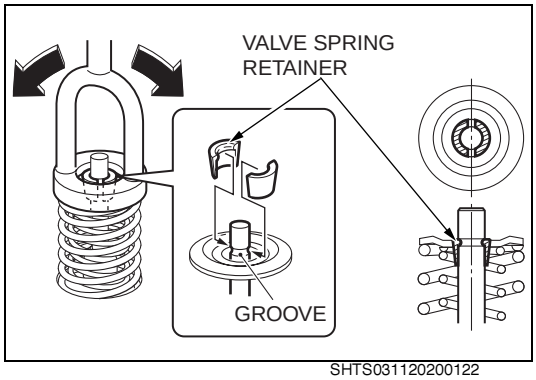
(2) Make sure that the spring seat (lower) is fitted and put the valve spring and spring seat (upper) on the cylinder head.
(3) Insert the valve spring retainer into the hole on the spring seat (upper).



SHTS031120200121

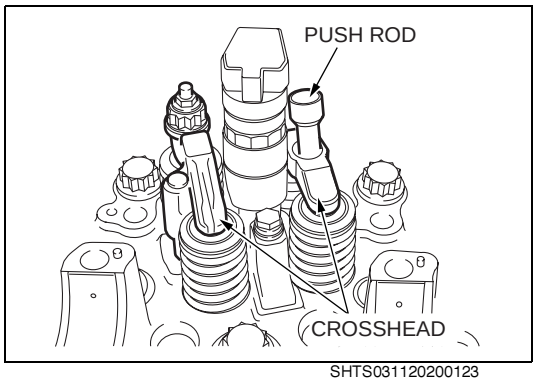
(4) Compress the valve spring using the special tool and fit the valve spring retainer.
SST: Valve spring press (S0947-01170)

⚠ CAUTION
- **If eye bolts are used, attach a washer in between so that the cylinder head top surface will not be damaged.**
- **Handle this work carefully not to allow the valve spring upper seat to contact with the valve stem seal when compressing the valve spring.**



SHTS031120200122

HINT
- **For easier works in this step, compress a spring while waggling a special tool to insert the valve spring retainer into a groove.**
- **For easier works in this step, position the slits in the valve spring retainer longitudinally to the special tool.**
- **The valve spring is of constant pitch type. This type of spring does not require vertical (top/bottom) directionality.**



SHTS031120200123

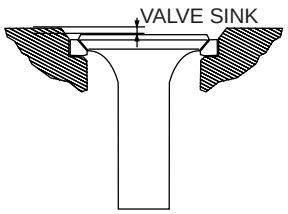
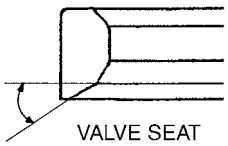
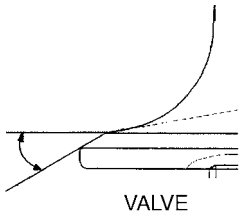
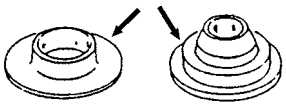
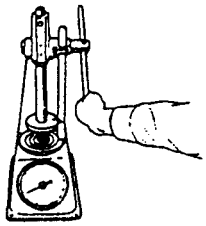
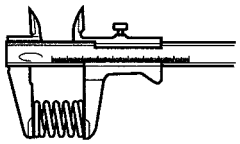
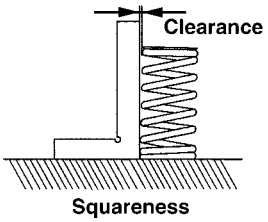
5. INSTALL THE CROSSHEAD.
(1) Install the crosshead and make sure that the crosshead and the push rod are on each valves.

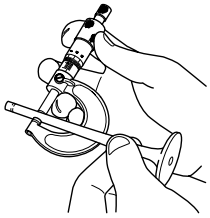
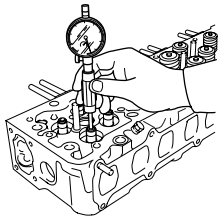
6. INSTALL THE CYLINDER HEAD ASSEMBLY.
(1) Install the cylinder head assembly.
Refer to the section **"CYLINDER HEAD ASSEMBLY"**.

INSPECTION AND REPAIR

EN0311202H300005

Unit: mm {in.}

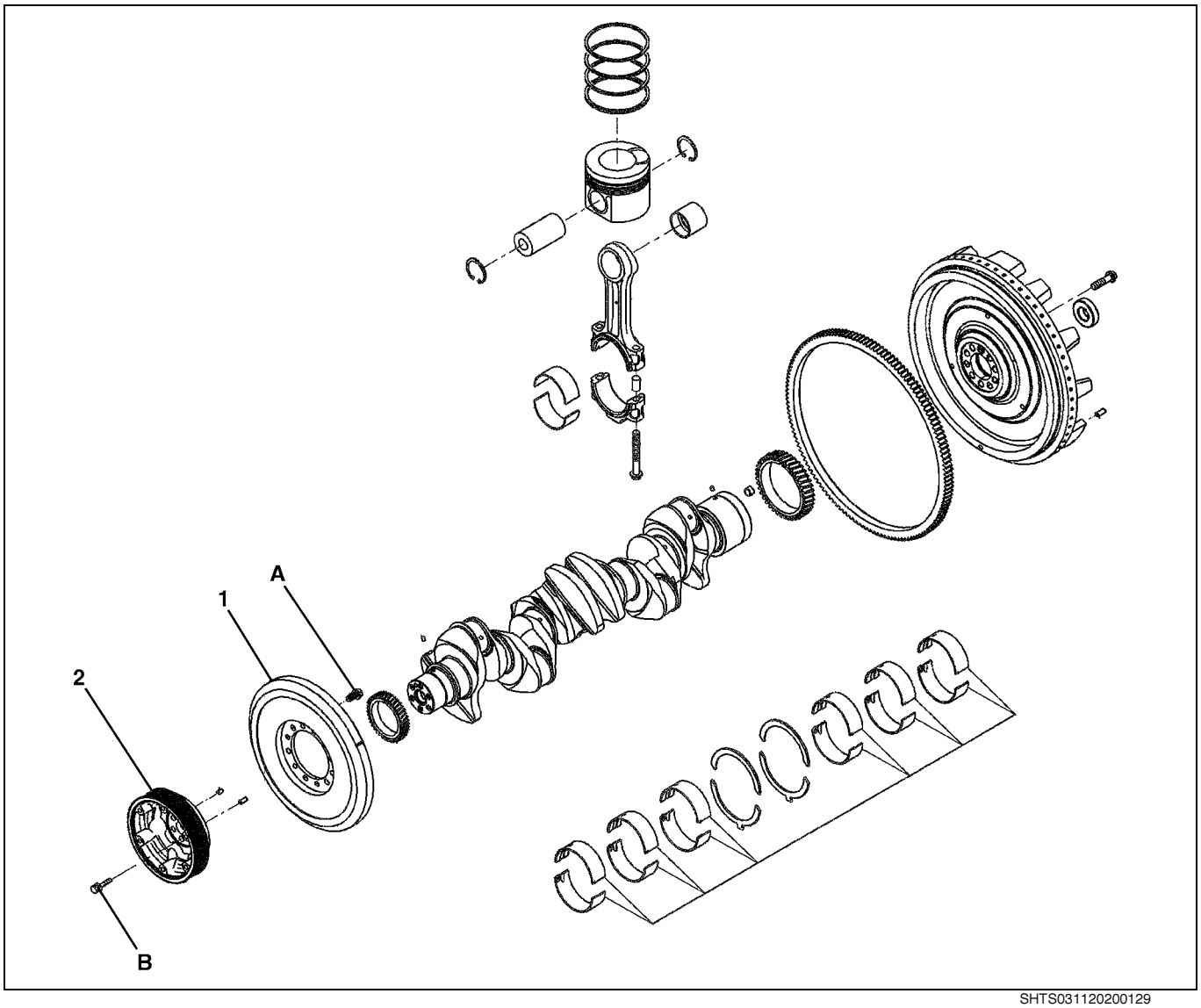
Inspection item			Standard	Limit	Remedy	Inspection procedure
Valve sink		IN	0.55-0.95 {0.0217-0.0374}	1.3 {0.0511}	Replace the valve and valve seat.	Measure 
		EX	1.15-1.55 {0.0453-0.0610}	1.9 {0.0748}	Replace the valve and valve seat.	
Valve seat angle		IN	30°	30°-30°35'	Resurface the valve and/or valve seat.	Measure 
		EX	45°	45°-45°30'		
Valve face angle		IN	30°	29°30'-30°		
		EX	45°	44°30'-45°		
Wear and damage of valve spring seat upper and lower			—	—	Replace.	Visual check 
Outer valve spring	Setting load		138.3 N {14.1 kgf, 31.0 lbf} at 43.3 {1.704}	127.2 N {13.0 kgf, 28.6 lbf}	Replace.	Measure  Setting road
	Free length (reference value)		75.7 {2.980}	72.7 {2.862}	Replace.	
	Squareness		—	3.3 {0.1299}	Replace.	
Inner valve spring	Setting load		330.1 N {33.6 kgf, 74.2 lbf} at 45.3 {1.783}	303.7 N {31.0 kgf, 68.3 lbf}	Replace.	 Free length
	Free length (reference value)		64.6 {2.543}	61.6 {2.425}	Replace.	
	Squareness		—	2.8 {0.1102}	Replace.	 Squareness

Inspection item		Standard	Limit	Remedy	Inspection procedure
Intake valve	Stem outside diameter	7 {0.2756}	6.92 {0.2724}	Replace the valve.	Measure  
	Guide inside diameter	7 {0.2756}	6.92 {0.2724}	Replace the valve guide.	
	Clearance	0.023-0.058 {0.0010-0.0022}	0.12 {0.0047}	Replace the valve and/ or valve guide.	
Exhaust valve	Stem outside diameter	7 {0.2756}	6.92 {0.2724}	Replace the valve.	
	Guide inside diameter	7 {0.2756}	6.92 {0.2724}	Replace the valve guide.	
	Clearance	0.053-0.083 {0.0020-0.0033}	0.15 {0.0059}	Replace the valve and/ or valve guide.	

CRANKSHAFT DAMPER

COMPONENT LOCATOR

EN0311202D100006



SHTS031120200129

1	Crankshaft damper	2	Crankshaft pulley

Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

A	118 {1,203, 87}	B	108 {1,101, 79}

REPLACEMENT

EN0311202H100002

REMOVE THE CRANKSHAFT DAMPER.

1. REMOVE THE COOLING FAN ASSEMBLY AND THE FAN SHROUD RING.

(1) Remove the cooling fan assembly and the fan shroud ring.
Refer to the section **"COOLING FAN AND FAN CLUTCH"** in the chapter **"COOLING SYSTEM"**.

2. REMOVE THE V-RIBBED BELT.

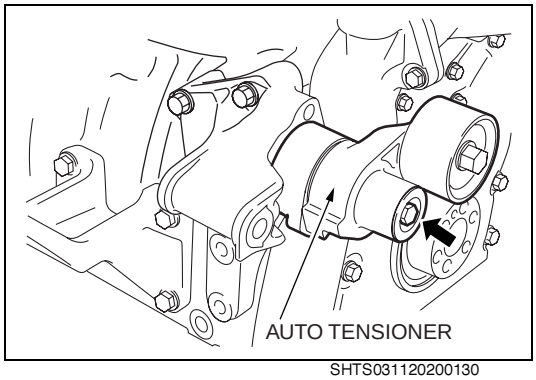
(1) Remove the V-ribbed belt.
Refer to the section **"V-RIBBED BELT"** in the chapter **"ALTERNATOR"**.

3. REMOVE THE COOLANT PUMP PULLEY.

(1) Remove the coolant pump pulley from the coolant pump.
Refer to the section **"COOLANT PUMP"** in the chapter **"COOLING SYSTEM"**.

4. REMOVE THE AUTO TENSIONER.

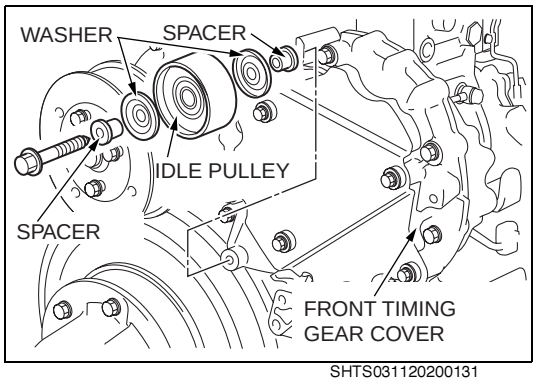
(1) Remove the bolt to remove the auto tensioner.



SHTS031120200130

5. REMOVE THE IDLE PULLEY.

(1) Remove the bolt to remove two spacers, two washers and the idle pulley from the front timing gear cover.



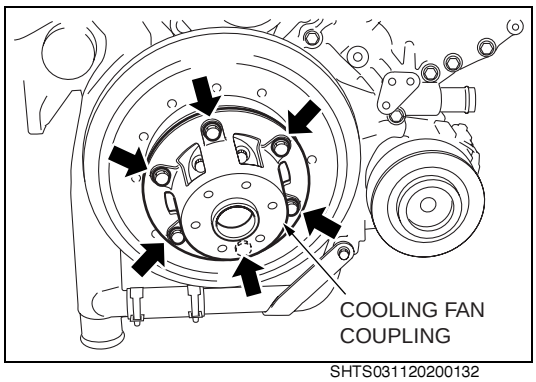
SHTS031120200131

6. REMOVE THE COOLING FAN COUPLING.

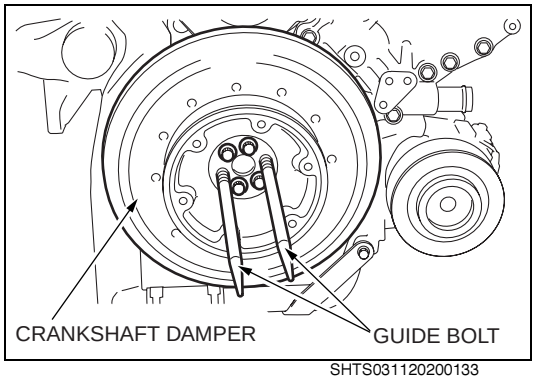
(1) Remove the bolts to remove the cooling fan coupling.

HINT

Insert a large flat head screwdriver into the flywheel gear through an access hole in the flywheel housing to prevent synchronic turning of the crankshaft.



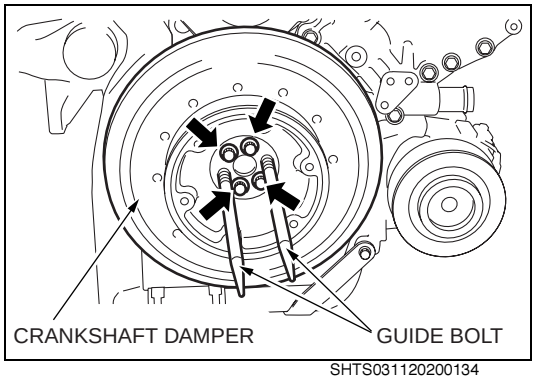
SHTS031120200132



SHTS031120200133

7. REMOVE THE CRANKSHAFT DAMPER.

(1) First remove two horizontal bolts among other crankshaft damper mounting bolts, and fasten guide bolts for the purpose of preventing accidental drop.



SHTS031120200134

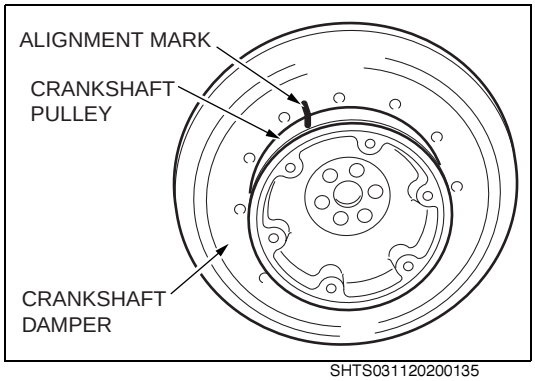
(2) While holding the crankshaft damper, remove other bolts to remove the crankshaft damper.

⚠ CAUTION

- **Crankshaft is a heavy component. Handle it carefully.**
- **The crankshaft damper is precisely balanced. If the crankshaft damper is dropped, do not reuse it.**

HINT

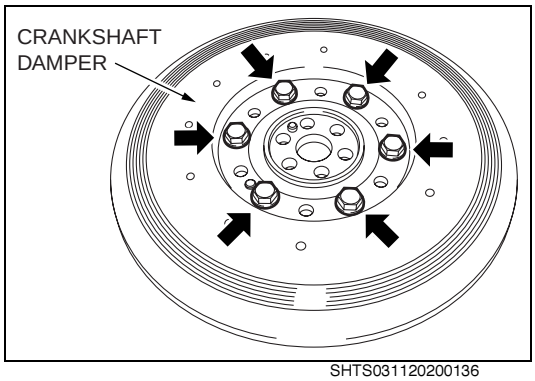
- **Insert a large flat head screwdriver into the flywheel gear through an access hole in the flywheel housing to prevent synchronic turning of the crankshaft.**
- **There is a knock pin in the area mating with the crankshaft. If it is hard to remove the crankshaft damper, use a plastic hammer to slightly hammer the back face of the crankshaft damper.**



SHTS031120200135

8. REMOVE THE CRANKSHAFT PULLEY.

(1) Indicate alignment marks on the crankshaft pulley and the crankshaft damper.

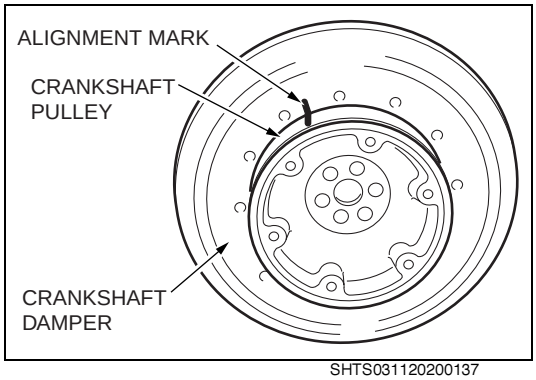


SHTS031120200136

(2) Remove the bolts to remove the crankshaft pulley from the crankshaft damper.

HINT

For easier works in this step, attach the removed cooling fan coupling temporarily to fixate the crankshaft pulley.



SHTS031120200137

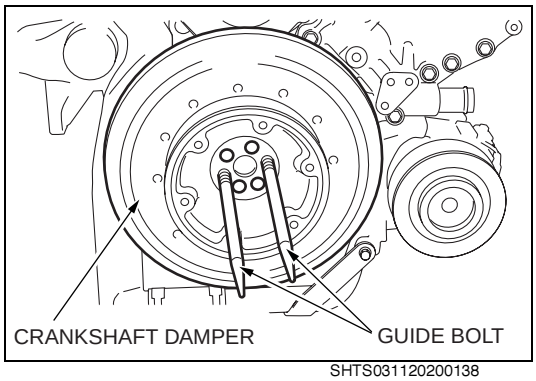
INSTALL THE CRANKSHAFT DAMPER.

1. INSTALL THE CRANKSHAFT PULLEY.

(1) Apply engine oil to the bolt surface and bolt threads of the crankshaft pulley installation bolt.

(2) Align the alignment marks and install the crankshaft pulley to the crankshaft damper with the bolt.
Seating torque:
118 N·m {1,203 kgf·cm, 87 lbf·ft}

HINT
For easier works in this step, attach the removed cooling fan coupling temporarily to fixate the crankshaft pulley.



SHTS031120200138

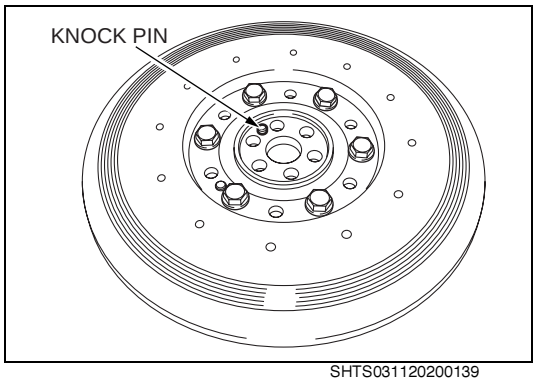
2. INSTALL THE CRANKSHAFT DAMPER.

(1) Apply engine oil to the bolt surface and bolt threads of the crankshaft damper installation bolt.

(2) Install two guide bolts and match the crankshaft damper with the installation position.

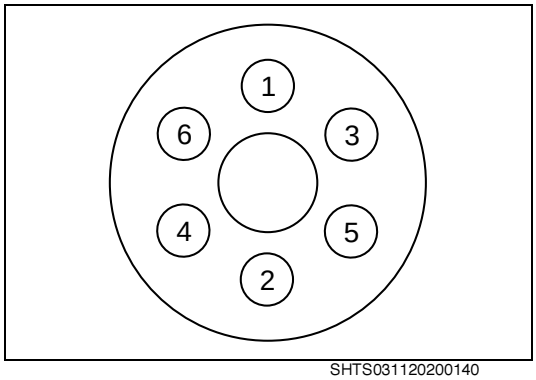
NOTICE
Remove the guide bolts after pretightening the bolts.

⚠ CAUTION
- **The crankshaft damper is a heavy component. Handle it carefully.**
- **The crankshaft damper is precisely balanced. If the crankshaft damper is dropped, do not reuse it.**



SHTS031120200139

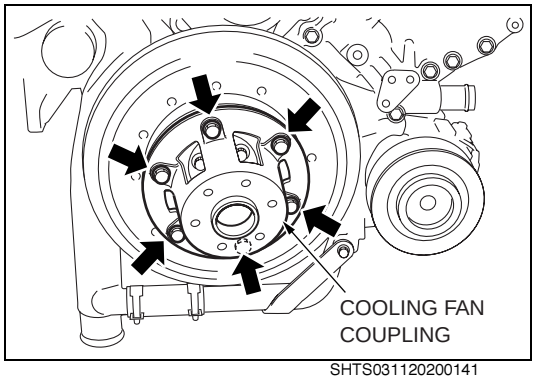
HINT
Note that there is a knock pin. Make sure of a knock hole in aligning with the mounting position.



SHTS031120200140

(3) Tighten the crankshaft installation bolts in the order shown in the figure to the specified torque.
Seating torque:
108 N·m {1,101 kgf·cm, 79 lbf·ft}

HINT
Insert a large flat head screwdriver into the flywheel gear through an access hole in the flywheel housing, to prevent synchronous rotations of the crankshaft.



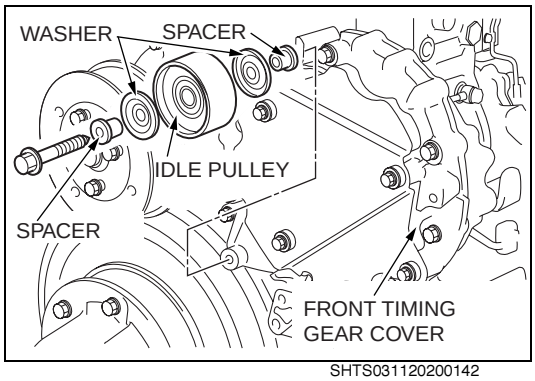
SHTS031120200141

3. INSTALL THE COOLING FAN COUPLING.

(1) Install the cooling fan coupling with the bolts.

HINT

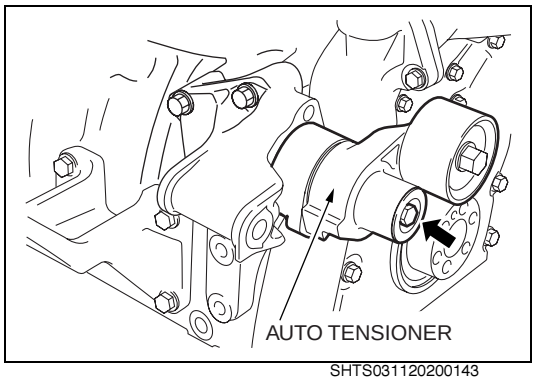
Insert a large flat head screwdriver into the flywheel gear through an access hole in the flywheel housing, to prevent synchronous rotations of the crankshaft.



SHTS031120200142

4. INSTALL THE IDLE PULLEY.

(1) Install the idle pully to front timing gear cover. Attach two spacers and two washer, and tighten a bolt.



SHTS031120200143

5. INSTALL THE AUTO TENSIONER.

(1) Install the auto tensioner with the bolt.

6. INSTALL THE COOLANT PUMP PULLEY.

(1) Install the coolant pump pulley to the coolant pump.
Refer to the section **"COOLANT PUMP"** in the chapter **"COOLING SYSTEM"**.

7. INSTALL THE V-RIBBED BELT.

(1) Install the V-ribbed belt.
Refer to the section **"V-RIBBED BELT"** in the chapter **"ALTERNATOR"**.

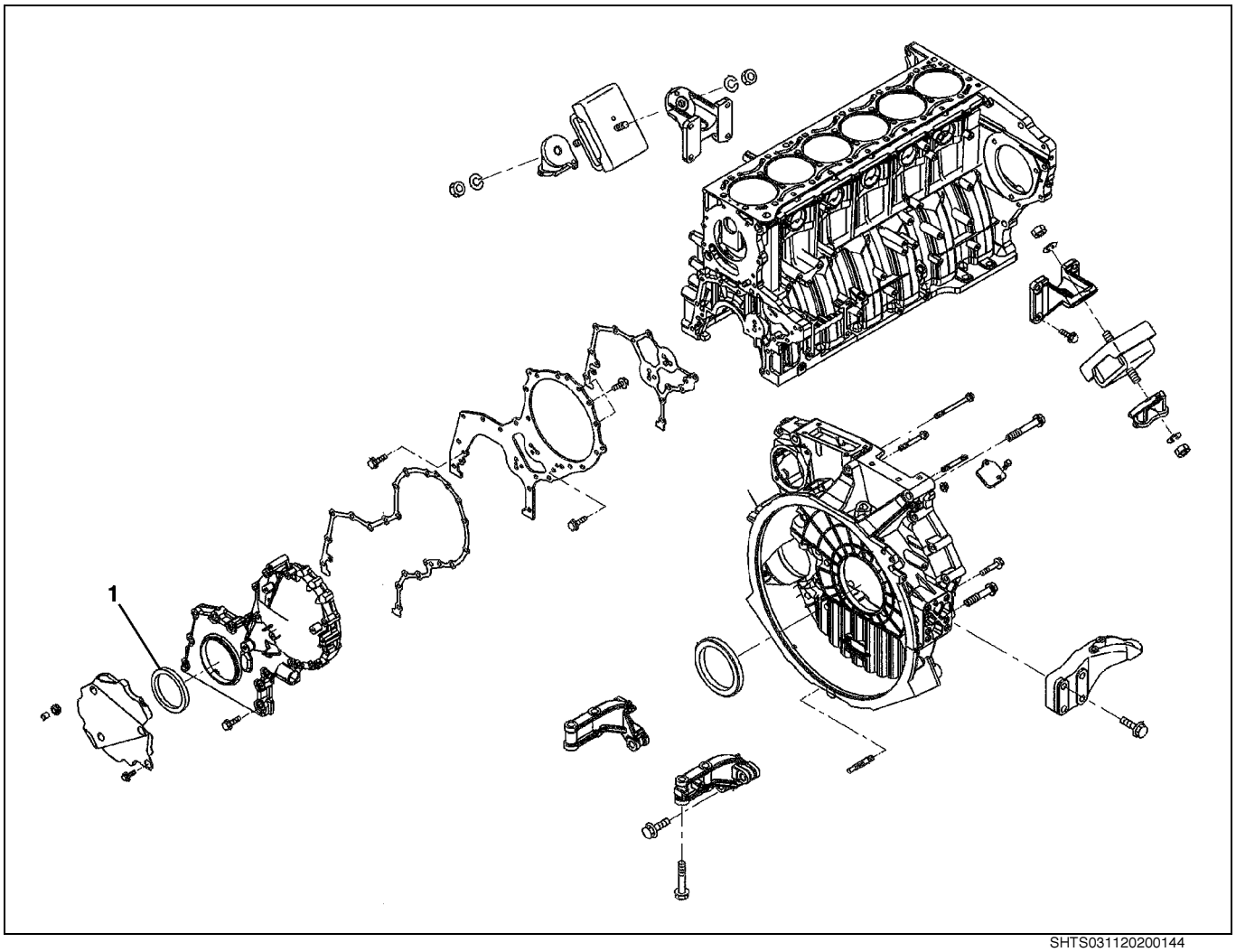
8. INSTALL THE COOLING FAN ASSEMBLY AND THE FAN SHROUD RING.

(1) Install the cooling fan assembly and the fan shroud ring.
Refer to the section **"COOLING FAN AND FAN CLUTCH"** in the chapter **"COOLING SYSTEM"**.

CRANKSHAFT FRONT OIL SEAL

COMPONENT LOCATOR

EN0311202D100007



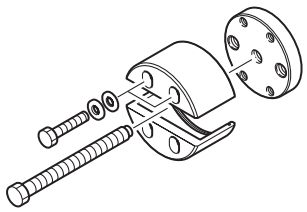
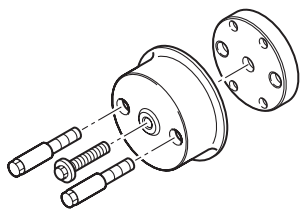
SHTS031120200144

1 Crankshaft front oil seal	

SPECIAL TOOL

EN0311202K100002

Prior to starting an engine overhaul, it is necessary to have these special tools.

Illustration	Part number	Tool name	Remarks
	09220-E1090	OIL SEAL PULLER	
	09210-E1010	OIL SEAL PRESS	

REPLACEMENT

EN0311202H100003

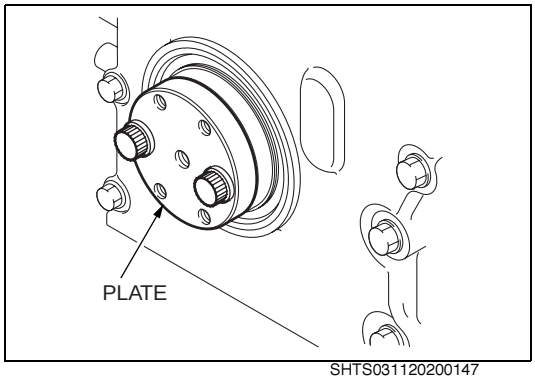
REMOVE THE CRANKSHAFT FRONT OIL SEAL.

1. REMOVE THE CRANKSHAFT DAMPER.

(1) Remove the crankshaft damper.
Refer to the section **"CRANKSHAFT DAMPER"**.

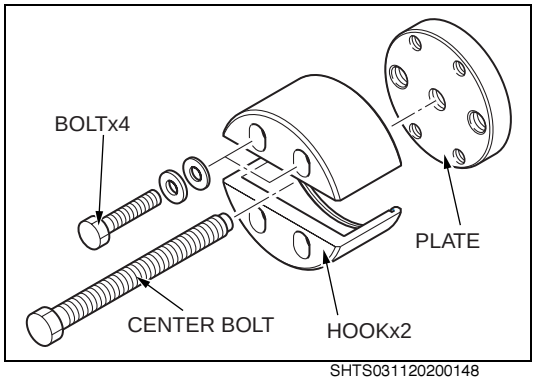
2. REMOVE THE CRANKSHAFT FRONT OIL SEAL.

(1) Place the plate at the crankshaft using the crankshaft damper installation bolts.
SST: Oil seal puller (09220-E1090)



SHTS031120200147

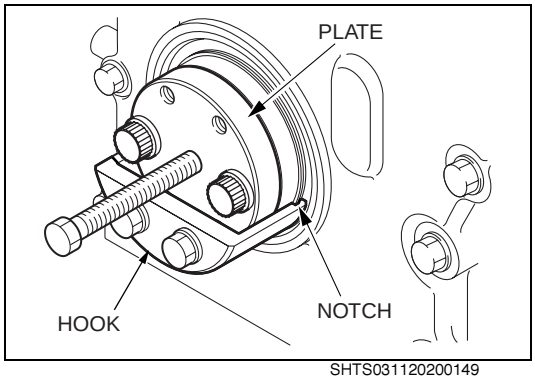
HINT
Structure of the oil seal puller (special tool)



SHTS031120200148

(2) Engage the hook with the oil seal notch and install the hook using the bolt supplied.

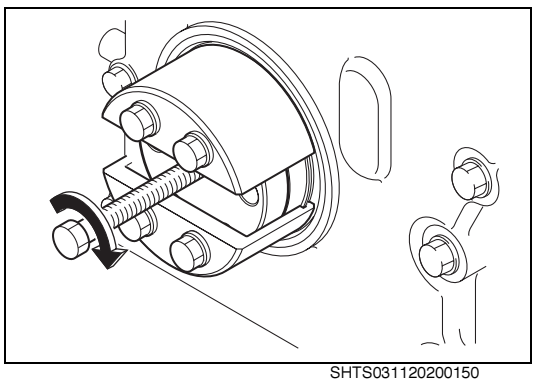
(3) Remove the installed bolt in step (1).

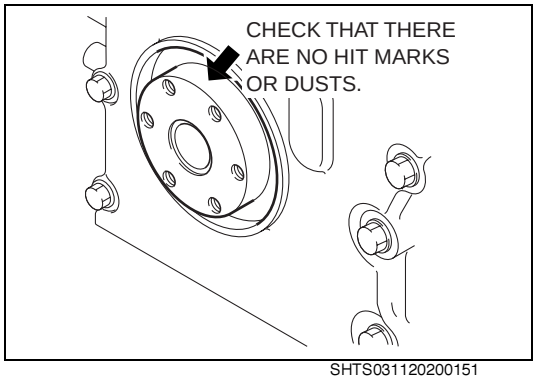


SHTS031120200149

(4) Install the center bolt and tighten it to remove the crankshaft front oil seal.

NOTICE
While ensuring the engagement between the special tool and an oil seal, pull off the oil seal with a care not to allow the special tool to come off in the middle of this work.


SHTS031120200150

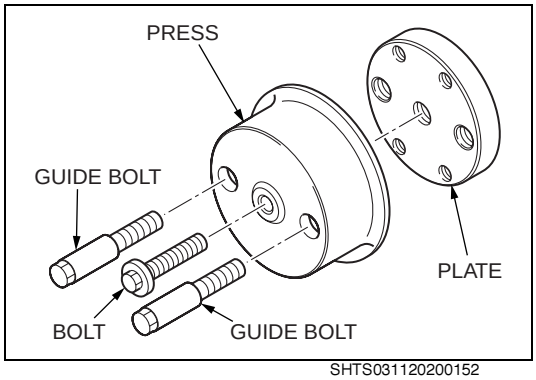


SHTS031120200151

INSTALL THE CRANKSHAFT FRONT OIL SEAL.

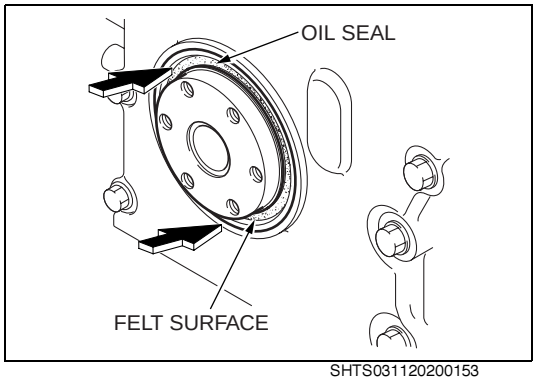
1. INSTALL THE CRANKSHAFT FRONT OIL SEAL.

(1) Check that there are no hit marks or dusts on the front timing gear cover and crankshaft oil seal insertion area.



SHTS031120200152

(2) Clean the edges and surface of the special tools.
SST: Oil seal press (09210-E1010)

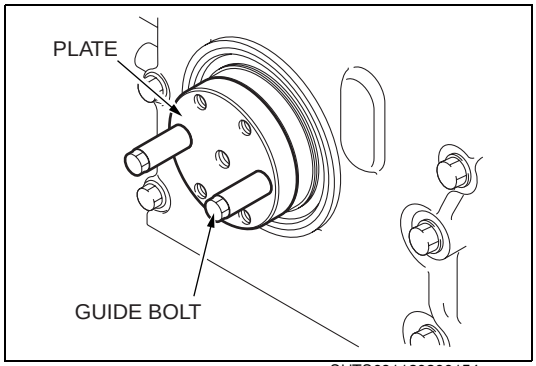


SHTS031120200153

(3) Apply a small amount of engine oil to inner/outer peripheries of a new oil seal.
(4) Set the oil seal to its proper direction, and manually insert it into the crankshaft until it stops.

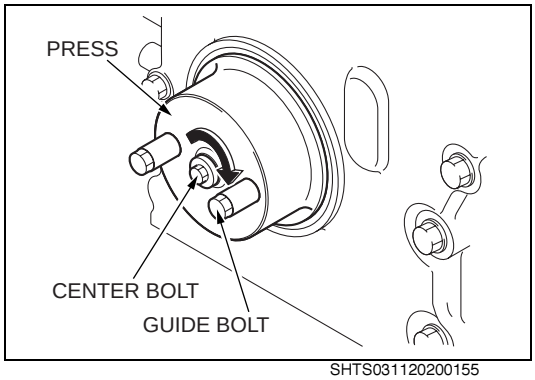
NOTICE

- **The felt surface off the oil seal must face the outer side and the slinger (metal plate) must face the inner side of the engine.**
- **Install the oil seal without tiling.**



SHTS031120200154

(5) Install the plate to the crankshaft using two guide bolts.



SHTS031120200155

(6) Insert the press in alignment with the oil seal guide. Tighten a center bolt to press-fit the oil seal.

NOTICE
Press-fit the oil seal evenly on the whole periphery.

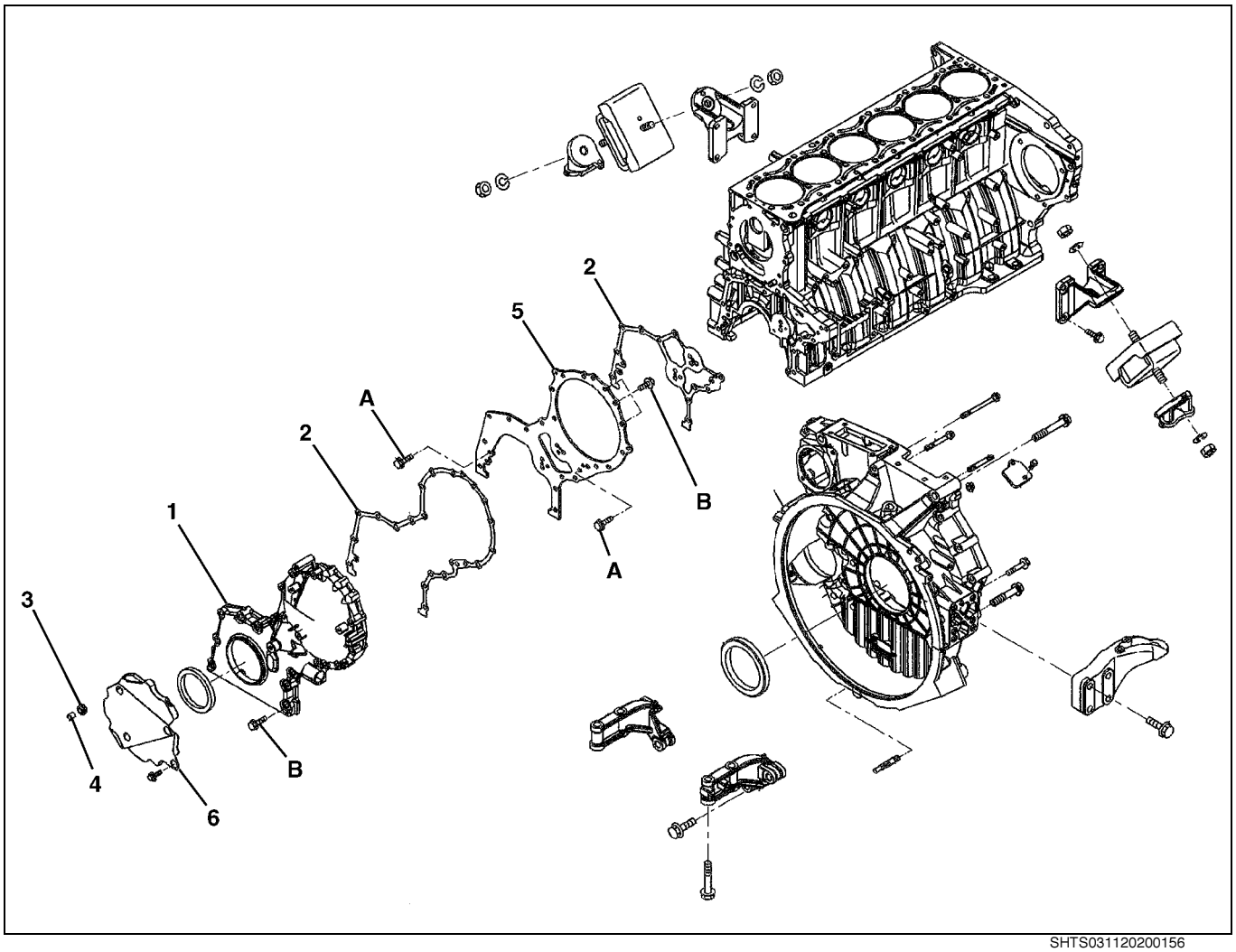
(7) Tighten a center bolt until the press comes to contact. Check that the oil seal has been press-fitted evenly on the whole periphery.
(8) Remove the special tools.

2. INSTALL THE CRANKSHAFT DAMPER.
(1) Install the crankshaft damper.
Refer to the section **"CRANKSHAFT DAMPER"**.

FRONT TIMING GEAR COVER AND TIMING GEAR

COMPONENT LOCATOR

EN0311202D100008

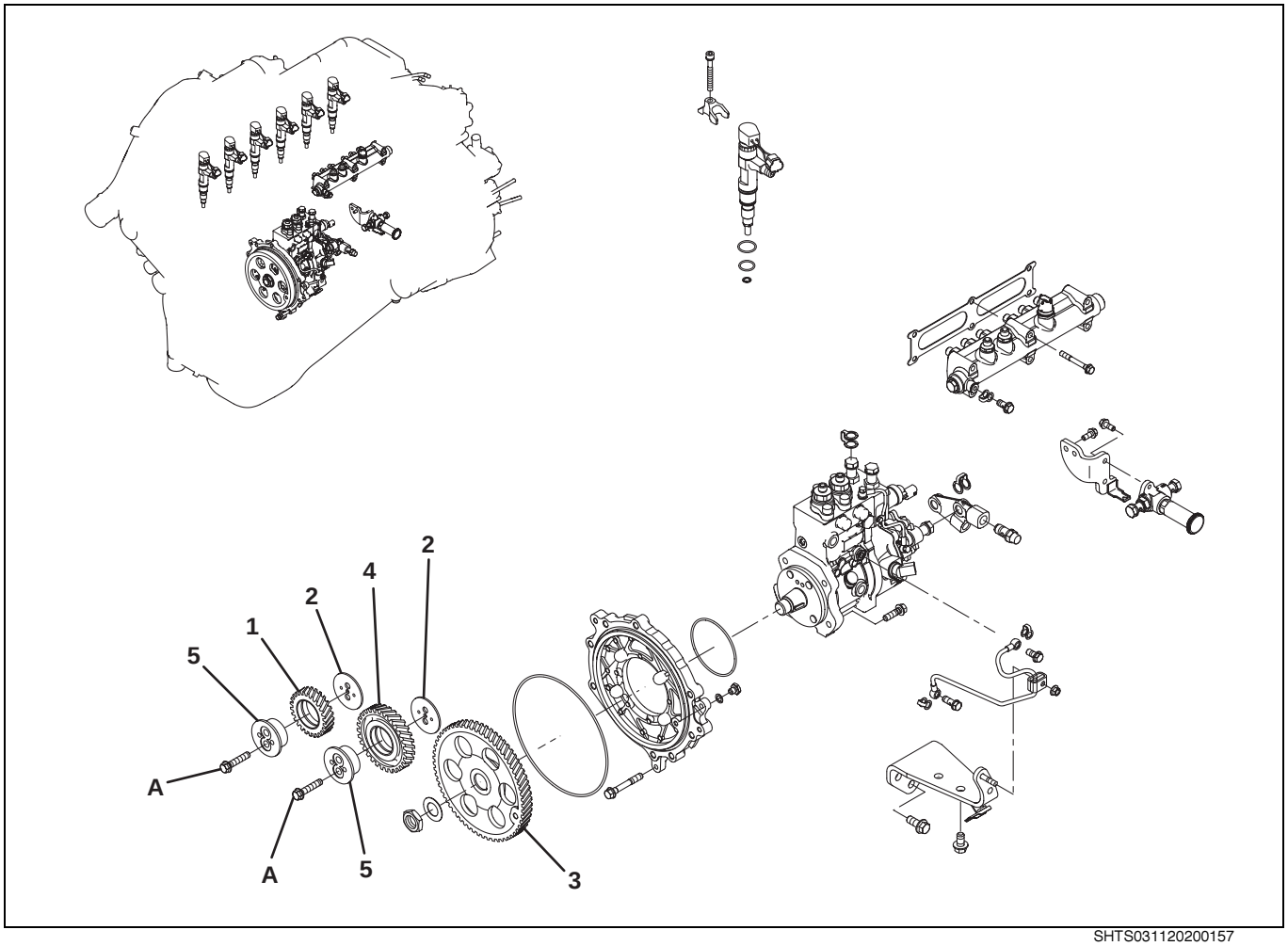


SHTS031120200156

1	Front timing gear cover	4	Spacer
2	Gasket	5	End plate
3	Silent block	6	Insulator

Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

A	28.5 {290, 21}	B	55 {560, 41}



SHTS031120200157

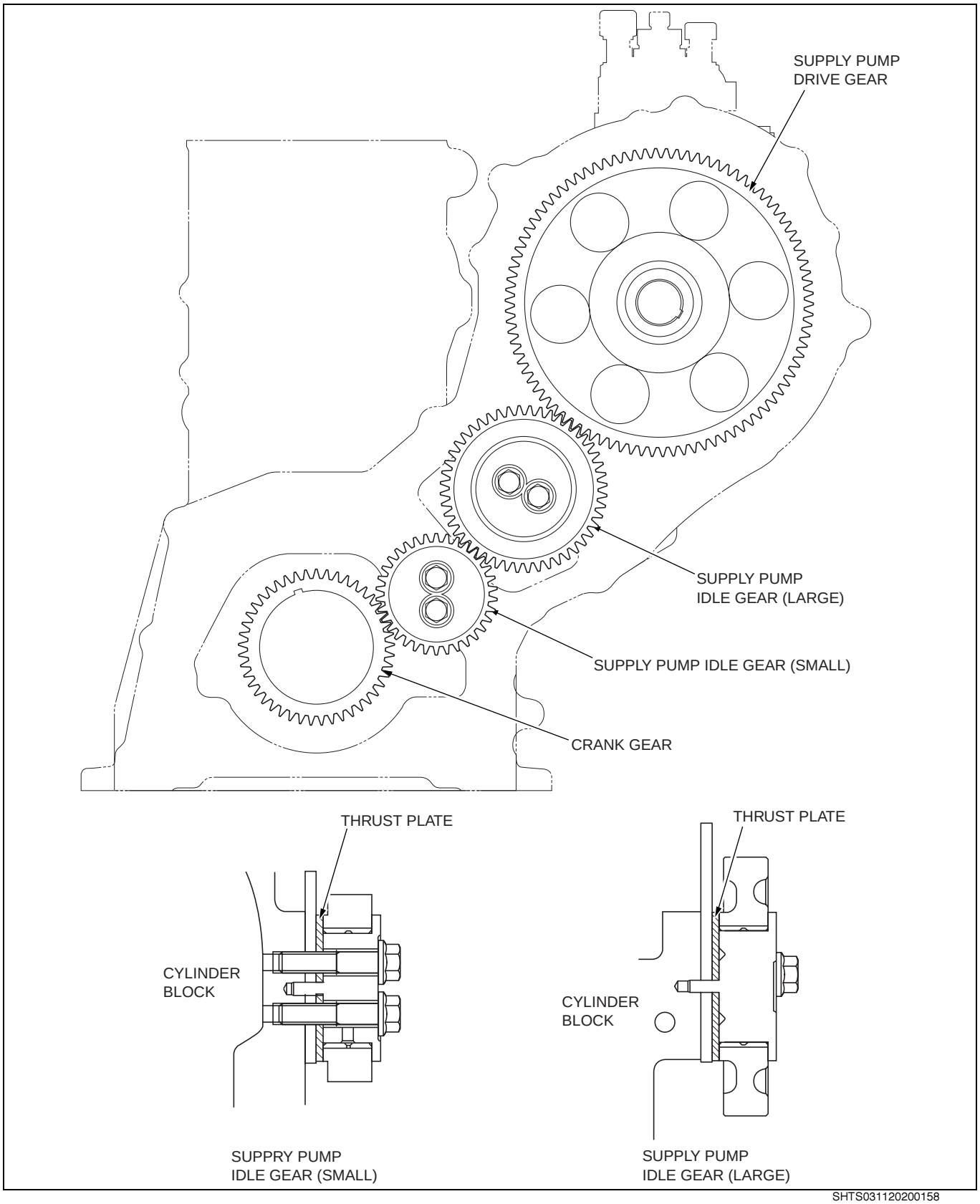
1	Supply pump idle gear (Small)	4	Supply pump idle gear (Large)
2	Thrust plate	5	Idle gear shaft
3	Supply pump drive gear		

Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

A	20 {205, 15} + 90°		

DESCRIPTION

EN0311202C100001



SHTS031120200158

OVERHAUL

EN0311202H200005

REMOVE THE PERIPHERAL COMPONENTS/PARTS AROUND THE FRONT TIMING GEAR COVER.

1. REMOVE THE EGR PIPE AND THE VALVE.

(1) Remove the EGR pipe and the EGR valve.
Refer to the section **"EGR VALVE AND COOLER"** in the chapter **"EMISSION CONTROL"**.

2. REMOVE THE INTAKE PIPE (INTAKE SIDE).

(1) Remove the intake pipe (intake side).
Refer to the section **"INTAKE PIPE (INTAKE SIDE)"** in the chapter **"AIR INTAKE SYSTEM"**.

3. REMOVE THE CRANKSHAFT DAMPER.

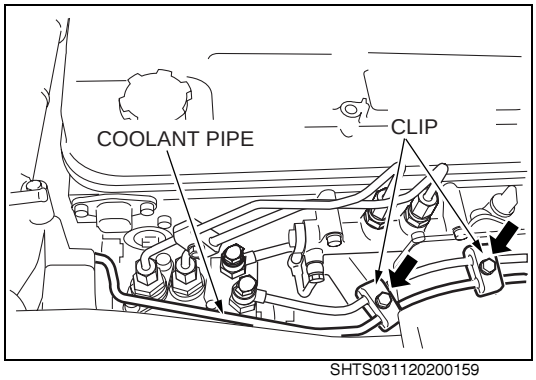
(1) Remove the crankshaft damper.
Refer to the section **"CRANKSHAFT DAMPER"**.

4. REMOVE THE CRANKSHAFT FRONT OIL SEAL.

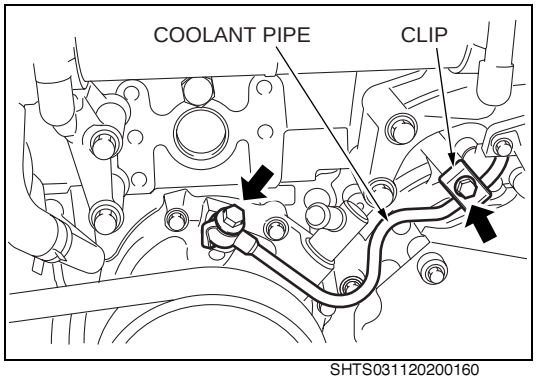
(1) Remove the crankshaft front oil seal.
Refer to the section **"CRANKSHAFT FRONT OIL SEAL"**.

5. REMOVE THE OIL PAN.

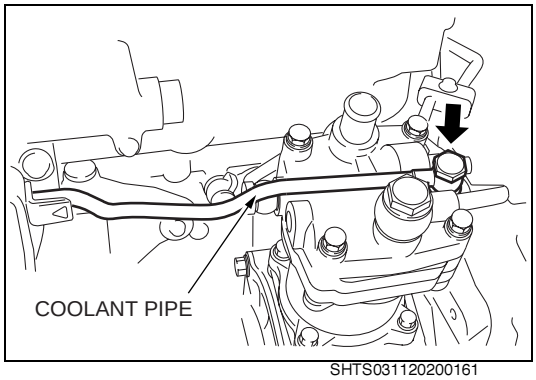
(1) Remove the oil pan.
Refer to the section **"OIL PAN"** in the chapter **"LUBRICATING SYSTEM"**.



SHTS031120200159



SHTS031120200160

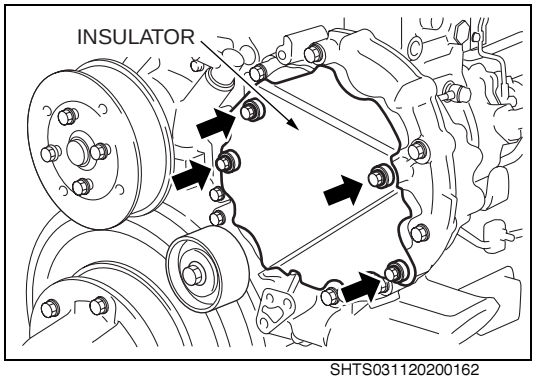


SHTS031120200161

6. REMOVE THE COOLANT PIPE (COOLANT PUMP).

(1) Remove three clips securing the coolant pipe between the coolant pump and the air compressor.

(2) Remove union bolts to remove the coolant pipe between coolant pump and the air compressor.

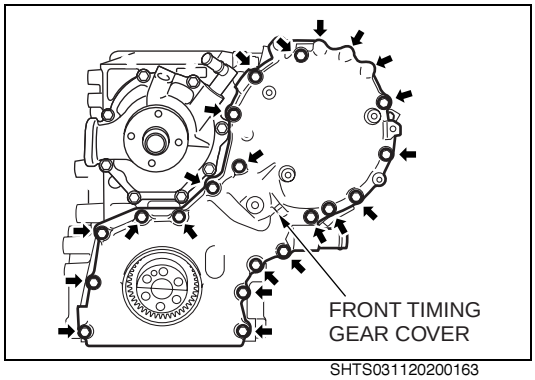


SHTS031120200162

REMOVE THE FRONT TIMING GEAR COVER.

1. REMOVE THE FRONT TIMING GEAR COVER.

(1) Remove four bolts to remove the insulator from the front timing gear cover.



SHTS031120200163

(2) Remove the twenty-two bolts to remove the front timing gear cover from the end plate.

REMOVE THE FRONT TIMING GEAR AND THE END PLATE.

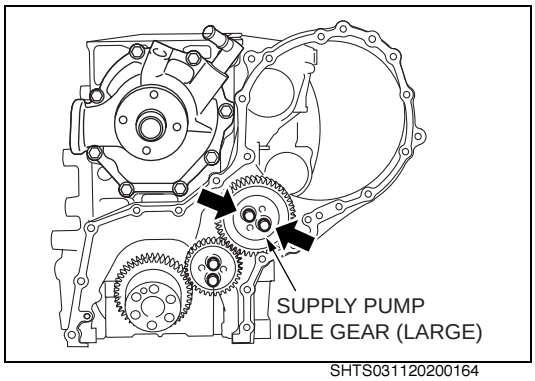
1. REMOVE THE SUPPLY PUMP.

(1) Remove the supply pump.
Refer to the section **"SUPPLY PUMP"** in the chapter **"FUEL SYSTEM"**.

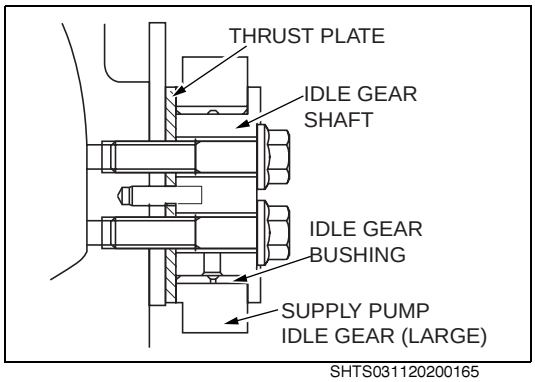
2. REMOVE THE FRONT TIMING GEAR.

(1) Remove two bolts to remove the idle gear shaft, the supply pump idle gear (large) and the thrust washer.

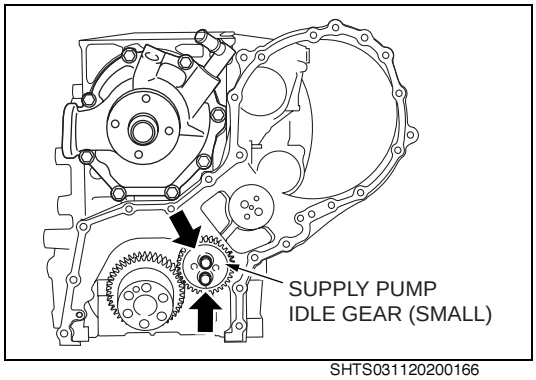
⚠ CAUTION
Take care not to drop the thrust plate and the supply pump idle gear (large).



SHTS031120200164



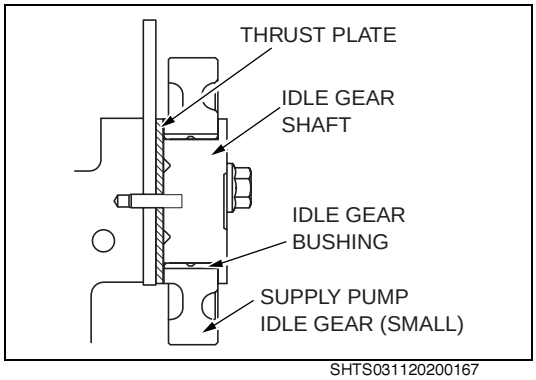
SHTS031120200165



SHTS031120200166

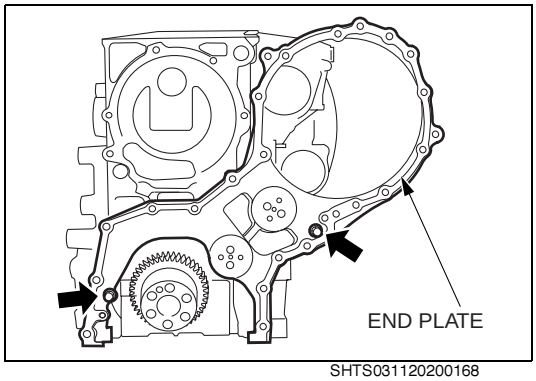
(2) Remove two bolts to remove the idle gear shaft, the supply pump idle gear (small) and the thrust washer.

⚠ CAUTION
Take care not to drop the thrust plate and the supply pump idle gear (small).

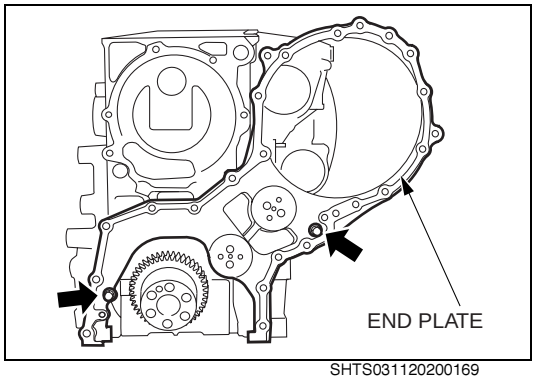


SHTS031120200167

3. REMOVE THE END PLATE.
(1) Remove two bolts to remove the end plate and the gasket.



SHTS031120200168



SHTS031120200169

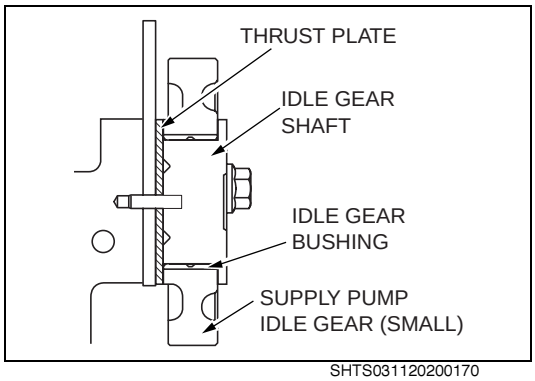
INSTALL THE FRONT TIMING GEAR AND THE END PLATE.

1. INSTALL THE END PLATE.

(1) Remove dirt from the mating surface between the end plate and the cylinder block.

(2) Replace an old gasket with a new one. Attach the end plate, and tighten two bolts.
Tightening Torque:
28.5 N·m {290 kgf·cm, 21 lbf·ft}

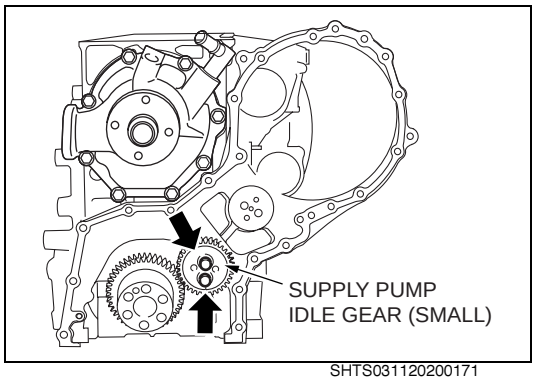
HINT
For easier works in this step, use guide bolts.



SHTS031120200170

2. INSTALL THE FRONT TIMING GEAR.

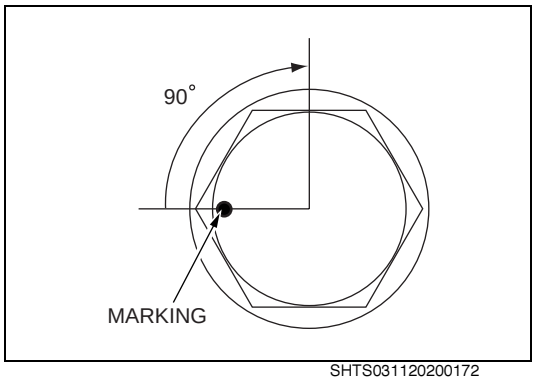
(1) Apply engine oil to the idle gear shaft, the thrust washer, the idle gear bushing on the supply pump idle gear (small), the idle gear shaft mounting bolt seat and the bolt threads. Assemble these parts as shown in the figure.



SHTS031120200171

(2) Install the assembled idle gear shaft, the idle gear (small) and the thrust plate to the end plate, and tighten two bolts.
Seating torque:
20 N·m {205 kgf·cm, 15 lbf·ft}

NOTICE
Pretighten bolts until the thrust plate contacts with the end plate. Then fully tighten them to the specified torque.

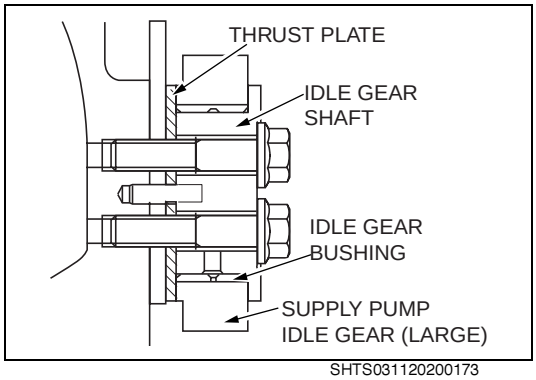


SHTS031120200172

(3) Mark the idle gear shaft installation bolts with paint to indicate the same direction.

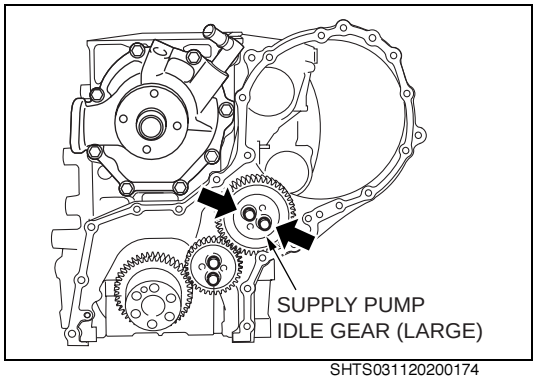
(4) Turn the bolts 90° (1/4 turn) and make sure that all paint marks face the same direction.

NOTICE
When adding torque, never untighten the bolts, even if they have been overtightened.



SHTS031120200173

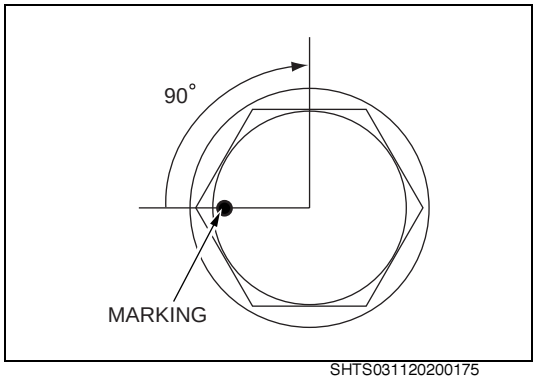
(5) Apply engine oil to the idle gear shaft, the thrust washer, the idle gear bushing on the supply pump idle gear (large), the idle gear shaft mounting bolt seat and the bolt threads. Assemble these parts as shown in the figure.



SHTS031120200174

(6) Install the assembled idle gear shaft, the idle gear (large) and the thrust plate to the end plate, and tighten two bolts.
Seating torque:
20 N·m {205 kgf·cm, 15 lbf·ft}

NOTICE
Pretighten bolts until the thrust plate contacts with the end plate. Then fully tighten them to the specified torque.

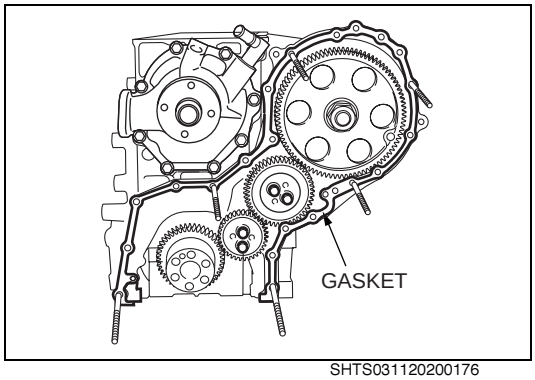


SHTS031120200175

(7) Mark the idle gear shaft installation bolts with paint to indicate the same direction.
(8) Turn the bolts 90° (1/4 turn) and make sure that all paint marks face the same direction.

NOTICE
When adding torque, never untighten the bolts, even if they have been overtightened.

3. INSTALL THE SUPPLY PUMP.
(1) Install the supply pump.
Refer to the section **"SUPPLY PUMP"** in the chapter **"FUEL SYSTEM"**.

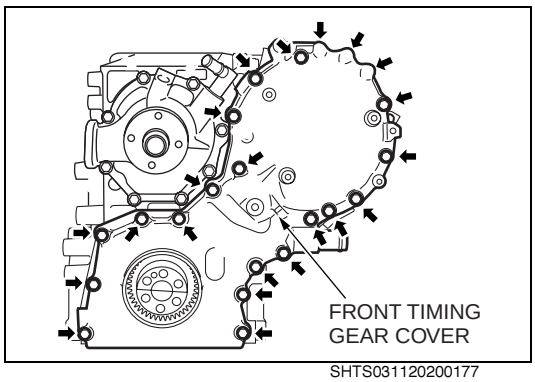


SHTS031120200176

INSTALL THE FRONT TIMING GEAR COVER.

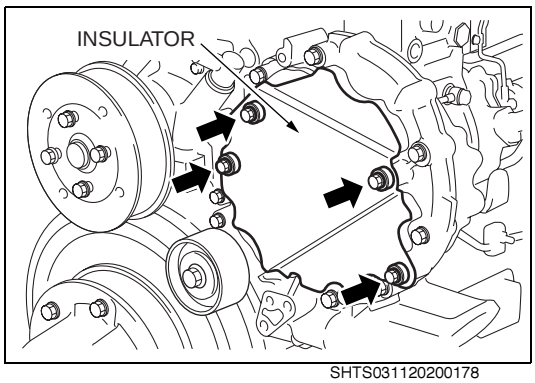
1. INSTALL THE FRONT TIMING GEAR COVER.

(1) Install the guide bolt to the cylinder block and match new gasket with the end plate.



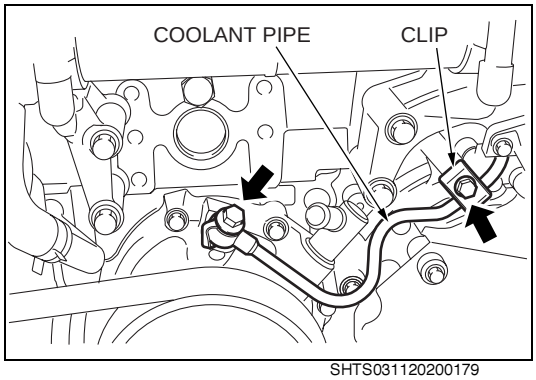
SHTS031120200177

(2) Install the front timing gear cover to the end plate, and tighten twenty-two bolts.
Tightening Torque:
55 N·m {560 kgf·cm, 41 lbf·ft}

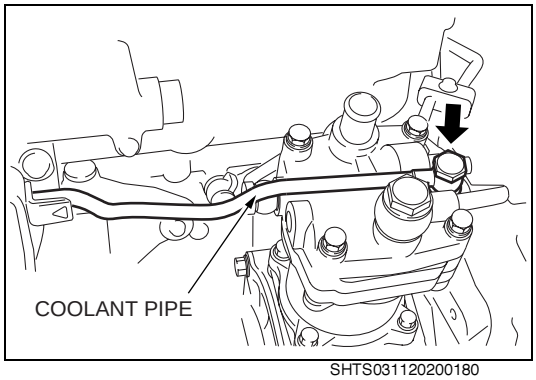


SHTS031120200178

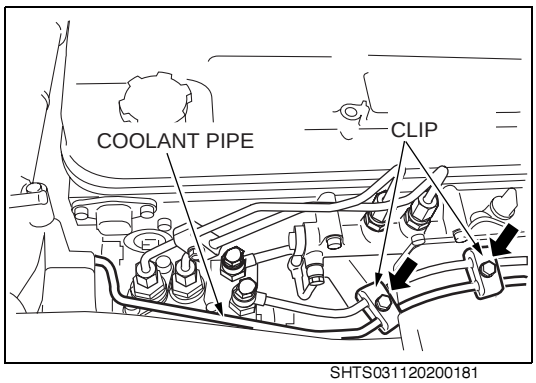
(3) Install the insulator to the front timing gear cover with four bolts.



SHTS031120200179



SHTS031120200180



SHTS031120200181

INSTALL THE PERIPHERAL COMPONENTS/PARTS AROUND THE FRONT TIMING GEAR COVER.

1. INSTALL THE COOLANT PIPE (COOLANT PUMP).

(1) Replace an old gasket with a new one. Connect one coolant pipe between the coolant pump and the air compressor, and fasten a union bolt.

(2) Fasten three clips to secure the fuel pipe and the coolant pipe above the intake pipe (intake side).

2. INSTALL THE OIL PAN.

(1) Replace the gasket with a new one and install the oil pan.
Refer to the section **"OIL PAN"** in the chapter **"LUBRICATING SYSTEM"**.

3. INSTALL THE CRANKSHAFT FRONT OIL SEAL.

(1) Using the special tool, press into the crankshaft front oil seal.
Refer to the section **"CRANKSHAFT FRONT OIL SEAL"**.

4. INSTALL THE CRANKSHAFT DAMPER.

(1) Install the crankshaft damper.
Refer to the section **"CRANKSHAFT DAMPER"**.

5. ISNTALL THE INTAKE PIPE (INTAKE SIDE).

(1) Replace the gasket with a new one and install the intake pipe (intake side).
Refer to the section **"INTAKE PIPE (INTAKE SIDE)"** in the chapter **"AIR INTAKE SYSTEM"**.

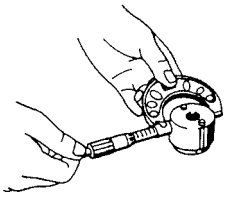
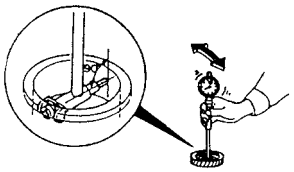
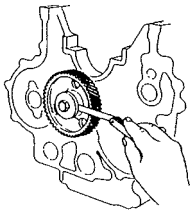
6. INSTALL THE EGR PIPE AND THE VALVE.

(1) Replace the gasket with a new one and install the EGR pipe and the EGR valve.
Refer to the section **"EGR VALVE AND COOLER"** in the chapter **"EMISSION CONTROL"**.

INSPECTION AND REPAIR

EN0311202H300006

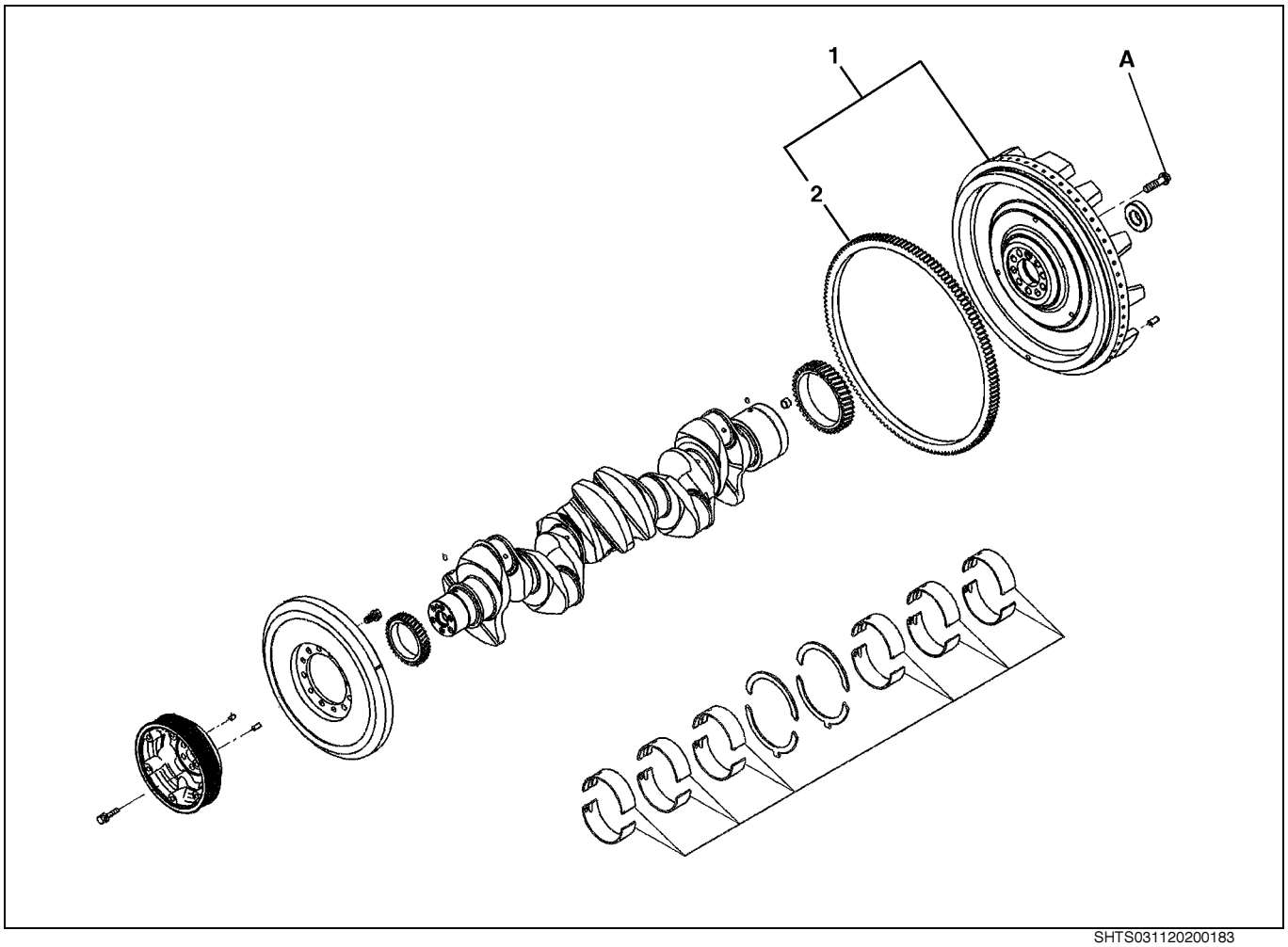
Unit: mm {in.}

Inspection item		Standard	Limit	Remedy	Inspection procedure
Idle gear shaft outside diameter		50 {1.9685}	—	—	Measure  Outside diameter
Idle gear shaft bushing inside diameter		50 {1.9685}	—	—	
Clearance between idle gear shaft and idle gear bushing		0.025-0.066 {0.0010-0.0259}	0.2 {0.0078}	Replace idle gear shaft bushing and/or idle gear.	
Idle gear end play		0.200-0.260 {0.0078-0.0102}	0.3 {0.0118}	Replace idle gear shaft bushing and/or idle gear.	 Inside diameter
Crank gear backlash	Crank gear - supply pump idle gear (small)	0.020-0.114 {0.0007-0.0044}	—	Replace gear.	
	Supply pump idle gear (small) - supply pump idle gear (large)	0.021-0.115 {0.0008-0.0045}	—		
	Supply pump idle gear (large) - supply pump drive gear	0.020-0.170 {0.0007-0.0066}	—		 End play

FLYWHEEL ASSEMBLY

COMPONENT LOCATOR

EN0311202D100009



SHTS031120200183

1 Flywheel assembly	2 Ring gear

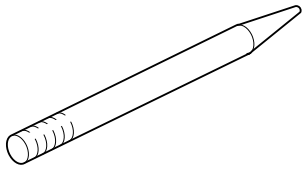
Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

A 186 {1,896, 137}	

SPECIAL TOOL

EN0311202K100003

Prior to starting an engine overhaul, it is necessary to have this special tool.

Illustration	Part number	Tool name	Remarks
	S0948-11340	GUIDE	

OVERHAUL

EN0311202H200006

REMOVE THE FLYWHEEL ASSEMBLY.

1. REMOVE THE ENGINE SPEED MAIN SENSOR.

(1) Remove the engine speed main sensor from the flywheel housing.
Refer to the section **"ENGINE SPEED MAIN SENSOR"** in the chapter **"ENGINE CONTROL"**.

⚠ CAUTION
Remove the engine speed main sensor before removing the flywheel. If not removed, it will result in damage of the sensor.

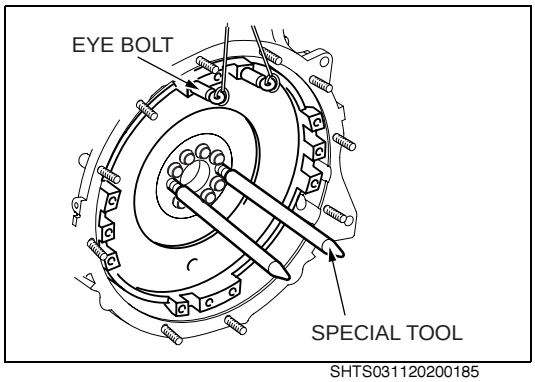
2. REMOVE THE PILOT BEARING.

(1) Using the special tool, remove the pilot bearing from the flywheel.
Refer to the chapter **"CLUTCH MAIN UNIT"** in the workshop manual (chassis).

3. REMOVE THE FLYWHEEL ASSEMBLY.

(1) First remove two horizontal bolts among other flywheel mounting bolts, and fasten guide bolts for the purpose of preventing accidental drop.

SST: Guide (S0948-11340)



SHTS031120200185

HINT
Insert a large flat head screwdriver into the flywheel gear through an access hole in the flywheel housing to prevent synchronic turning of the crankshaft.

(2) Fasten eye bolts to the clutch mounting area. Use a hoist to lift up and remove other bolts. Slide the flywheel off by using a special tool (guide).

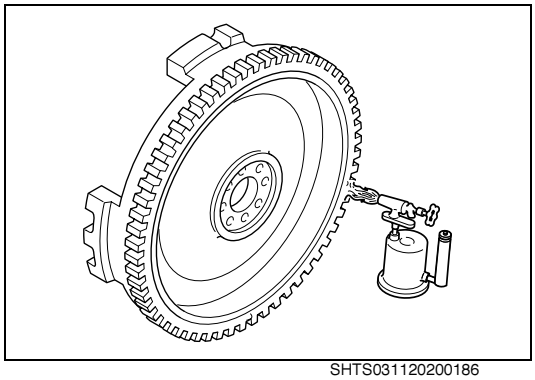
⚠ WARNING
The flywheel is too heavy. When installing, be careful not to drop it on your feet.

DISASSEMBLE THE FLYWHEEL ASSEMBLY.

1. REMOVE THE RING GEAR.

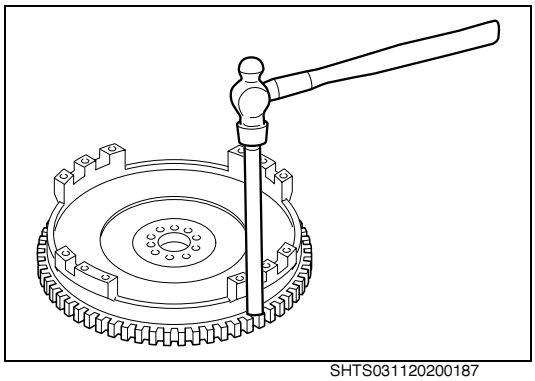
(1) Heat the ring gear evenly to about 200°C {392°F} with a torch.

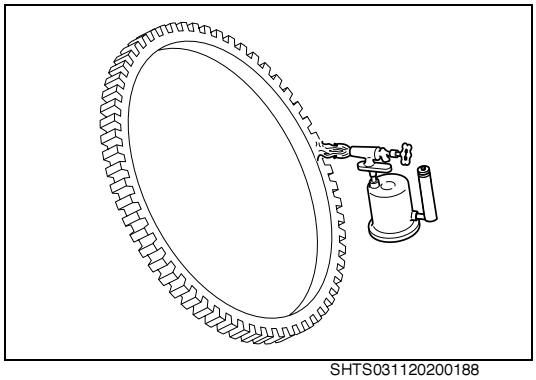
⚠ CAUTION
Never touch the heated ring gear or flywheel with your bare hand. This can result in personal injury.


SHTS031120200186

(2) Tap the ring gear periphery lightly using a brass bar and a hammer to remove the gear.

⚠ CAUTION
Never touch the heated ring gear or flywheel with your bare hand. This can result in personal injury.


SHTS031120200187

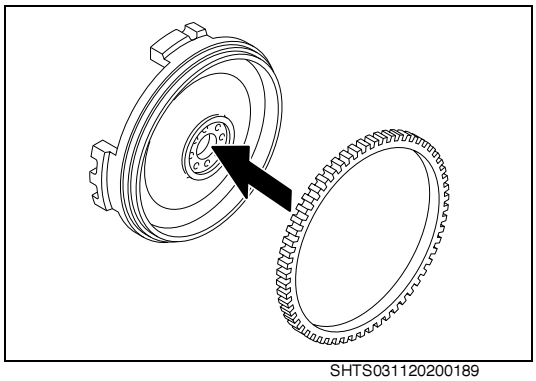

SHTS031120200188

ASSEMBLE THE FLYWHEEL ASSEMBLY.

1. INSTALL THE RING GEAR.

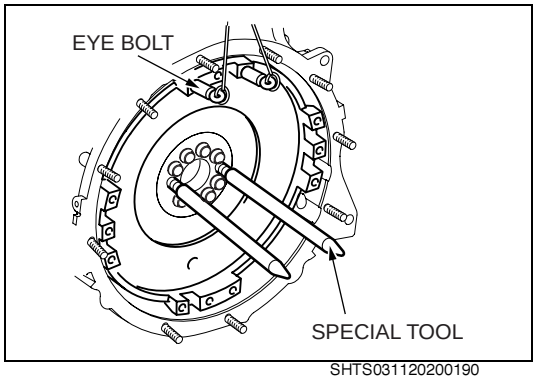
(1) Heat the ring gear evenly to about 200°C {392°F} with a torch.

⚠ CAUTION
Never touch the heated ring gear or flywheel with your bare hand. This can result in personal injury.


SHTS031120200189

(2) Insert the ring gear into the flywheel so that the chamfered side is upward.

⚠ CAUTION
Never touch the heated ring gear or flywheel with your bare hand. This can result in personal injury.



SHTS031120200190

INSTALL THE FLYWHEEL ASSEMBLY.

1. INSTALL THE FLYWHEEL ASSEMBLY.

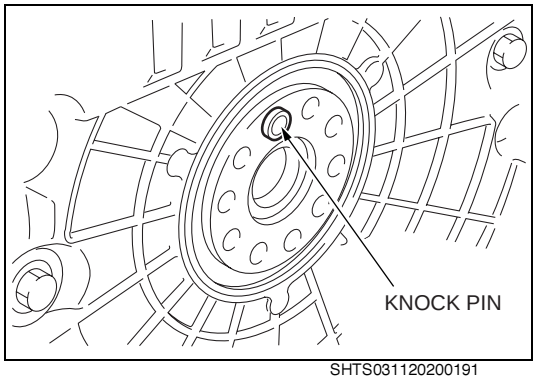
(1) Make sure that there are no burns or dirt on the contact surface or in the threaded holes of the crankshaft or flywheel.

(2) Install the special tools to the crankshaft.
SST: Guide (S0948-11340)

(3) Install eye bolts to the clutch mounting threads. Use a hoist to lift up and set the flywheel assembly to its installation position.

⚠ WARNING
The flywheel is too heavy. When installing, be careful not to drop it on your feet.

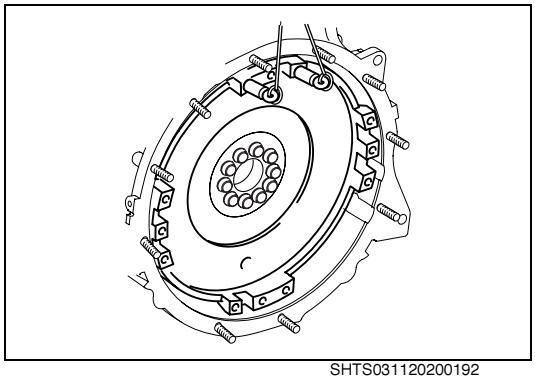
NOTICE
Remove the special tool after pretightening bolt.



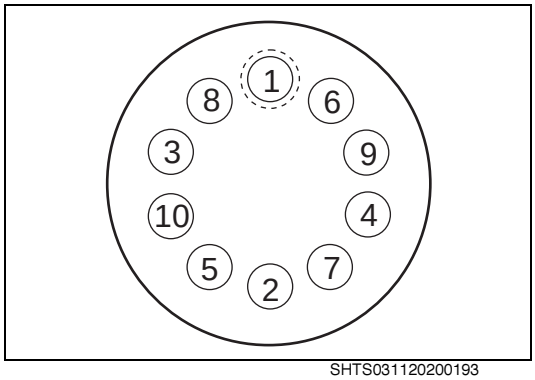
SHTS031120200191

HINT
Note that there is a knock pin. Make sure of a knock hole in aligning with the mounting position.

(4) Insert the flywheel assembly until it contacts with the crankshaft.


SHTS031120200192

(5) Apply engine oil to the bolt seat and bolt threads of the flywheel assembly mounting bolt.
(6) Finger-tighten eight bolts by two to three threads in the bolt holes other than those having special tools attached.
(7) Gradually pretighten these eight bolts.
(8) Remove special tools, and pretighten other two bolts in similar fashion.



SHTS031120200193

(9) Tighten the flywheel assembly installation bolts in the order shown in the figure to the specified torque below.
Seating torque:
186 N·m {1,896 kgf·cm, 137 lbf·ft}

HINT
Insert a large flat head screwdriver into the flywheel gear through an access hole in the flywheel housing to prevent synchronic turning of the crankshaft.

(10) Loosen all bolts.
(11) Tighten all bolts again in the order shown in the figure.
Seating torque:
186 N·m {1,896 kgf·cm, 137 lbf·ft}

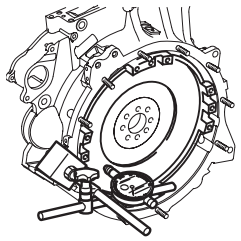
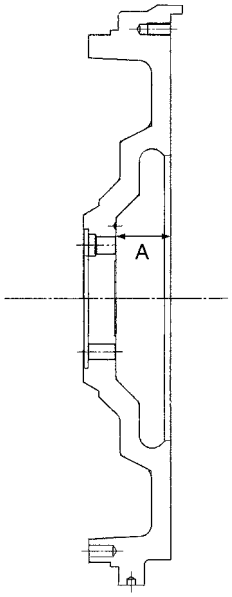
2. INSTALL THE PILOT BEARING.
(1) Install the pilot bearing to the flywheel.
Refer to the chapter **"CLUTCH MAIN UNIT"** in the workshop manual (chassis).

3. INSTALL THE ENGINE SPEED MAIN SENSOR.
(1) Install the engine speed main sensor to the flywheel housing.
Refer to the section **"ENGINE SPEED MAIN SENSOR"** in the chapter **"ENGINE CONTROL"**.

INSPECTION AND REPAIR

EN0311202H300007

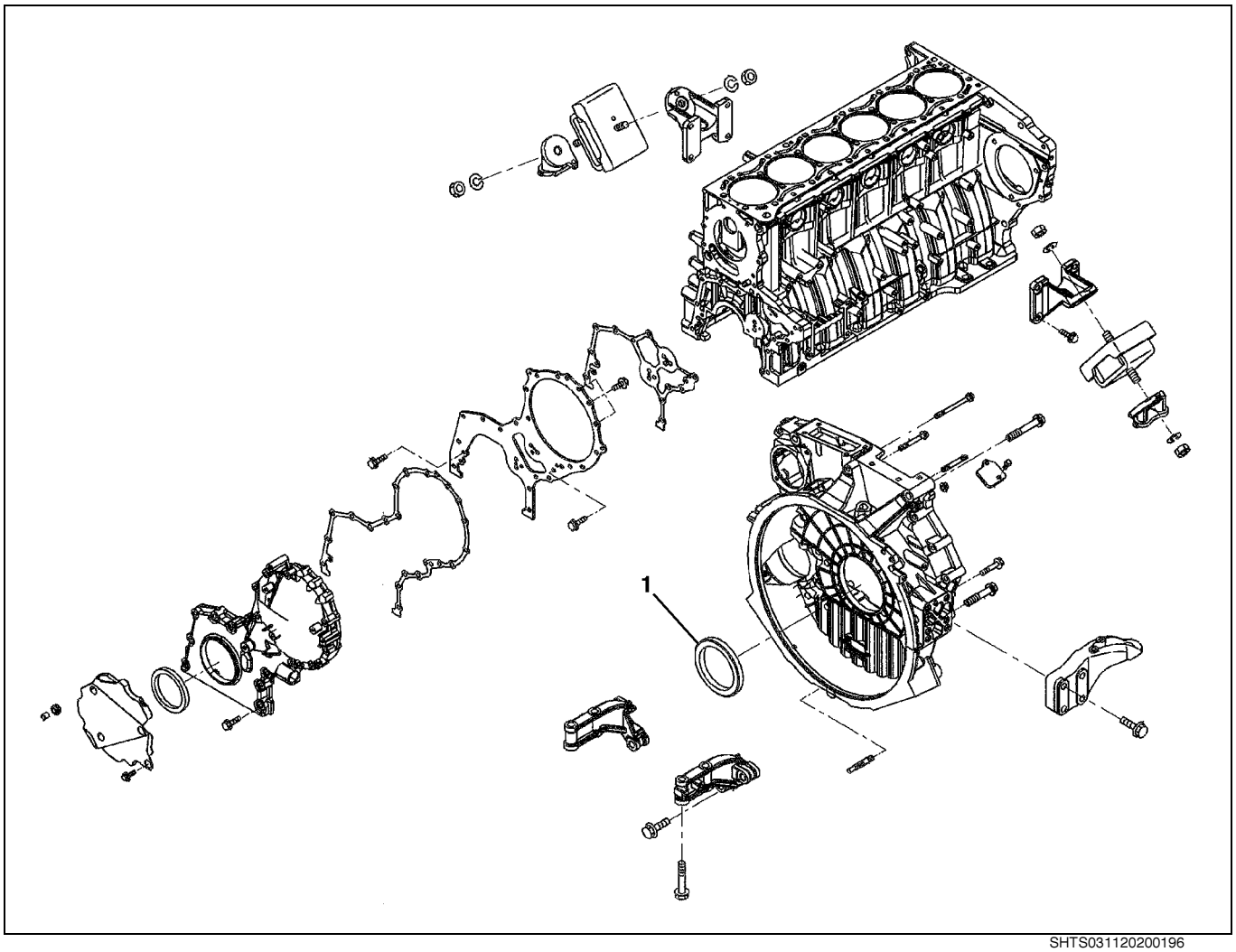
Unit: mm {in.}

Inspection item	Standard	Limit	Remedy	Inspection procedure
Flywheel surface deflection	**0-0.2 {0-0.0078}**	**0.2 {0.0078}**	**Repair.**	**Measure** 
Flywheel flange depth (Dimension A)	**49.5 {1.948}**	**—**	**Repair.**	**Measure** 

CRANKSHAFT REAR OIL SEAL

COMPONENT LOCATOR

EN0311202D100010



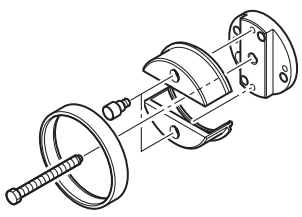
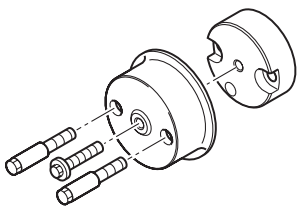
SHTS031120200196

1 Crankshaft rear oil seal	

SPECIAL TOOL

EN0311202K100004

Prior to starting an engine overhaul, it is necessary to have these special tools.

Illustration	Part number	Tool name	Remarks
	09220-E1070	OIL SEAL PULLER	
	09220-E1040	OIL SEAL PRESS	For Cylinder liner

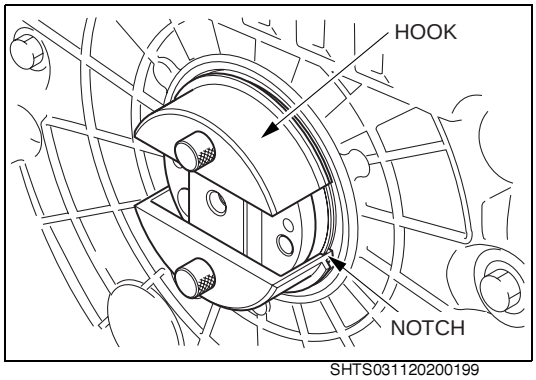
REPLACEMENT

EN0311202H100004

REMOVE THE CRANKSHAFT REAR OIL SEAL.

1. REMOVE THE FLYWHEEL ASSEMBLY.

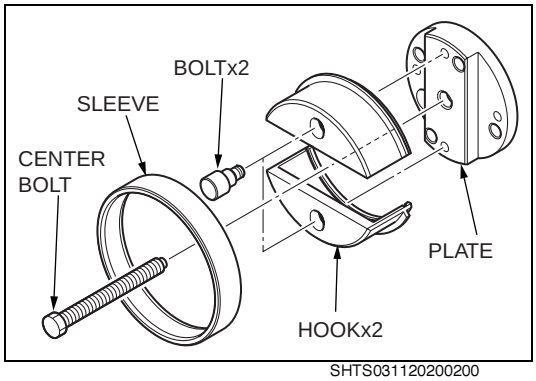
(1) Remove the flywheel assembly.
Refer to the section **"FLYWHEEL ASSEMBLY"**.



SHTS031120200199

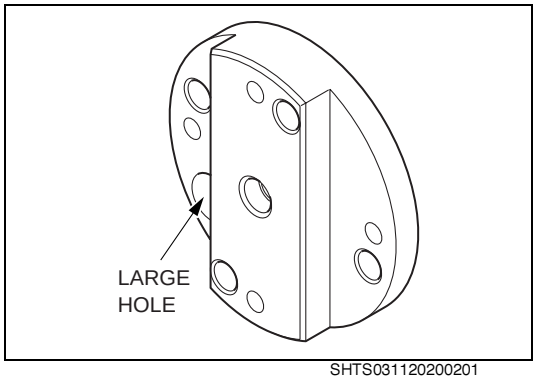
2. REMOVE THE CRANKSHAFT REAR OIL SEAL.

(1) Engage the oil seal puller hook with a tab on the crankshaft rear oil seal.
SST: Oil seal puller (09220-E1070)



SHTS031120200200

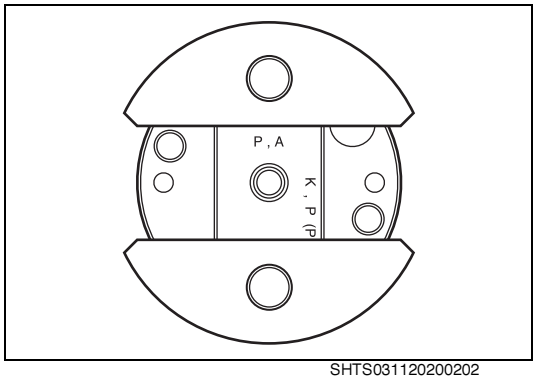
HINT
Structure of the oil seal puller (special tool)



SHTS031120200201

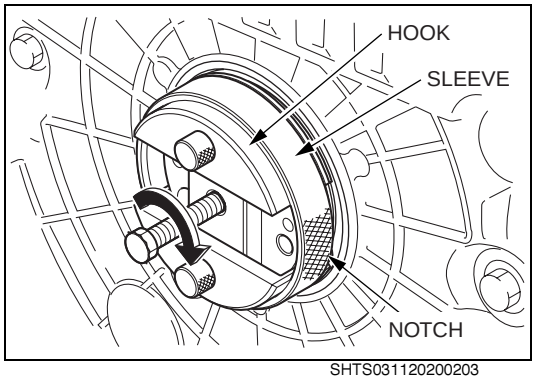
NOTICE

- **Align a large hole in the plate with the collar knock on the crankshaft.**



SHTS031120200202

- **This special tool is a common tool for A09C, K13C and P11C. Orient the special tool as shown in the figure.**



SHTS031120200203

(2) Attach a sleeve supplied with the oil seal puller (special tool), to the hook. Gradually tighten up to pull off the crankshaft rear oil seal.

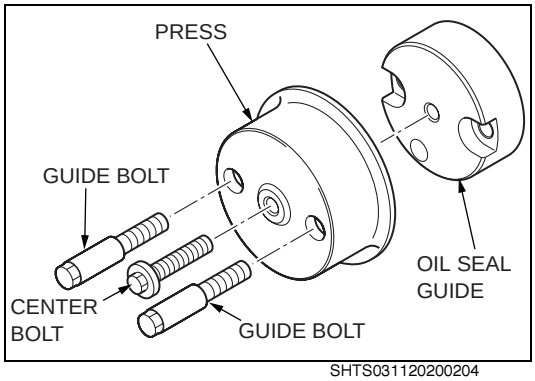
NOTICE
While ensuring the engagement between a special tool and an oil seal, pull off the oil seal with a care not to allow the special tool to come off in the middle of this work.

INSTALL THE CRANKSHAFT REAR OIL SEAL.

1. INSTALL THE CRANKSHAFT REAR OIL SEAL.

(1) Check that there are no hit marks or dusts on the flywheel housing or the crankshaft oil seal insertion area.

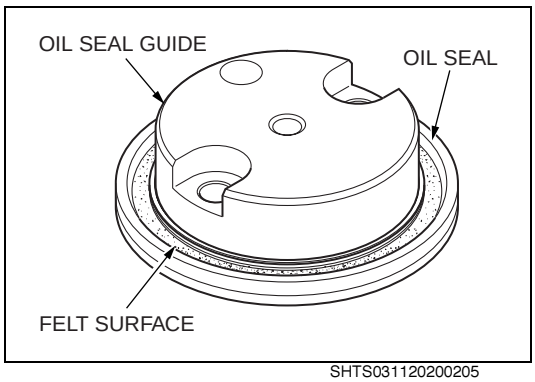
(2) Clean the oil seal press (special tool).
SST: Oil seal press (09220-E1040)



SHTS031120200204

HINT
Structure of oil seal press (special tool).

(3) Apply a small amount of engine oil to the inner/outer peripheries of a new oil seal.

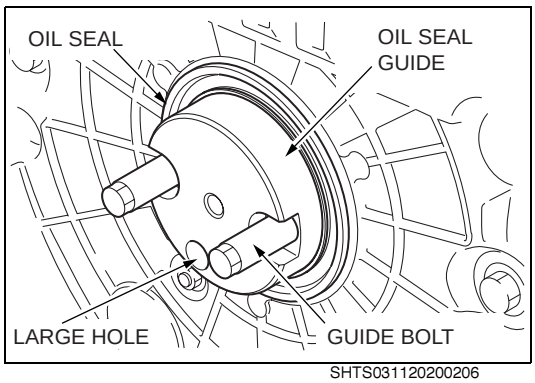


SHTS031120200205

(4) Attach the oil seal to the oil seal guide of the oil seal press (special tool). Make sure that the oil seal is positioned in its proper orientation.

NOTICE

- **Make sure that the crankshaft rear oil seal is positioned in its proper front/rear directions (the felt surface must be positioned toward the flywheel).**
- **Do not allow the oil seal to slant.**

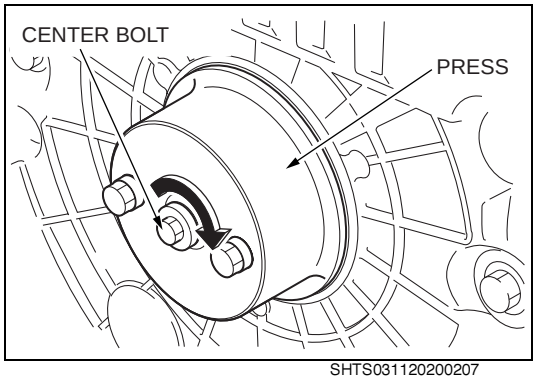


SHTS031120200206

(5) Attach the oil seal guide having an oil seal, to the end face of the crankshaft. Fasten two guide bolts.

NOTICE

- **A large hole in the oil seal guide must be aligned with the collar knock on the crankshaft.**
- **After tightening the guide bolts, check that a height difference between the crankshaft and the oil seal guide distributes evenly on the whole periphery.**



SHTS031120200207

(6) Insert the press in alignment with the oil seal guide. Tighten a center bolt to press-fit the oil seal.

NOTICE
Press-fit the oil seal evenly on the whole periphery.

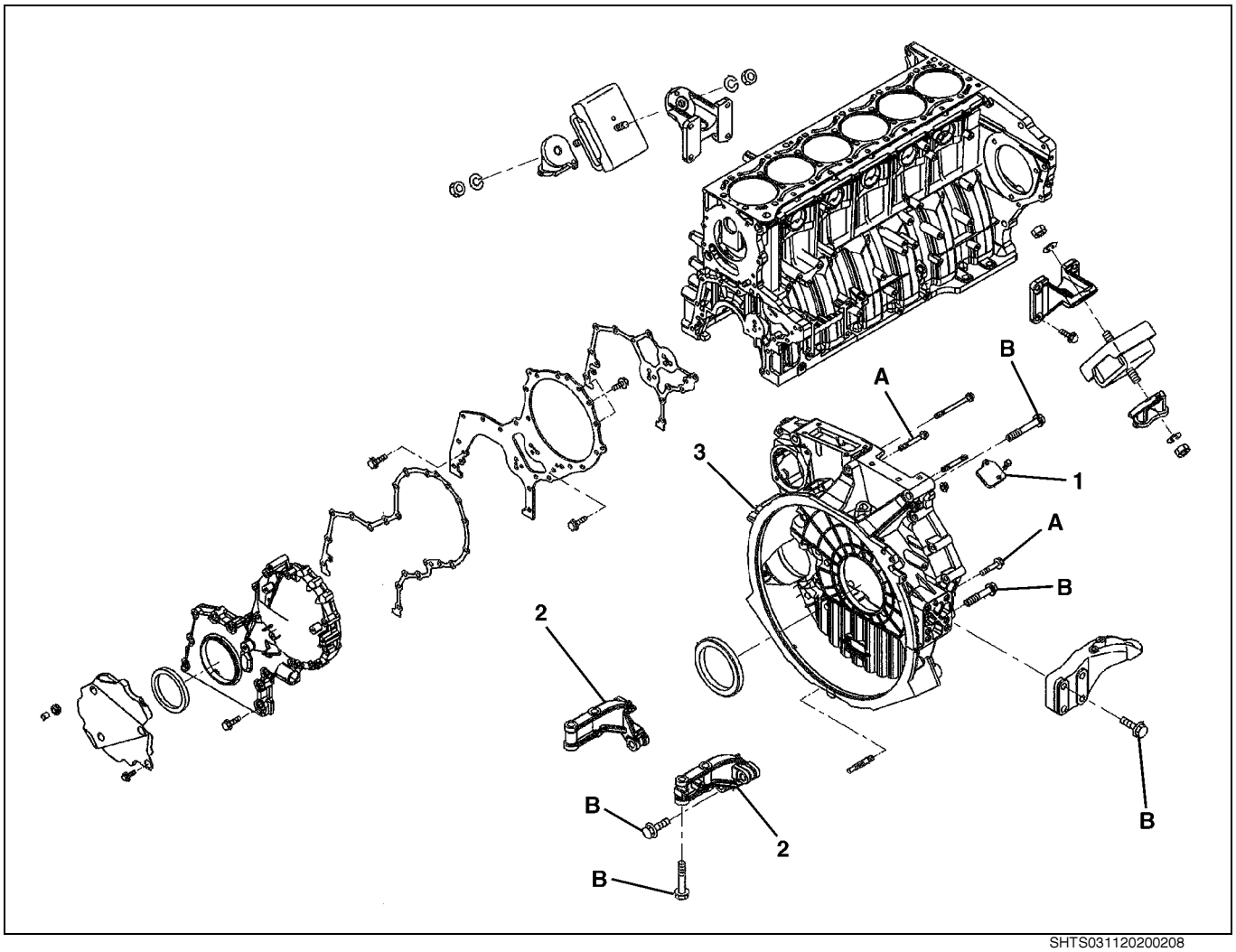
(7) Tighten a center bolt until the press comes to contact. Check that the oil seal has been press-fitted evenly on the whole periphery.
(8) Remove the special tool.

2. INSTALL THE FLYWHEEL ASSEMBLY.
(1) Install the flywheel assembly.
Refer to the section **"FLYWHEEL ASSEMBLY"**.

FLYWHEEL HOUSING

COMPONENT LOCATOR

EN0311202D100011



SHTS031120200208

1	Dust cover	3	Flywheel housing
2	Housing stay		

Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

A	68.5 {700, 51} (M10)	B	225 {2,300, 166} (M16)

REPLACEMENT

EN0311202H100005

REMOVE THE FLYWHEEL HOUSING.

1. REMOVE THE FUEL PIPE.

(1) Remove the fuel pipe around the flywheel housing.
Refer to the section **"FUEL PIPE"** in the chapter **"FUEL SYSTEM"**.

2. REMOVE THE AIR COMPRESSOR.

(1) Remove the air compressor.
Refer to the section **"AIR COMPRESSOR"** in the chapter **"AIR COMPRESSOR"**.

3. REMOVE THE STARTER.

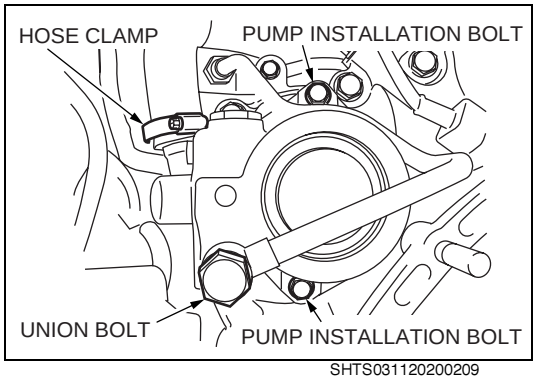
(1) Remove the starter.
Refer to the section **"STARTER"** in the chapter **"STARTER"**.

4. REMOVE THE POWER STEERING PUMP.

(1) Remove the oil hose.

NOTICE

- **Use a connector as oil might drop off during disconnection of oil hose. Use a cover to protect the hose against incoming dust.**
- **Disposal of engine oil must comply with the specified procedures (waste disposal) or other environmentally-conscious procedures.**



SHTS031120200209

(2) Remove the union bolt and gasket. Disconnect the pipe.
(3) Remove two power steering pump installation bolts.

5. REMOVE THE CYLINDER HEAD ASSEMBLY.

(1) Remove the cylinder head assembly.
Refer to the section **"CYLINDER HEAD ASSEMBLY"**.

6. REMOVE THE OIL PAN.

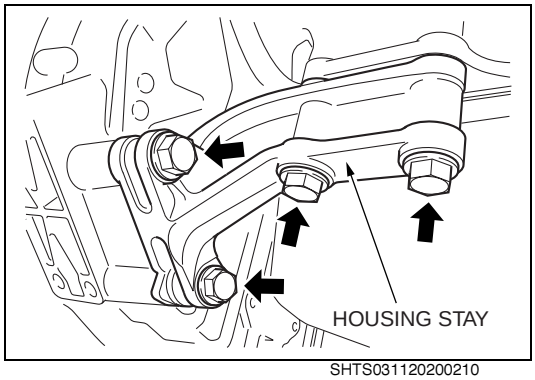
(1) Remove the oil pan.
Refer to the section **"OIL PAN"** in the chapter **"LUBRICATING SYSTEM"**.

7. REMOVE THE FLYWHEEL ASSEMBLY.

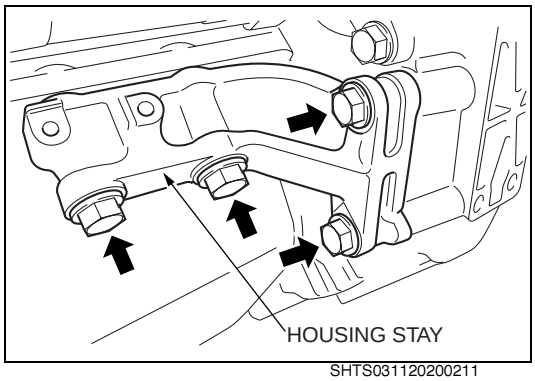
(1) Remove the flywheel assembly.
Refer to the section **"FLYWHEEL ASSEMBLY"**.

8. REMOVE THE CRANKSHAFT REAR OIL SEAL.

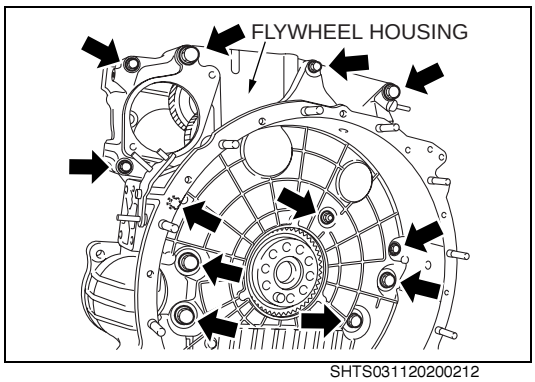
(1) Using the special tool, remove the crankshaft rear oil seal.
Refer to the section **"CRANKSHAFT REAR OIL SEAL"**.



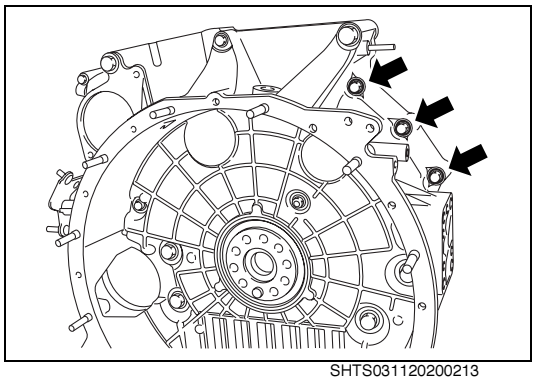
SHTS031120200210

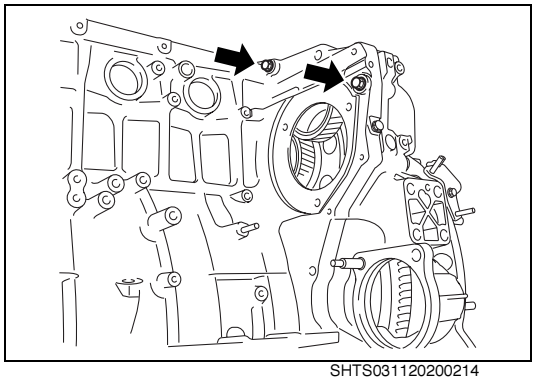


SHTS031120200211



SHTS031120200212


SHTS031120200213


SHTS031120200214

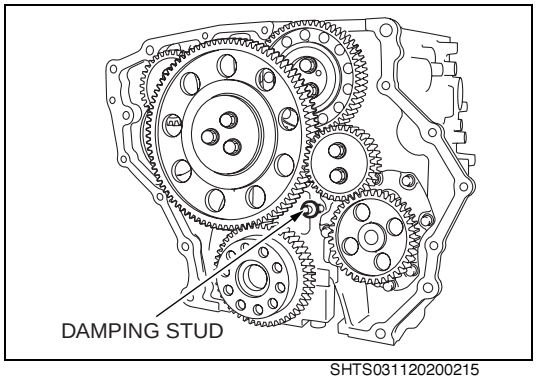
9. REMOVE THE FLYWHEEL HOUSING.

(1) Remove the bolts to remove the flywheel housing and the housing stay on the cylinder block.

(2) Remove the bolts to remove the flywheel housing.

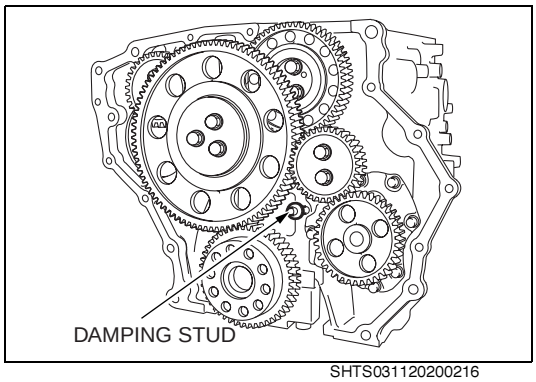
HINT

- **Since the flywheel housing is also used as a rear mounting, only a dedicated engine bench can accommodate the engine. If a dedicated engine bench is not available, set the engine upside down and place the cylinder block mating surface on a wooden work bench before proceeding with works.**
- **If it is difficult to remove the flywheel housing, pretighten one mounting nut in the center of the flywheel housing. Use a plastic hammer to lightly hammer the back surface for removal.**



SHTS031120200215

(3) Remove the damping stud from the flywheel housing.

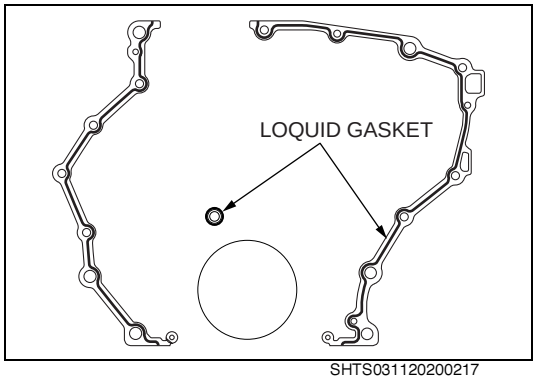


SHTS031120200216

INSTALL THE FLYWHEEL HOUSING.

1. INSTALL THE FLYWHEEL HOUSING.

(1) Install the damping stud to the flywheel housing.
Tightening Torque:
55 N·m {560 kgf·cm, 41 lbf·ft}



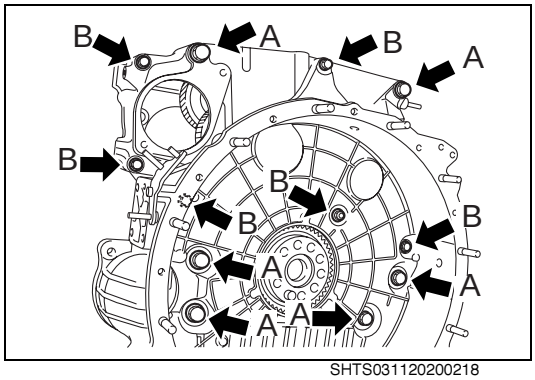
SHTS031120200217

(2) Remove dirt from the mating surface between the flywheel housing and the cylinder block using a scraper.

(3) Apply liquid gasket (ThreeBond TB1207D, silver) to the flywheel housing as shown in the figure.

NOTICE

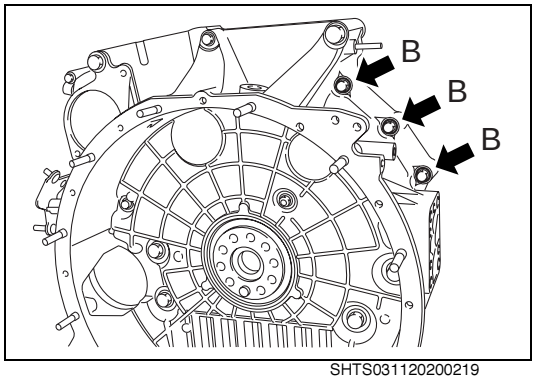
- **Apply liquid gasket without intermittence.**
- **Apply liquid gasket at a width of 1.5 to 2.5 mm {0.0591 to 0.0984 in.}.**
- **Proceed with a next step within 20 min. after applying liquid gasket.**



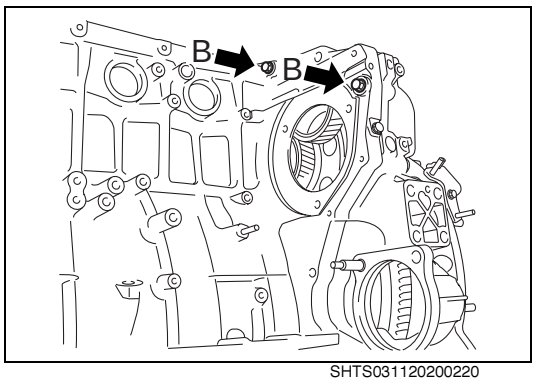
SHTS031120200218

(4) Fasten two to four guide bolts. Set the flywheel housing to its mounting position on the cylinder block, by referencing to the guide bolts.

(5) Install the flywheel housing and tighten the bolts to the specified torque.
Tightening Torque:
A: 225 N·m {2,300 kgf·cm, 166 lbf·ft}
B: 68.5 N·m {700 kgf·cm, 51 lbf·ft}

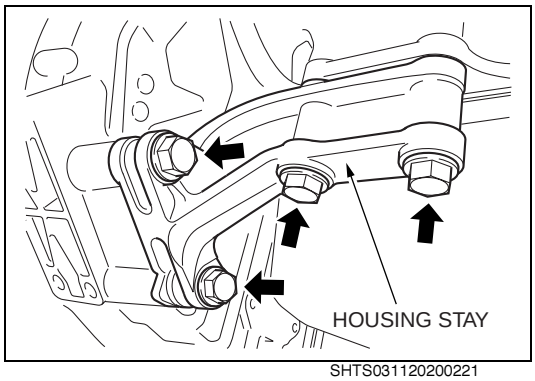


SHTS031120200219

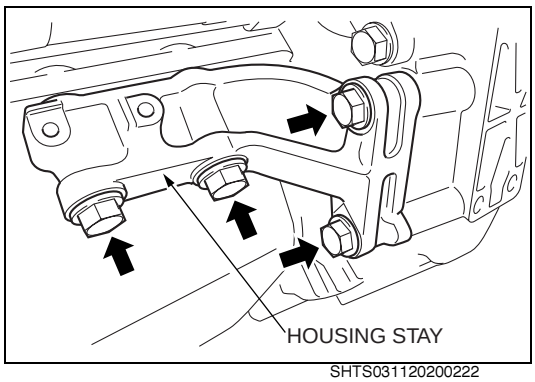


SHTS031120200220

(6) Pretighten bolts and make sure of tight contact with the flywheel housing and the cylinder block. Then, tighten bolts to the specified torque.
Tightening Torque:
225 N·m {2,300 kgf·cm, 166 lbf·ft}



SHTS031120200221



SHTS031120200222

2. INSTALL THE CRANKSHAFT REAR OIL SEAL.

(1) Using the special tool, install the crankshaft rear oil seal.
Refer to the section **"CRANKSHAFT REAR OIL SEAL"**.

3. INSTALL THE FLYWHEEL ASSEMBLY.

(1) Install the flywheel assembly.
Refer to the section **"FLYWHEEL ASSEMBLY"**.

4. INSTLL THE OIL PAN.

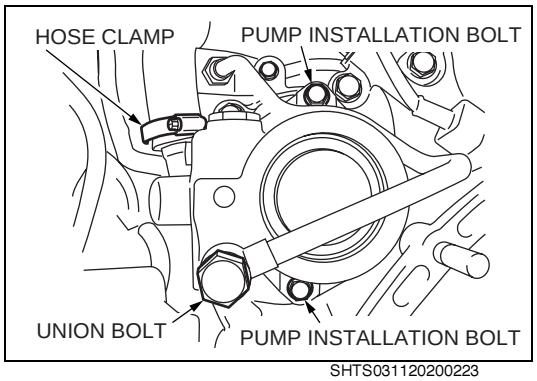
(1) Replace the gasket with a new one and install the oil pan.
Refer to the section **"OIL PAN"** in the chapter **"LUBRICATING SYSTEM"**.

5. INSTALL THE CYLINDER HEAD ASSEMBLY.

(1) Install the cylinder head assembly.
Refer to the section **"CYLINDER HEAD ASSEMBLY"**.

6. INSTALL THE POWER STEERING PUMP.

(1) Attach new O-ring. Install the power steering pump, and tighten two bolts.
Tightening Torque:
55 N·m {560 kgf·cm, 41 lbf·ft}



SHTS031120200223

(2) Connect the oil hose.

(3) Attach new gasket. Install the pipe, and tighten the union bolt.
Tightening Torque:
39 N·m {400 kgf·cm, 29 lbf·ft}

(4) Bleed air from the power steering oil pump and the power steering oil pipe.
Refer to the section **"POWER STEERING SYSTEM"** in the chapter **"POWER STEERING"** in the workshop manual (chassis).

7. INSTALL THE STARTER.

(1) Install the starter.
Refer to the section **"STARTER"** in the chapter **"STARTER"**.

8. INSTALL THE AIR COMPRESSOR.

(1) Install the air compressor.
Refer to the section **"AIR COMPRESSOR"** in the chapter **"AIR COMPRESSOR"**.

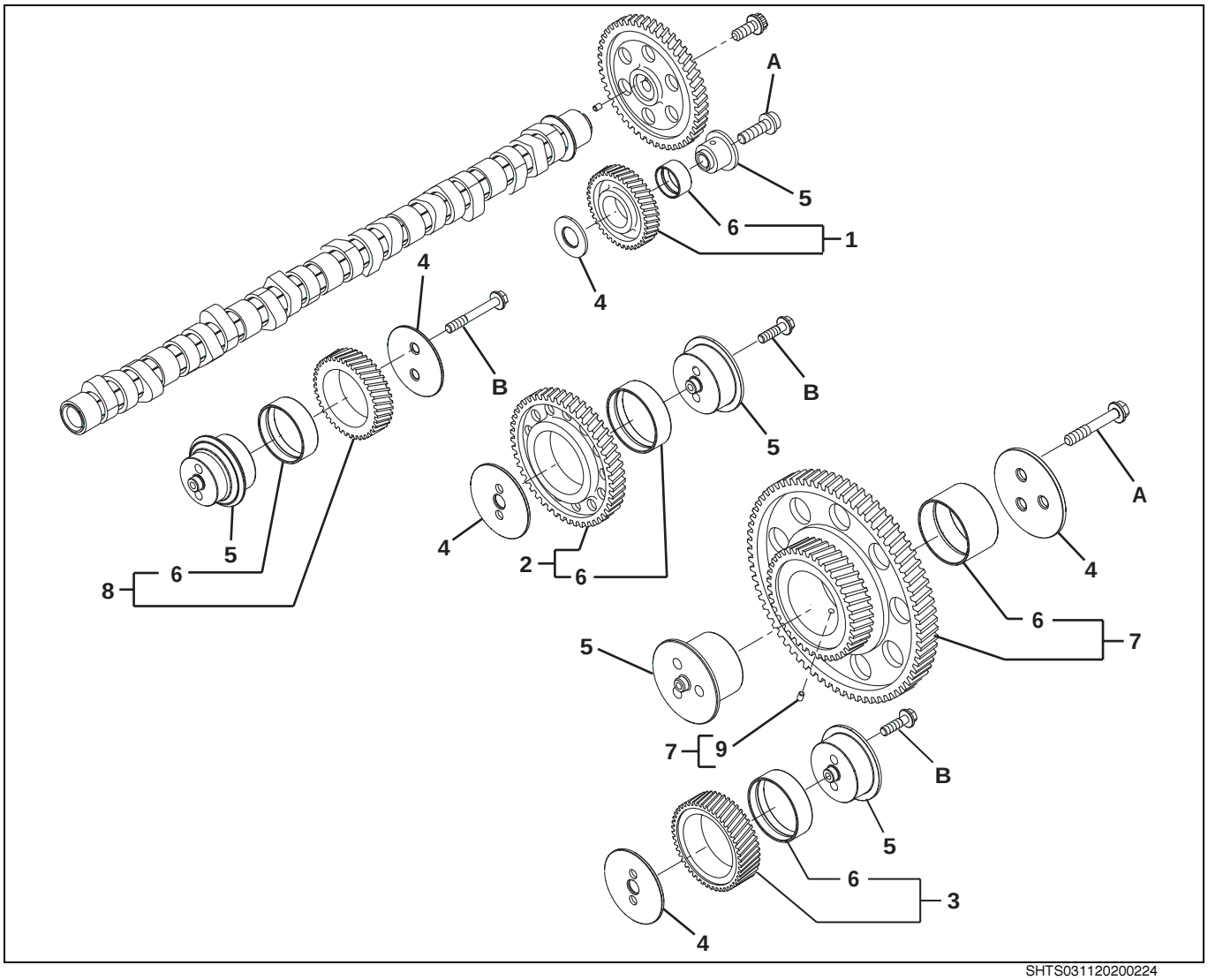
9. INSTALL THE FUEL PIPE.

(1) Install the fuel pipe around the flywheel housing.
Refer to the section **"FUEL PIPE"** in the chapter **"FUEL SYSTEM"**.

REAR TIMING GEAR AND CAM IDLE GEAR

COMPONENT LOCATOR

EN0311202D100012



SHTS031120200224

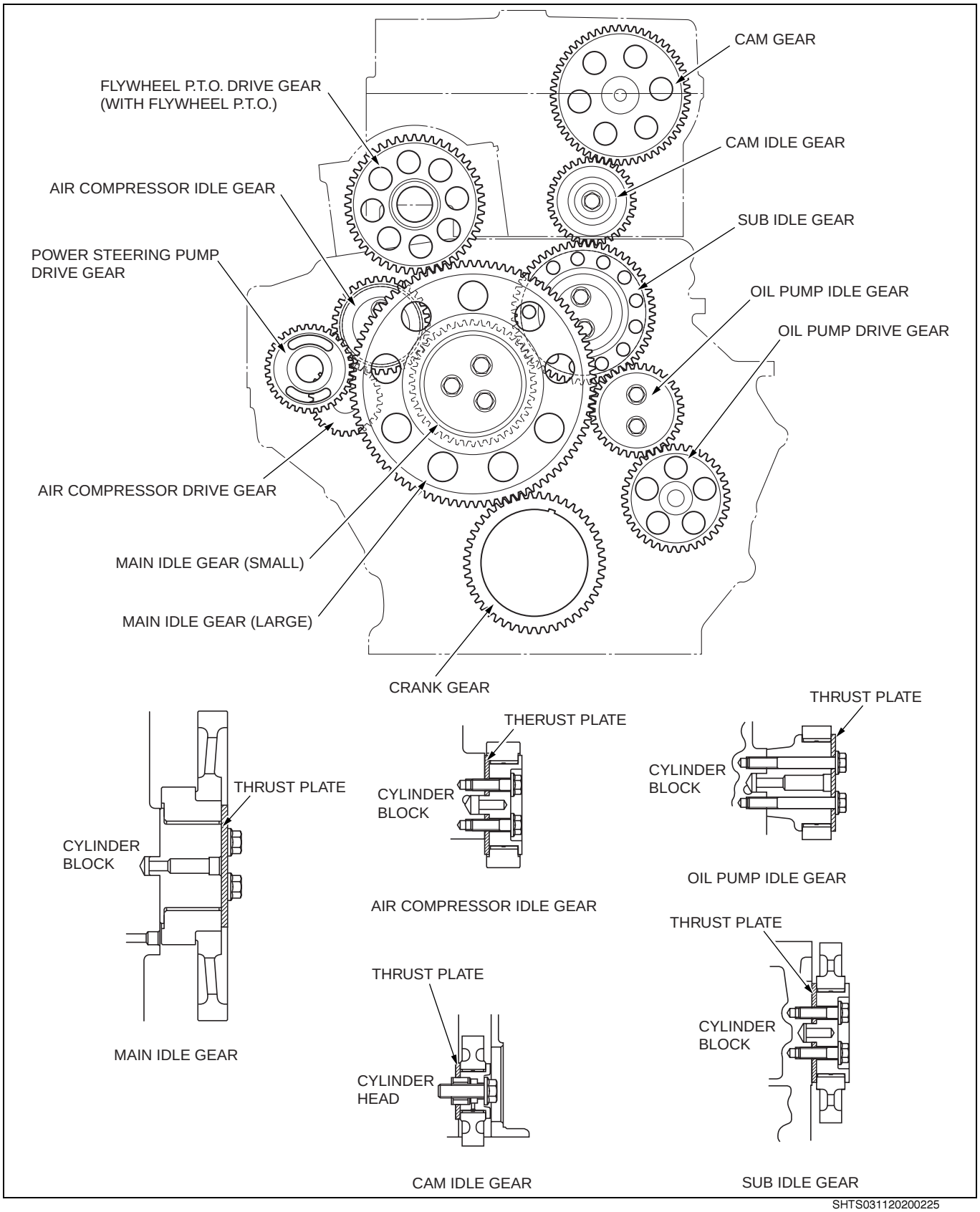
1	Cam idle gear	6	Bushing
2	Sub idle gear	7	Main idle gear
3	Air compressor idle gear	8	Oil pump idle gear
4	Thrust plate	9	Pin
5	Idle gear shaft		

Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

A	108 {1,101, 80}	B	68.5 {700, 51}

DESCRIPTION

EN0311202C100002

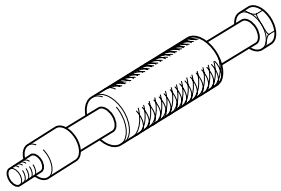


SHTS031120200225

SPECIAL TOOL

EN0311202K100005

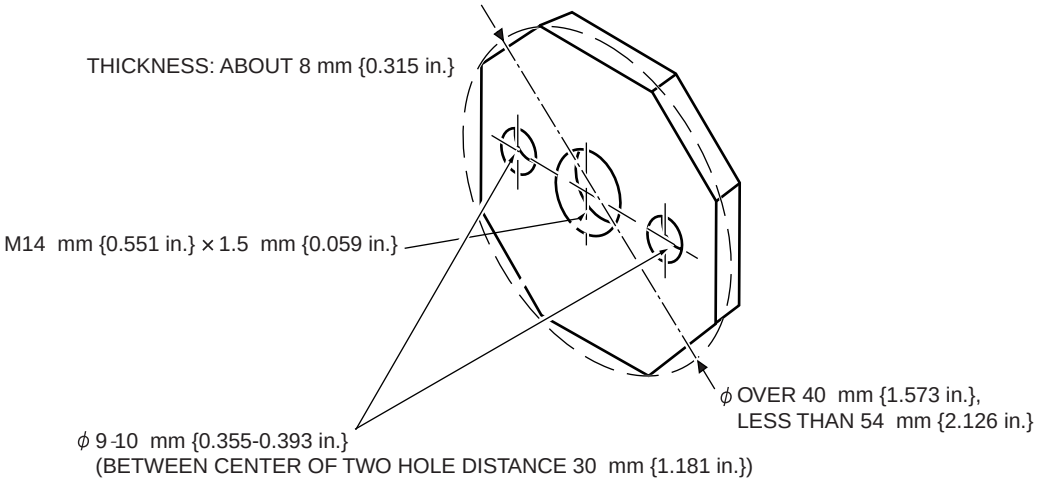
Prior to starting an engine overhaul, it is necessary to have this special tool.

Illustration	Part number	Tool name	Remarks
	S0942-01510	SLIDING HAMMER	For Piston ring

PROPOSAL TOOL

EN0311202K100006

IDLE GEAR SHAFT EJECTOR JIG
(FOR REMOVING IDLE GEAR)



SHTS031120200227

OVERHAUL

EN0311202H200007

REMOVE THE CAMSHAFT GEAR AND THE CAM IDLE GEAR.

1. REMOVE THE CAMSHAFT ASSEMBLY.

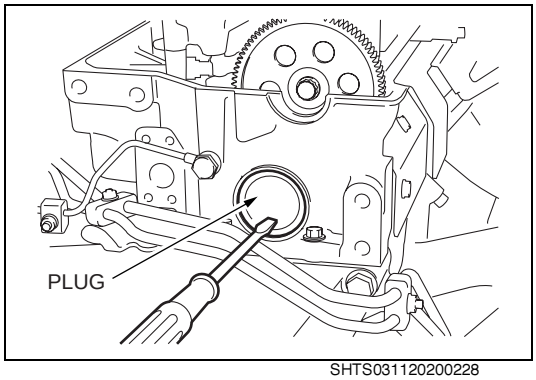
(1) Remove the camshaft assembly.
Refer to the section **"CAMSHAFT ASSEMBLY"**.

2. REMOVE THE CAMSHAFT GEAR.

(1) Remove the camshaft gear.
Refer to the section **"CAMSHAFT ASSEMBLY"**.

3. REMOVE THE CAM IDLE GEAR.

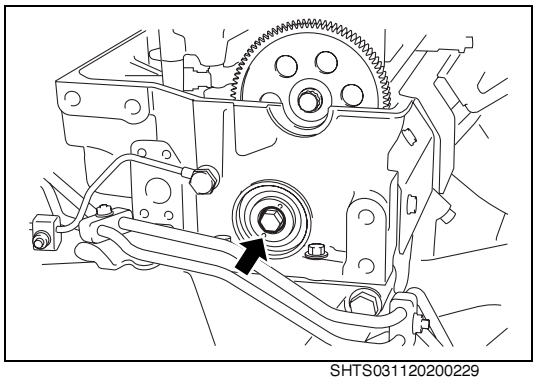
(1) Use a flat head screwdriver to tap at the lower area of the plug on the cylinder head and tilt the plug.



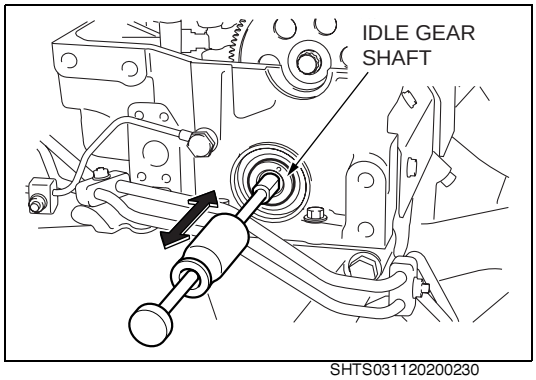
SHTS031120200228

⚠ CAUTION
Take care not to damage a mating surface with the cylinder head.

(2) Use a plier to pull off the tilted plug.

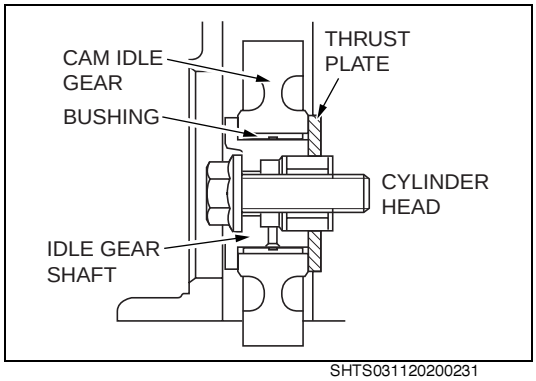

SHTS031120200229

(3) Remove a bolt from the idle gear shaft.



SHTS031120200230

(4) Use the special tool to pull off the idle gear shaft from the cylinder head. Remove the cam idle gear and the thrust plate.
SST: Sliding hammer (S0942-01510)



SHTS031120200231

NOTICE
Take care not to drop the thrust plate into the flywheel housing.

HINT
Setting the engine body upside down or in a lateral posture will prevent the parts from dropping into the flywheel housing during works.

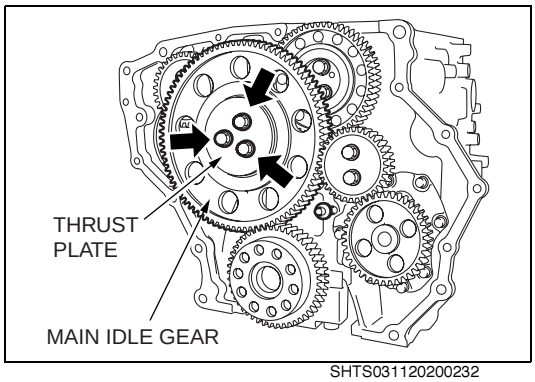
REMOVE THE TIMING GEAR IN THE FLYWHEEL HOUSING.

1. REMOVE THE FLYWHEEL HOUSING.

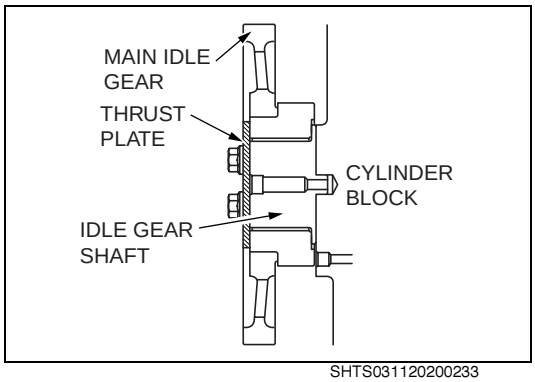
(1) Remove the flywheel housing.
Refer to the section **"FLYWHEEL HOUSING"**.

2. REMOVE THE MAIN IDLE GEAR.

(1) Remove three bolts of the idle gear shaft and remove the thrust plate and the main idle gear.

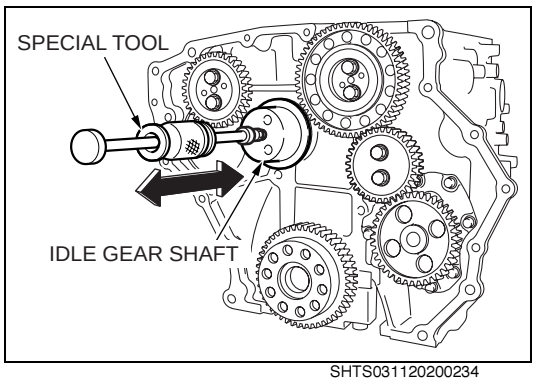


SHTS031120200232

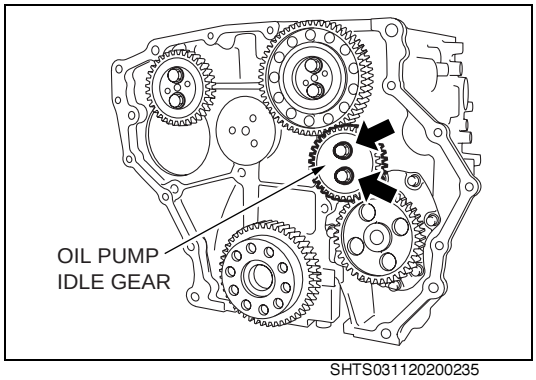


SHTS031120200233

(2) Using the special tool, remove the idle gear shaft.
SST: Sliding hammer (S0942-01510)



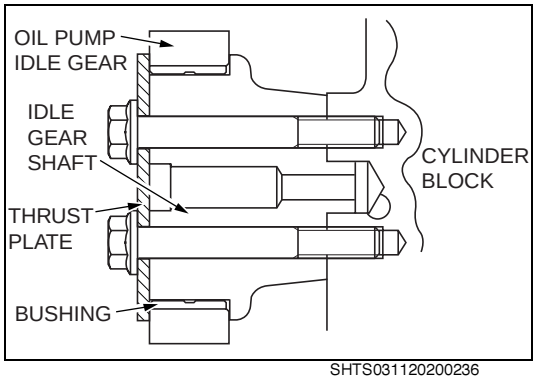
SHTS031120200234



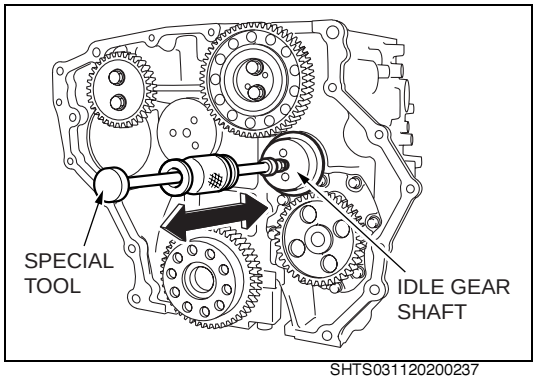
SHTS031120200235

3. REMOVE THE OIL PUMP IDLE GEAR.

(1) Remove two bolts from the idle gear shaft and remove the thrust plate and the oil pump idle gear.

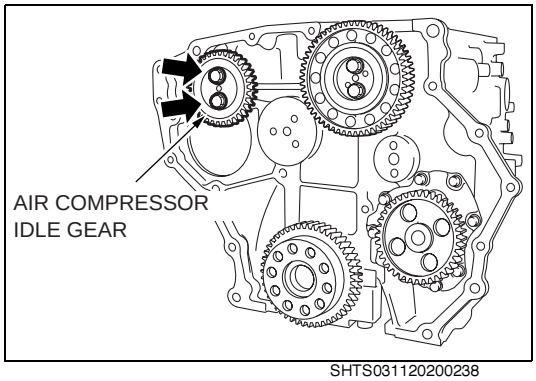


SHTS031120200236



SHTS031120200237

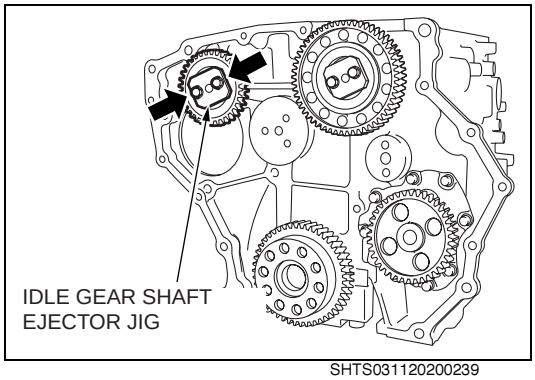
(2) Using the special tool, remove the idle gear shaft.
SST: Sliding hammer (S0942-01510)



SHTS031120200238

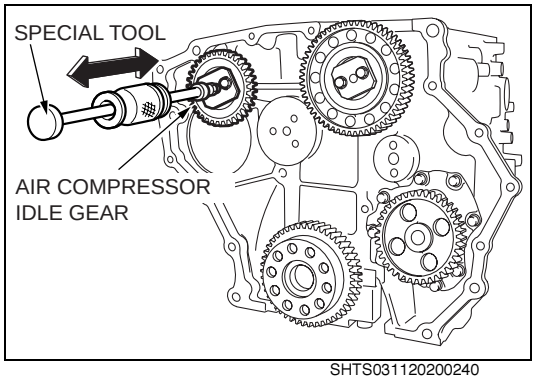
4. REMOVE THE AIR COMPRESSOR IDLE GEAR.

(1) Remove two bolts from the idle gear shaft.



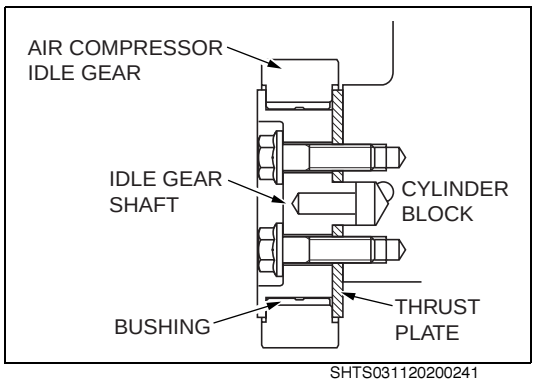
SHTS031120200239

(2) Install the idle gear shaft ejector jig to the idle gear shaft.



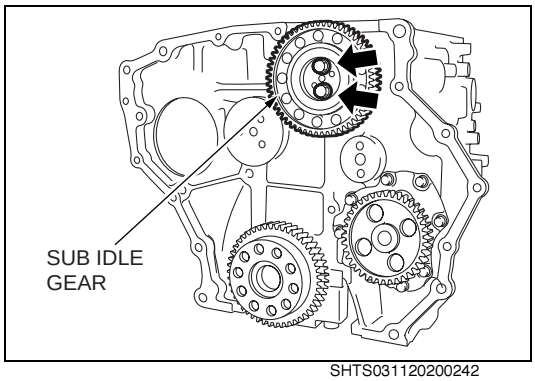
SHTS031120200240

(3) Remove the idle gear shaft using the special tool and remove the air compressor idle gear and the thrust plate.
SST: Sliding hammer (S0942-01510)



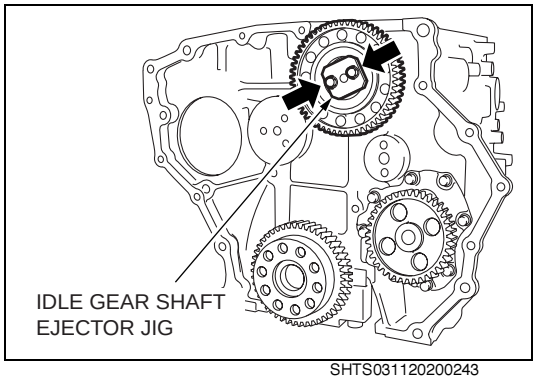
SHTS031120200241

NOTICE
Take care not to drop the thrust plate and the idle gear.



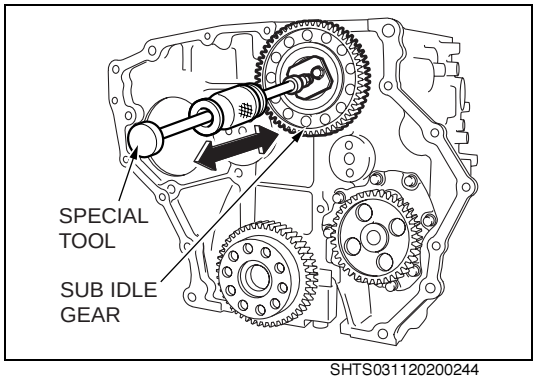
SHTS031120200242

5. REMOVE THE SUB IDLE GEAR.
(1) Remove two bolts from the idle gear shaft.



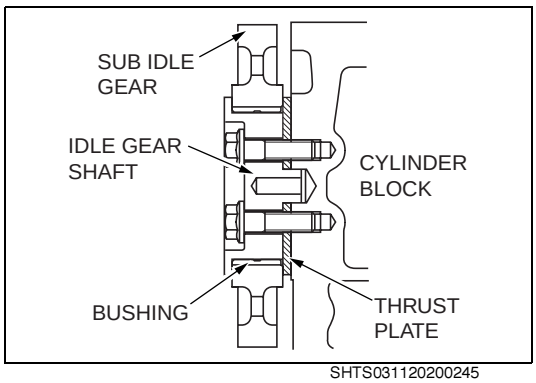
SHTS031120200243

(2) Attach the idle gear shaft ejector jig to the idle gear shaft.



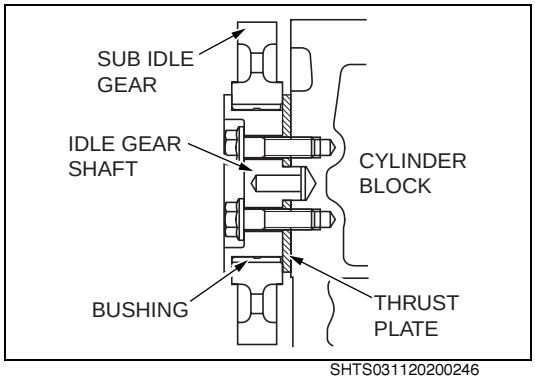
SHTS031120200244

(3) Remove the idle gear shaft using the special tool and remove the sub idle gear and the thrust plate.
SST: Sliding hammer (S0942-01510)



SHTS031120200245

NOTICE
Take care not to drop the thrust plate and the idle gear.

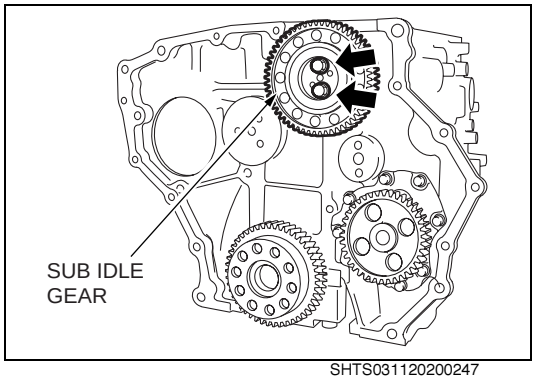


SHTS031120200246

INSTALL THE TIMING GEAR IN THE FLYWHEEL HOUSING.

1. INSTALL THE SUB IDLE GEAR.

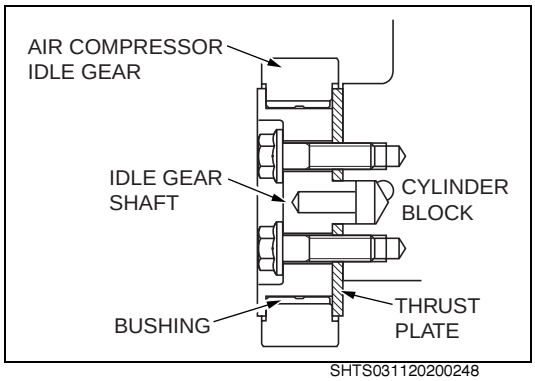
(1) Apply engine oil to the thrust plate, the sub idle gear bushing, the idle gear shaft, the idle gear shaft mounting bolt seat and the bolt threads. Assemble these parts as shown in the figure.



SHTS031120200247

(2) Install the assembled idle gear shaft, the sub idle gear and the thrust plate to the cylinder block, and tighten two bolts.
Tightening Torque:
68.5 N·m {700 kgf·cm, 51 lbf·ft}

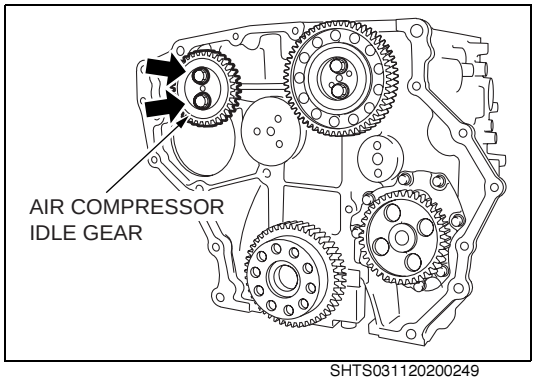
NOTICE
Pretighten bolts until the thrust plate contacts with the cylinder block. Then fully tighten them to the specified torque.



SHTS031120200248

2. INSTALL THE AIR COMPRESSOR IDLE GEAR.

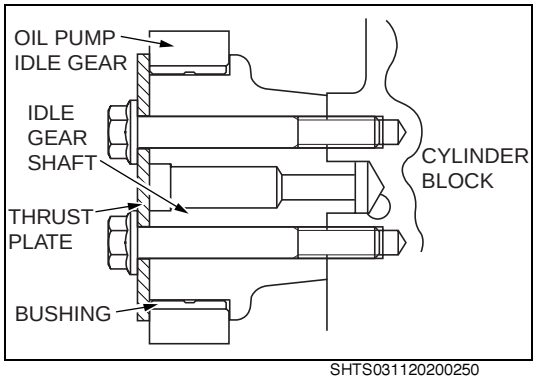
(1) Apply engine oil to the thrust plate, the air compressor idle gear bushing, the idle gear shaft, the idle gear shaft mounting bolt seat and the bolt threads. Assemble these parts as shown in the figure.



SHTS031120200249

(2) Install the assembled idle gear shaft, the air compressor idle gear and the thrust plate to the cylinder block, and tighten two bolts.
Tightening Torque:
68.5 N·m {700 kgf·cm, 51 lbf·ft}

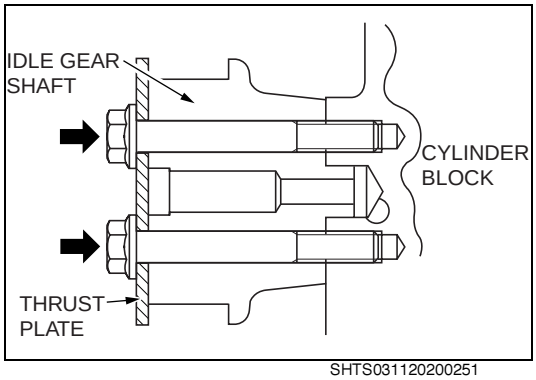
NOTICE
Pretighten bolts until the thrust plate contacts with the cylinder block Then fully tighten them to the specified torque.



SHTS031120200250

3. INSTALL THE OIL PUMP IDLE GEAR.

(1) Apply engine oil to the thrust plate, the oil pump idle gear bushing, the idle gear shaft, the idle gear shaft mounting bolt seat and the bolt threads. Assemble these parts as shown in the figure.



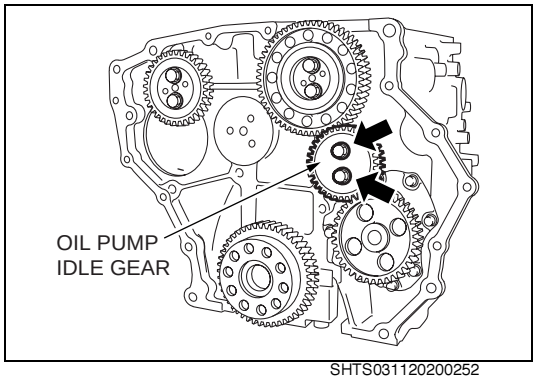
SHTS031120200251

(2) Without installing the oil pump idle gear, install only the idle gear shaft and the thrust plate to the cylinder block, and tighten two bolts.

NOTICE

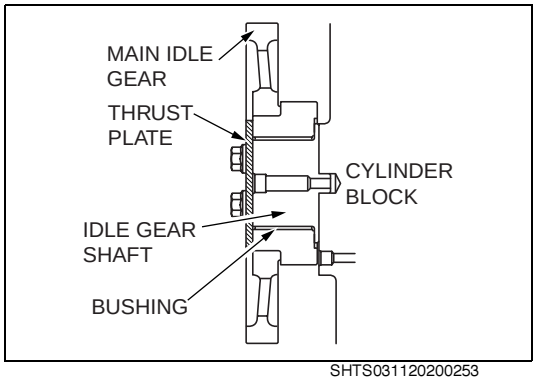
Omit the gear in this step so that the idle gear shaft will be fully seated to the cylinder block.

(3) Remove the bolts and thrust plate.



SHTS031120200252

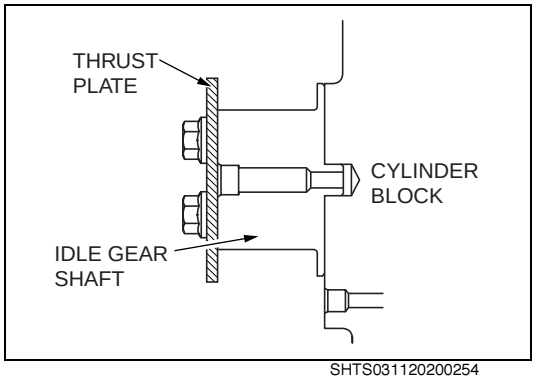
(4) Install the oil pump idle gear to the idle gear shaft. Attach the thrust plate, and tighten two bolts.
Tightening Torque:
68.5 N·m {700 kgf·cm, 51 lbf·ft}



SHTS031120200253

4. INSTALL THE MAIN IDLE GEAR.

(1) Apply engine oil to the thrust plate, the main idle gear bushing, the idle gear shaft, the idle gear shaft mounting bolt seat and the bolt threads. Assemble these parts as shown in the figure.

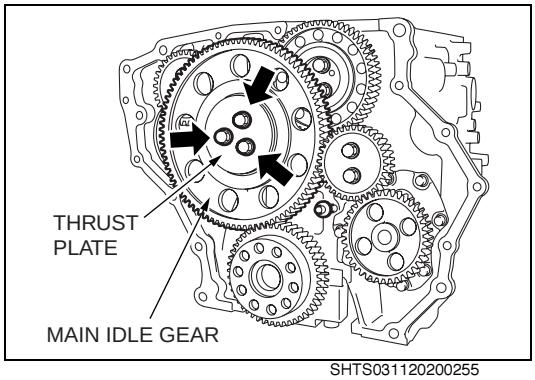


SHTS031120200254

(2) Without installing the main idle gear, attach only the idle gear shaft and the thrust plate to the cylinder block, and tighten three bolts.

NOTICE
Omit the gear in this step so that the idle gear shaft will be fully seated to the cylinder block.

(3) Remove the bolts and thrust plate.

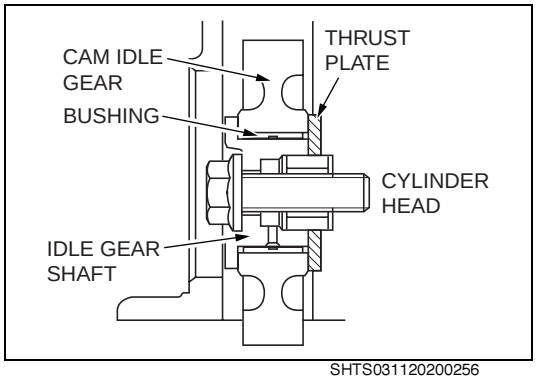


SHTS031120200255

(4) Install the main idle gear to the idle gear shaft. Attach the thrust plate, and tighten three bolts.
Tightening Torque:
108 N·m {1,101 kgf·cm, 79 lbf·ft}

5. CHECK THE IDLE GEARS.
(1) Use a thickness gauge to measure thrust play in each idle gear, and use a dial gauge to measure backlash in each idle gear. Check that each measurement reading falls within the standard value.

6. INSTALL THE FLYWHEEL HOUSING.
(1) Install the flywheel housing.
Refer to the section **"FLYWHEEL HOUSING"**.

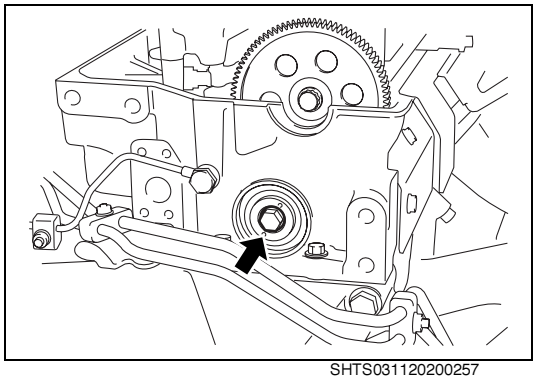


SHTS031120200256

INSTALL THE CAMSHAFT GEAR AND THE CAM IDLE GEAR.

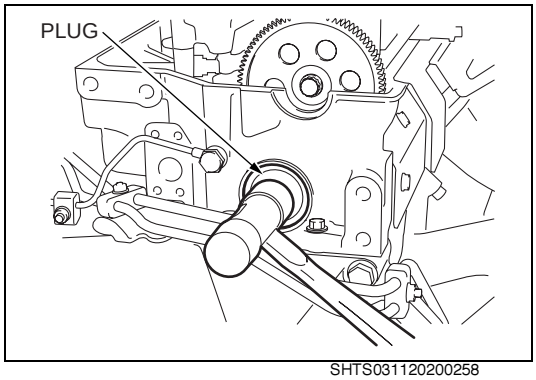
1. INSTALL THE CAM IDLE GEAR.

(1) Apply engine oil to the thrust plate, the cam idle gear bushing, the idle gear shaft, the idle gear shaft mounting bolt seat and the bolt threads. Assemble these parts as shown in the figure.


SHTS031120200257

(2) Install the assembled idle gear shaft, the cam idle gear and the thrust plate to the cylinder head, and tighten a bolt.
Seating torque:
108 N·m {1,101 kgf·cm, 79 lbf·ft}

NOTICE
Pretighten bolts until the thrust plate contacts with the cylinder head. Then fully tighten them to the specified torque.



SHTS031120200258

(3) Using a plastic hammer, strike new plug into the cylinder head.

HINT
Hammer the plug until it is flush with the cylinder head.

2. INSTALL THE CAMSHAFT GEAR.

(1) Install the camshaft gear.
Refer to the section **"CAMSHAFT ASSEMBLY"**.

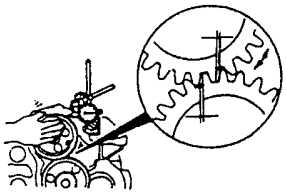
3. INSTALL THE CAMSHAFT ASSEMBLY.

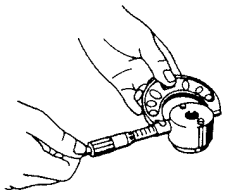
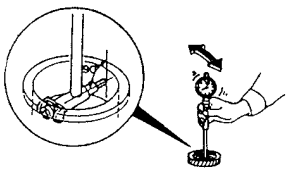
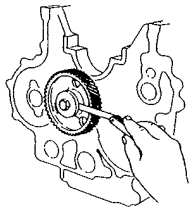
(1) Install the camshaft assembly.
Refer to the section **"CAMSHAFT ASSEMBLY"**.

INSPECTION AND REPAIR

EN0311202H300008

Unit: mm {in.}

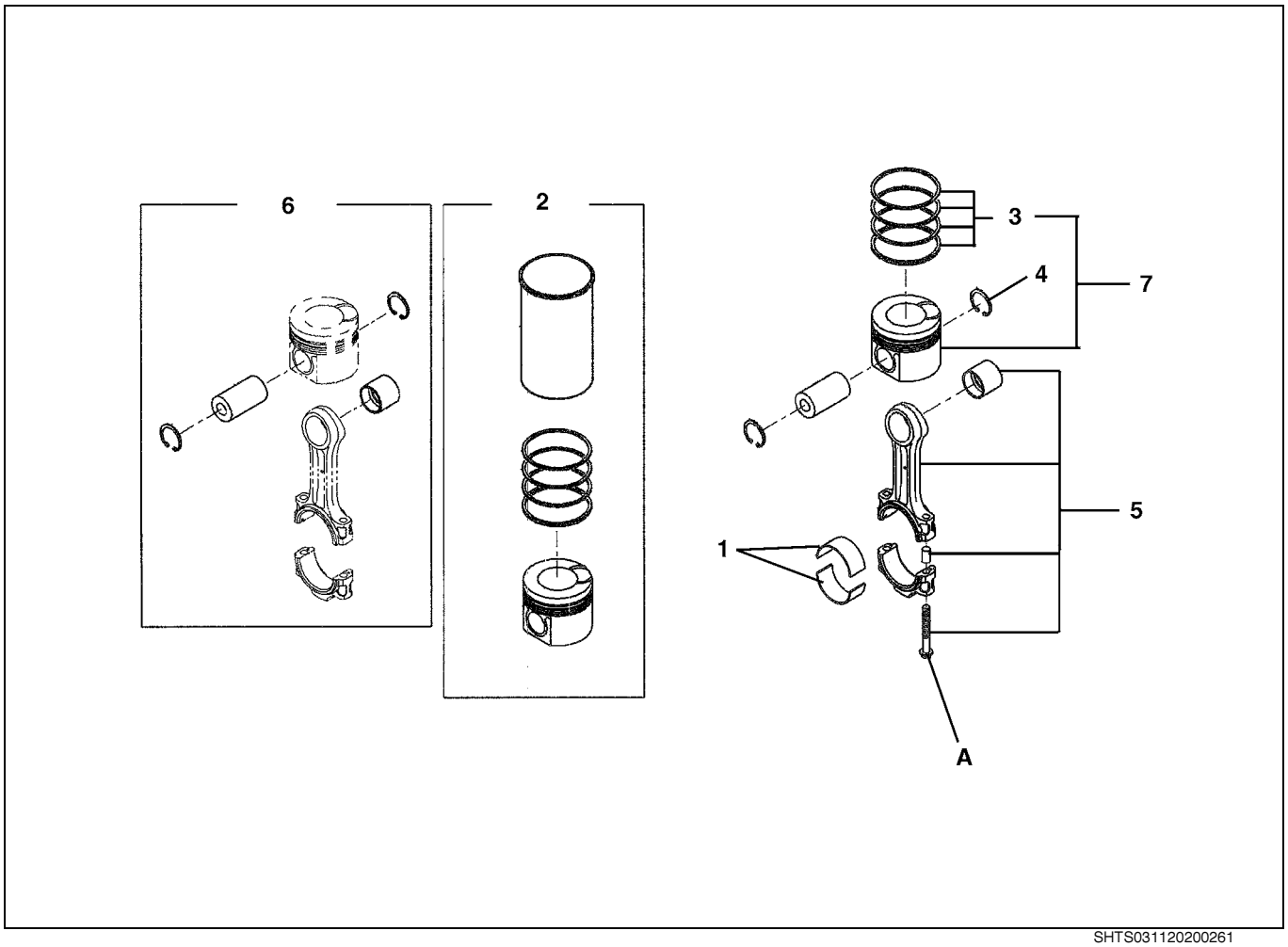
Inspection item		Standard	Limit	Remedy	Inspection procedure
Timing gear backlash	Crankshaft-Main idle gear (large)	0.039-0.162 {0.0015-0.0063}	0.30 {0.0118}	Replace gear.	Measure 
	Main idle gear (small)-Air compressor idle	0.020-0.122 {0.0007-0.0048}	0.10 {0.0039}		
	Air compressor idle-Air compressor	0.020-0.133 {0.0007-0.0048}	—		
	Main idle gear (small)-Sub idle gear	0.039-0.148 {0.0015-0.0058}	0.30 {0.0118}		
	Sub idle-Oil pump	0.030-0.131 {0.0012-0.0051}	0.30 {0.0118}		
	Sub idle-Cam idle	0.040-0.226 {0.0015-0.0088}	0.30 {0.0118}		
	Cam idle-Camshaft	0.040-0.151 {0.0015-0.0059}	0.30 {0.0118}		
	Main idle gear (large)-Oil pump idle gear	0.039-0.157 {0.0015-0.0061}	0.30 {0.0118}		
	Oil pump idle gear-Oil pump drive gear	0.020-0.122 {0.0007-0.0048}	0.30 {0.0118}		
	Main idle gear (large)-Power steering pump	0.039-0.216 {0.0015-0.0085}	0.30 {0.0118}		
	Main idle gear (large)-Flywheel PTO drive gear	0.030-0.326 {0.0012-0.0128}	0.40 {0.0157}		

Inspection item		Standard	Limit	Remedy	Inspection procedure
Main idle gear shaft	Shaft outside diameter	73 {2.874}	—	—	Measure  Outside diameter  Inside diameter  End play
	Bushing inside diameter	73 {2.874}	—	—	
	Clearance	0.030-0.090 {0.0012-0.0035}	0.20 {0.0079}	Replace bushing and/or shaft.	
	End play	0.040-0.120 {0.0016-0.0047}	0.30 {0.0118}	Replace gear and/or shaft.	
Sub idle gear shaft	Shaft outside diameter	72 {2.834}	—	—	
	Bushing inside diameter	72 {2.834}	—	—	
	Clearance	0.030-0.079 {0.0012-0.0031}	0.20 {0.0079}	Replace bushing and/or shaft.	
	End play	0.040-0.120 {0.0016-0.0047}	0.30 {0.0118}	Replace gear and/or shaft.	
Cam idle gear shaft	Shaft outside diameter	34 {1.339}	—	—	
	Bushing inside diameter	34 {1.339}	—	—	
	Clearance	0.025-0.075 {0.0010-0.0029}	0.20 {0.0079}	Replace bushing and/or shaft.	
	End play	0.040-0.120 {0.0016-0.0047}	0.30 {0.0118}	Replace gear and/or shaft.	
Air compressor idle gear	Shaft outside diameter	72 {2.834}	—	—	
	Bushing inside diameter	72 {2.834}	—	—	
	Clearance	0.030-0.079 {0.0012-0.0031}	0.20 {0.0079}	Replace bushing and/or shaft.	
	End play	0.040-0.120 {0.0016-0.0047}	0.30 {0.0118}	Replace bushing and/or shaft.	
Oil pump idle gear	Shaft outside diameter	65 {2.559}	—	—	
	Bushing inside diameter	65{2.559}	—	—	
	Clearance	0.030-0.079 {0.0012-0.0031}	0.20 {0.0079}	Replace bushing and/or shaft.	
	End play	0.040-0.120 {0.0016-0.0047}	0.30 {0.0118}	Replace bushing and/or shaft.	

PISTON AND CONNECTING ROD

COMPONENT LOCATOR

EN0311202D100013



SHTS031120200261

1	Connecting rod bearing	5	Connecting rod assembly
2	Piston kit	6	Piston pin kit
3	Piston ring	7	Piston assembly
4	Retainer ring		

Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

A	60 {610, 44} + 90° + 45°	

SPECIAL TOOL

EN0311202K100007

Prior to starting an engine overhaul, it is necessary to have these special tools.

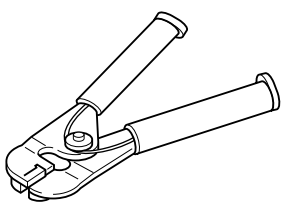
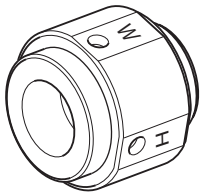
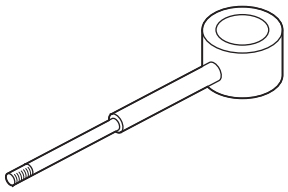
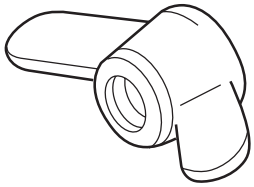
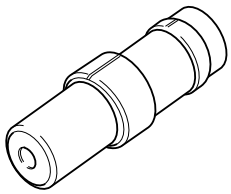
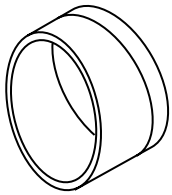
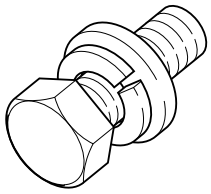
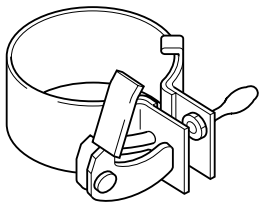
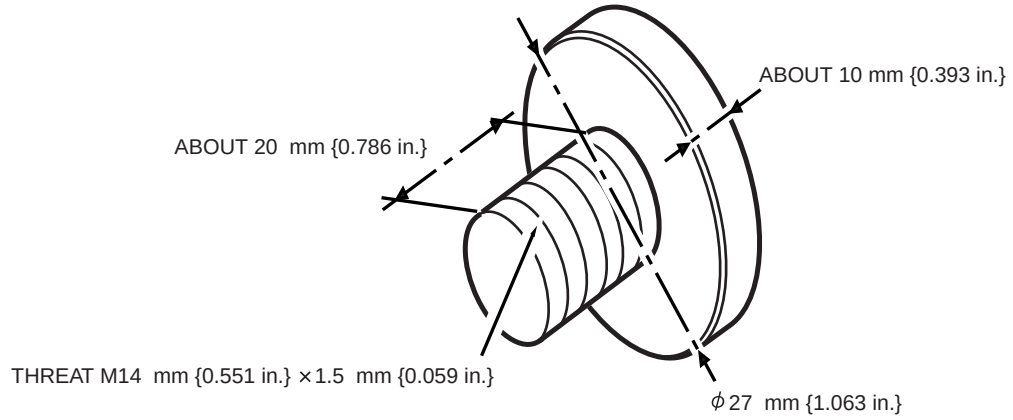
Illustration	Part number	Tool name	Remarks
	S0944-21011	PISTON RING EXPANDER	For Piston ring

Illustration	Part number	Tool name	Remarks
	09222-E1010	GUIDE	For Connecting rod bushing
	09222-E1020	PRESS SUB ASSEMBLY	
	SL271-01036	WING NUT	
	09222-E1030	SPINDLE	
	09222-E1040	GUIDE	For Connecting rod bushing
	SH691-20825	BOLT	
	S0944-11370	PISTON RING HOLDER	

PROPOSAL TOOL

EN0311202K100008

CYLINDER LINER STOPPER JIG



SHTS031120200270

OVERHAUL

EN0311202H200008

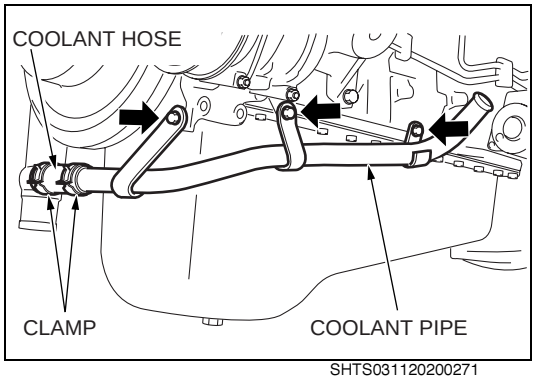
REMOVE THE PISTON AND THE CONNECTING ROD.

1. REMOVE THE CYLINDER HEAD ASSEMBLY.

(1) Remove the cylinder head assembly.
Refer to the section **"CYLINDER HEAD ASEEMBLY"**.

2. REMOVE THE COOLANT PIPE (OIL PAN SIDE).

(1) Remove three bolts and clamps to remove the coolant pipe.



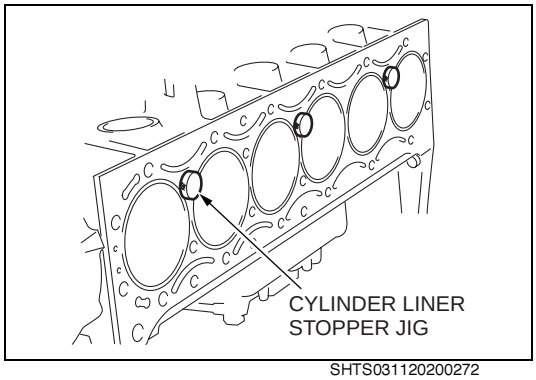
SHTS031120200271

3. REMOVE THE OIL PAN.

(1) Remove the oil pan.
Refer to the section **"OIL PAN"** in the chapter **"LUBRICATING SYSTEM"**.

4. REMOVE THE OIL STARAINER AND THE PLATE.

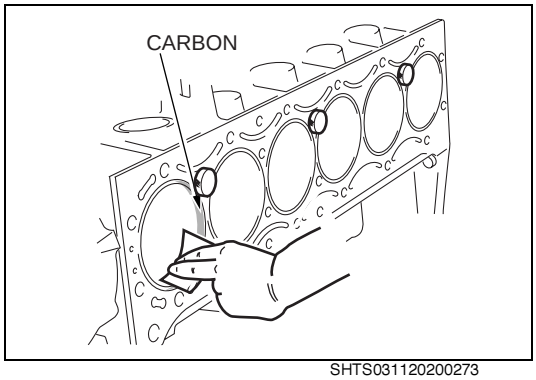
(1) Remove the oil strainer and the plate.
Refer to the section **"OIL STRAINER AND PLATE"** in the chapter **"LUBRICATING SYSTEM"**.



SHTS031120200272

5. REMOVE THE PISTON AND THE CONNECTING ROD.

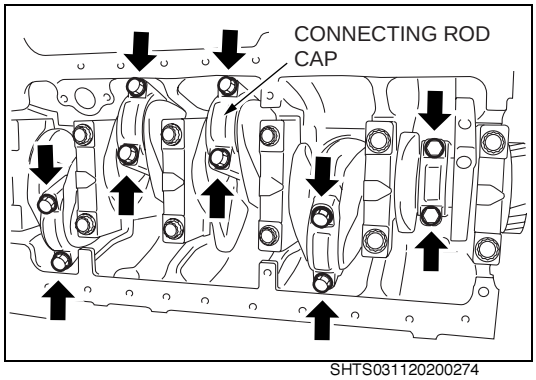
(1) Attach the cylinder liner stopper jig on the top surface of the cylinder block to prevent the cylinder liner from coming off.



SHTS031120200273

(2) Remove carbon deposits from the end inside the cylinder liner with a scraper or emery paper (recommended: No.150) in a circular direction.

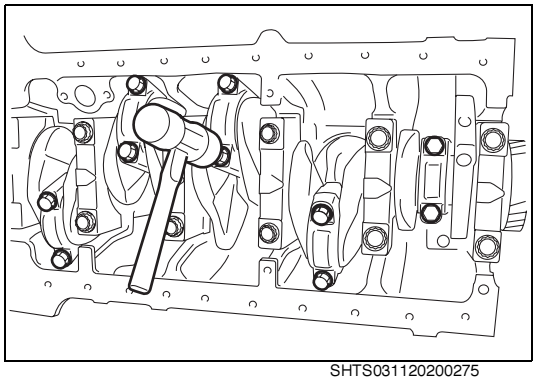
⚠ CAUTION
Handle this work carefully not to scuff the lower areas below the carbon.



SHTS031120200274

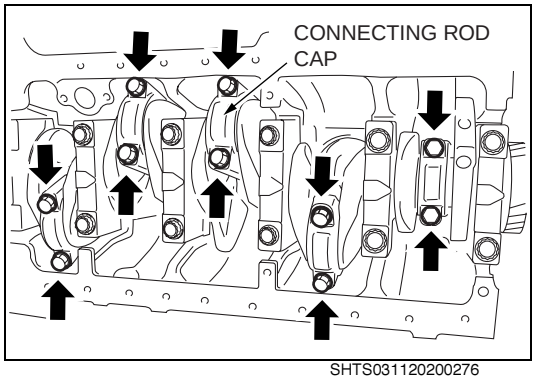
(3) Loosen the bolts of the connecting rod cap.

HINT
Do not remove but just loosen some millimeters.


SHTS031120200275

(4) Use a plastic hammer to hammer the bolt head on the connecting rod cap and separate the cap from the connecting rod.

HINT
Hammering the bolt head will ease separation although the connecting rod cap is engaged by a knock pin.



SHTS031120200276

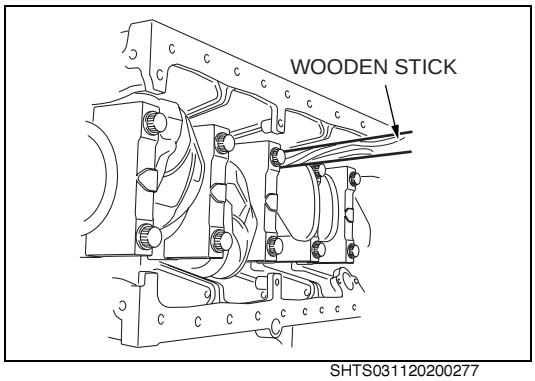
(5) Remove the bolts from the connecting rod cap to remove the connecting rod cap.

NOTICE

- **Take care as the connecting rod bearing attached to the connecting rod cap might drop off due to impacts.**
- **Misassembly of connecting rods and connecting rod caps can be prevented by identifying the removed connecting rod caps in the order of cylinder numbers in storage.**

HINT

In order to prevent turning of the crankshaft, insert a crowbar into the adjust hole in the balance weight and place it against the oil pan mounting flange.

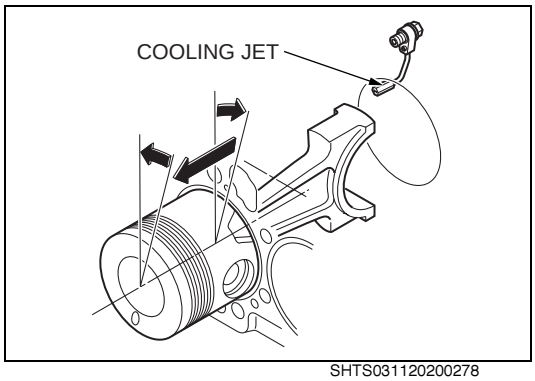


SHTS031120200277

(6) Use a wooden stick to push (tap at) the connecting rod from beneath the engine and remove the connecting rods together with the pistons in the upward direction of the engine.

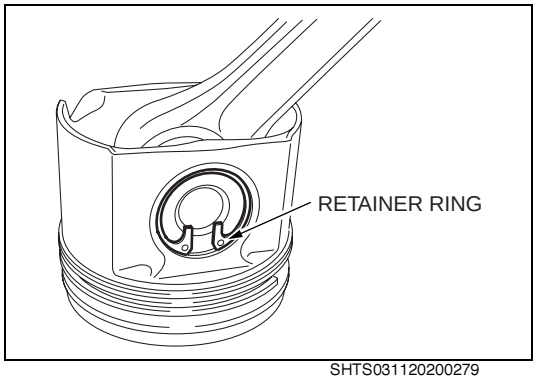
NOTICE

- **Take care as the connecting rod bearing attached to the connecting rod might drop off due to impacts.**



SHTS031120200278

- **When removing the piston, be careful that the cooling jet is not struck by the connecting rod.**
- **The removed connecting rod caps in the order of cylinder numbers in storage.**



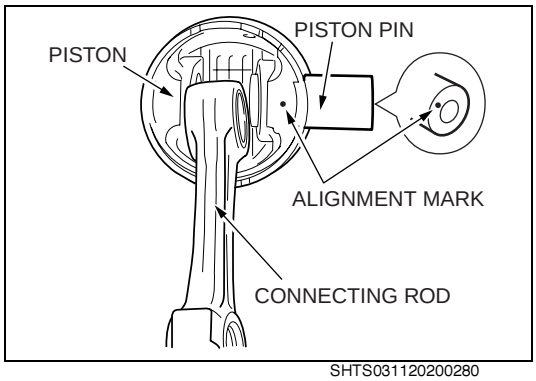
SHTS031120200279

DISASSEMBLE THE PISTON AND THE CONNECTING ROD.

1. REMOVE THE PISTON AND THE CONNECTING ROD.

(1) Using a plier, remove the retainer ring.

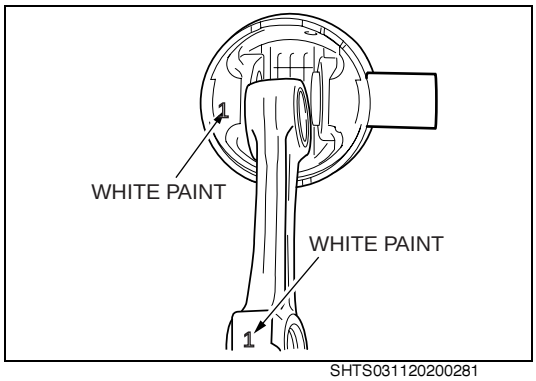
⚠ CAUTION
Wear a pair of safety goggles, because the retainer ring may spring out the groove at the time of removal.



SHTS031120200280

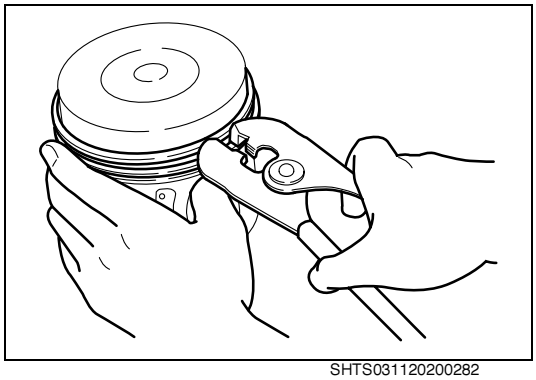
(2) Indicate an alignment mark on the back face and the side face of the piston. Pull off the piston pin and disengage it from the connecting rod.

NOTICE
The removed connecting rod caps in the order of cylinder numbers in storage.



SHTS031120200281

HINT
Use white paint to write a cylinder number on the piston and the connecting rod as shown in the figure.

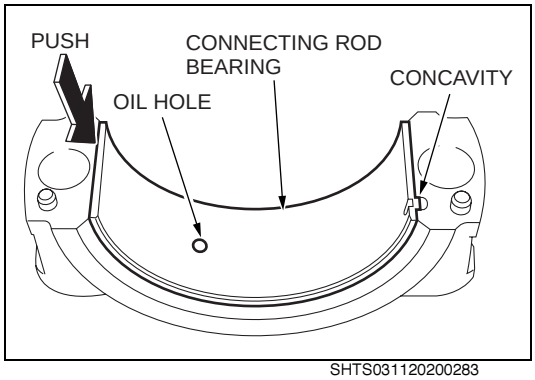

SHTS031120200282

2. REMOVE THE PISTON RING.

(1) Remove the piston ring using the special tool.
SST: Piston ring expander (S0944-21011)

⚠ CAUTION
Handle the piston rings carefully because they are made of a special casting which is easily broken.

NOTICE
Keep the piston rings for each cylinder separately.



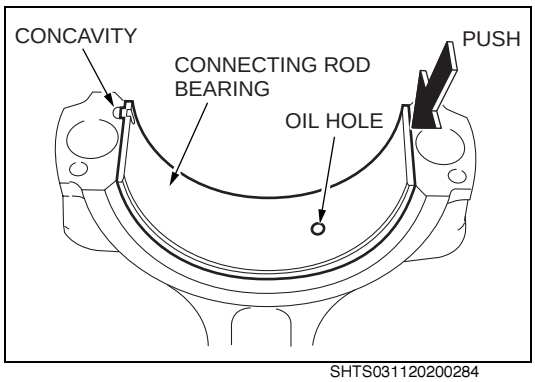
SHTS031120200283

3. REMOVE THE CONNECTING ROD BEARING.

(1) Remove the connecting rod bearing from the connecting rod bearing cap.

HINT

For easier works in this step, push the end of the cam bearing on the opposite side from a concavity.

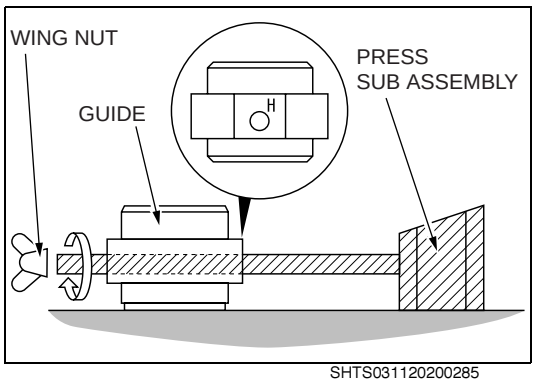


SHTS031120200284

(2) Remove the connecting rod bearing from the connecting rod.

HINT

For easier works in this step, push the end of the cam bearing on the opposite side from a concavity.



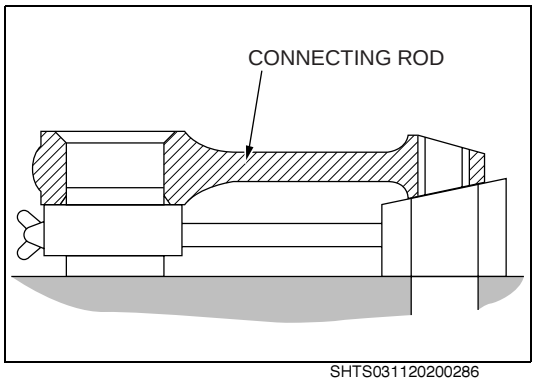
SHTS031120200285

4. REMOVE THE CONNECTING ROD BUSHING.

(1) Assemble special tools (i.e. press subassembly and guide) on the flat tables, and fixate such jointed special tools with a wing nut (special tool).
SST:
Guide (09222-E1010)
Press sub assembly (09222-E1020)
Wing nut (SL271-01036)

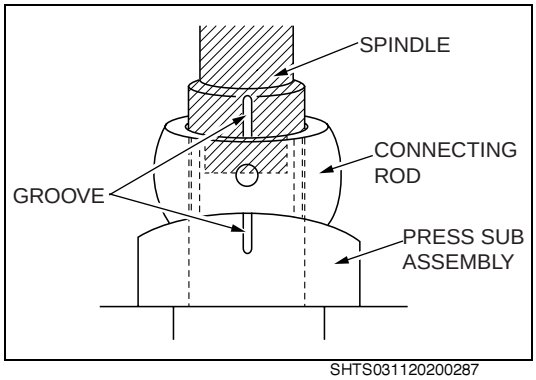
NOTICE

- **Assemble special tools with a mark "H" located on top.**
- **Make sure that bottom faces of a guide and a press subassembly are level.**



SHTS031120200286

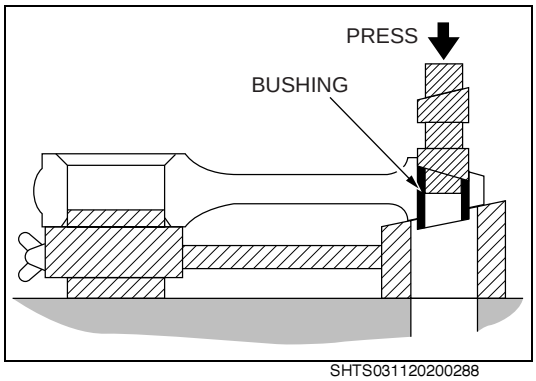
(2) Without a bearing at a large end, assemble the connecting rod and place it on the special tool assembly.



SHTS031120200287

(3) Install a spindle (special tool) to the connecting rod bushing.
SST: Spindle (09222-E1030)

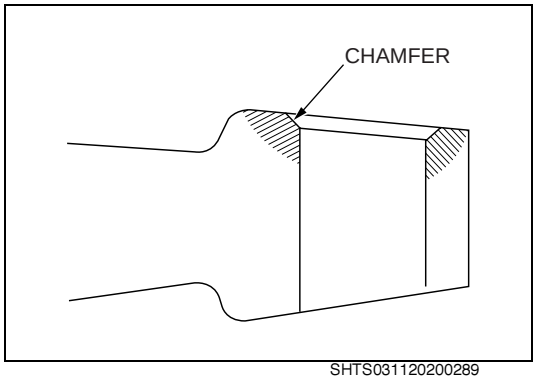
NOTICE
Align a groove in a press sub assembly with a groove in a spindle (special tool).



SHTS031120200288

(4) Using a press, remove the connecting rod bushing.

NOTICE
Apply a press slowly.

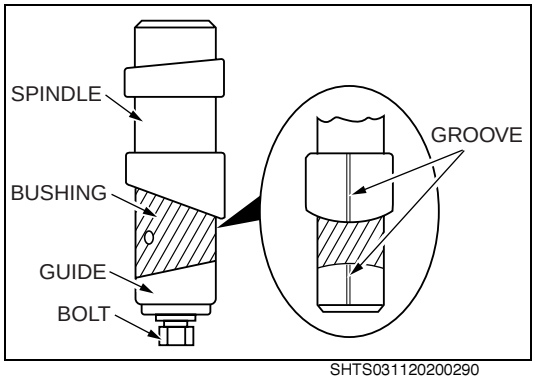


SHTS031120200289

(5) Chamfer one side of the connecting rod at a small end evenly as shown in the figure.

NOTICE

- **Remove burrs thoroughly.**
- **After chamfering, remove dirt from the oil hole and the inner surface at a small end.**



SHTS031120200290

ASSEMBLE THE PISTON AND THE CONNECTING ROD.

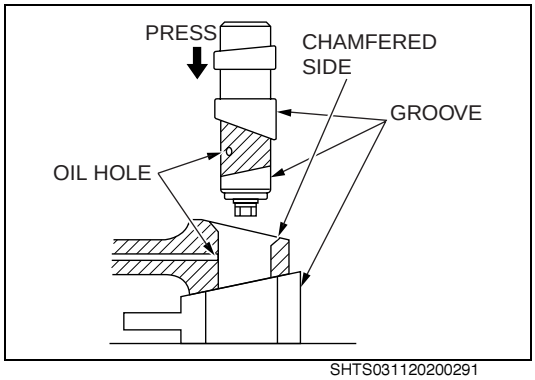
1. INSTALL THE CONNECTING ROD BUSHING.

(1) Attach a new bushing to a spindle (special tool), and then fit a guide (special tool) and a bolt (special tool).
SST:
Spindle (09222-E1030)
Guide (09222-E1040)
Bolt (SH691-20825)

Tightening Torque:
5-6 N·m {50-70 kgf·cm, 3.7-4.4 lbf·ft}

NOTICE

- **Align a groove in a guide (special tool) with a groove in a spindle (special tool).**
- **Ensure tight contact of the end surfaces between a spindle (special tool) and a guide (special tool).**



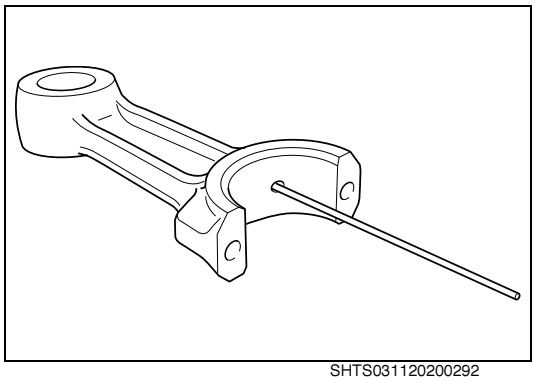
SHTS031120200291

(2) Align an oil hole in the bushing fitted to a special tool, with an oil hole in the connecting rod. Check that a groove in a spindle (special tool) matches with a groove in a press sub assembly (special tool).

NOTICE

- **Place the connecting rod in such orientation that the chamfered side of the connecting rod inner diameter at a small end will face the direction toward a bushing.**
- **Apply engine oil to the inner diameter surface of the connecting rod.**

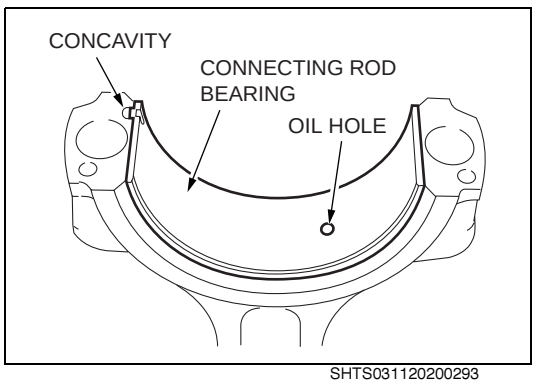
(3) Use a press to press-fit a bushing into the connecting rod.


SHTS031120200292

(4) Insert a stick of 4 mm {0.1575 in.} in diameter into an oil hole at a large end of the connecting rod. See through an oil hole at a small end to check that a stick goes through.

⚠ CAUTION
Clogging in an oil hole will cause insufficient oiling, resulting in seizure.

(5) Inert a new piston pin and check for unsmoothness or play.



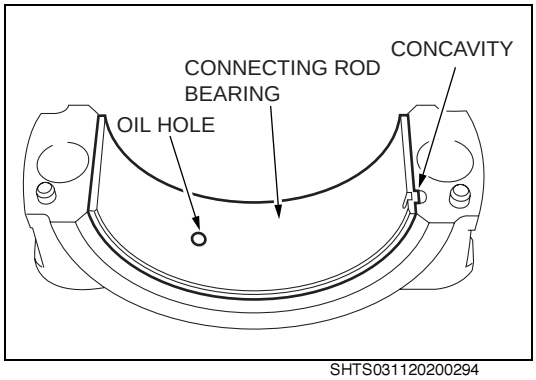
SHTS031120200293

2. INSTALL THE CONNECTING ROD BEARING.

(1) Install the connecting rod bearing in alignment with a concavity in the connecting rod, and apply engine oil.

⚠ CAUTION
Misalignment of oil holes will cause insufficient oiling, resulting in seizure.

NOTICE
Make sure that oil holes are mating with each other.

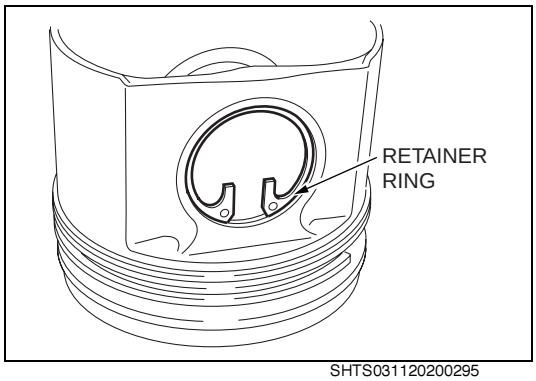


SHTS031120200294

(2) Install the connecting rod bearing in alignment with a concavity in the connecting rod cap, and apply engine oil.

⚠ CAUTION
Misalignment of oil holes will cause insufficient oiling, resulting in seizure.

NOTICE
Make sure that oil holes are mating with each other.



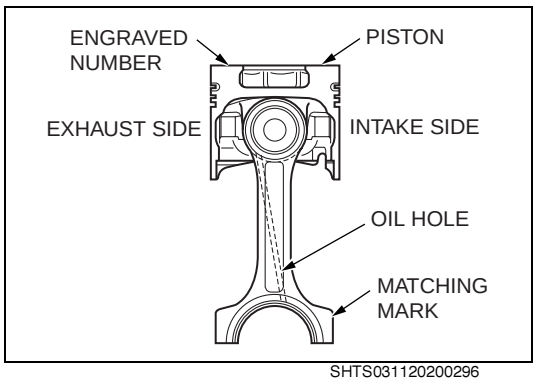
SHTS031120200295

3. INSTALL THE PISTON AND THE CONNECTING ROD.

(1) Use a plier to fit a new retainer ring to one side of the piston.

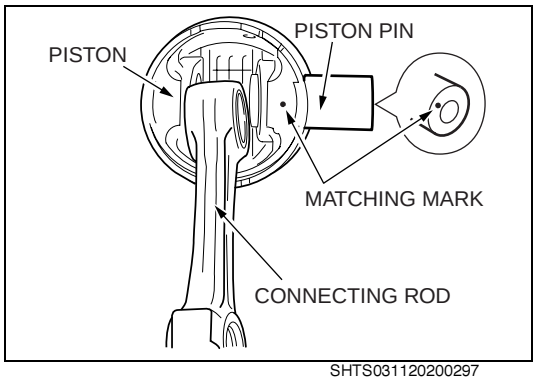
⚠ CAUTION
Wear a pair of safety goggles, because the retainer ring may spring out the groove at the time of installation.

NOTICE
Make sure that the retainer ring is fitted in the groove securely.



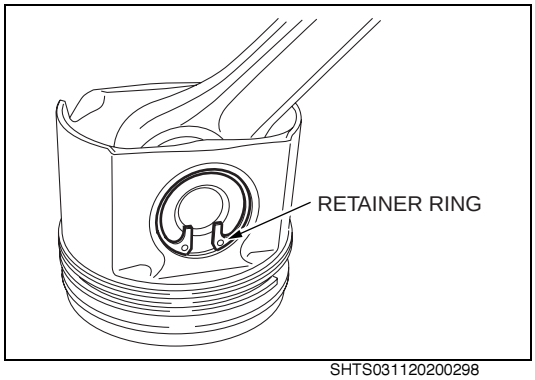
SHTS031120200296

(2) Assemble the engraved number on the piston to be opposite to the connecting rod matching mark.



SHTS031120200297

(3) Align the piston pin with matching mark on the piston and insert the piston pin.

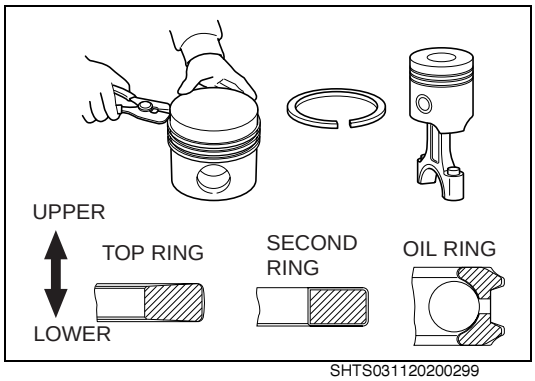


SHTS031120200298

(4) Use a plier to fit a new retainer ring to the other side of the piston.

⚠ CAUTION
Wear a pair of safety goggles, because the retainer ring may spring out the groove at the time of installation.

NOTICE
Make sure that the retainer ring is fitted in the groove securely.

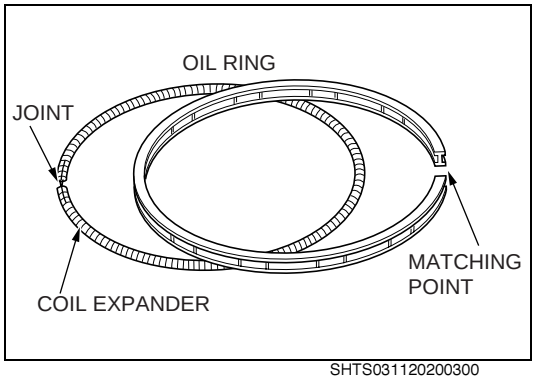


SHTS031120200299

4. INSTALL THE PISTON RING.

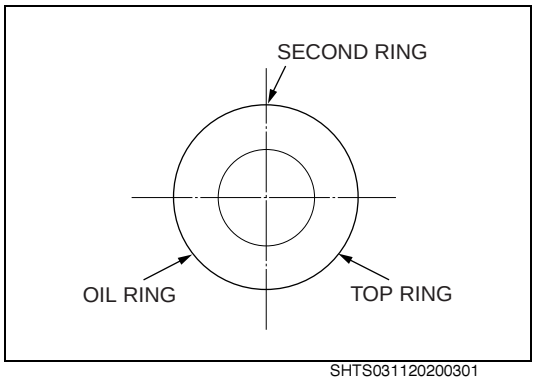
(1) Install in the order of oil ring, second ring and top ring using the special tool.
SST: Piston ring expander (S0944-21011)

NOTICE
Install the second ring that turn the identification print on the piston ring to upper surface.



SHTS031120200300

(2) Connect the joint of the coil expander for the oil ring and install it inside the piston ring. Assemble the ring with the joint 180° opposite to the matching point.



SHTS031120200301

(3) Position the matching points of the piston ring at a even distance as shown in the figure.

INSTALL THE PISTON AND THE CONNECTION ROD.

1. INSTALL THE PISTON AND THE CONNECTING ROD.

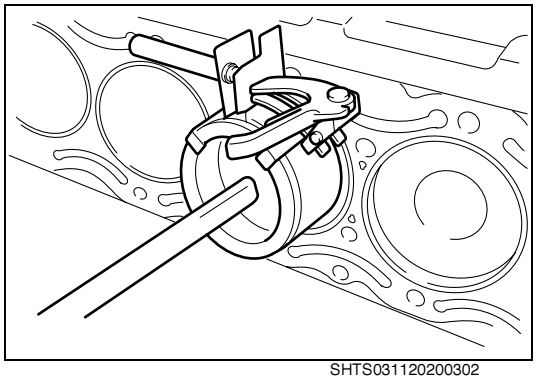
(1) Set the crankshaft to the top dead center in association with a cylinder into which the piston and connecting rod will be inserted (work on two cylinders at each time).

NOTICE

If not set to the top dead center, the connecting rod will contact with the cooling jet.

(2) Apply engine oil to the piston, cylinder liner and connecting rod bearing.

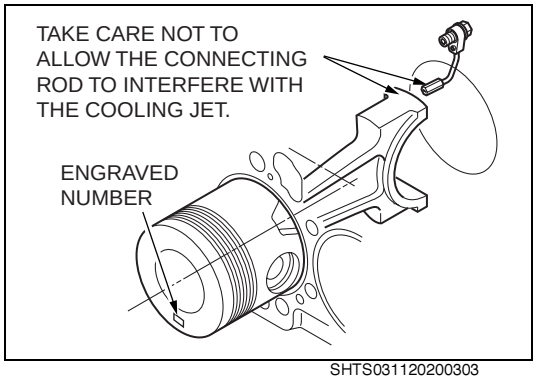
(3) Compress the piston ring using the special tool.
SST: Piston ring holder (S0944-11370)


SHTS031120200302

NOTICE

- **Install the piston and the connecting rod by referencing to a cylinder number identified during removal works.**
- **Make sure that there is no deformation or flaw on the special tool.**

(4) Use a wooden stick to insert the piston with a reasonable care not to allow the connecting rod to interfere with the cooling jet.



SHTS031120200303

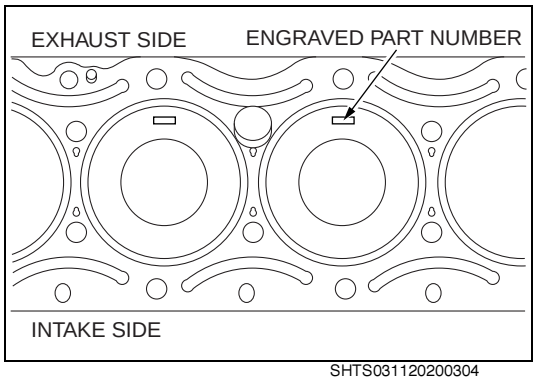
⚠ CAUTION

Do not damage the cylinder liner, crankshaft and piston cooling jet.

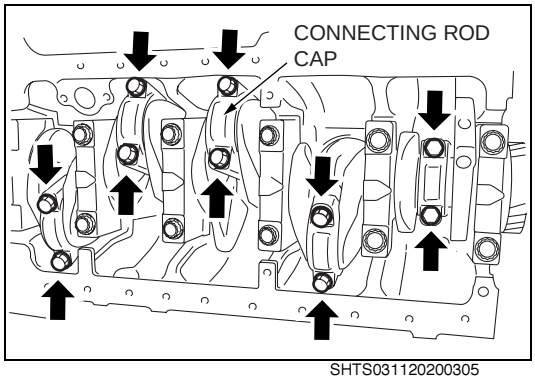
NOTICE

Insert the piston with a engraved part number facing the exhaust side.

(5) Check that a engraved part number on the piston is located on the exhaust side.



SHTS031120200304

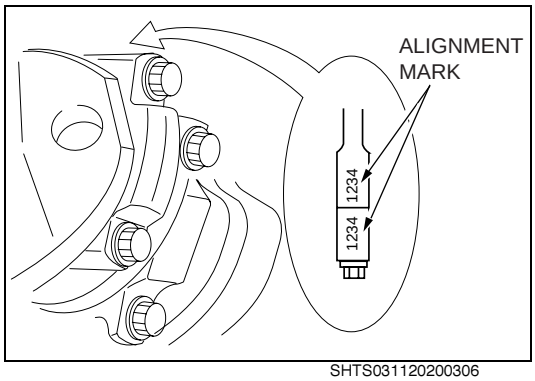


SHTS031120200305

(6) Apply engine oil to bolt threads and seats. Pretighten bolts by referencing to an identification indicated during removal of the connecting rod cap from the connecting rod.

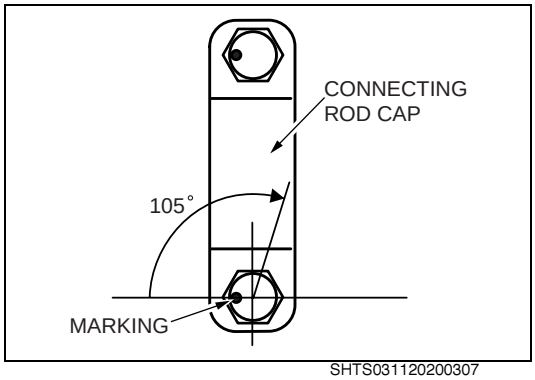
HINT
The cap has a knock pin as a misassembly-proof function. Position this pin properly in place.

NOTICE
Make sure that the connecting rod cap is paired with a correct connecting rod.



SHTS031120200306

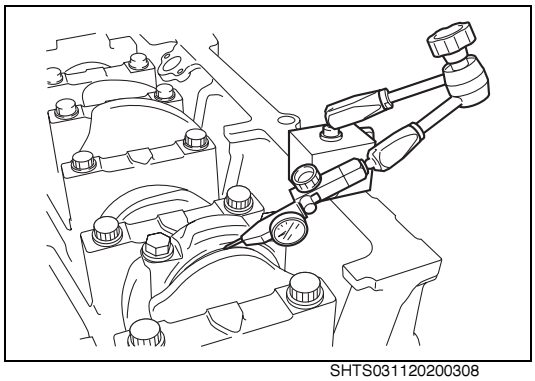
(7) Turn the crankshaft to the bottom dead center.
(8) Check that alignment marks engraved on the connecting rod cap and on the connecting rod show the same number and are positioned in the same direction.



SHTS031120200307

(9) Tighten the connecting rod bolts.
Seating torque:
60 N·m {610 kgf·cm, 44 lbf·ft}
(10) Mark the bolts heads in the same direction with paint.
(11) Tighten the bolts 105° and make sure that the paint marks face the same direction.

NOTICE
When adding torque, never untighten the bolts, even if they have been overtightened.

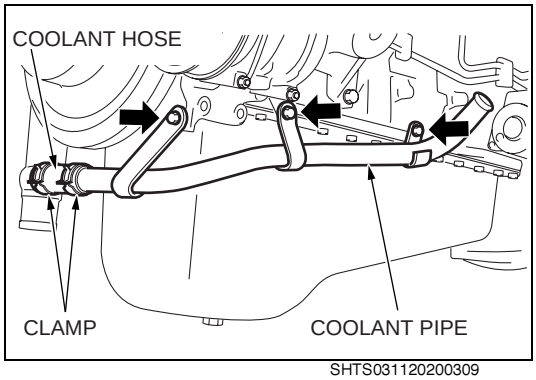

SHTS031120200308

(12) After installation, using a dial gauge, make sure that the end play is within the standard value.

Standard (mm {in.})	Limit (mm {in.})
0.20-0.52 {0.0079-0.0204}	0.8 {0.0315}

2. INSTALL THE OIL STRAINER AND THE PLATE.
(1) Install the oil strainer and the plate.
Refer to the section **"OIL STRAINER AND PLATE"** in the chapter **"LUBRICATING SYSTEM"**.

3. INSTALL THE OIL PAN.
(1) Replace the gasket with a new one and install the oil pan.
Refer to the section **"OIL PAN"** in the chapter **"LUBRICATING SYSTEM"**.



SHTS031120200309

4. INSTALL THE COOLANT PIPE (OIL PAN SIDE).

(1) Insert the coolant hose and fix it with the clamps.
(2) Install the coolant pipe with three bolts.

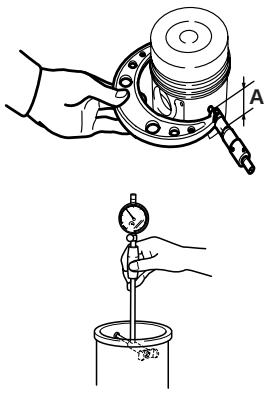
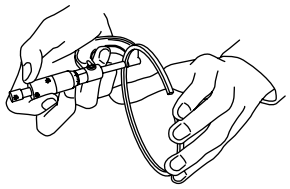
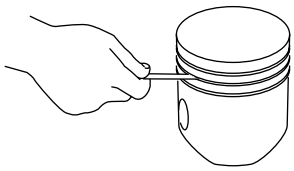
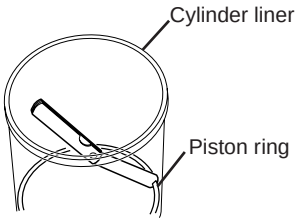
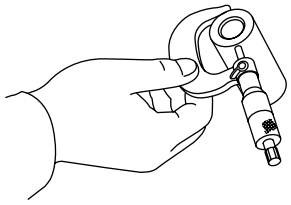
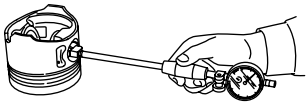
5. INSTALL THE CYLINDER HEAD ASSEMBLY.

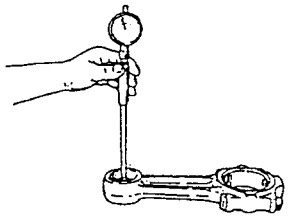
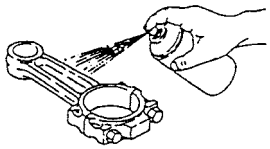
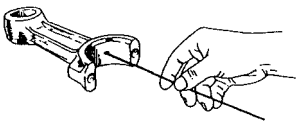
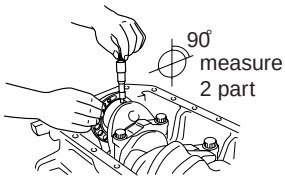
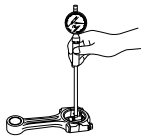
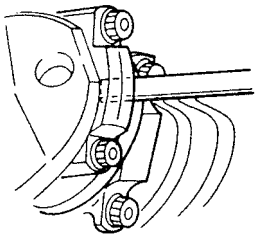
(1) Install the cylinder head assembly.
Refer to the section **"CYLINDER HEAD ASSEMBLY"**.

INSPECTION AND REPAIR

EN0311202H300009

Unit: mm {in.}

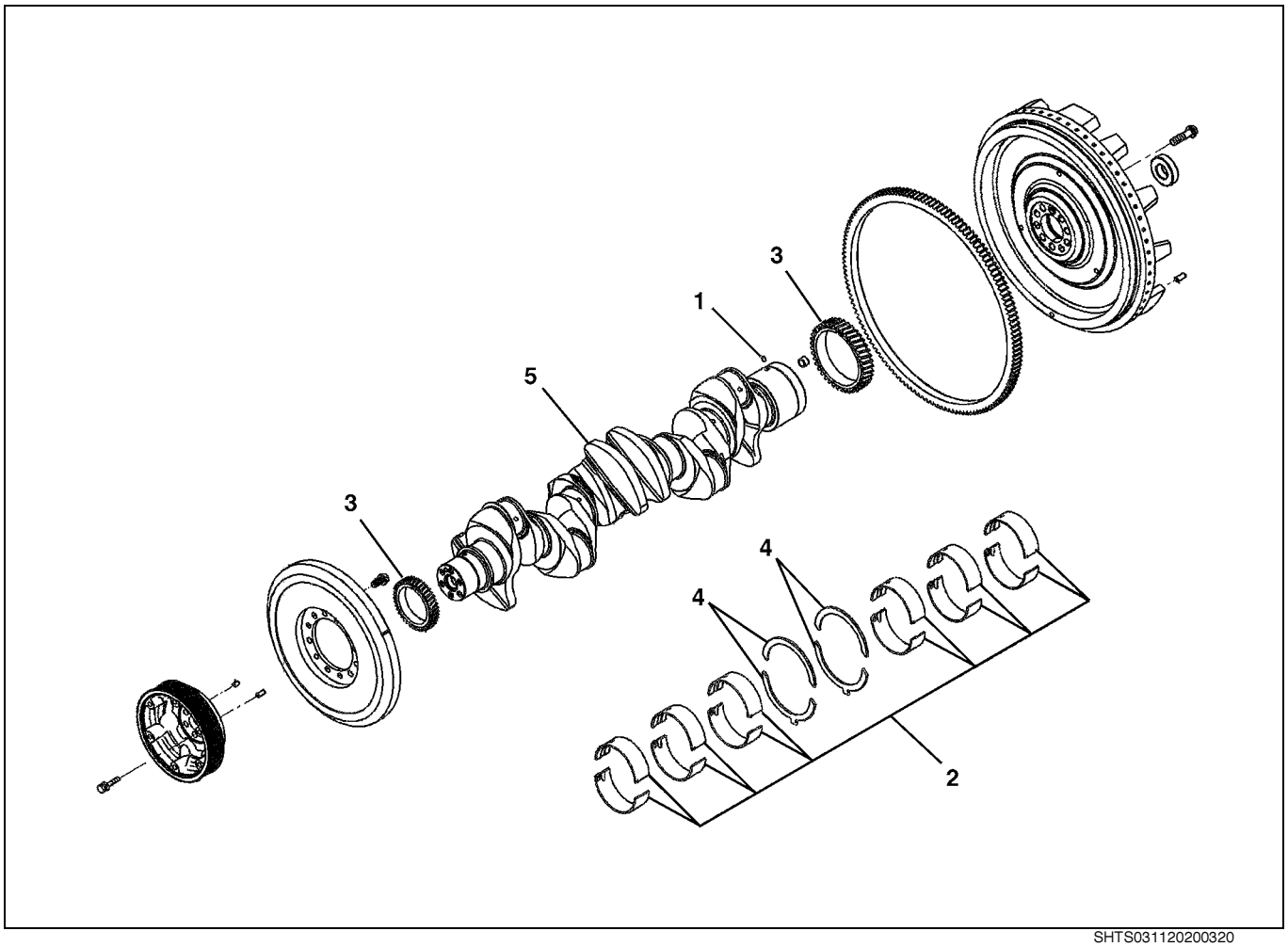
Inspection item		Standard	Limit	Remedy	Inspection procedure
Piston outside diameter at A: 23 {0.9055}		111.935 {4.4068}	—	Replace piston and/ or liner.	Measure 
Liner inside diameter (Apply the value obtained at the most worn point to the cylinder liner inside diameter.)		112 {4.409}	—		
Clearance between piston and cylinder liner		0.057-0.077 {0.0022-0.0030}	—		
Piston ring width	Top	2.948 {0.1160}	2.848{0.112}	Replace ring.	Measure 
	Second	2.0 {0.0787}	1.9 {0.0748}		
	Oil	4.0 {0.1575}	3.9 {0.1535}		
Piston ring groove width	Top	taper	—	Replace piston.	Measure 
	Second	2.0 {0.0787}	2.2 {0.0866}		
	Oil	4.0 {0.1575}	4.1 {0.1614}		
Gap between ends of piston ring	Top	0.30-0.40 {0.0119-0.0157}	1.5 {0.0591}	Replace piston ring.	Measure 
	Second	0.75-0.90 {0.0296-0.0354}	1.5 {0.0591}		
	Oil	0.15-0.30 {0.0059-0.0118}	1.0 {0.0393}		
Piston pin outside diameter		42 {1.6535}	41.96 {1.6519}	Replace piston pin.	Measure 
Piston pin bore inside diameter		42 {1.6535}	42.05 {1.6555}	Replace piston.	
Clearance between piston pin and piston pin bore		-0.011-0.026 {-0.00043-0.00102}	0.05 {0.0020}	Replace piston and/ or piston pin.	

Inspection item	Standard	Limit	Remedy	Inspection procedure
Connecting rod bushing inside diameter	42 {1.6535}	42.1{1.6574}	Replace connecting rod bushing.	Measure 
Clearance between piston pin and connecting rod bushing	0.035-0.050 {0.0014-0.0019}	0.08 {0.0031}	Replace piston pin and/or connecting rod bushing	—
Wear or damage of connecting rod *Dye penetrant check (Color check)	—	—	Replace.	Visual check 
Clogging of connecting rod oil hole	—	—	Replace.	Visual check 
Crank pin outside diameter	73 {2.874}	72.8 {2.8661}	Replace crankshaft.	Measure  
Clearance between connecting rod bearing and crank pin	0.031-0.082 {0.0013-0.0032}	0.3 {0.0118}	Replace connecting rod bearing.	
Connecting rod end play	0.20-0.52 {0.0079-0.0204}	0.8 {0.0315}	Replace connecting rod and/or crankshaft.	Measure 
Connecting rod bolt	67 {2.637}	68 {2.677}	Replace connecting rod bolt.	Measure

CRANKSHAFT

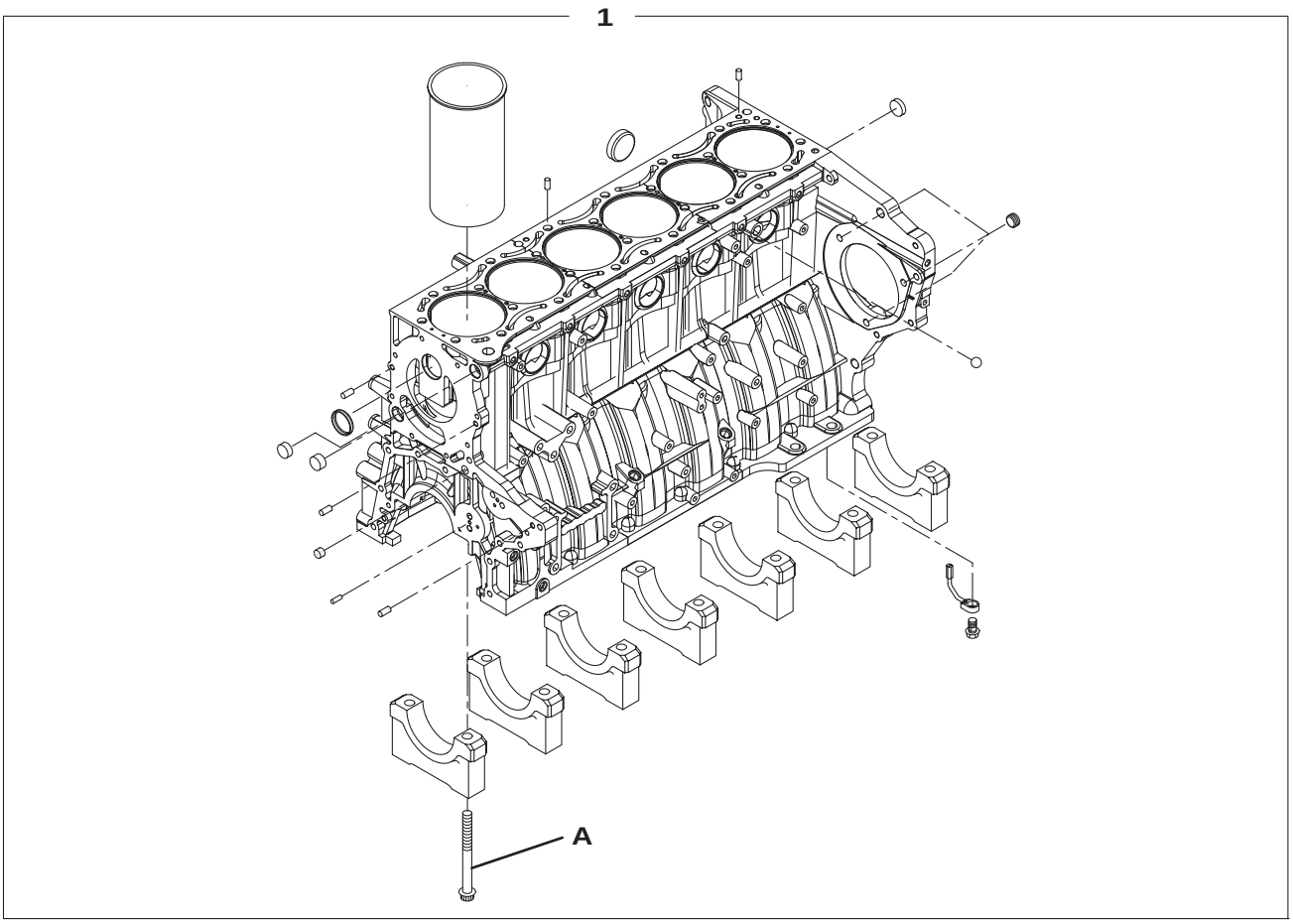
COMPONENT LOCATOR

EN0311202D100014



SHTS031120200320

1	Pin	4	Thrust bearing
2	Crankshaft bearing	5	Crankshaft
3	Crankshaft gear		



SHTS031120200321

1 Cylinder block assembly	

Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

A 100 {1,020, 74} + 135° + 90°	

REPLACEMENT

EN0311202H100006

REMOVE THE CRANKSHAFT.

1. REMOVE THE CYLINDER HEAD ASSEMBLY.

(1) Remove the cylinder head assembly.
Refer to the section **"CYLINDER HEAD ASEEMBLY"**.

2. REMOVE THE PISTON AND THE CONNECTING ROD.

(1) Remove the piston and the connecting rod.
Refer to the section **"PISTON AND CONNECTING ROD"**.

3. REMOVE THE FRONT TIMING GEAR COVER.

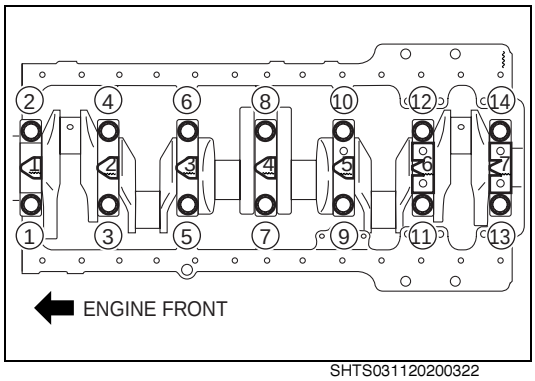
(1) Remove the front timing gear cover.
Refer to the section **"FRONT TIMING GEAR COVER AND TIMING GEAR"**.

4. REMOVE THE FLYWHEEL HOUSING.

(1) Remove the flywheel housing.
Refer to the section **"FLYWHEEL HOUSING"**.

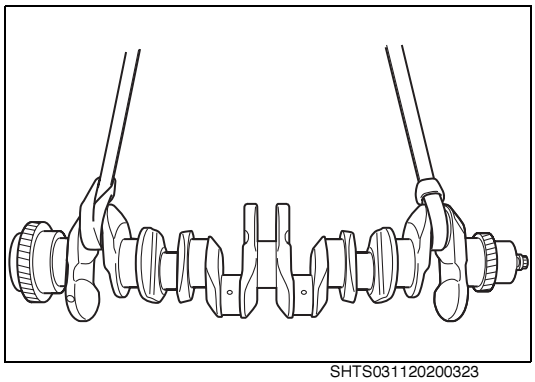
5. REMOVE THE CRANKSHAFT.

(1) Gradually loosen (turn approximately 90° at each time) and remove the main bearing cap bolts in the sequential order shown in the figure.



SHTS031120200322

(2) Remove the main bearing cap. Using a hoist, remove the crankshaft.



SHTS031120200323

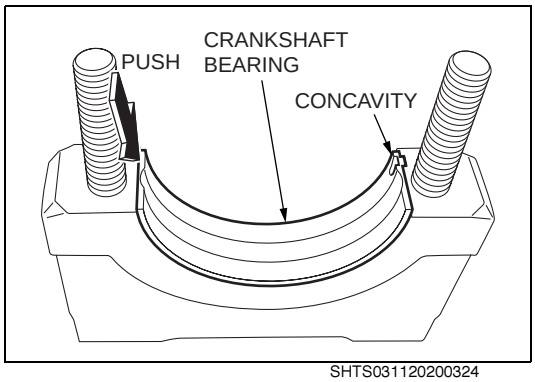
⚠ CAUTION
Crankshaft is a heavy component. Handle it carefully.

NOTICE
Take care as the crankshaft bearing and the thrust bearing might drop off from the main bearing cap or the cylinder block due to impacts.

HINT
A clearance from the cylinder block will be the largest if the crankshaft is lifted with the crank pins No.1 and No.6 positioned upward. Lift the crankshaft carefully and avoid contact between the cylinder block and the balance weight at the rear end of the crankshaft.

6. REMOVE THE CRANKSHAFT BEARING AND THE THRUST BEARING.

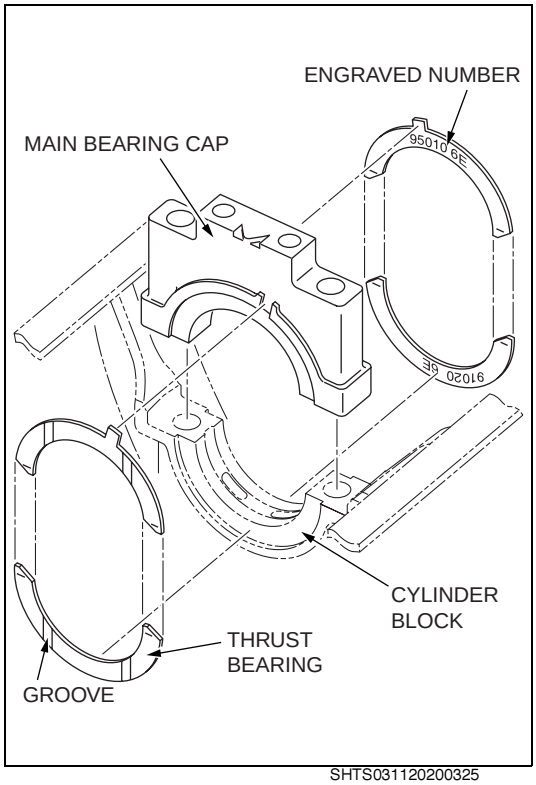
(1) Remove the crankshaft bearing from the main bearing cap.



SHTS031120200324

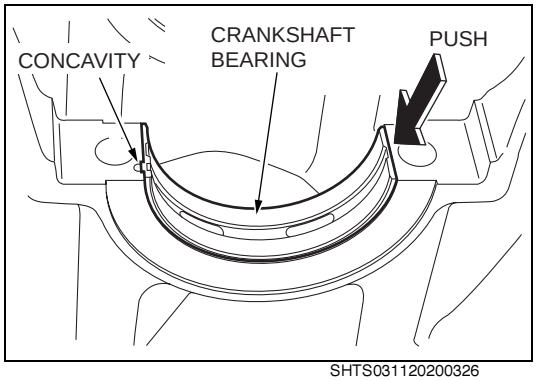
NOTICE
The removed crankshaft bearing in the order of cylinder numbers in storage.

HINT
For easier works in this step, push the end of the crankshaft bearing on the opposite side from a concavity.



SHTS031120200325

(2) Remove the thrust bearings from the cylinder block and the main bearing cap.

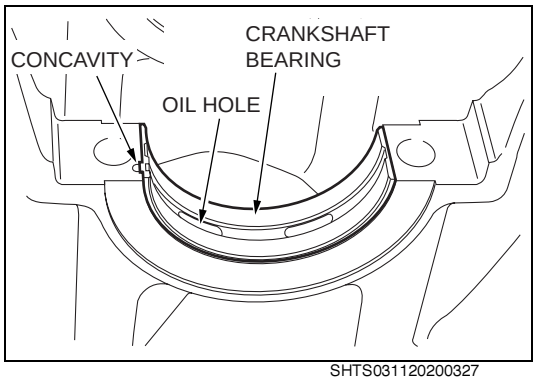


SHTS031120200326

(3) Remove the crankshaft bearing from the cylinder block.

NOTICE
The removed crankshaft bearing in the order of cylinder numbers in storage.

HINT
For easier works in this step, push the end of the crankshaft bearing on the opposite side from a concavity.



SHTS031120200327

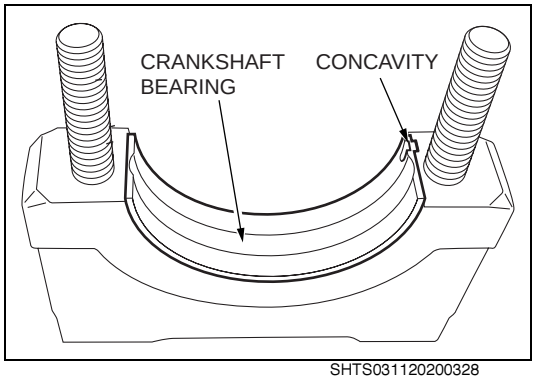
INSTALL THE CRANKSHAFT.

1. INSTALL THE CRANKSHAFT BEARING AND THE THRUST BEARING.

(1) Install the crankshaft bearing in alignment with a concavity in the cylinder block, and apply engine oil.

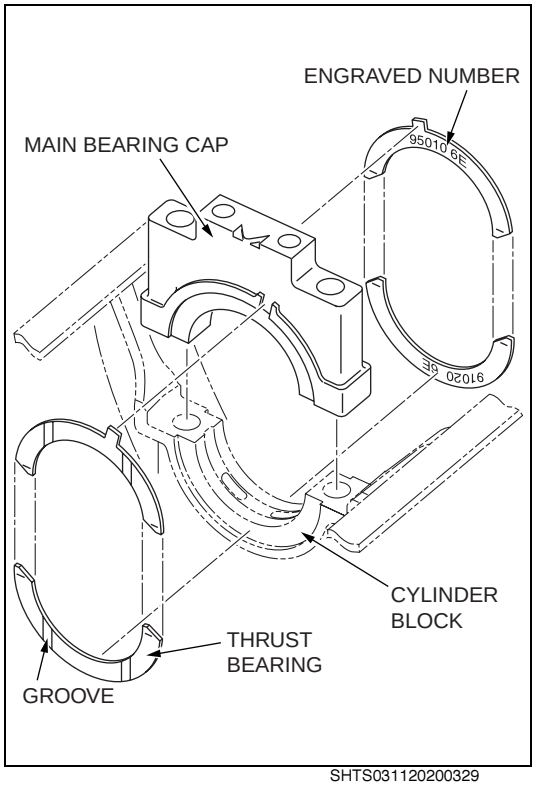
⚠ CAUTION
Misaligned oil holes will cause insufficient oiling, resulting in seizure.

NOTICE
Make sure that oil holes are aligned with each other.



SHTS031120200328

(2) Install the crankshaft bearing in alignment with a concavity in the main bearing cap, and apply engine oil.

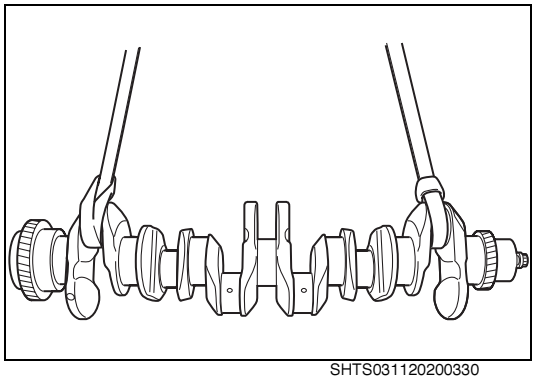


SHTS031120200329

(3) Install the thrust bearing with the groove side (front) toward the crank arm and with the part No. stamp (back) toward the main bearing cap.

NOTICE
Apply engine oil or grease to the back of the thrust bearing to prevent loosening during installation.

HINT
In this step, do not attach the thrust bearing on the cylinder block side as it will be inserted after the crankshaft is placed.

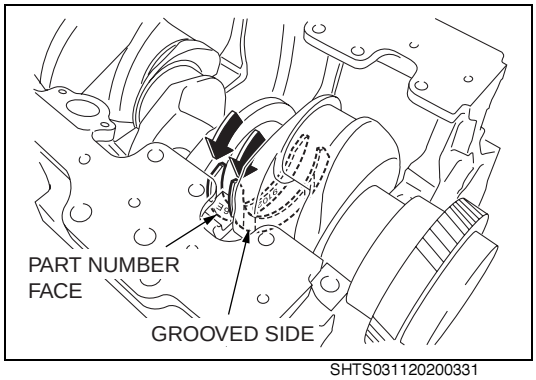

SHTS031120200330

2. INSTALL THE CRANKSHAFT.

(1) Using a hoist, set the crankshaft on the cylinder block.

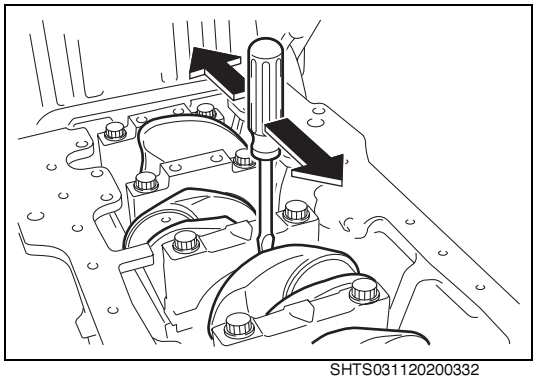
⚠ CAUTION
Crankshaft is a heavy component. Handle it carefully.

HINT
A clearance from the cylinder block will be the largest if the crankshaft is lifted with the crank pins No.1 and No.6 positioned upward. Lift the crankshaft carefully and avoid contact between the cylinder block and the balance weight at the rear end of the crankshaft.

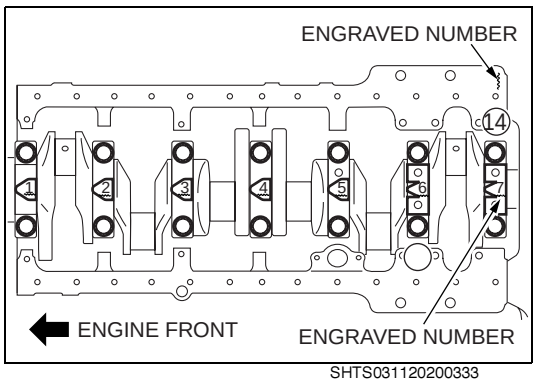


SHTS031120200331

(2) Insert the thrust bearing on the cylinder block side into a gap between the crankshaft and the cylinder block. Make sure that the grooved (front) side faces the crank arm and the part number (back side) faces the cylinder block.


SHTS031120200332

HINT
For easier works in this step, use a flat head screwdriver to broaden a gap for inserting the thrust bearing.

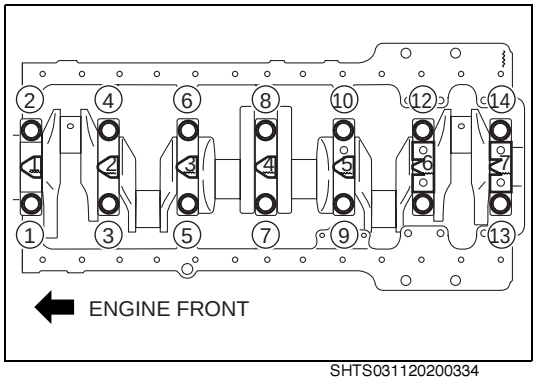


SHTS031120200333

(3) With thrust bearings and main bearings installed, set the main bearing caps to the cylinder block.

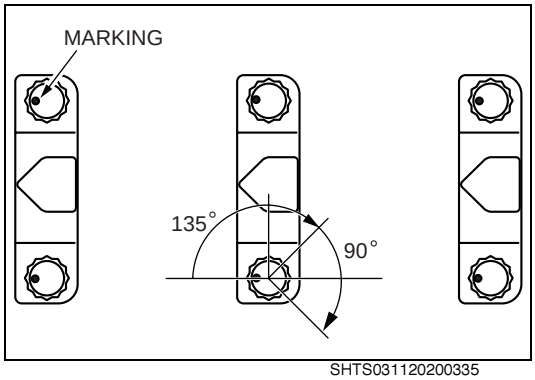
NOTICE

- **The pentagonal marks on the main bearing caps must face the frontward direction of the engine and line up in the ascending order from the front side: i.e. "1" to "7".**
- **Cross-check the engraved number on each main bearing cap with that on the cylinder block.**



SHTS031120200334

(4) Apply engine oil to bolt seat surfaces and bolt threads of the bearing cap bolt.
(5) Tighten the bearing cap bolts in the order shown in the figure.
Seating torque:
100 N·m {1,020 kgf·cm, 74 lbf·ft}
(6) Loosen the bearing cap No.6 having a thrust bearing. Use a plastic hammer to tap at the front and rear ends of the crankshaft.
(7) Loosen all bearing cap bolts.
(8) Tighten the bearing cap bolts in the same order as in step (5).
Seating torque:
100 N·m {1,020 kgf·cm, 74 lbf·ft}
(9) Mark the bearing cap bolt heads with paint to indicate the same directions.



SHTS031120200335

(10) Tighten the bolts 135° (3/8 turn) in the same order as in step (5).
(11) Tighten the bolts 90° (1/4 turn) in the same order as in step (5).

(12) Make sure that all paint marks face the same direction.

NOTICE
When adding torque, never untighten the bolt, even if they have been overtightened.

(13) After tightening, use a plastic hammer to tap at the front and rear ends of the crankshaft for better fitting.

NOTICE

- **Make sure that the crankshaft rotates smoothly.**
- **Measure end play in the crankshaft and check that a measurement reading falls within the standard value.**

Standard (mm {in.})	Limit (mm {in.})
0.110-0.274 {0.0044-0.0107}	0.5 {0.0197}

3. INSTALL THE FLYWHEEL HOUSING.
(1) Apply liquid gasket and install the flywheel housing.
Refer to the section **"FLYWHEEL HOUSING"**.

4. INSTALL THE FRONT TIMING GEAR COVER.
(1) Install the front timing gear cover.
Refer to the section **"FRONT TIMING GEAR COVER AND TIMING GEAR"**.

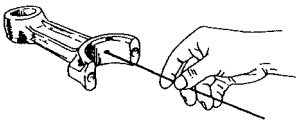
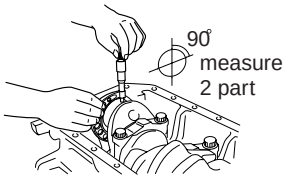
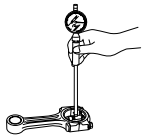
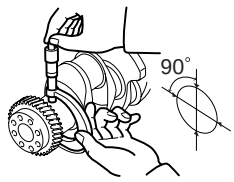
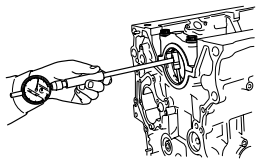
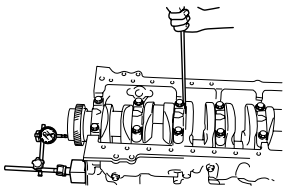
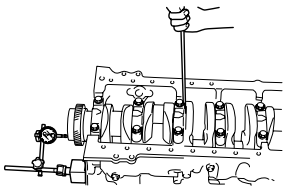
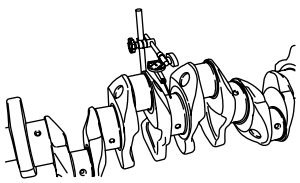
5. INSTALL THE PISTON AND THE CONNECTING ROD.
(1) Install the piston and the connecting rod.
Refer to the section **"PISTON AND CONNECTING ROD"**.

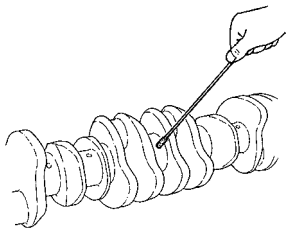
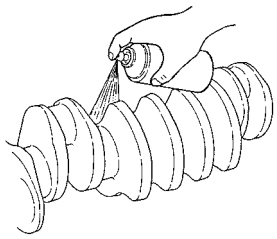
6. INSTALL THE CYLINDER HEAD ASSEMBLY.
(1) Install the cylinder head assembly.
Refer to the section **"CYLINDER HEAD ASEEMBLY"**.

INSPECTION AND REPAIR

EN0311202H300010

Unit: mm {in.}

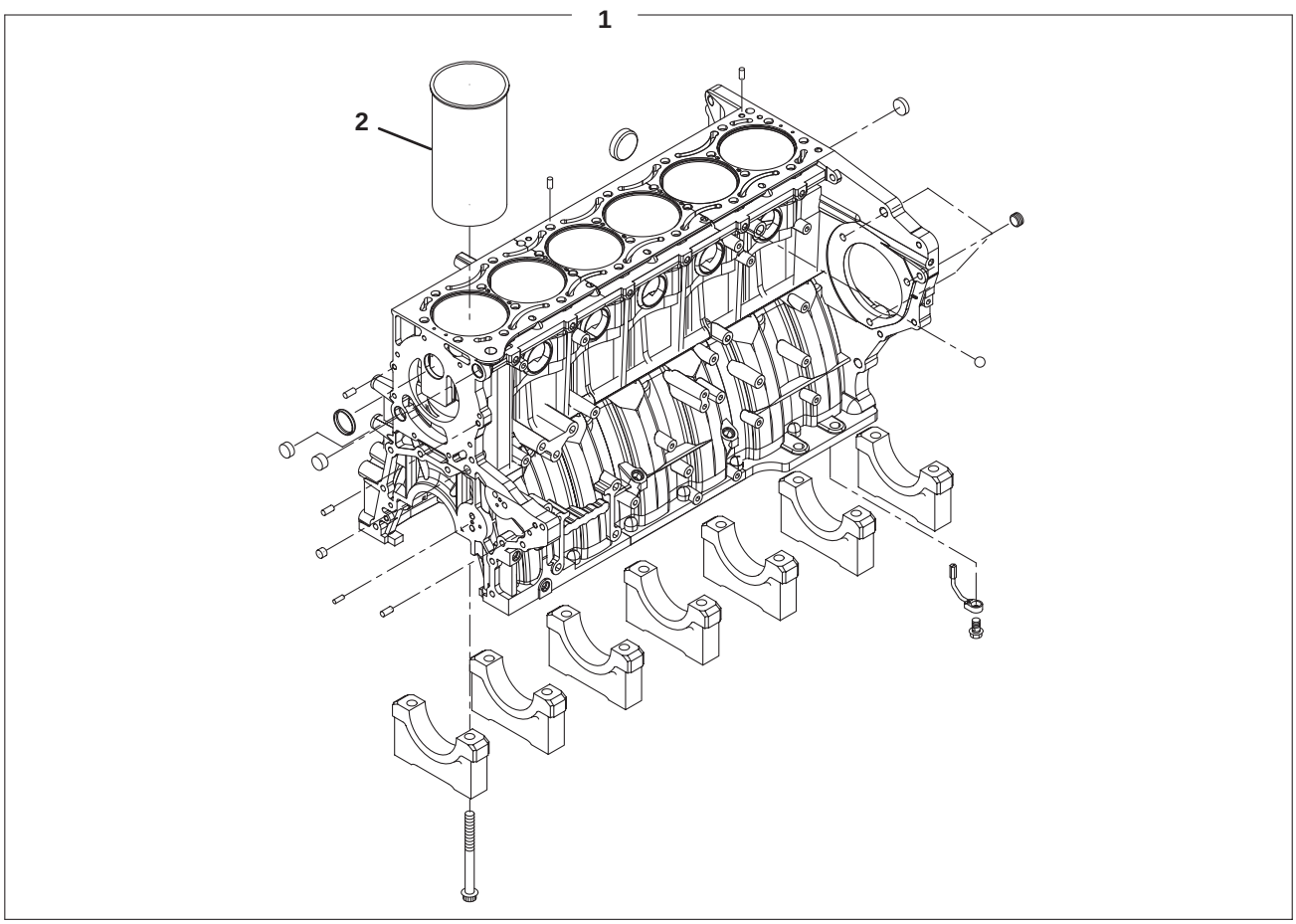
Inspection item	Standard	Limit	Remedy	Inspection procedure
Clogging of connecting rod oil hole	—	—	Replace.	Visual check 
Crank pin outside diameter	73 {2.874}	72.8 {2.8661}	Replace crankshaft.	Measure  
Crank journal outside diameter	90 {3.543}	89.8 {3.5354}	Replace crankshaft.	Measure 
Clearance between crank journal and main bearing	0.051-0.102 {0.0021-0.0040}	0.3 {0.0118}	Replace main bearing.	
Crankshaft end play	0.110-0.274 {0.0043-0.0107}	0.5 {0.0197}	Replace crankshaft.	Measure 
Main bearing cap bolt	146.5 {5.767}	147.5 {5.8070}	Replace.	Measure 
Crankshaft deflection	0-0.15 {0-0.0059}	0.15 {0.0059}	Regrind under size.	Measure 

Inspection item	Standard	Limit	Remedy	Inspection procedure
Clogging of crankshaft oil hole	**—**	**—**	**Clean.**	**Visual check** 
Crack and wear of crankshaft ***Dye penetrant check (Color check)**	**—**	**—**	**Replace.**	**Visual check** 

CYLINDER LINER

COMPONENT LOCATOR

EN0311202D100015



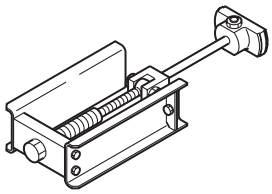
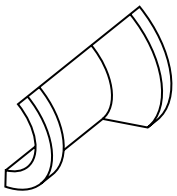
SHTS031120200341

1 Cylinder block assembly	2 Cylinder liner

SPECIAL TOOL

EN0311202K100009

Prior to starting an engine overhaul, it is necessary to have these special tools.

Illustration	Part number	Tool name	Remarks
	S0942-02100	CYLINDER LINER PULLER	
	S0947-11490	GUIDE	

REPLACEMENT

EN0311202H100007

REMOVE THE CYLINDER LINER.

1. REMOVE THE CYLINDER HEAD ASSEMBLY.

(1) Remove the cylinder head assembly.
Refer to the section **"CYLINDER HEAD ASEEMBLY"**.

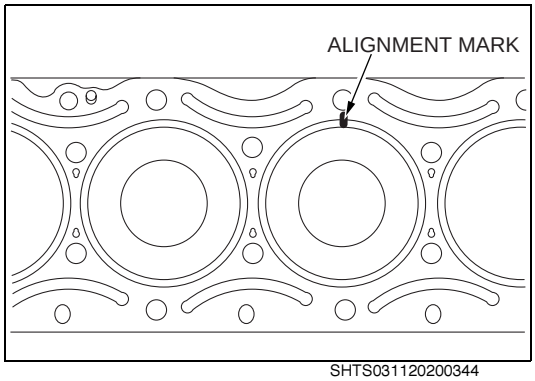
2. REMOVE THE PISTON AND THE CONNECTING ROD.

(1) Remove the piston and the connecting rod.
Refer to the section **"PISTON AND CONNECTING ROD"**.

3. REMOVE THE CYLINDER LINER.

(1) Put alignment marks on the cylinder block and liner flange.

NOTICE
Do not make alignment marks with a punch.



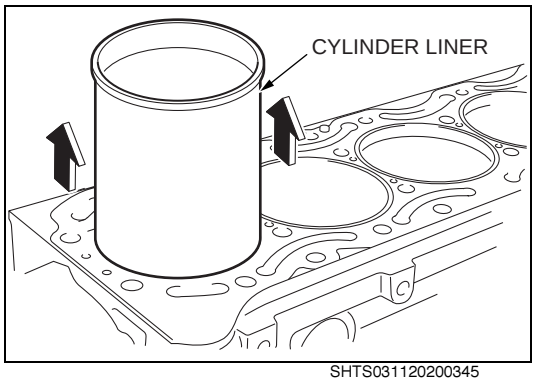
SHTS031120200344

(2) Hold the cylinder liner end with your both hands and pull it off in one breath in the upward direction of the cylinder block.

⚠ CAUTION
Handle the cylinder liner carefully. Do not reuse a cylinder liner if dropped.

NOTICE
The removed cylinder liner in the order of cylinder numbers in storage.

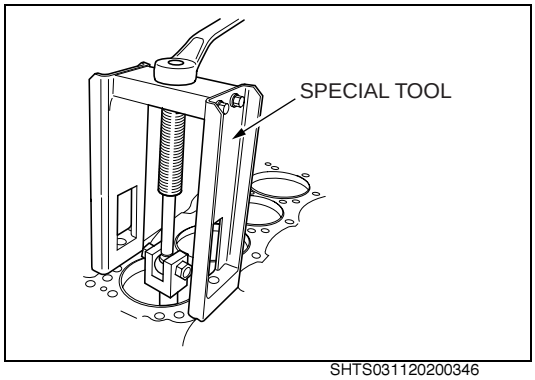
HINT
If the cylinder liner is not pulled off vertically in one breath, it will be caught by the cylinder block and not be smoothly removed.



SHTS031120200345

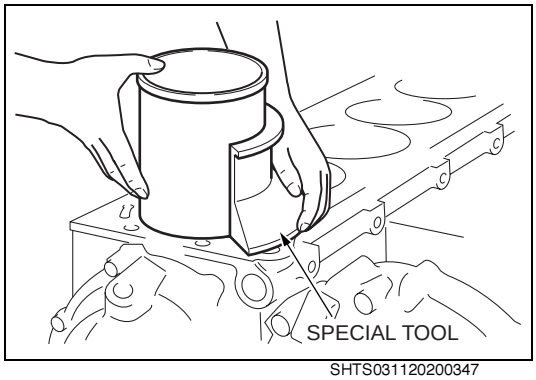
(3) If manual pull-off is not practicable due to damages in the cylinder liner or the cylinder block, use the special tool to pull off the cylinder liner from the cylinder block in the upward direction.

SST: Cylinder liner puller (S0942-02100)



SHTS031120200346

⚠ CAUTION
Carefully set the special tool to prevent touching to the piston cooling jet.



SHTS031120200347

INSTALL THE CYLINDER LINER.

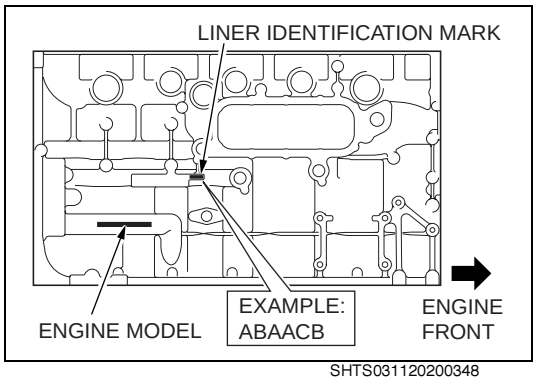
1. INSTALL THE CYLINDER LINER.

(1) Apply engine oil to the inner surface of the cylinder block bore.

(2) Align an alignment mark on the cylinder liner with that on the cylinder block. Use the special tool to insert the cylinder liner vertically.
SST: Guide (S0947-11490)

HINT

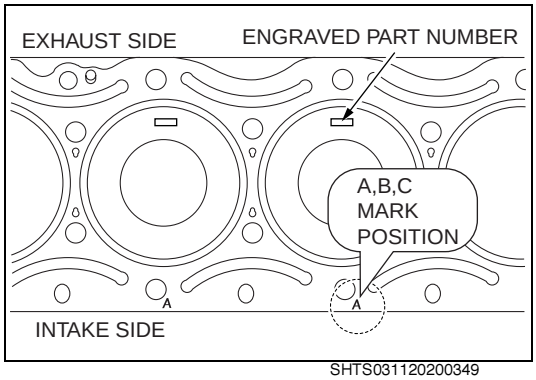
This special tool may not be needed for insertion if the cylinder liner is inserted in the vertical direction.



SHTS031120200348

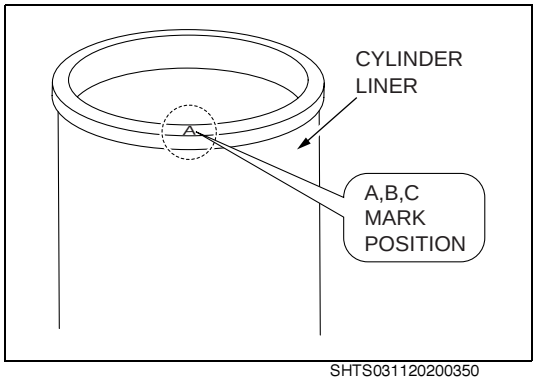
NOTICE

- **If a new cylinder liner is to be installed, attach the cylinder liner having the same liner identification mark (A, B or C) as stamped on the cylinder block in the order of cylinders.**
- **These figures show an example of the cylinder No.1 with the liner B.**



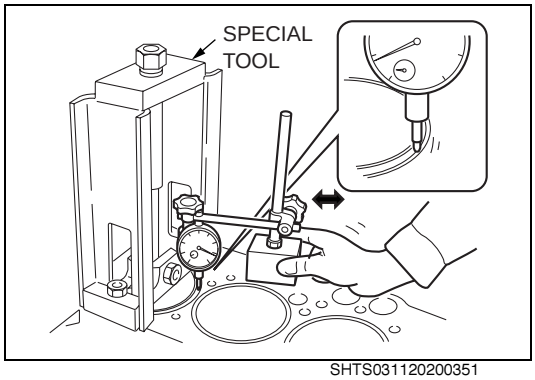
SHTS031120200349

- **The upper surface of the cylinder block intake side is engraved liner identification mark (A, B or C).**



SHTS031120200350

- **Locate an alphabet mark (A, B or C) on the intake side.**

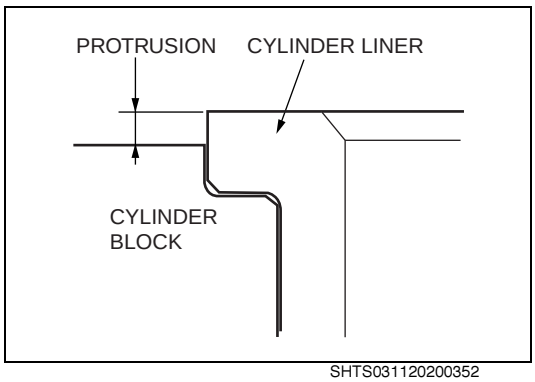


SHTS031120200351

2. MEASURE THE PROTRUSION AT THE CYLINDER LINER FLANGE.

(1) Using the special tool, fix the cylinder liner.
Tightening Torque:
9.8 N·m {100 kgf·cm, 7.2 lbf·ft}

SST: Cylinder liner puller (S0942-02100)



SHTS031120200352

(2) Use a dial gauge to measure protrusion of the collar.
Standard value: 0.04-0.11 mm {0.0016-0.0043 in.}

3. INSTALL THE PISTON AND THE CONNECTING ROD.

(1) Install the piston and the connecting rod.
Refer to the section **"PISTON AND CONNECTING ROD"**.

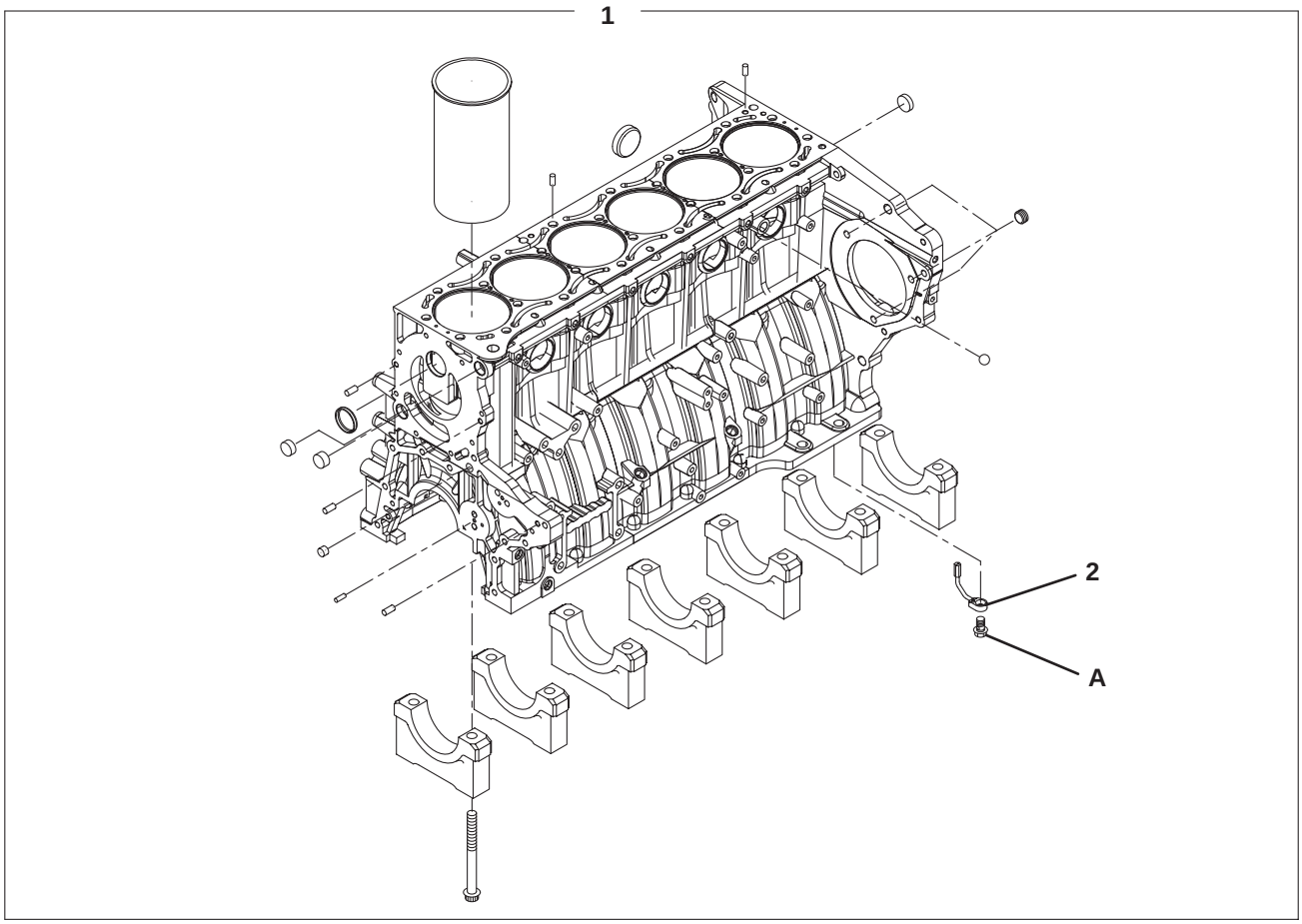
4. INSTALL THE CYLINDER HEAD ASSEMBLY.

(1) Install the cylinder head assembly.
Refer to the section **"CYLINDER HEAD ASEEMBLY"**.

CYLINDER BLOCK

COMPONENT LOCATOR

EN0311202D100016



SHTS031120200353

1	Cylinder block assembly	2	Cooling jet

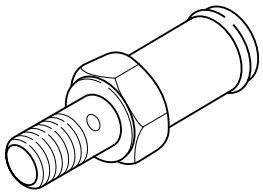
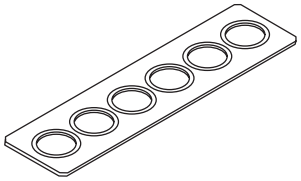
Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

A 22 {225, 16}	

SPECIAL TOOL

EN0311202K100010

Prior to starting an engine overhaul, it is necessary to have these special tools.

Illustration	Part number	Tool name	Remarks
	SZ910-24098	BOLT	For Cooling jet
	09219-E1011	GAGE	For Cooling jet

OVERHAUL

EN0311202H200009

REMOVE THE CYLINDER BLOCK.

1. REMOVE THE COOLING FAN ASSEMBLY AND THE FAN SHROUD RING.

(1) Remove the cooling fan assembly and the fan shroud ring.
Refer to the section **"COOLING FAN AND FAN CLUTCH"** in the chapter **"COOLING SYSTEM"**.

2. REMOVE THE ALTERNATOR.

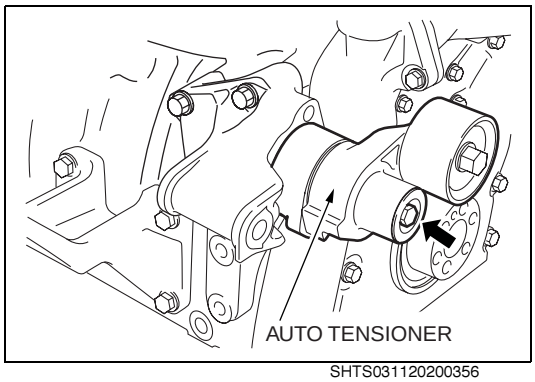
(1) Remove the alternator.
Refer to the section **"ALTERNATOR"** in the chapter **"ALTERNATOR"**.

3. REMOVE THE CYLINDER HEAD ASSEMBLY.

(1) Remove the cylinder head assembly.
Refer to the section **"CYLINDER HEAD ASSEMBLY"**.

4. REMOVE THE AUTO TENSIONER.

(1) Remove the bolt to remove the auto tensioner.



SHTS031120200356

5. REMOVE THE CRANKSHAFT DAMPER.

(1) Remove the crankshaft damper.
Refer to the section **"CRANKSHAFT DAMPER"**.

6. REMOVE THE CRANKSHAFT FRONT OIL SEAL.

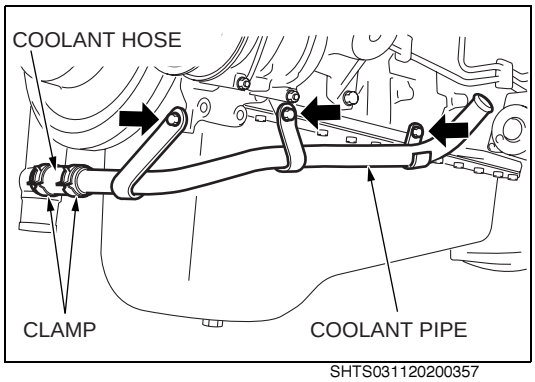
(1) Using the special tool, remove the crankshaft front oil seal.
Refer to the section **"CRANKSHAFT FRONT OIL SEAL"**.

7. REMOVE THE FRONT TIMING GEAR COVER AND THE END PLATE.

(1) Remove the front timing gear cover and the end plate.
Refer to the section **"FRONT TIMING GEAR COVER AND TIMING GEAR"**.

8. REMOVE THE COOLANT PIPE (OIL PAN SIDE).

(1) Remove three bolts and clamps, remove the coolant pipe (oil pan side).



SHTS031120200357

9. REMOVE THE OIL LEVEL GAUGE AND THE GUIDE.

(1) Remove the oil level gauge and the oil level gauge guide.
Refer to the section **"OIL LEVEL GAUGE AND GUIDE"** in the chapter **"LUBRICATING SYSTEM"**.

10. REMOVE THE OIL PAN.

(1) Remove the oil pan.
Refer to the section **"OIL PAN"** in the chapter **"LUBRICATING SYSTEM"**.

11. REMOVE THE OIL STRAINER AND THE PLATE.

(1) Remove the oil strainer and the plate.
Refer to the section **"OIL STRAINER AND PLATE"** in the chapter **"LUBRICATING SYSTEM"**.

12. REMOVE THE PISTON AND THE CONNECTING ROD.

(1) Remove the piston and the connecting rod.
Refer to the section **"PISTON AND CONNECTING ROD"**.

13. REMOVE THE CYLINDER LINER.

(1) Remove the cylinder liner.
Refer to the section **"CYLINDER LINER"**.

14. REMOVE THE FUEL PIPE.

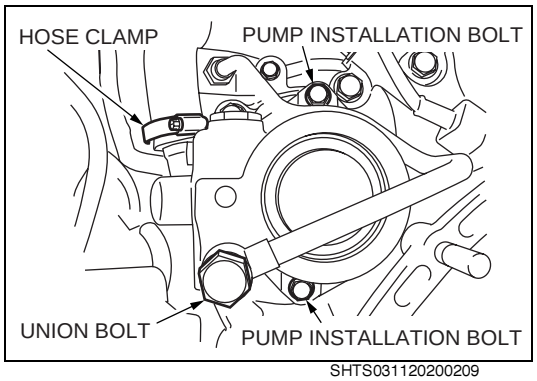
(1) Remove the fuel pipe around the cylinder block.
Refer to the section **"FUEL PIPE"** in the chapter **"FUEL SYSTEM"**.

15. REMOVE THE AIR COMPRESSOR.

(1) Remove the air compressor.
Refer to the section **"AIR COMPRESSOR"** in the chapter **"AIR COMPRESSOR"**.

16. REMOVE THE STARTER.

(1) Remove the starter.
Refer to the section **"STARTER"** in the chapter **"STARTER"**.



SHTS031120200209

17. REMOVE THE POWER STEERING PUMP.

(1) Remove the oil hose.

NOTICE

- **Use a connector as power steering fluid might drop off during disconnection of oil hose. Use a cover to protect the hose against incoming dust.**
- **Disposal of power steering fluid must comply with the specified procedures (waste disposal) or other environmentally-conscious procedures.**

(2) Remove the union bolt and gasket. Disconnect the pipe.
(3) Remove two power steering pump installation bolts.

18. REMOVE THE FLYWHEEL ASSEMBLY.

(1) Remove the flywheel assembly.
Refer to the section **"FLYWHEEL ASSEMBLY"**.

19. REMOVE THE CRANKSHAFT REAR OIL SEAL.

(1) Using the special tool, remove the crankshaft rear oil seal.
Refer to the section **"CRANKSHAFT REAR OIL SEAL"**.

20. REMOVE THE FLYWHEEL HOUSING.

(1) Remove the flywheel housing.
Refer to the section **"FLYWHEEL HOUSING"**.

21. REMOVE THE REAR TIMING GEAR.

(1) Remove the idle gear shaft and idle gears.
Refer to the section **"REAR TIMING GEAR AND CAM IDLE GEAR"**.

22. REMOVE THE OIL PUMP.

(1) Remove the oil pump.
Refer to the section **"OIL PUMP"** in the chapter **"LUBRICATING SYSTEM"**.

23. REMOVE THE CRANKSHAFT.

(1) Remove the crankshaft.
Refer to the section **"CRANKSHAFT"**.

24. REMOVE THE OIL COOLER.

(1) Remove the oil cooler.
Refer to the section **"OIL COOLER"** in the chapter **"LUBRICATING SYSTEM"**.

25. REMOVE THE COOLANT PIPE (OIL COOLER CASE FRONT).

(1) Remove the coolant pipe (oil cooler case front).
Refer to the section **"COOLANT PIPE"** in the chapter **"COOLING SYSTEM"**.

26. REMOVE THE COOLANT PUMP.

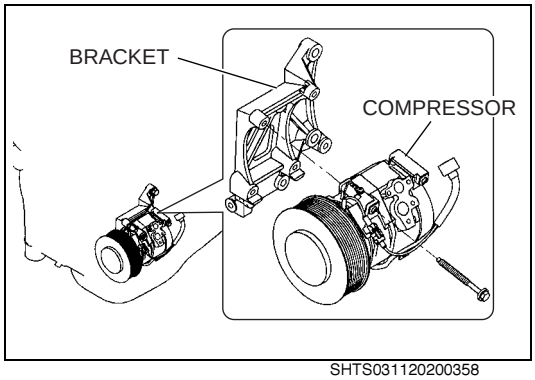
(1) Remove the coolant pump.
Refer to the section **"COOLANT PUMP"** in the chapter **"COOLING SYSTEM"**.

27. REMOVE THE ENGINE MOUNTING AND THE BRACKET.

(1) Remove the engine mounting and the bracket.
Refer to the section **"ENGINE MOUNTING AND BRACKET"**.

28. REMOVE THE AIR CONDITIONER COMPRESSOR.

(1) Call in the refrigerant.
(2) Remove the hose from the compressor.
(3) Remove four bolts to remove the compressor from the bracket.



SHTS031120200358

29. REMOVE THE ENGINE ECU.

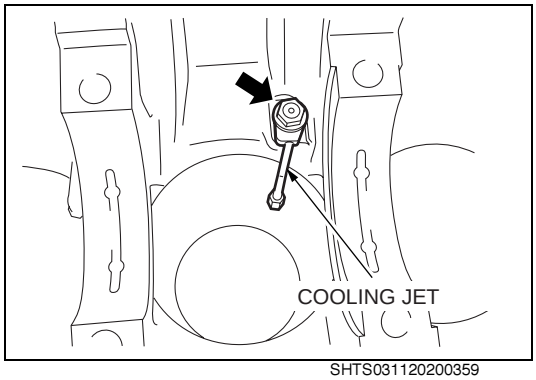
(1) Remove the engine ECU.
Refer to the section **"ENGINE ECU AND ENGINE ECU COOLER"** in the chapter **"ENGINE CONTROL"**.

30. REMOVE THE ENGINE ECU COOLER.

(1) Remove the engine ECU cooler.
Refer to the section **"ENGINE ECU AND ENGINE ECU COOLER"** in the chapter **"ENGINE CONTROL"**.

31. REMOVE THE DC MOTOR CONTROLLER.

(1) Remove the DC motor controller from the cylinder block.
Refer to the section **"DC MOTOR CONTROLLER"** in the chapter **"TURBOCHARGER"**.

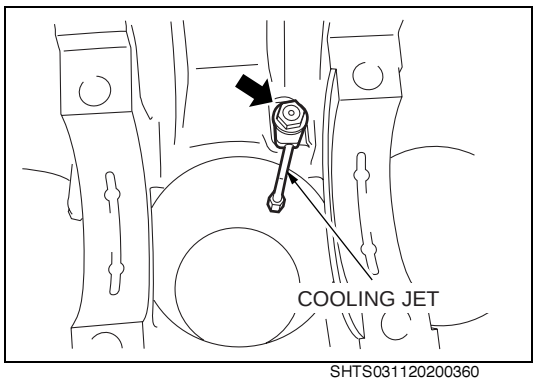


SHTS031120200359

32. REMOVE THE COOLING JET.

(1) Remove the union bolt to remove the cooling jet from the cylinder block.

INSTALL THE CYLINDER BLOCK.



SHTS031120200360

1. INSTALL THE COOLING JET.

(1) Install the cooling jet to the cylinder block.
Tightening Torque:
22 N·m {225 kgf·cm, 16 lbf·ft}

(2) After installing the pistons, check that there is no interference between the cooling jet and the piston at the bottom dead center.

2. INSTALL THE DC MOTOR CONTROLLER.

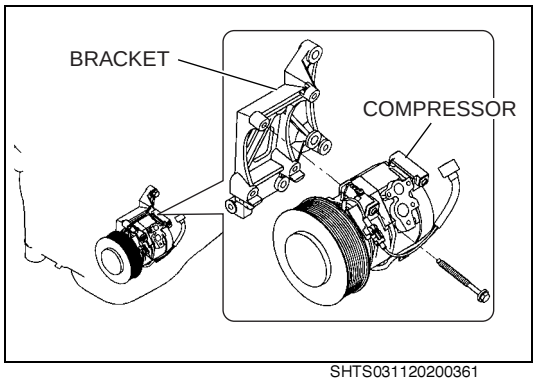
(1) Install the DC motor controller to the cylinder block.
Refer to the section **"DC MOTOR CONTROLLER"** in the chapter **"TURBOCHARGER"**.

3. INSTALL THE ENGINE ECU COOLER.

(1) Install the engine ECU cooler.
Refer to the section **"ENGINE ECU AND ENGINE ECU COOLER"** in the chapter **"ENGINE CONTROL"**.

4. INSTALL THE ENGINE ECU.

(1) Install the engine ECU.
Refer to the section **"ENGINE ECU AND ENGINE ECU COOLER"** in the chapter **"ENGINE CONTROL"**.



SHTS031120200361

5. INSTALL THE AIR CONDITIONER COMPRESSOR.

(1) Install the compressor to the bracket, and tighten four bolts.
Tightening Torque:
25 N·m {250 kgf·cm, 18 lbf·ft}

(2) Install the suction hose and the discharge hose to the compressor.

(3) Fill in the refrigerant.

6. INSTALL THE ENGINE MOUNTING AND THE BRACKET.
(1) Install the engine mounting and the bracket.
Refer to the section **"ENGINE MOUNTING AND BRACKET"**.

7. INSTALL THE COOLANT PUMP.
(1) Apply liquid gasket to joint surface and install the coolant pump.
Refer to the section **"COOLANT PUMP"** in the chapter **"COOLING SYSTEM"**.

8. INSTALL THE COOLANT PIPE (OIL COOLER CASE FRONT).
(1) Replace the O-ring with a new one and install the coolant pipe (oil cooler case front).
Refer to the section **"COOLANT PIPE"** in the chapter **"COOLING SYSTEM"**.

9. INSTALL THE OIL COOLER.
(1) Replace the gasket with a new one and install the oil cooler.
Refer to the section **"OIL COOLER"** in the chapter **"LUBRICATING SYSTEM"**.

10. INSTALL THE CRANKSHAFT.
(1) Install the crankshaft.
Refer to the section **"CRANKSHAFT"**.

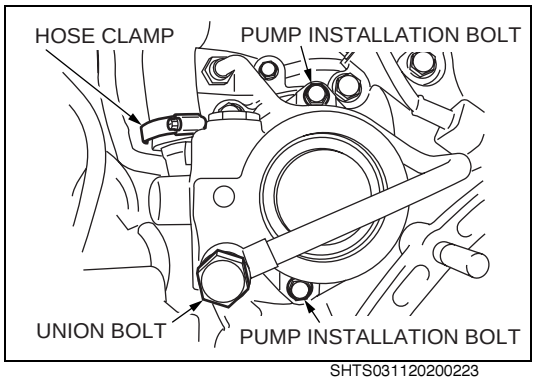
11. INSTALL THE OIL PUMP.
(1) Replace the gasket with a new one and install the oil pump.
Refer to the section **"OIL PUMP"** in the chapter **"LUBRICATING SYSTEM"**.

12. INSTALL THE REAR TIMING GEAR.
(1) Install the idle gears and idle gear shaft.
Refer to the section **"REAR TIMING GEAR AND CAM IDLE GEAR"**.

13. INSTALL THE FLYWHEEL HOUSING.
(1) Apply liquid gasket and install the flywheel housing.
Refer to the section **"FLYWHEEL HOUSING"**.

14. INSTALL THE CRANKSHAFT REAR OIL SEAL.
(1) Using the special tool, press the crankshaft rear oil seal.
Refer to the section **"CRANKSHAFT REAR OIL SEAL"**.

15. INSTALL THE FLYWHEEL ASSEMBLY.
(1) Install the flywheel assembly.
Refer to the section **"FLYWHEEL ASSEMBLY"**.



SHTS031120200223

16. INSTALL THE POWER STEERING PUMP.
(1) Attach new O-ring. Install the power steering pump, and tighten two bolts.
Tightening Torque:
55 N·m {560 kgf·cm, 41 lbf·ft}

(2) Connect the oil hose.
(3) Attach new gasket. Install the pipe, and tighten the union bolt.
Tightening Torque:
39 N·m {400 kgf·cm, 29 lbf·ft}

(4) Bleed air from the power steering oil pump and the power steering oil pipe.
Refer to the section **"POWER STEERING SYSTEM"** in the chapter **"POWER STEERING"** in the workshop manual (chassis).

17. INSTALL THE STARTER.
(1) Install the starter.
Refer to the section **"STARTER"** in the chapter **"STARTER"**.

18. INSTALL THE AIR COMPRESSOR.

(1) Install the air compressor.
Refer to the section **"AIR COMPRESSOR"** in the chapter **"AIR COMPRESSOR"**.

19. INSTALL THE FUEL PIPE.

(1) Install the fuel pipe around the cylinder block.
Refer to the section **"FUEL PIPE"** in the chapter **"FUEL SYSTEM"**.

20. INSTALL THE CYLINDER LINER.

(1) Install the cylinder liner.
Refer to the section **"CYLINDER LINER"**.

21. INSTALL THE PISTON AND THE CONNECTING ROD.

(1) Remove the piston and the connecting rod.
Refer to the section **"PISTON AND CONNECTING ROD"**.

22. INSTALL THE OIL STRAINER AND THE PLATE.

(1) Install the oil strainer and the plate.
Refer to the section **"OIL STRAINER AND PLATE"** in the chapter **"LUBRICATING SYSTEM"**.

23. INSTALL THE OIL PAN.

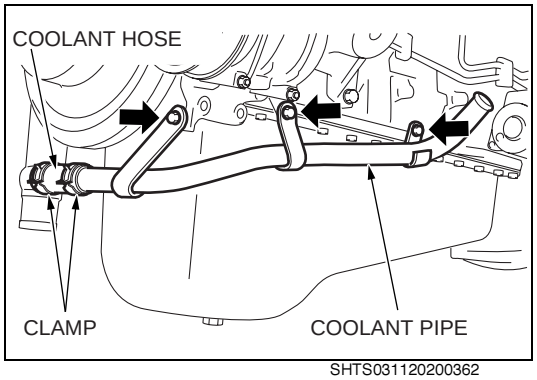
(1) Replace the gasket with a new one and install the oil pan.
Refer to the section **"OIL PAN"** in the chapter **"LUBRICATING SYSTEM"**.

24. INSTALL THE OIL LEVEL GAUGE AND THE GUIDE.

(1) Install the oil level gauge guide and insert the oil level gauge.
Refer to the section **"OIL LEVEL GAUGE AND GUIDE"** in the chapter **"LUBRICATING SYSTEM"**.

25. INSTALL THE COOLANT PIPE (OIL PAN SIDE).

(1) Insert the coolant hose and fix it with the clamps.
(2) Install the coolant pipe (oil pan side) with three bolts.



SHTS031120200362

26. INSTALL THE CYLINDER HEAD ASSEMBLY.

(1) Install the cylinder head assembly.
Refer to the section **"CYLINDER HEAD ASSEMBLY"**.

27. INSTALL THE FRONT TIMING GEAR COVER AND THE END PLATE.

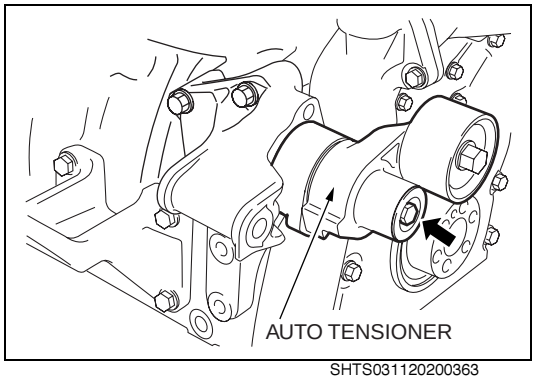
(1) Replace the gasket with a new one and install the end plate and the front timing gear cover.
Refer to the section **"FRONT TIMING GEAR COVER AND TIMING GEAR"**.

28. INSTALL THE CRANKSHAFT FRONT OIL SEAL.

(1) Using the special tool, press the crankshaft front oil seal.
Refer to the section **"CRANKSHAFT FRONT OIL SEAL"**.

29. INSTALL THE CRANKSHAFT DAMPER.

(1) Install the crankshaft damper.
Refer to the section **"CRANKSHAFT DAMPER"**.



SHTS031120200363

30. INSTALL THE AUTO TENSIONER.

(1) Install the auto tensioner with a bolt.

31. INSTALL THE ALTERNATOR.

(1) Install the alternator.
Refer to the section **"ALTERNATOR"** in the chapter **"ALTERNATOR"**.

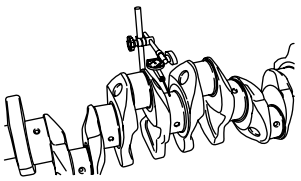
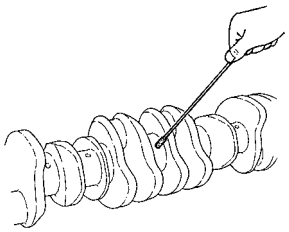
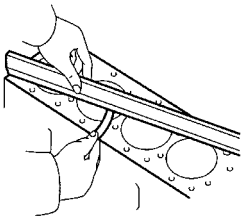
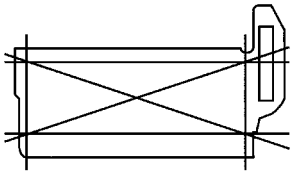
32. INSTALL THE COOLING FAN ASSEMBLY AND THE FAN SHROUD RING.

(1) Install the cooling fan assembly and the fan shroud ring.
Refer to the section **"COOLING FAN AND FAN CLUTCH"** in the chapter **"COOLING SYSTEM"**.

INSPECTION AND REPAIR

EN0311202H300011

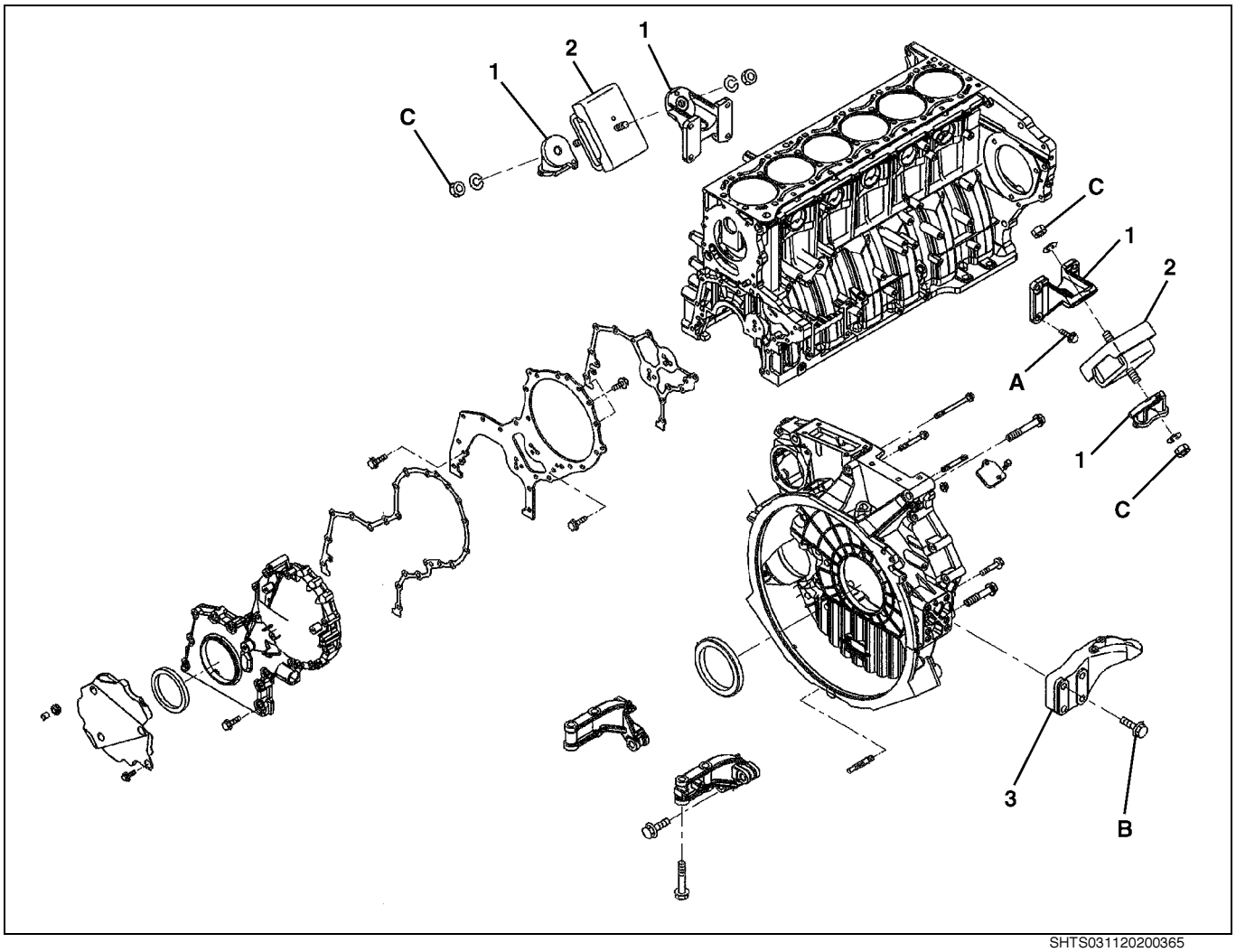
Unit: mm {in.}

Inspection item	Standard	Limit	Remedy	Inspection procedure
Crankshaft deflection	—	0.15 {0.0059}	Regrind under size.	Measure 
Clogging of crankshaft oil hole	—	—	Clean.	Visual check 
Crack and wear of cylinder block *Dye penetrant check (Color check)	—	—	Replace.	Visual check
Cylinder block upper surface flatness	0.05 {0.0019}	0.10 {0.0039} (Repair) 0.15 {0.0059} (Service)	Replace. NOTICE: Do not grind for repair.	Measure  

ENGINE MOUNTING AND BRACKET

COMPONENT LOCATOR

EN0311202D100017



SHTS031120200365

1	Front engine mounting bracket	3	Rear engine mounting bracket
2	Front engine mounting		

Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

A	125 {1,280, 92}	C	200 {2,040, 147}
B	108 {1,100, 80}		

REPLACEMENT

EN0311202H200010

CHECK BEFORE START OF MAINTENANCE WORKS

1. CHECK THE ENGINE MOUNTING.

(1) Check the engine mounting for cracks, damages or wears. Make replacement if a trouble is found.

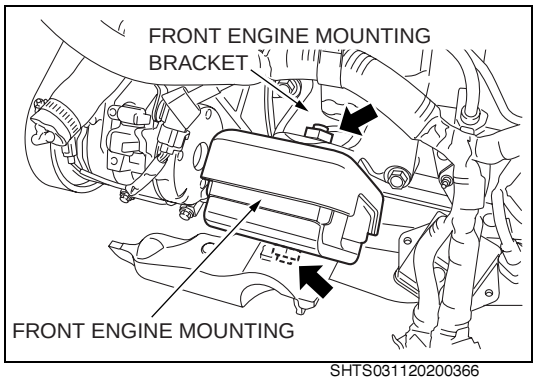
REMOVE THE ENGINE MOUNTING AND THE BRACKET.

1. LIFT THE ENGINE ASSEMBLY.

(1) Before removing the engine mounting, lift and hold up the engine assembly.
Refer to the section **"DISMOUNTING AND MOUNTING"** in the chapter **"ENGINE INTRODUCTION"**.

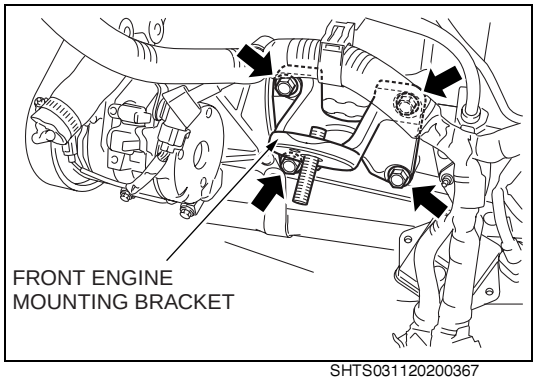
2. REMOVE THE ENGINE MOUNTING AND THE BRACKET.

(1) Remove nuts to remove the front engine mounting from the front engine mounting bracket.



SHTS031120200366

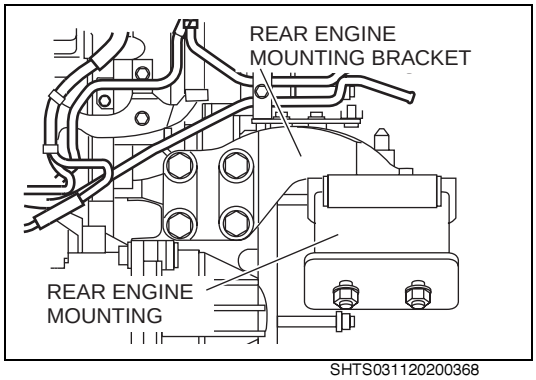
(2) Remove bolts to remove the front engine mounting bracket from the cylinder block.



SHTS031120200367

(3) Remove bolts to remove the rear engine mounting from the rear engine mounting bracket.

(4) Remove bolts to remove the rear engine mounting bracket from the flywheel housing.



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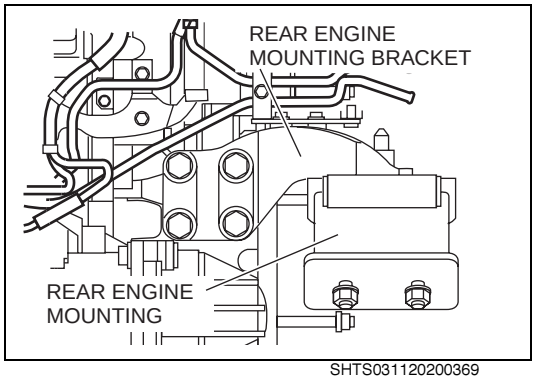
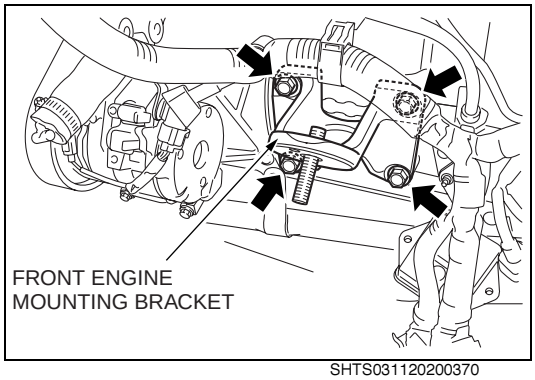
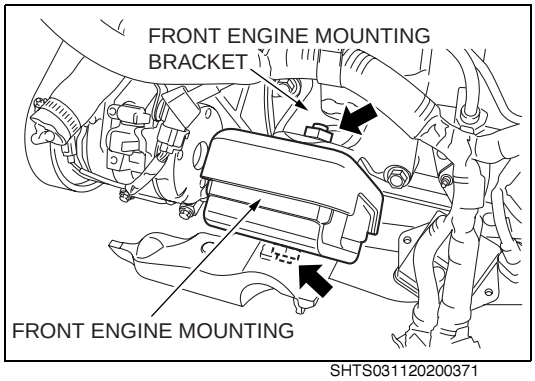


SHTS031120200369



SHTS031120200370



SHTS031120200371

INSTALL THE ENGINE MOUNTING AND BRACKET.

1. INSTALL THE ENGINE MOUNTING AND THE BRACKET.

(1) Install the rear engine mounting bracket to the flywheel housing, and tighten bolts.
Tightening Torque:
225 N·m {2,294 kgf·cm, 165 lbf·ft}

(2) Install the rear engine mounting, and tighten bolts.
Tightening Torque:
166-224 N·m {1,693-2,284 kgf·cm, 122-165 lbf·ft}

(3) Install the front engine mounting bracket to the cylinder block, and tighten bolts.
Tightening Torque:
125 N·m {1,280 kgf·cm, 92 lbf·ft}

(4) Install the front engine mounting, and tighten nuts.
Tightening Torque:
200 N·m {2,040 kgf·cm, 147 lbf·ft}

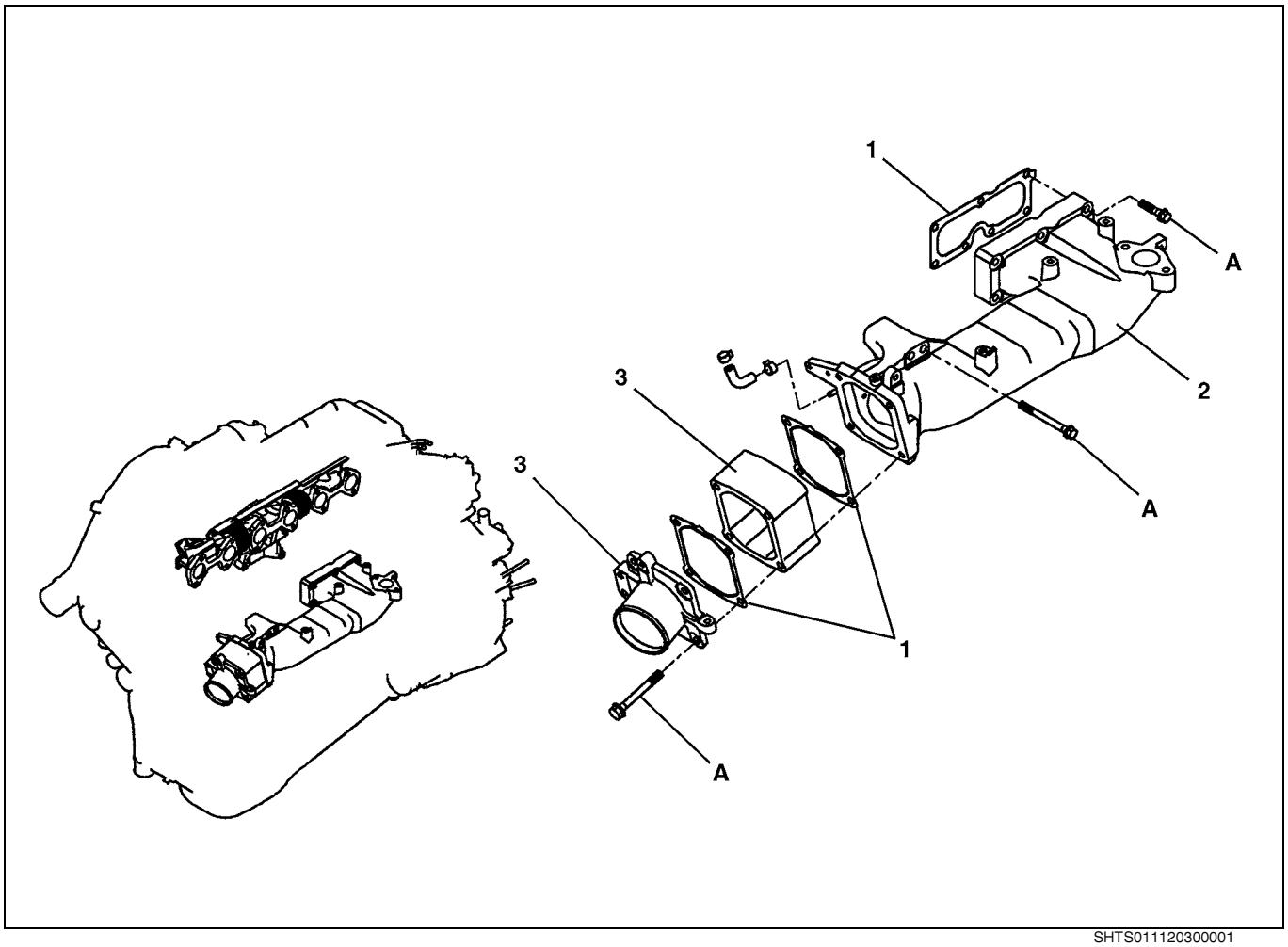
AIR INTAKE SYSTEM (A09C)

EN03-001

INTAKE PIPE (INTAKE SIDE)

COMPONENT LOCATOR

EN0111203D100001



SHTS011120300001

1	Gasket	3	Intake pipe
2	Intake pipe (Intake side)		

Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

A	55 {560, 41}		

REPLACEMENT

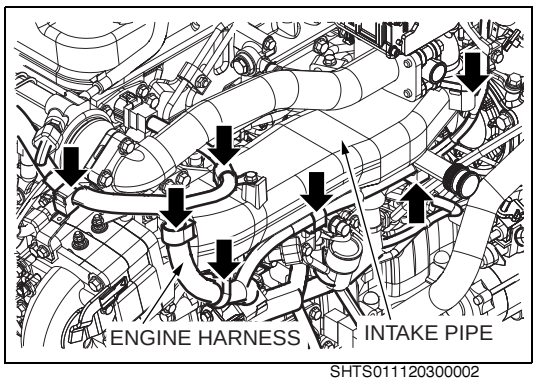
EN0111203H100001

REMOVE THE INTAKE PIPE (INTAKE SIDE).

1. DISCONNECT THE HARNESS.

(1) Disconnect the connector of the boost pressure sensor.
Refer to the section **"BOOST PRESSURE SENSOR"**.

(2) Unlock seven clamps and disconnect the engine harness from the intake pipe.



SHTS011120300002

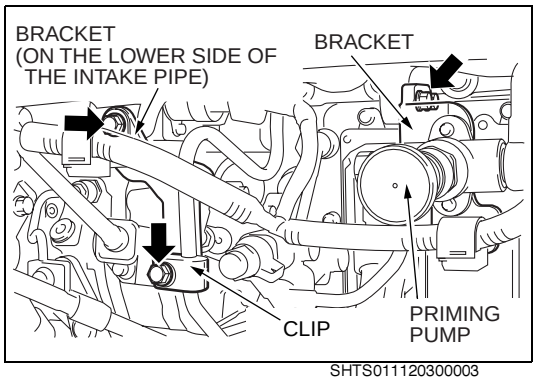
2. REMOVE THE EGR VALVE AND THE EGR PIPE.

(1) Remove the EGR valve and the EGR pipe.
Refer to the section **"EGR VALVE AND COOLER"** in the chapter **"EMISSION CONTROL"**.

3. DISCONNECT THE INTAKE PIPE (INTAKE SIDE).

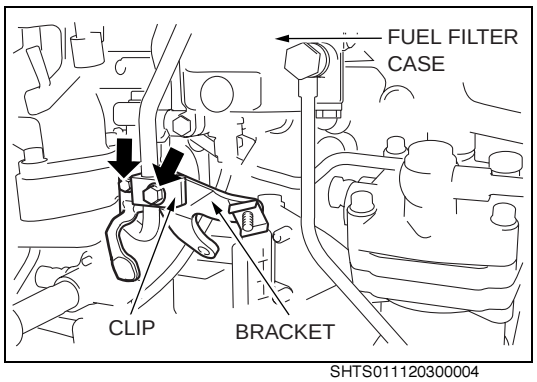
(1) Remove two bolts to remove a clip and a bracket (on the lower side of the intake pipe).

(2) Remove two bolts to remove the bracket for the priming pump.

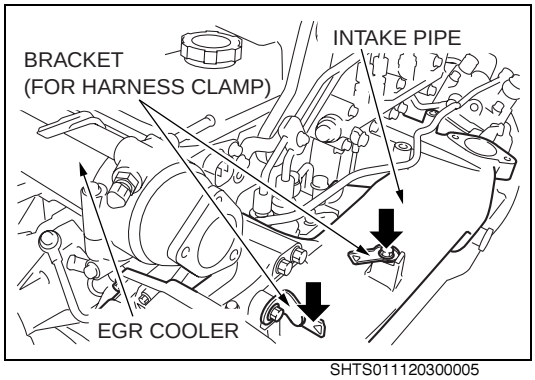


SHTS011120300003

(3) Remove two bolts to remove a clip and a bracket (on the rear side of the intake pipe).



SHTS011120300004



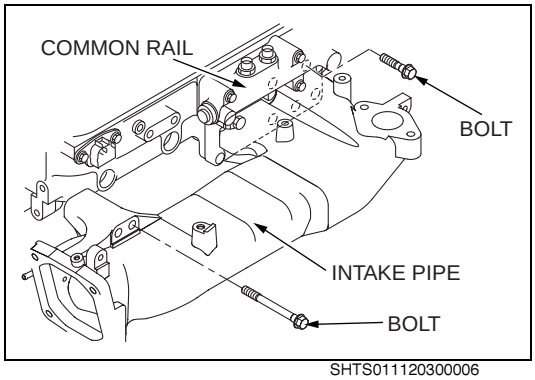
SHTS011120300005

(4) Remove two bolts to remove brackets (for harness clamp) from the intake pipe.

(5) Remove a union bolt to disconnect the coolant pipe between the coolant pump and the air compressor.
Refer to the section **"COOLANT PUMP"** in the chapter **"COOLING SYSTEM"**.

(6) Remove a union bolt to disconnect the fuel feed pipe No.5 between the supply pump and the fuel filter case.
Refer to the section **"SUPPLY PUMP"** in the chapter **"FUEL SYSTEM"**.

(7) Remove nine bolts to remove the intake pipe and a gasket from the cylinder head.



SHTS011120300006

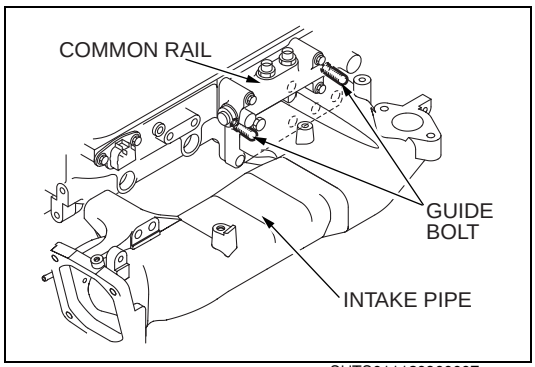
HINT
After disconnecting the intake pipe, cover an opening in the cylinder head to prevent contamination.

INSTALL THE INTAKE PIPE (INTAKE SIDE).

1. CONNECT THE INTAKE PIPE (INTAKE SIDE).

(1) Clean the inner areas of the intake manifold and of the cylinder head.

(2) Attach two guide bolts to the cylinder head in the horizontal position and align a new gasket with the installation position.

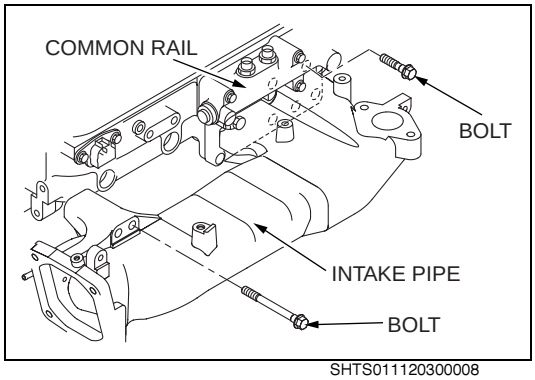


SHTS011120300007

NOTICE
Remove two guide bolts after pretightening seven mounting bolts for the intake pipe.

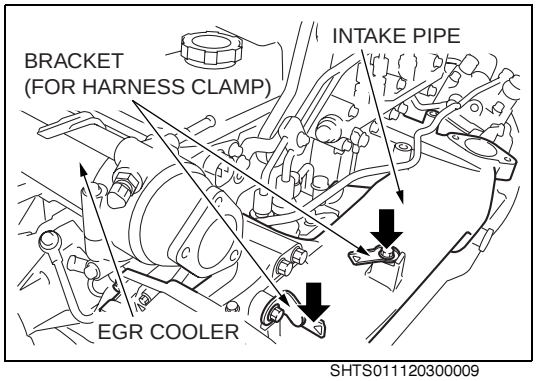
(3) Pretighten nine bolts to preconnect the intake pipe to the cylinder head.

(4) Tighten nine bolts at a specified torque.
Tightening Torque:
55 N·m {560 kgf·cm, 41 lbf·ft}



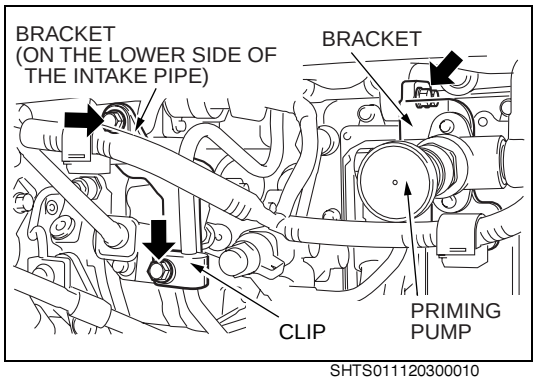
SHTS011120300008

(5) Tighten a union bolt to connect the fuel feed pipe No.5 between the supply pump and the fuel filter.
Refer to the section **"SUPPLY PUMP"** in the chapter **"FUEL SYSTEM"**.
(6) Tighten a union bolt to connect the coolant pipe between the coolant pump and the air compressor.
Refer to the section **"COOLANT PUMP"** in the chapter **"COOLING SYSTEM"**.
(7) Install the brackets (for harness clamp) to the intake pipe, and tighten two bolts.



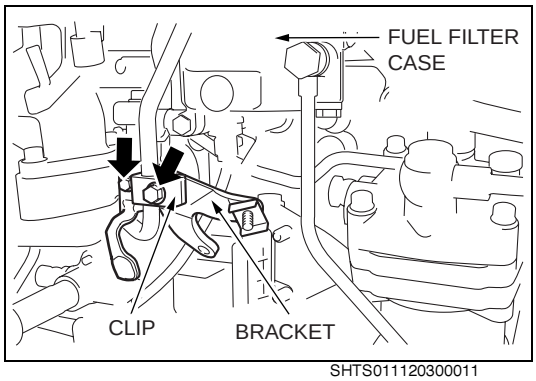
SHTS011120300009

(8) Install the bracket for the priming pump, and tighten two bolts.
(9) Fasten the clip and install the bracket (on the lower side of the intake pipe). Tighten two bolts.



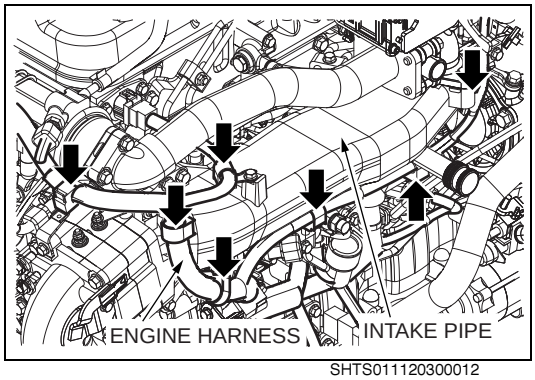
SHTS011120300010

(10) Install the bracket (on the rear side of the intake pipe), and tighten a bolt.
(11) Tighten a bolt to secure the clip.



SHTS011120300011

2. INSTALL THE EGR VALVE AND THE EGR PIPE.
(1) Install the EGR valve and the EGR pipe.
Refer to the section **"EGR VAVLE AND COOLER"** in the chapter **"EMISSION CONTROL"**.



SHTS011120300012

3. CONNECT THE HARNESS.

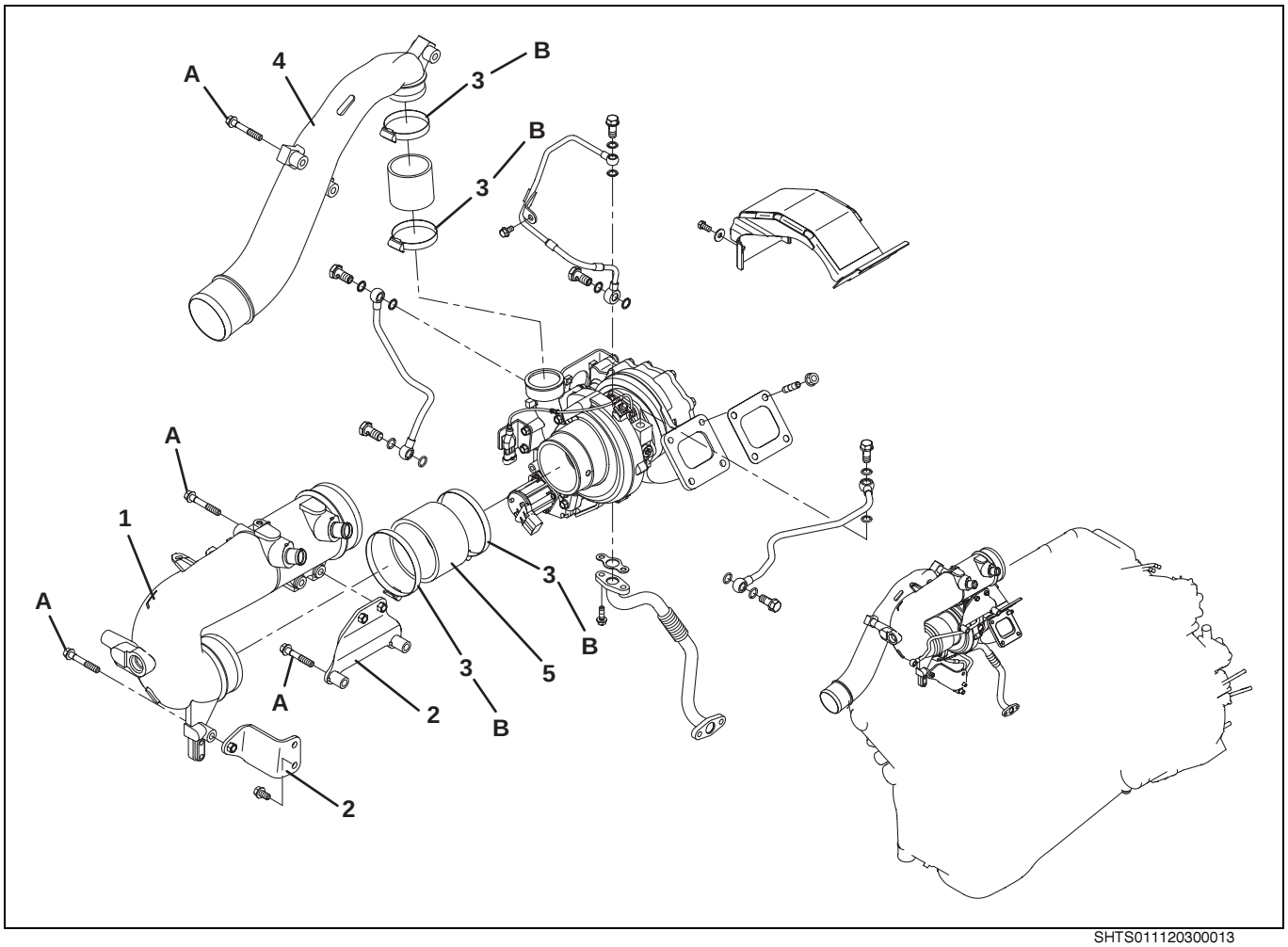
(1) Install the engine harness to the intake pipe, and fasten seven clamps.

(2) Connect the connector of the boost pressure sensor.
Refer to the section **"BOOST PRESSURE SENSOR"**.

INTAKE PIPE (EXHAUST SIDE)

COMPONENT LOCATOR

EN0111203D100002



SHTS011120300013

1	U-turn pipe	4	Boost pipe
2	Bracket	5	Air hose
3	Clamp		

Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

A	55 {560, 41}	B	5 {50, 3.7}

REPLACEMENT

EN0111203H100002

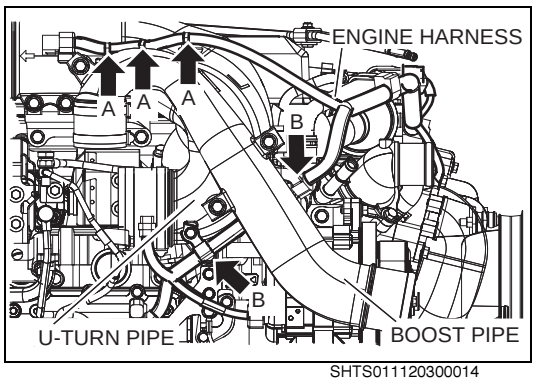
REMOVE THE INTAKE PIPE (EXHAUST SIDE).

1. REMOVE THE AIR COMPRESSOR SUCTION HOSE.

(1) Remove the air compressor suction hose.
Refer to the section **"AIR COMPRESSOR"** in the chapter **"AIR COMPRESSOR"**.

2. DISCONNECT THE HARNESS.

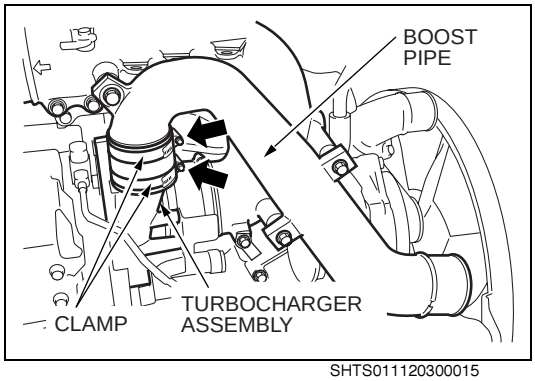
(1) Pull off three A clamps and unlock two B clamps. Disconnect the engine harness from the intake pipe (exhaust side).



SHTS011120300014

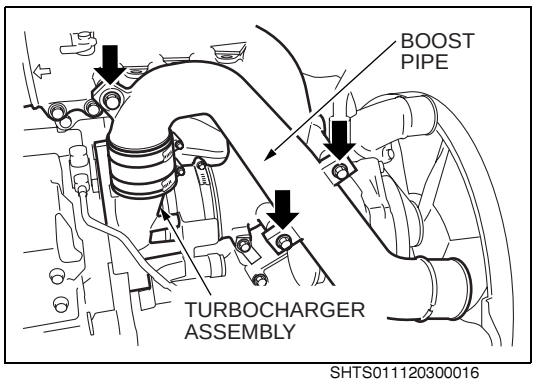
3. DISCONNECT THE INTAKE PIPE (EXHAUST SIDE).

(1) Loosen two clamps on the boost pipe.



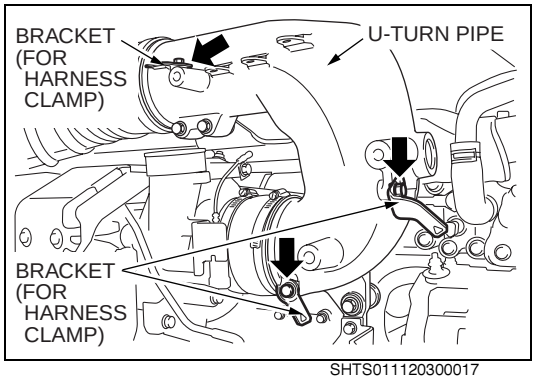
SHTS011120300015

(2) Remove three bolts to disconnect the boost pipe from the turbocharger assembly.

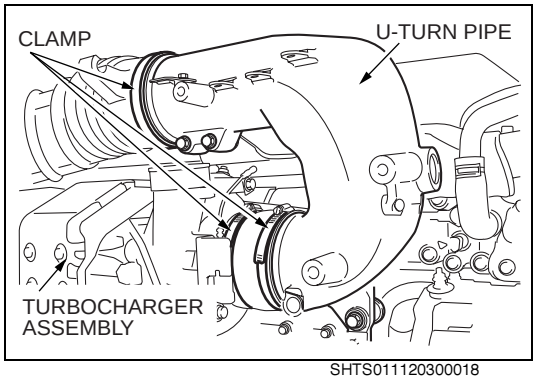


SHTS011120300016

(3) Remove three bolts to remove the brackets (for harness clamp) from the U-turn pipe.

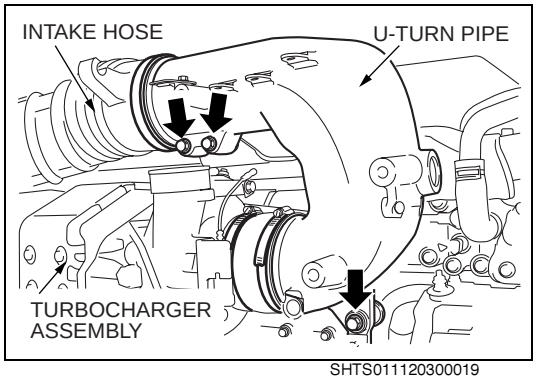


SHTS011120300017



SHTS011120300018

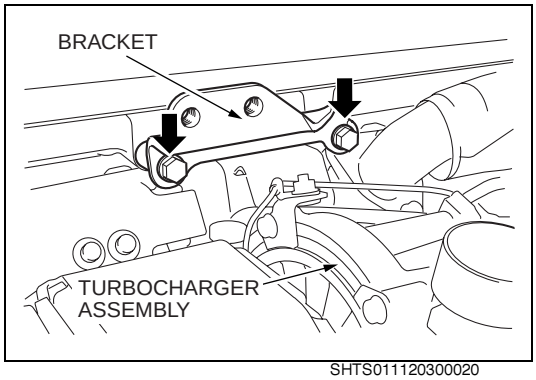
(4) Loosen three clamps on the U-turn pipe.



SHTS011120300019

(5) Remove three bolts to disconnect the U-turn pipe from the turbocharger assembly and the intake hose.

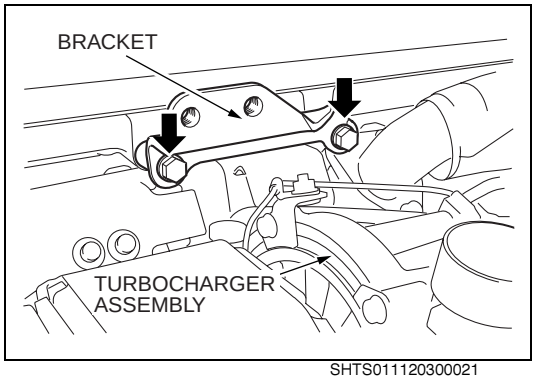
HINT
After disconnecting the U-turn pipe, cover an opening in the turbocharger assembly to prevent contamination.



SHTS011120300020

(6) Remove two bolts to remove the bracket from the cylinder head.

HINT
Do not take this step unless a trouble or failure has been found.



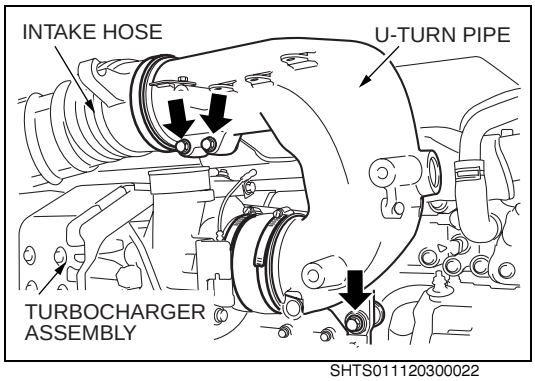
SHTS011120300021

INSTALL THE INTAKE PIPE (EXHAUST SIDE).

1. CONNECT THE INTAKE PIPE (EXHAUST SIDE).

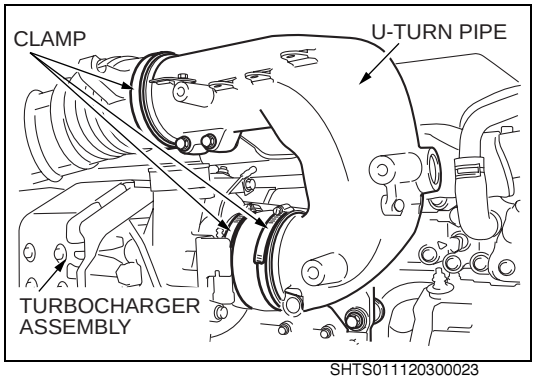
(1) Install the bracket to the cylinder head, and tighten two bolts.
Tightening Torque:
55 N·m {560 kgf·cm, 41 lbf·ft}

HINT
Omit this step if the bracket has not been removed.



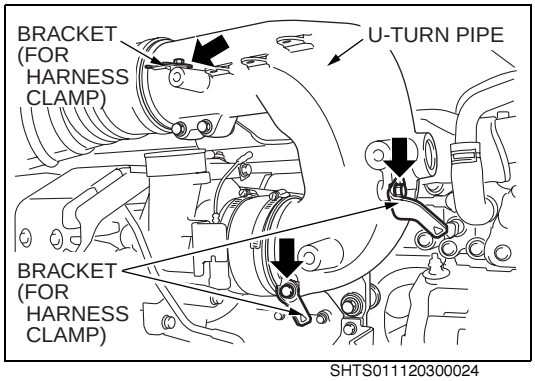
SHTS011120300022

(2) Insert the U-turn pipe into the intake hose and the turbocharger assembly, and tighten three bolts.
Tightening Torque:
55 N·m {560 kgf·cm, 41 lbf·ft}



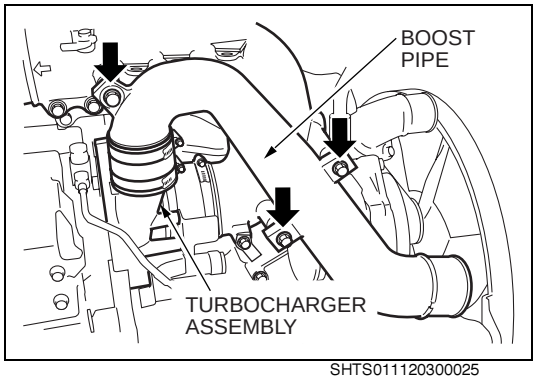
SHTS011120300023

(3) Tighten three clamps to connect the U-turn pipe to the turbocharger assembly.
Tightening Torque:
5 N·m {50 kgf·cm, 3.7 lbf·ft}



SHTS011120300024

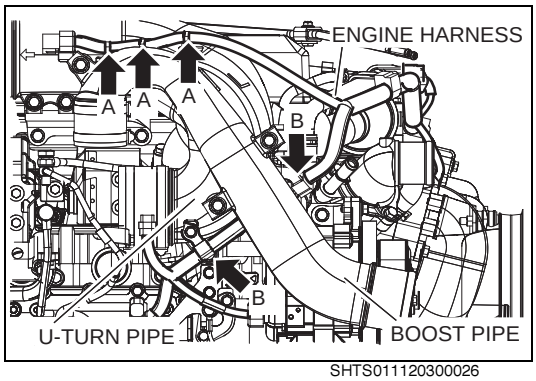
(4) Install the brackets (for harness clamp) to the U-turn pipe, and tighten three bolts.



SHTS011120300025

(5) Insert the boost pipe into the turbocharger assembly, and tighten three bolts.
Tightening Torque:
55 N·m {560 kgf·cm, 41 lbf·ft}

(6) Tighten two clamps to connect the boost pipe to the turbocharger assembly.
Tightening Torque:
5 N·m {50 kgf·cm, 3.7 lbf·ft}



SHTS011120300026

2. CONNECT THE HARNESS.

(1) Connect the engine harness to the intake pipe (exhaust side), and fasten three A clamps and two B clamps.

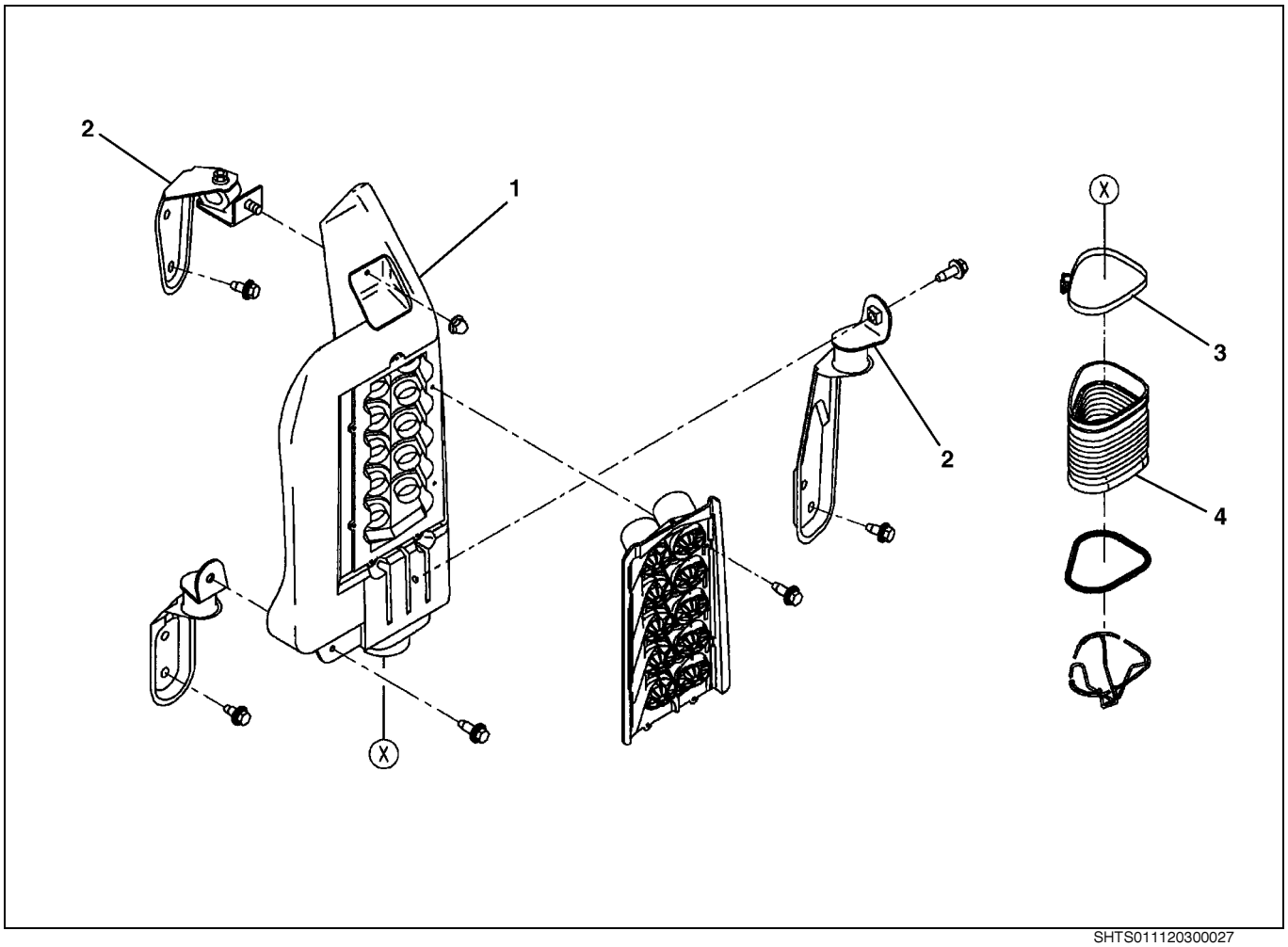
3. INSTALL THE AIR COMPRESSOR SUCTION HOSE.

(1) Install the air compressor suction hose.
Refer to the section **"AIR COMPRESSOR"** in the chapter **"AIR COMPRESSOR"**.

STACK DUCT

COMPONENT LOCATOR

EN0111203D100003

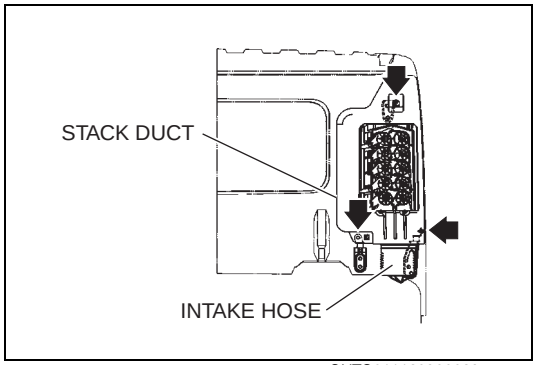


SHTS011120300027

1	Stack duct	3	Clamp
2	Bracket	4	Intake hose

REPLACEMENT

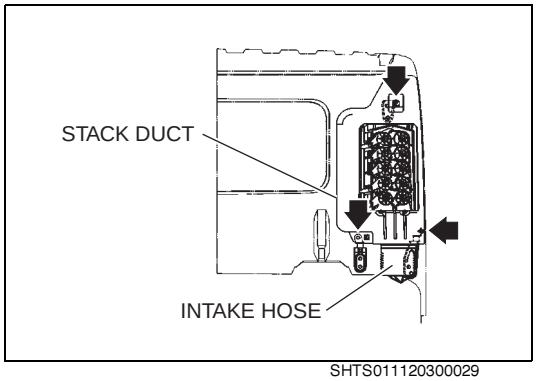
EN0111203H100003



SHTS011120300028

1. REMOVE THE STACK DUCT.

(1) Remove the bolts and nut to remove the stack duct.
(2) If necessary, remove the intake hose.



SHTS011120300029

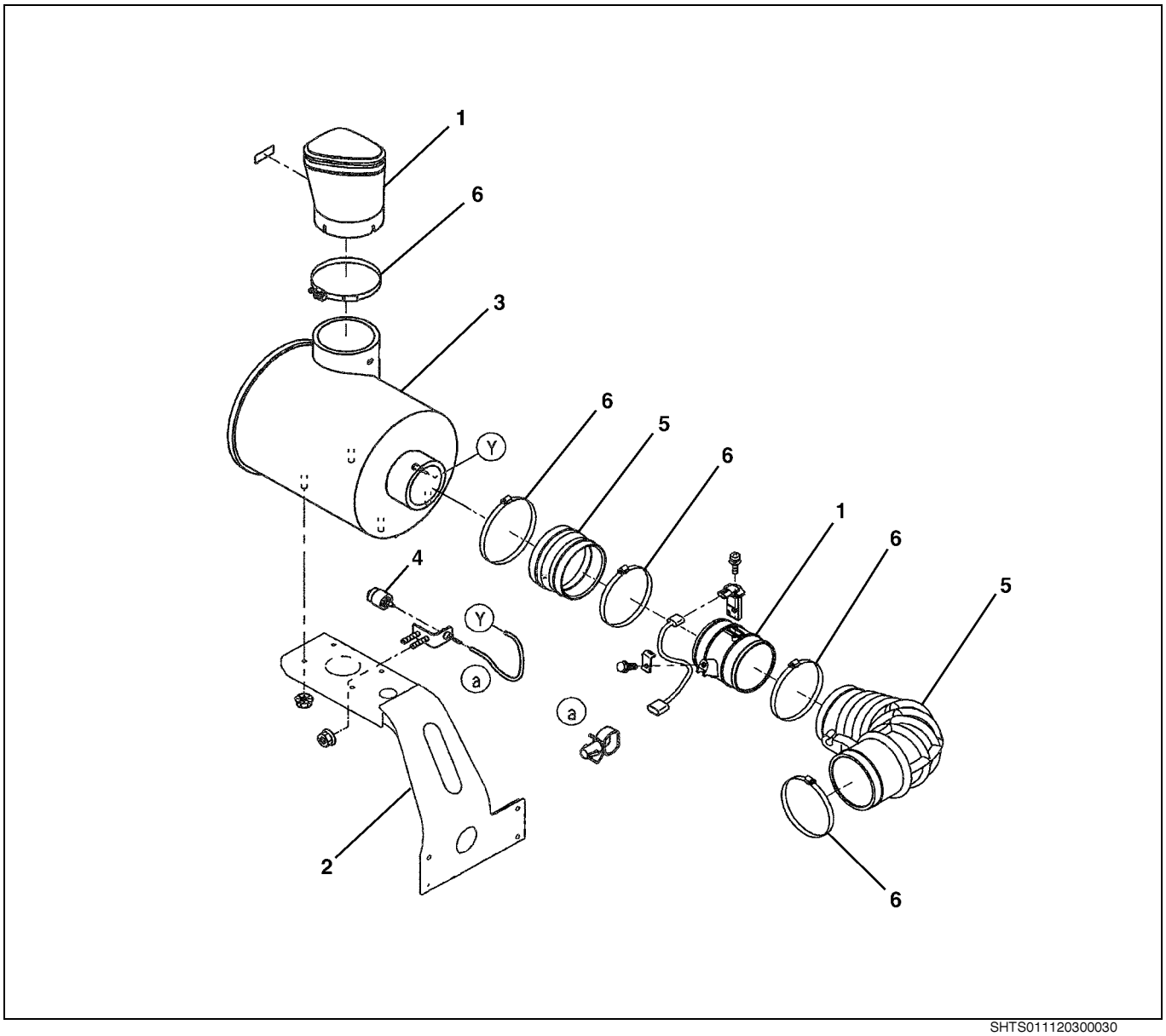
2. INSTALL THE STACK DUCT.

(1) Install the stack duct with the bolts and nut.

AIR CLEANER

COMPONENT LOCATOR

EN0111203D100004

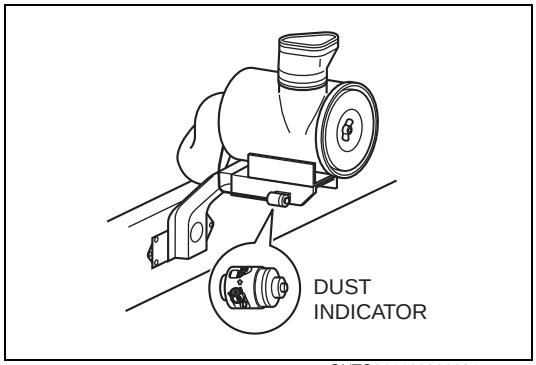


SHTS011120300030

1	Intake pipe	4	Dust indicator
2	Bracket	5	Intake hose
3	Air cleaner assembly (Dry)	6	Clamp

INSPECTION AND CLEANING

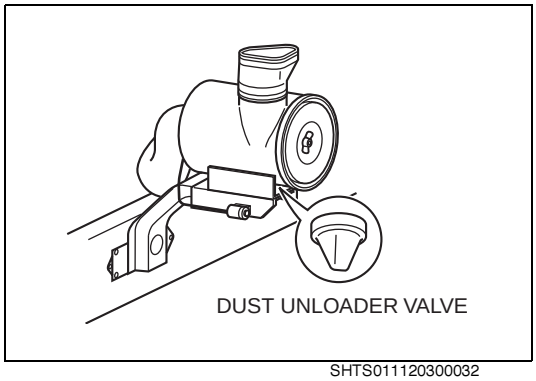
EN0111203H300001



SHTS011120300031

1. INSPECTION OF THE DUST INDICATOR

(1) If on inspection the dust indicator is red, clean or replace the air cleaner element.



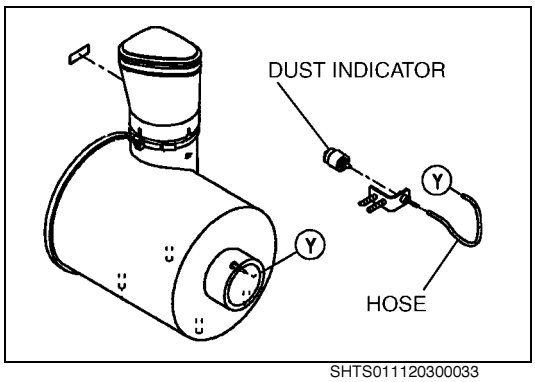
SHTS011120300032

2. CHECK THE DUST UNLOADER VALVE.

(1) Open the dust unloader valve with your fingers and remove dusts from the inner area. If damage is found, replace it.

REPLACEMENT

EN0111203H300002

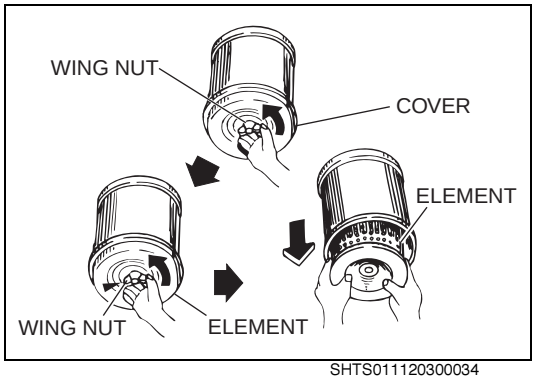


SHTS011120300033

REMOVE THE AIR CLEANER ELEMENT AND THE AIR CLEANER CASE.

1. REMOVE THE DUST INDICATOR.

(1) Remove the hose and bolt to remove the dust indicator.

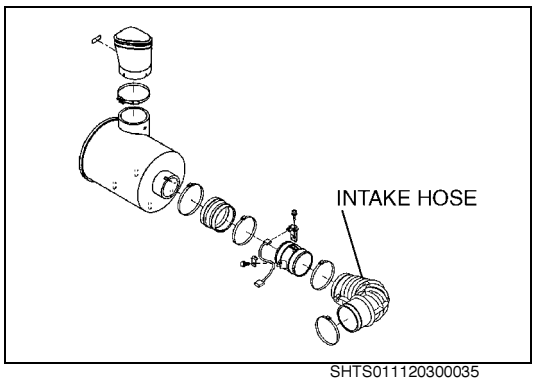


SHTS011120300034

2. REMOVE THE AIR CLEANER CASE.

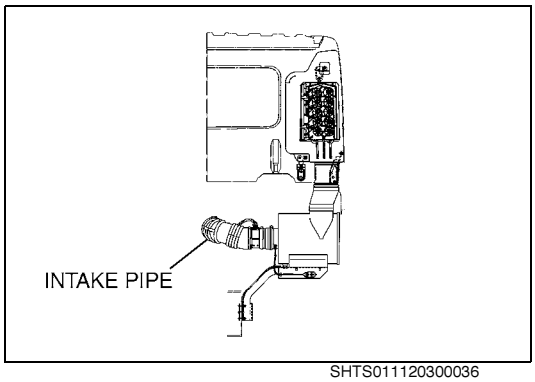
(1) Remove the wing nut to remove the cover.

(2) Remove the wing nut to remove the element.



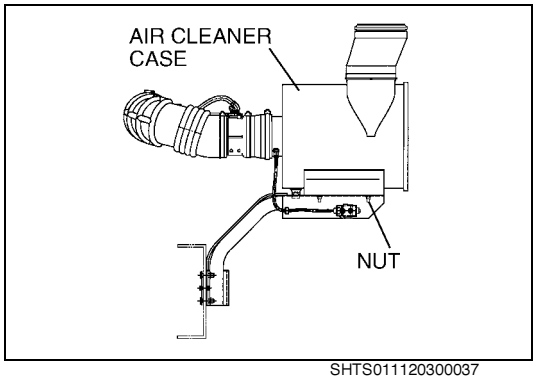
SHTS011120300035

(3) Hold a protrudent outer periphery at the end of the air cleaner element and slightly turn it to remove the air cleaner element.



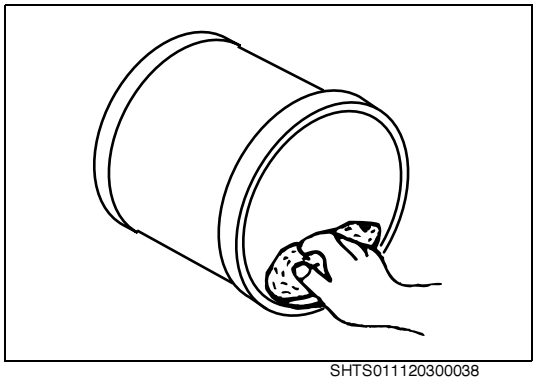
SHTS011120300036

(4) Loosen a clamp to disconnect the intake pipe connected to the air cleaner case.



SHTS011120300037

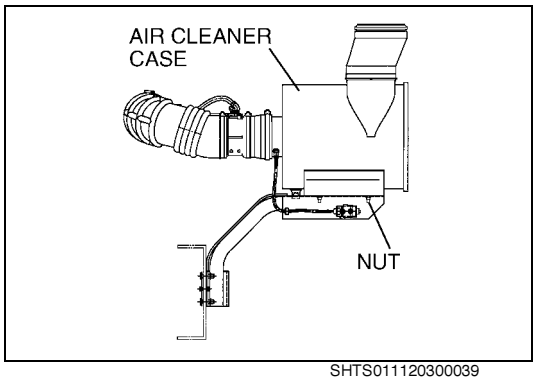
(5) Remove the nut to remove the air cleaner case.


SHTS011120300038

INSTALL THE AIR CLEANER ELEMENT AND THE AIR CLEANER CASE.

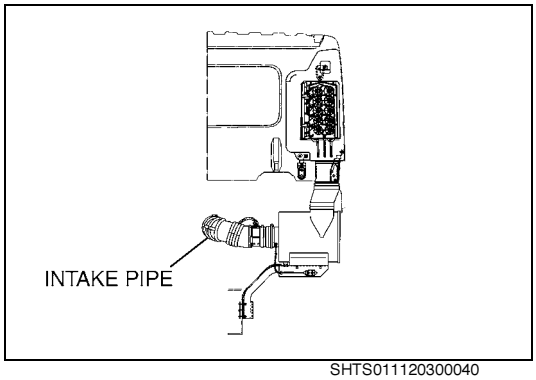
1. INSTALL THE AIR CLEANER CASE.

(1) Use a waste to clean the air cleaner cap and the inner area of the case.



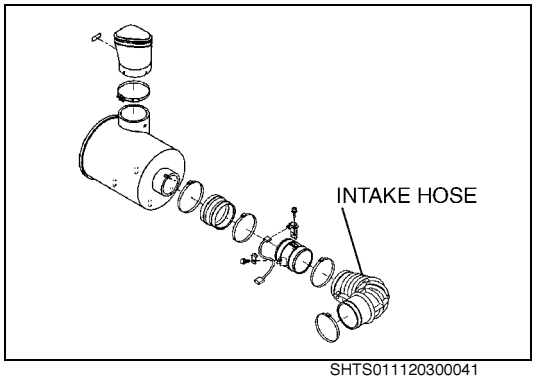
SHTS011120300039

(2) Install the air cleaner case, and tighten the nut.
Tightening Torque:
18-26 N·m {184-264 kgf·cm, 14-19 lbf·ft}



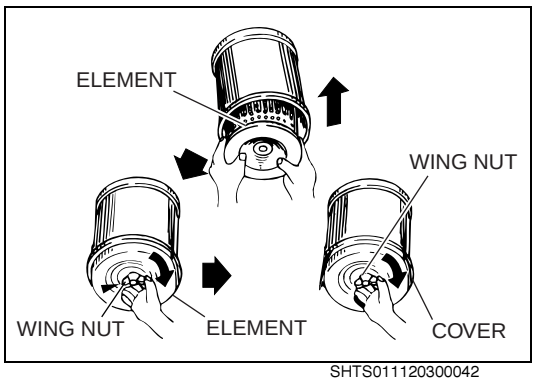
SHTS011120300040

(3) Insert the intake pipe into the air cleaner case and fix it with clamp.
Tightening Torque:
2.5-3.5 N·m {26-36 kgf·cm, 1.9-2.5 lbf·ft}



SHTS011120300041

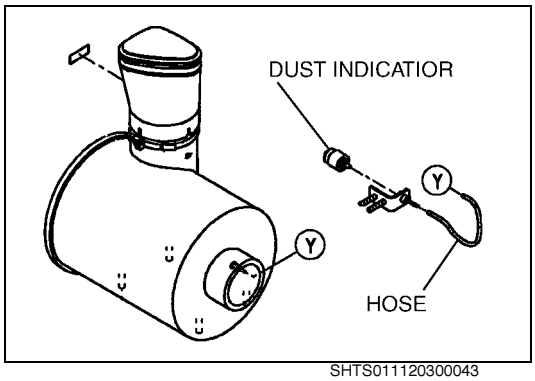
(4) Insert the intake hose connected to the air cleaner case and fix it with clamp.
Tightening Torque:
2.5-3.5 N·m {26-36 kgf·cm, 1.9-2.5 lbf·ft}



SHTS011120300042

(5) Insert the element into the case and fix it with wing nut.

(6) Install the cover to the case with the wing nut.



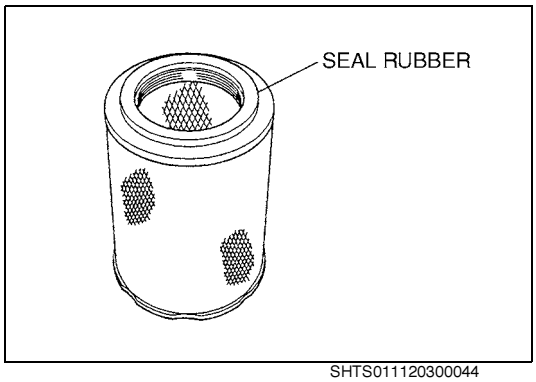
SHTS011120300043

2. INSTALL THE DUST INDICATOR.

(1) Install the dust indicator with bolt and connect the hose.

CLEANING OF THE AIR CLEANER ELEMENT

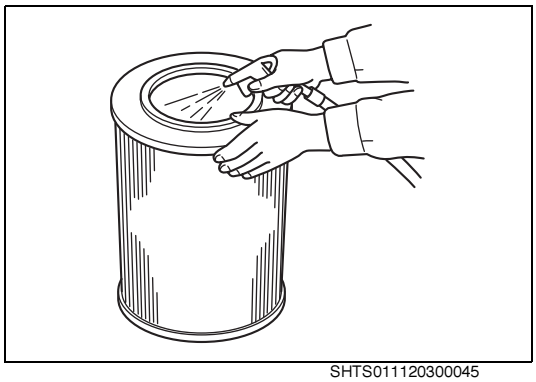
EN0111203H300003



SHTS011120300044

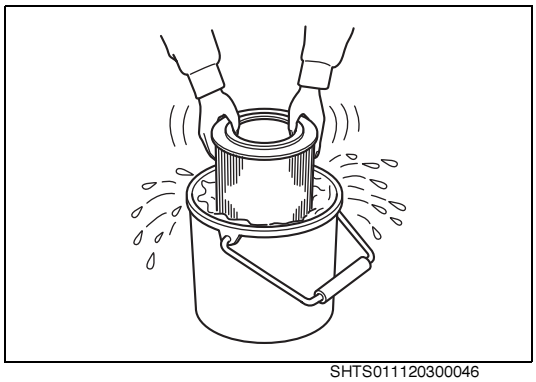
1. DRY TYPE

(1) Check the seal rubber for damage.
If a trouble is found, replace the air cleaner element.


SHTS011120300045

(2) If dry dusts are found, blow compressed air (688 kPa {7 kgf/cm^2, 100 lbf/in.^{2}} or less) to the inner wall of the air cleaner element to remove dusts.

⚠ CAUTION
In removing dust, do not flick the air cleaner element or whip the air cleaner element against the floor.


SHTS011120300046

(3) If soot or oil is sticking, immerse the element in commercially available element cleanser or diluted neutral detergent, to remove soot and oil.

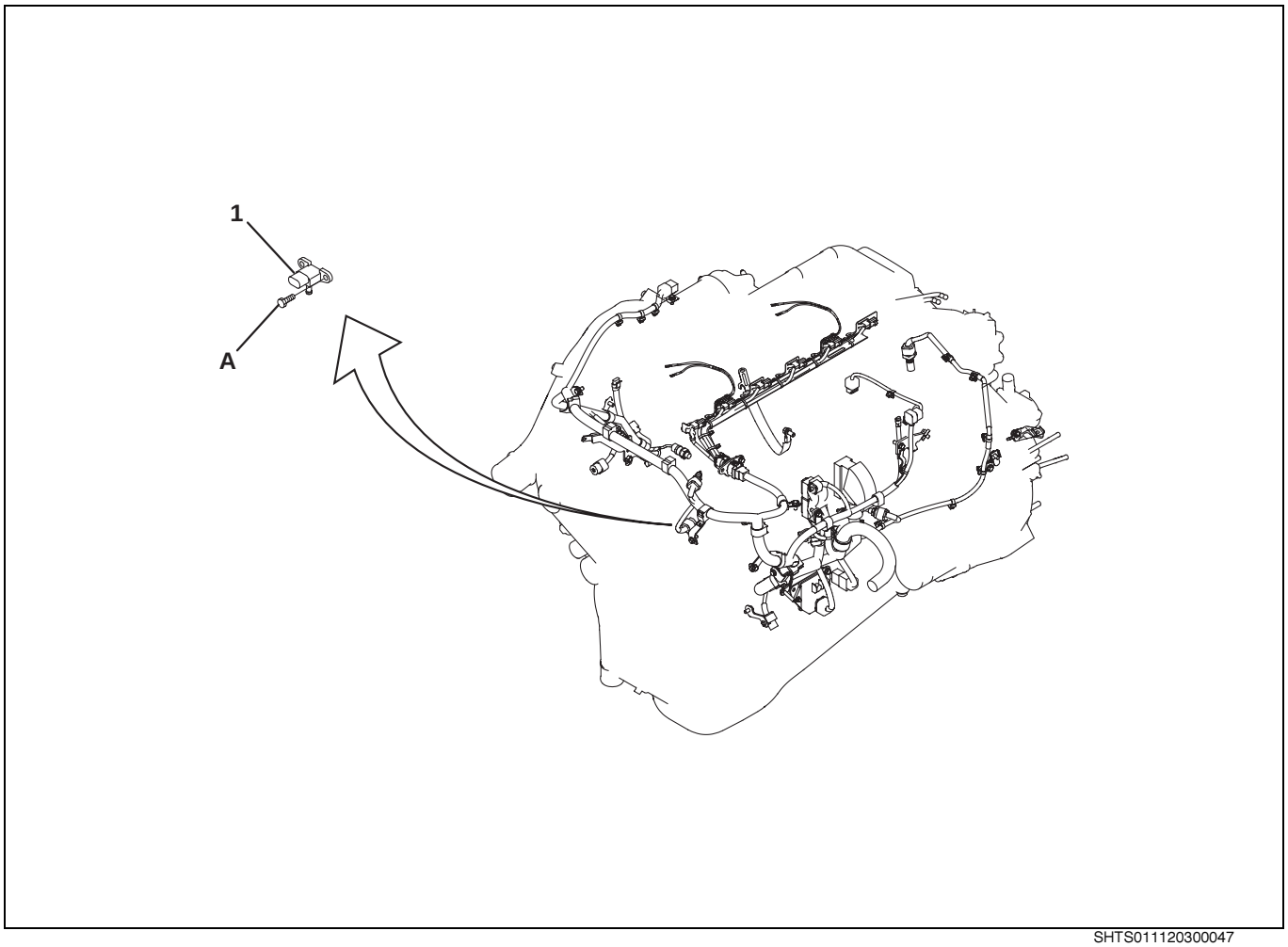
NOTICE

- **If neutral detergent is used, immerse the element for approximately 30 min.**
- **After cleaning, rinse the element well with running water.**
- **If a drying oven is used to dry the element, keep a temperature at 80°C {176°F} or less.**
- **Do not install an undried element in the vehicle.**
- **After drying out, check the element and the seal rubber for damage.**
- **Check that no dirt has run into the inner area.**

BOOST PRESSURE SENSOR

COMPONENT LOCATOR

EN0111203D100005



SHTS011120300047

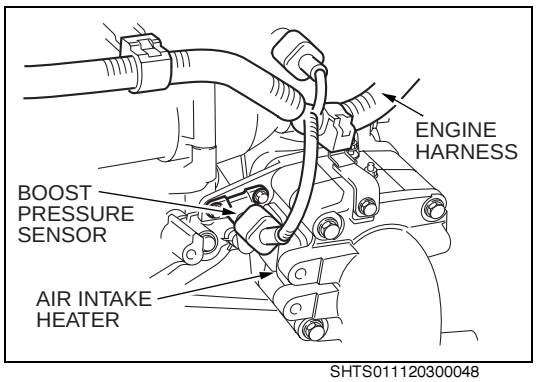
1 Boost pressure sensor	

Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

A 10 {102, 7.3}	

REPLACEMENT

EN0111203H300004

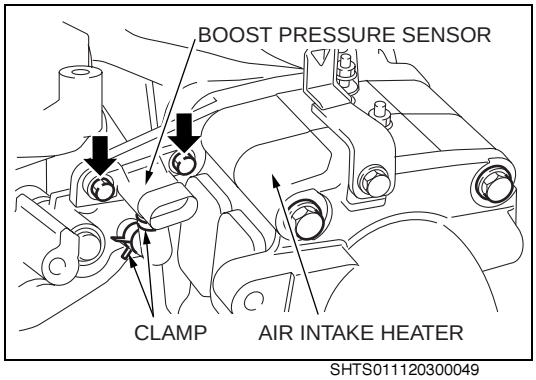


SHTS011120300048

REMOVE THE BOOST PRESSURE SENSOR.

1. DISCONNECT THE HARNESS.

(1) Disconnect the connector of the boost pressure sensor.

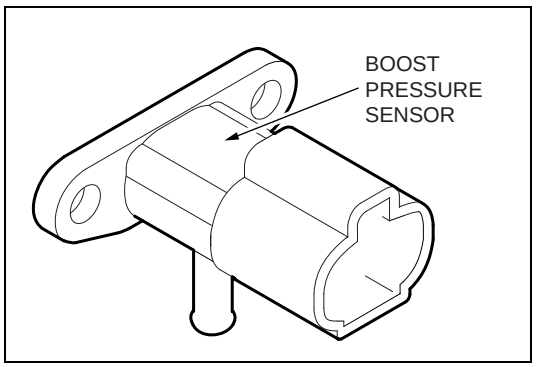


SHTS011120300049

2. REMOVE THE BOOST PRESSURE SENSOR.

(1) Remove two clamps to remove the hose from the boost pressure sensor.

(2) Remove two bolts to remove the boost pressure sensor from the intake pipe.

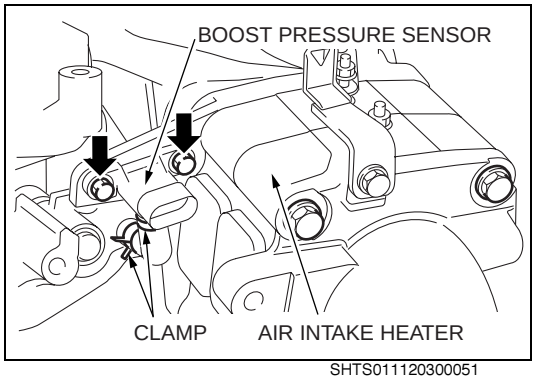


SHTS011120300050

COMPONENT CHECK

1. COMPONENT CHECK

(1) Use the Hino-DX to check the boost pressure sensor.



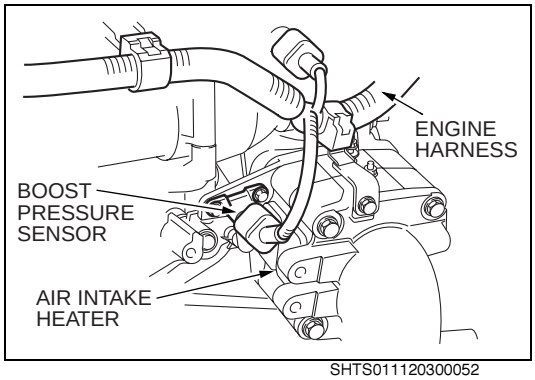
SHTS011120300051

INSTALL THE BOOST PRESSURE SENSOR.

1. INSTALL THE BOOST PRESSURE SENSOR

(1) Install the boost pressure sensor to the intake pipe, and tighten two bolts.
Tightening Torque:
10 N·m {102 kgf·cm, 7.3 lbf·ft}

(2) Insert a hose into the boost pressure sensor, and fasten two clamps.



SHTS011120300052

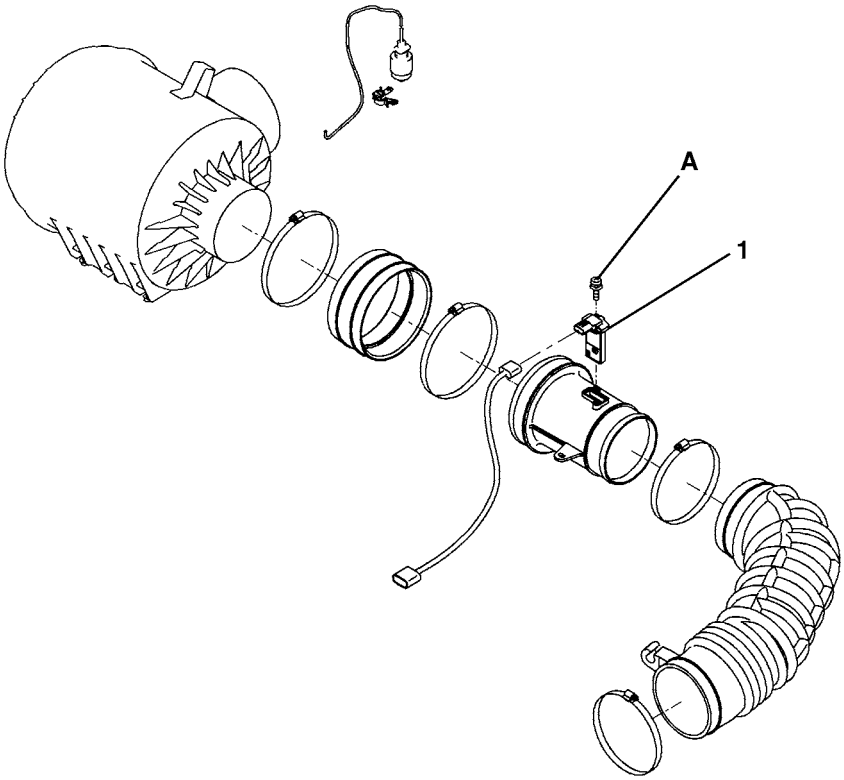
2. CONNECT THE HARNESS.

(1) Connect the connector of the boost pressure sensor.

AIR FLOW SENSOR

COMPONENT LOCATOR

EN0111203D100006



SHTS011120300053

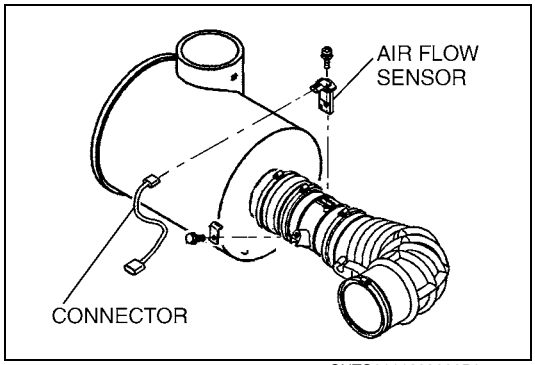
1 Air flow sensor	

Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

A 1.17-1.77 {12-17, 0.9-1.3}	

REPLACEMENT

EN0111203H300005

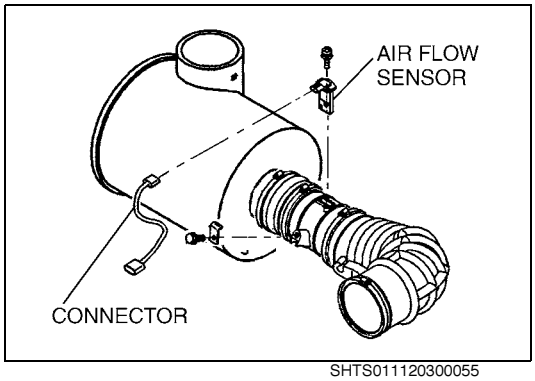


SHTS011120300054

1. REMOVE THE AIR FLOW SENSOR.

(1) Disconnect the connector of the air flow sensor.

(2) Remove a bolt to remove the air flow sensor.



SHTS011120300055

2. ISNTALL THE AIR FLOW SENSOR.

(1) Install the air flow sensor, and tighten a bolt.
Tightening Torque:
1.17-1.77 N·m {12-18 kgf·cm, 0.9-1.3 lbf·ft}

NOTICE

- **Do not apply an excessive torque in tightening the mounting bolt (M4) for air flow sensor.**
- **The connector of the air flow sensor must be positioned in the frontward direction of the vehicle.**

(2) Connect the connector of the air flow sensor.

INSPECTION

EN0111203H300006

COMPONENT CHECK

1. CHECKING THE AIR FLOW SENSOR (INTAKE AIR FLOW CHECK/ADJUSTMENT WITH HINO-DX)

NOTICE

The air flow sensor is one of fundamental components in the "EGR system (exhaust gas recirculation system)", and must be checked when a vehicle is delivered (1-year check).

HINT

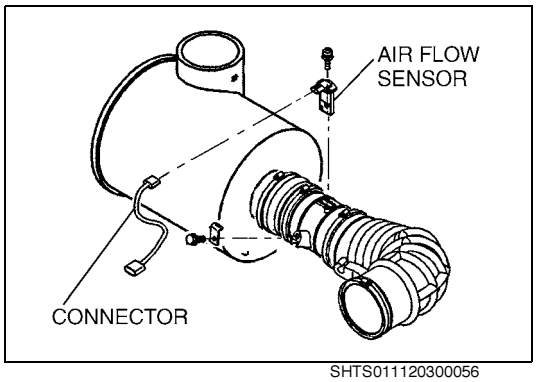
- **This vehicle employs an air flow sensor as one of components in the EGR system.**
- **If a check result obtained through this step does not fall within the specified limits, make replacement with a new air flow sensor.**

(1) Before start of checking, clean the air cleaner element or make replacement with a new element.
Arrange a new air flow sensor, aside from the onboard air flow sensor.
(2) Set the Hino-DX in place.
(3) Use the "onboard air flow sensor" to measure an intake air flow at the NMR (see the "Reference:" below) in accordance with the procedures for "intake air flow measurement" with the Hino-DX. -- (A)

HINT

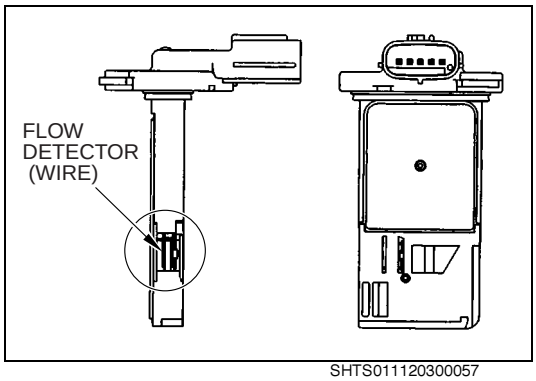
NMR = No load Maximum Revolution (max rpm at no load)

(4) Make sure of safety in the site where this measurement takes place. After the engine is fully warmed up, apply the accelerator at a full stroke and stabilize an engine speed (keep applying the accelerator). Keep this condition and record the "Engine Speed (r/min)" and the "Intake Air Flow (g/sec)" on the computer screen.
(5) Stop the engine and set the starter switch to the "LOCK" position. Then, disconnect a connector from the air flow sensor and remove the air flow sensor body from the intake pipe.



SHTS011120300056

(6) After installing a new air flow sensor, make sure to connect a connector.
(7) Take the same step as in the step (3) above with a new air flow sensor and measure an intake air flow. -- (B)
(8) Check whether air flow sensor characteristics show degradation.
   a. If an air flow measured on the onboard air flow sensor is lower than that on a new air flow sensor by 10% or greater (see the equation below), the onboard air flow sensor have some degradation. Keep a new air flow sensor installed and recover the vehicle to finish this check.
   Equation: {(B) - (A)} / (B) x 100 > 10
   b. If both air flow sensors show an equivalent air flow, the onboard air flow sensor is properly functioning. Reinstall an originally installed air flow sensor and finish this check.



SHTS011120300057

⚠ CAUTION

- **Do not touch the flow detector (wire) as this detector is very sensitive and precise. Directly touching the flow detector (wire) will cause damages.**
- **Do not apply an excessive torque in tightening the mounting bolt (M4) for air flow sensor.**

Tightening Torque:
1.17-1.77 N·m {12-18 kgf·cm, 0.9-1.3 lbf·ft}

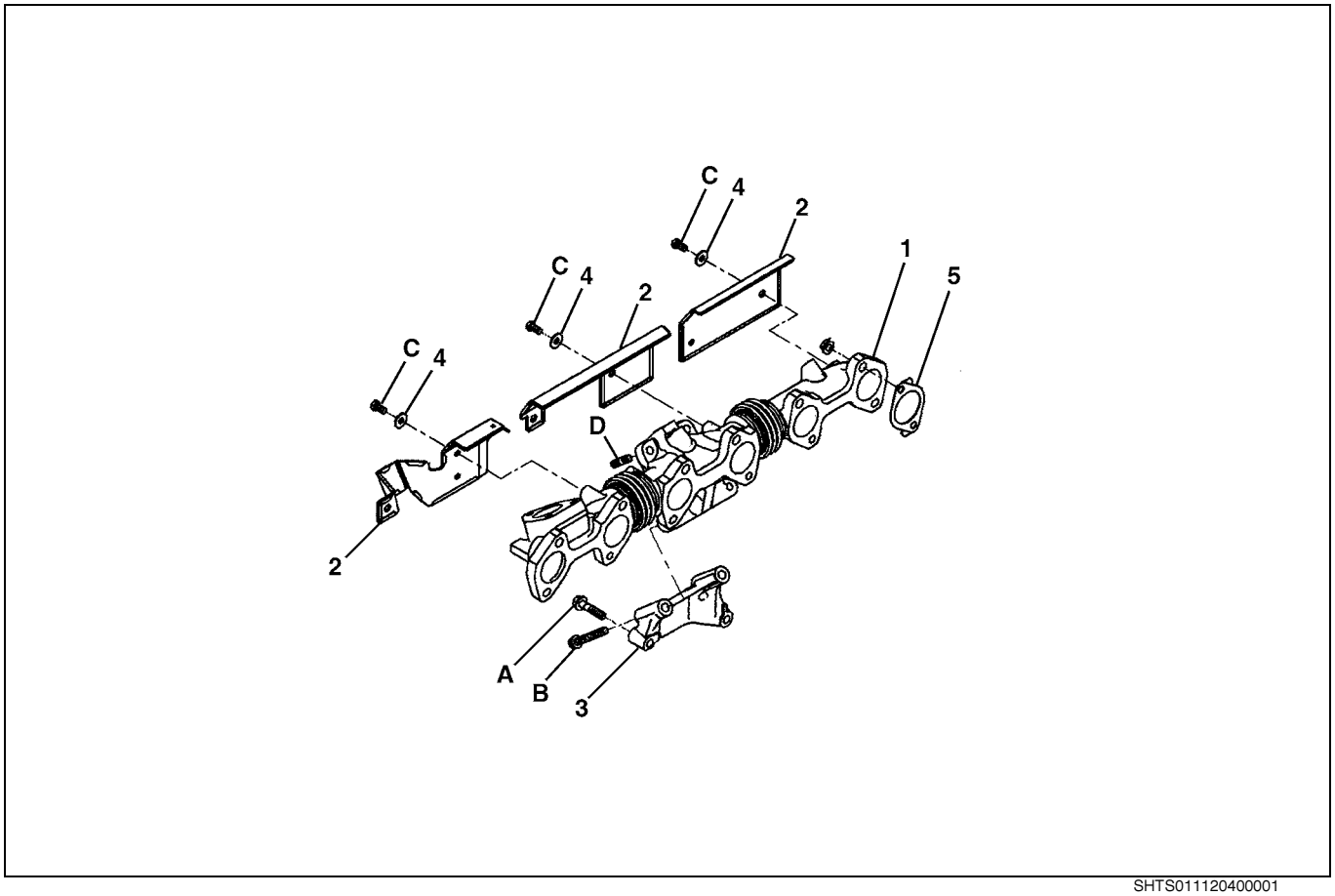
EXHAUST SYSTEM (A09C)

EN04-001

EXHAUST MANIFOLD

COMPONENT LOCATOR

EN0111204D100001



SHTS011120400001

1	Exhaust manifold	4	Washer
2	Insulator	5	Gasket
3	Exhaust manifold bracket		

Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

A	68.5 {700, 51}	C	25 {255, 18}
B	44.1 {450, 33} (1st time)	D	30 {305, 22}
	74.5 {760, 55} (2nd time)		

REPLACEMENT

EN0111204H100001

REMOVE THE EXHAUST MANIFOLD.

1. REMOVE THE EGR COOLER.

(1) Remove the EGR cooler.
Refer to the section **"EGR VALVE AND COOLER"** in the chapter **"EMISSION CONTROL"**.

2. REMOVE THE INTAKE PIPE (EXHAUST SIDE).

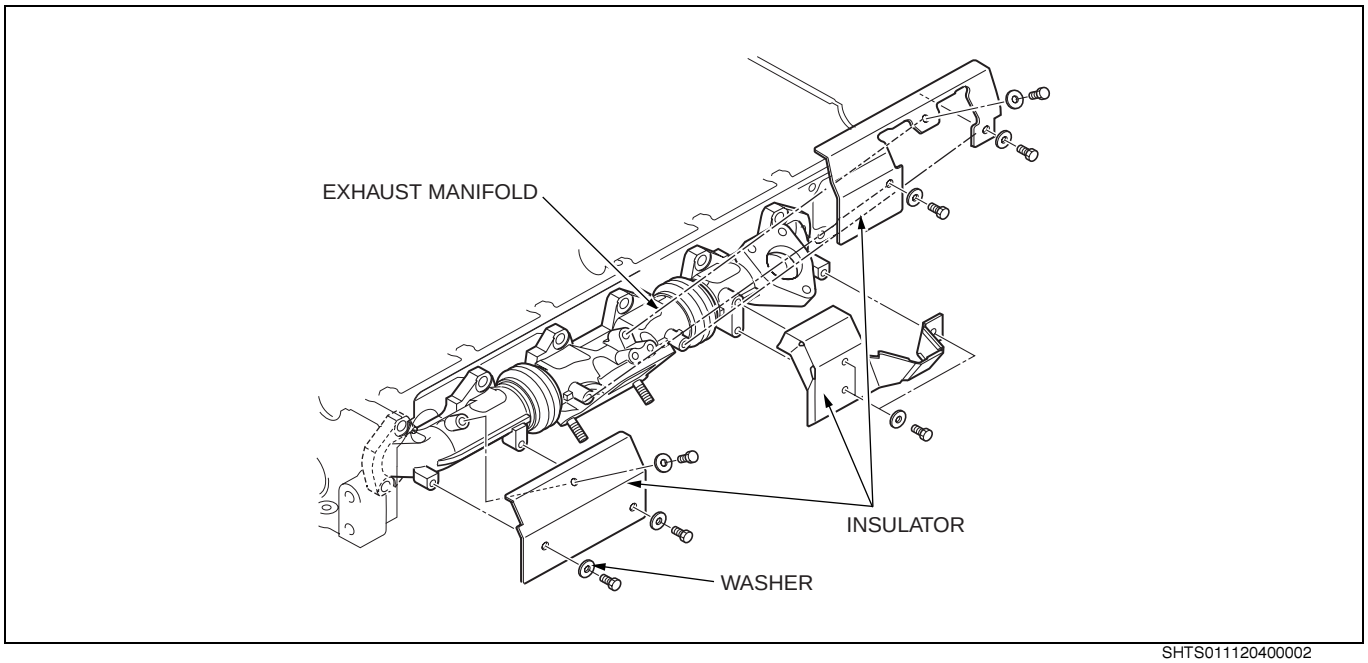
(1) Remove the U-turn pipe and boost pipe.
Refer to the section **"INTAKE PIPE (EXHAUST SIDE)"** in the chapter **"AIR INTAKE SYSTEM"**.

3. REMOVE THE TURBOCHARGER.

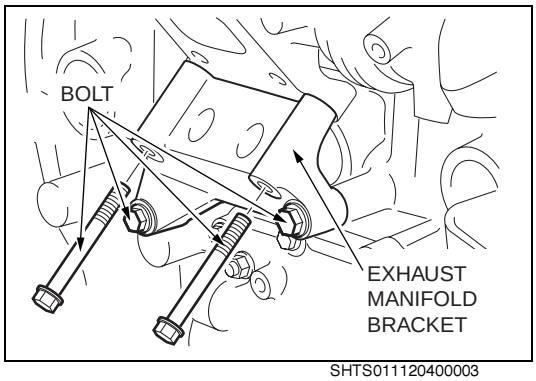
(1) Remove the turbocharger assembly.
Refer to the section **"TURBOCHARGER"** in the chapter **"TURBOCHARGER"**.

4. REMOVE THE EXHAUST MANIFOLD.

(1) Remove nine bolts to remove three insulators and washers from the exhaust manifold.



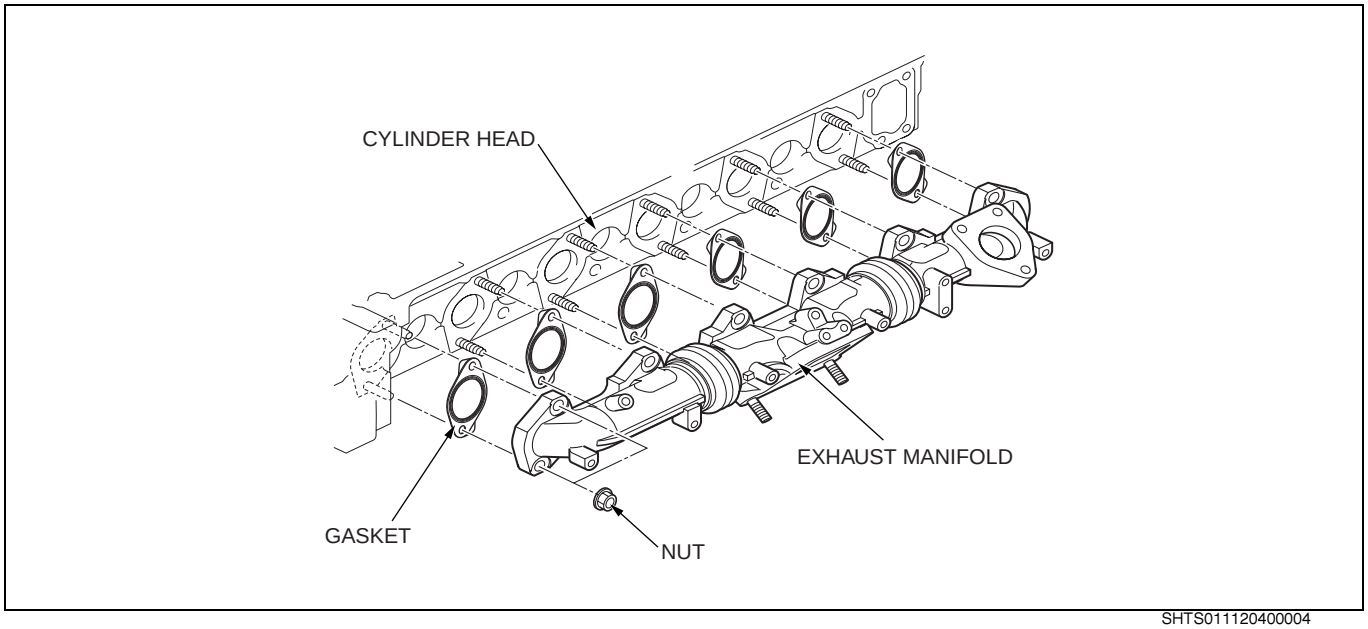
SHTS011120400002



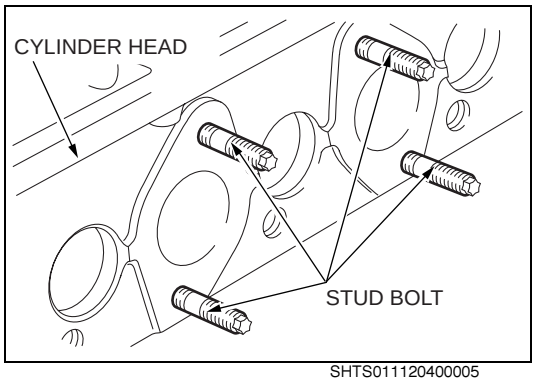
SHTS011120400003

(2) Remove four bolts to remove the exhaust manifold bracket from the cylinder block.

(3) Remove twelve nuts to remove the exhaust manifold from the cylinder head.



SHTS011120400004

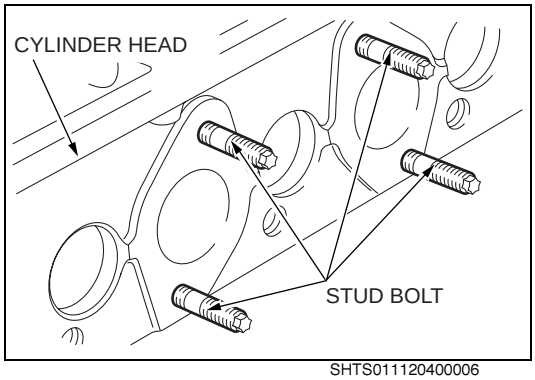


SHTS011120400005

5. REMOVE THE STUD BOLT.

(1) If corrosion is found in stud bolts (twelve bolts), use a torx socket or a commercially available bolt remover to remove corroded bolts.

(2) After removing debris (sealant, etc.) from female threads on the cylinder head side, use a tap (M10x1.5) again to clean the threads.



SHTS011120400006

INSTALL THE EXHAUST MANIFOLD.

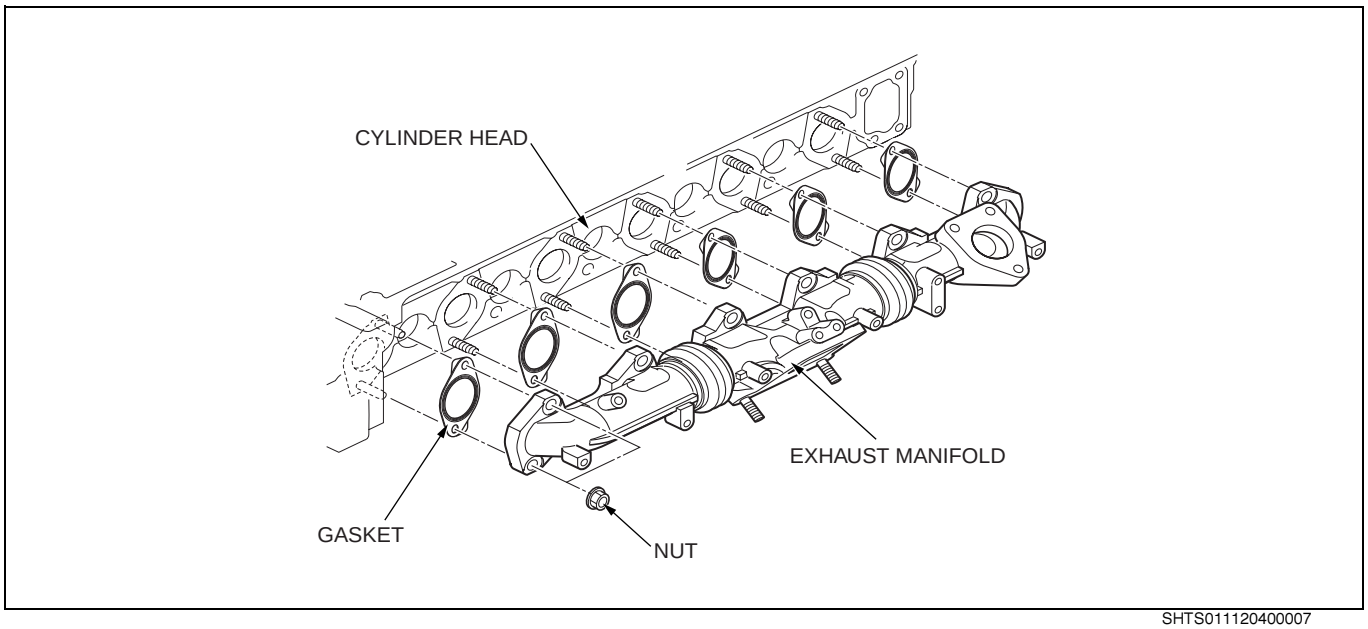
1. INSTALL THE STUD BOLT.

(1) Using a torx socket, tighten new stud bolts.
Tightening Torque:
30 N·m {305 kgf·cm, 22 lbf·ft}

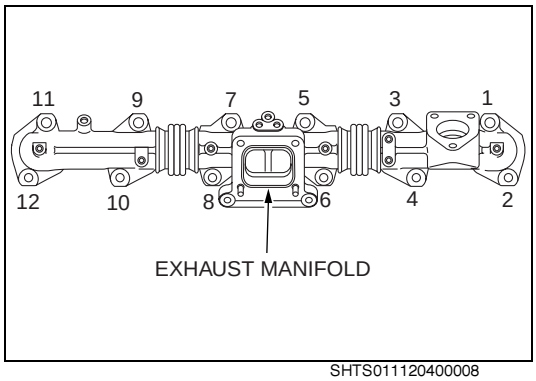
⚠ CAUTION
Do not tighten the stud bolts to an overtorque. Otherwise, the cylinder head might be cracked.

2. INSTALL THE EXHAUST MANIFOLD.

(1) Replace the gasket with new one and match the exhaust manifold with the installation position.

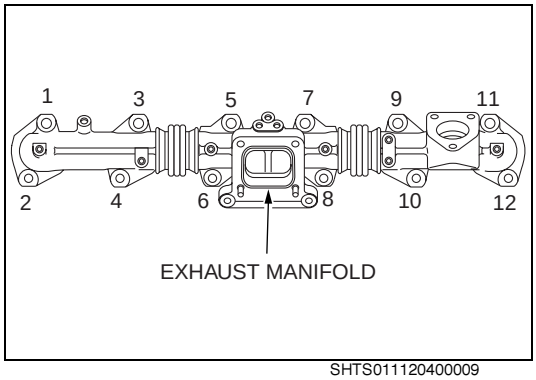


SHTS011120400007



SHTS011120400008

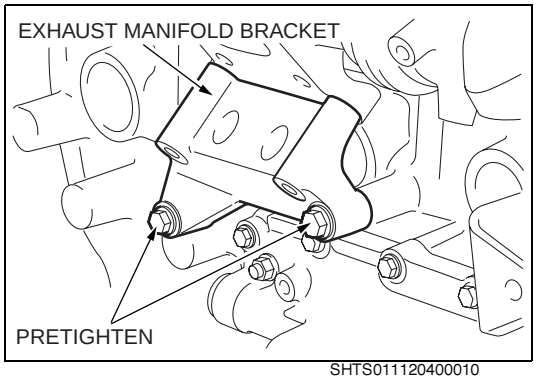
(2) Tighten twelve nuts in the order shown in the figure.
Tightening Torque:
44.1 N·m {450 kgf·cm, 33 lbf·ft}



SHTS011120400009

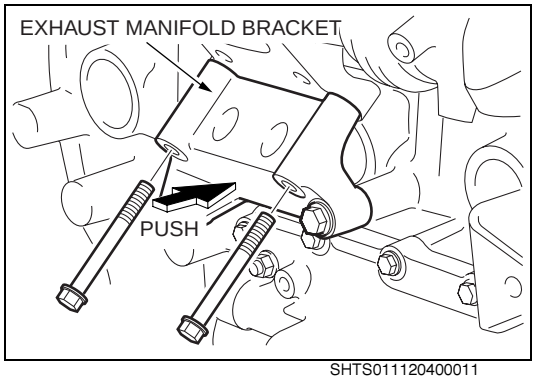
(3) Tighten twelve nuts in the order shown in the figure again.
Tightening Torque:
74.5 N·m {760 kgf·cm, 55 lbf·ft}

NOTICE
Be sure to tighten the nuts twice.



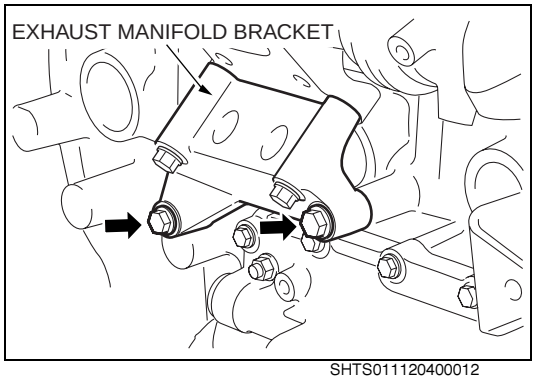
SHTS011120400010

(4) Pretighten bolts in the lower area of the exhaust manifold bracket on the cylinder block side.



SHTS011120400011

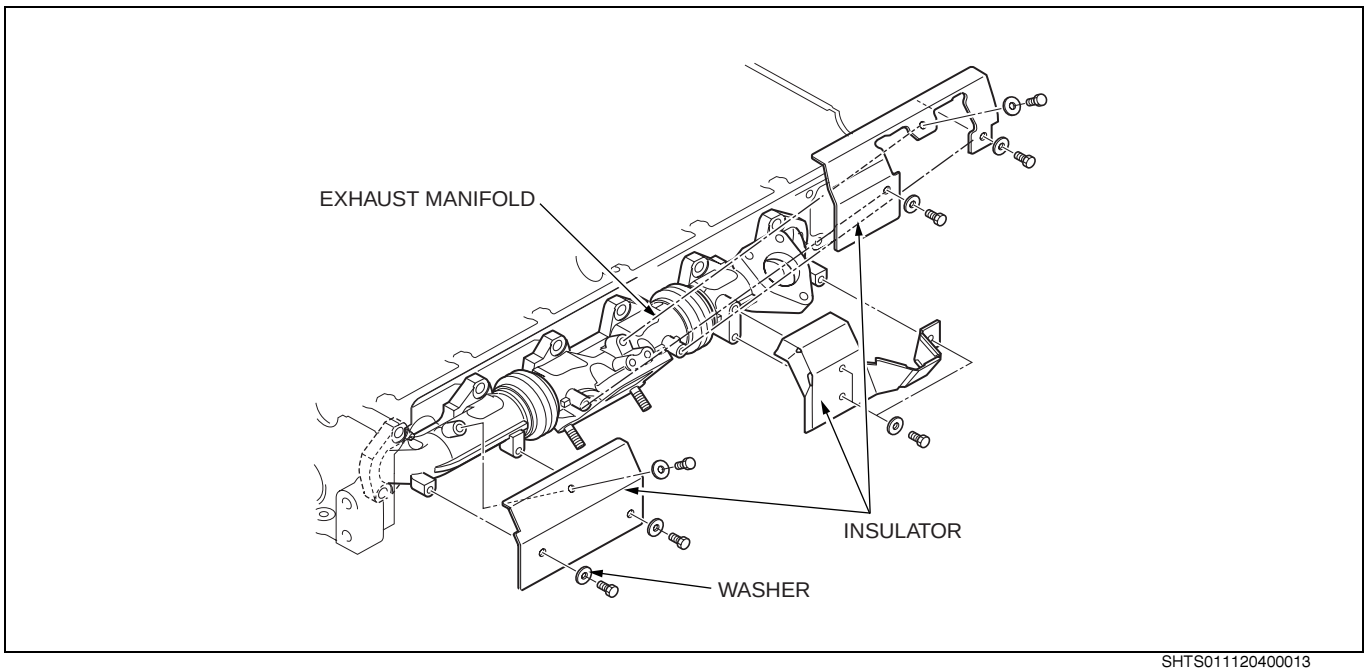
(5) Hold the exhaust manifold bracket against the cylinder block, and tighten the bolts on the exhaust manifold side.
Tightening Torque:
68.5 N·m {700 kgf·cm, 51 lbf·ft}



SHTS011120400012

(6) Tighten the pretightened bolts in the lower area of the exhaust manifold bracket on the cylinder block side.
Tightening Torque:
68.5 N·m {700 kgf·cm, 51 lbf·ft}

(7) Replace the washer with new one. Install three insulators to the exhaust manifold, and tighten nine bolts.
Tightening Torque:
25 N·m {255 kgf·cm, 18 lbf·ft}



SHTS011120400013

3. INSTALL THE TURBOCHARGER.

(1) Install the turbocharger assembly.
Refer to the section **"TURBOCHARGER"** in the chapter **"TURBOCHARGER"**.

4. INSTALL THE INTAKE PIPE (EXHAUST SIDE).

(1) Install the U-turn pipe and the boost pipe.
Refer to the section **"INTAKE PIPE (EXHAUST SIDE)"** in the chapter **"AIR INTAKE SYSTEM"**.

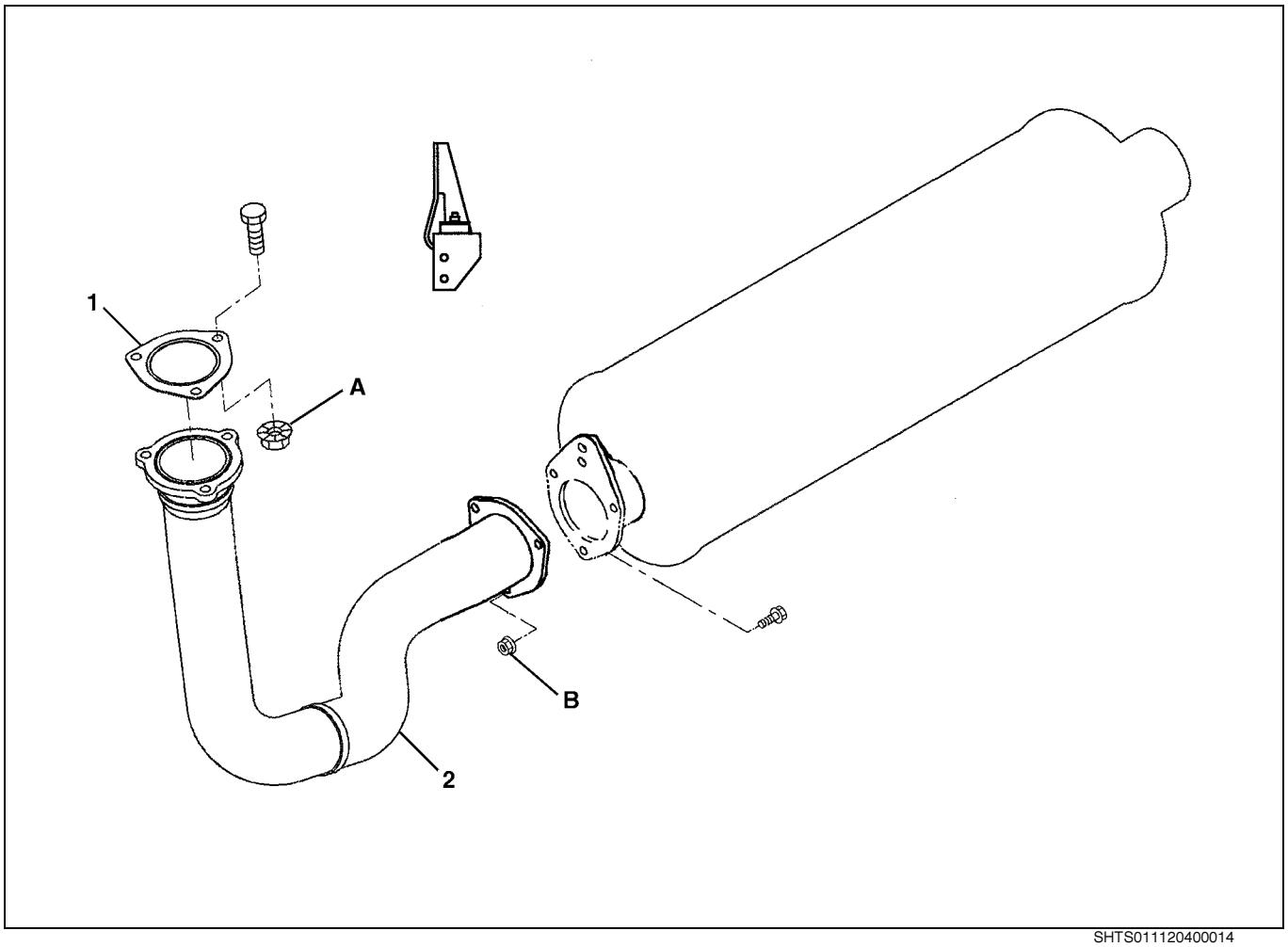
5. INSTALL THE EGR COOLER.

(1) Install the EGR cooler.
Refer to the section **"EGR VALVE AND COOLER"** in the chapter **"EMISSION CONTROL"**.

EXHAUST PIPE

COMPONENT LOCATOR

EN0111204D100002



SHTS011120400014

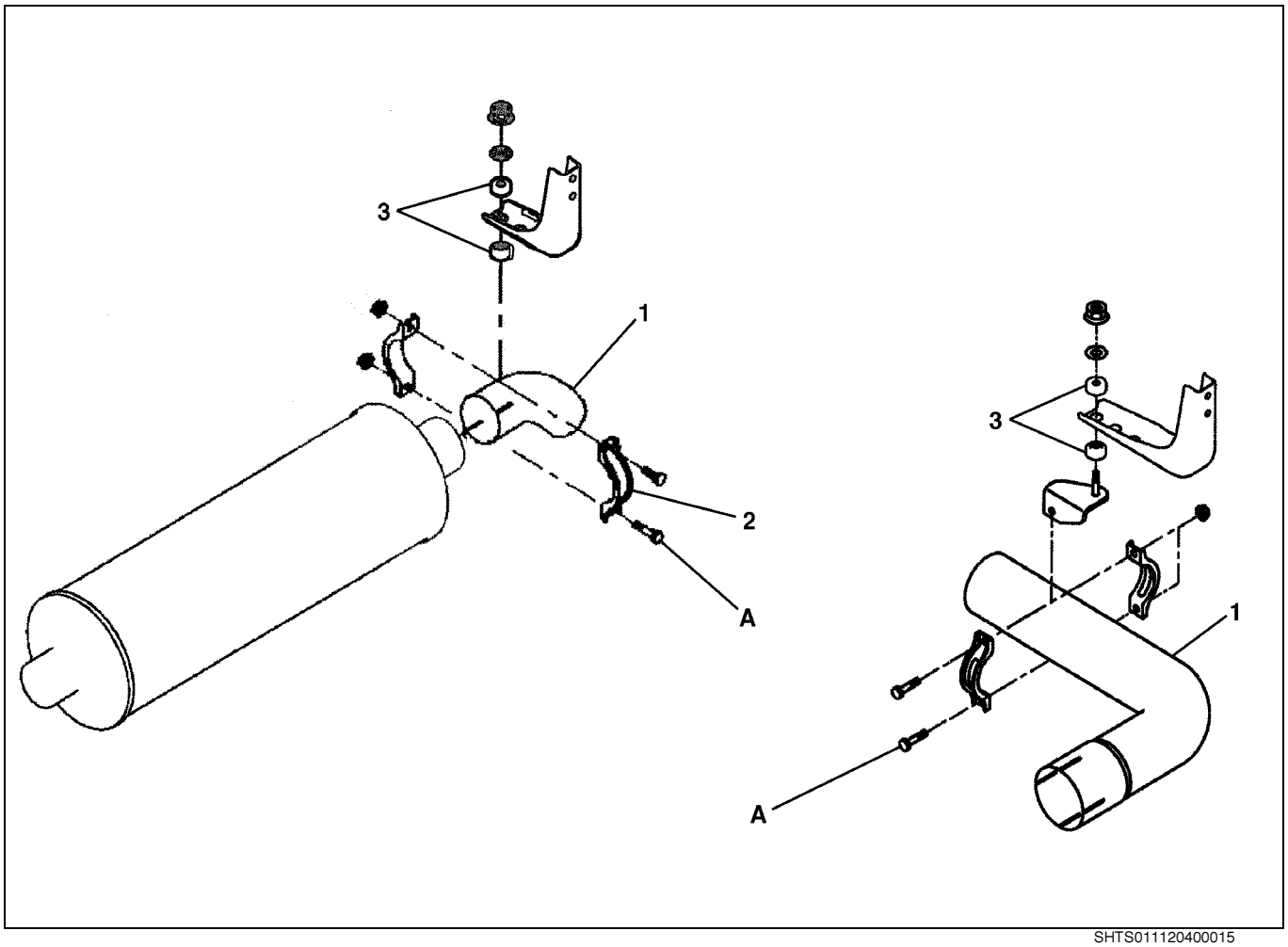
1	Gasket	2	Exhaust pipe

Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

A	29-35 {295-356, 21-25}	B	108-132 {1,101-1,346, 79-97}

NOTICE
Unspecified tightening torque shall be as follows.
M8: T= 23.5-29.5 N·m {239-300 kgf·cm, 17.3-21.7 lbf·ft}
M10: T=46-56 N·m {469-571 kgf·cm, 34-41 lbf·ft}
M12: T= 82-100 N·m {836-1,020 kgf·cm, 61-73 lbf·ft}

SHORT TAIL



SHTS011120400015

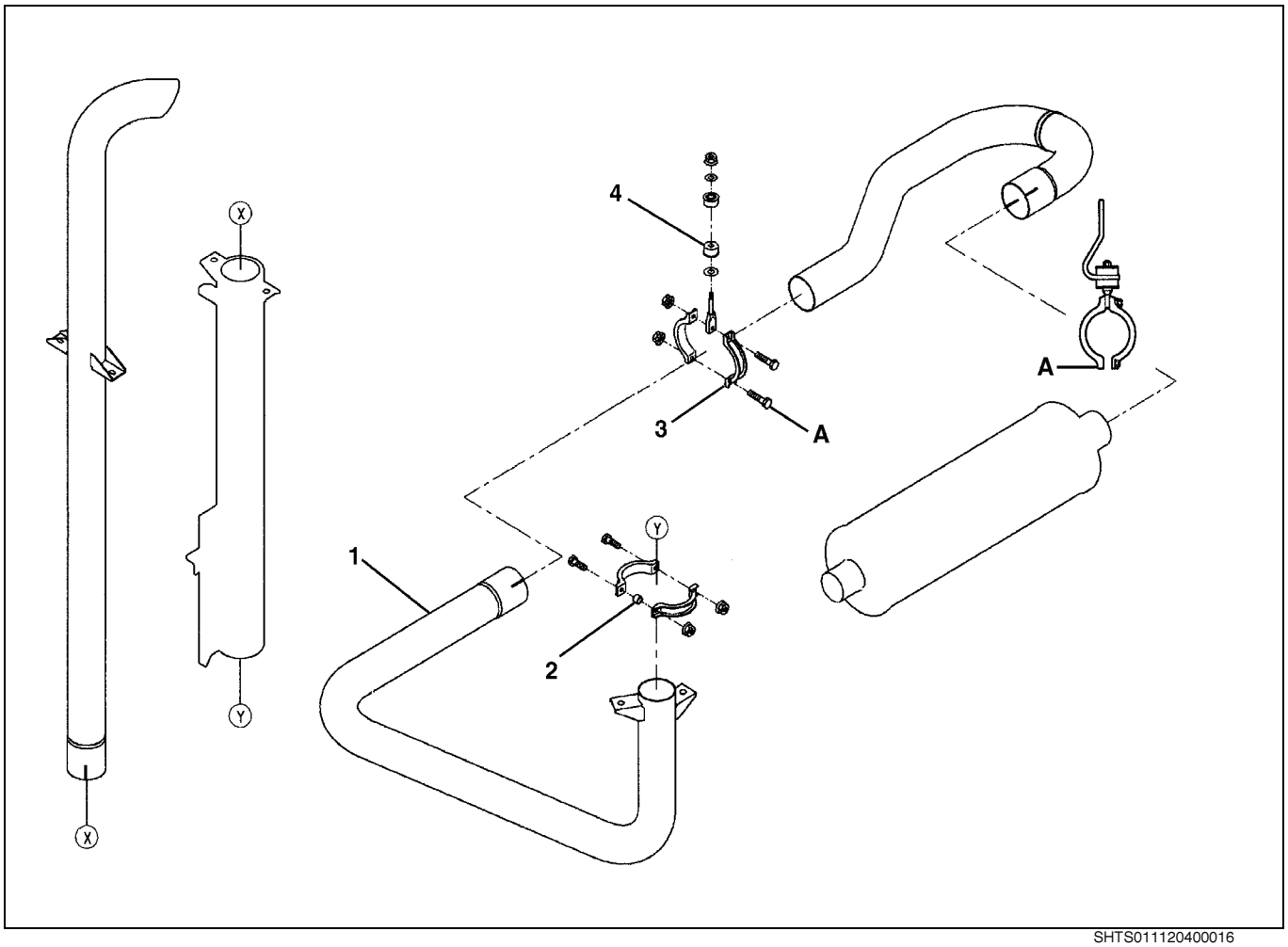
1	Exhaust tail pipe	3	Cushion
2	Clamp		

Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

A	20-24 {203-244, 14-17}		

NOTICE
Unspecified tightening torque shall be as follows.
M8: T= 23.5-29.5 N·m {239-300 kgf·cm, 17.3-21.7 lbf·ft}
M10: T=46-56 N·m {469-571 kgf·cm, 34-41 lbf·ft}
M12: T= 82-100 N·m {836-1,020 kgf·cm, 61-73 lbf·ft}

STACK TAIL



SHTS011120400016

1	Tail pipe	3	Clamp
2	Spacer	4	Cushion

Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

A	29-35 {295-356, 21-25}	

NOTICE
Unspecified tightening torque shall be as follows.
M8: T= 23.5-29.5 N·m {239-300 kgf·cm, 17.3-21.7 lbf·ft}
M10: T=46-56 N·m {469-571 kgf·cm, 34-41 lbf·ft}
M12: T= 82-100 N·m {836-1,020 kgf·cm, 61-73 lbf·ft}

REPLACEMENT

EN0111204H100002

REMOVE THE EXHAUST COMPONENTS.

1. REMOVE THE EXHAUST COMPONENTS.

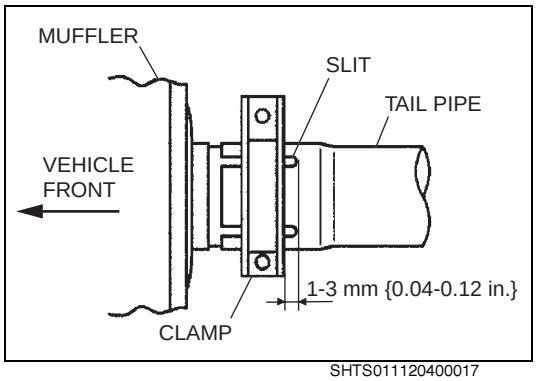
(1) Remove parts and sensor connectors on the exhaust components. Remove the exhaust pipe.

INSTALL THE EXHAUST COMPONENTS.

1. INSTALL THE EXHAUST COMPONENTS.

NOTICE

- **Replace the gasket with a new one.**
- **The mounting portion of the exhaust manifold is subjected to heat and is likely to come loose, so special nuts are employed. Be sure to use the correct nuts.**
- **When tightening the clamp, first tighten the upper bolt then the lower bolt.**
- **Removal and installation should be done completely.**
- **Fit the clamp to the muffler as shown in the figure.**



SHTS011120400017

- **Caution when handling and assembling the catalytic muffler. The ceramic part, which is easily broken, is contained inside the muffler. Be careful not to apply shocks to it. Excessive loads, hitting of hard things such as tools etc., onto the edges could cause it to shatter and drop off.**

⚠ WARNING

If the position on the tail pipe is incorrect, exhaust fumes may blow onto passers by and burns may also result.

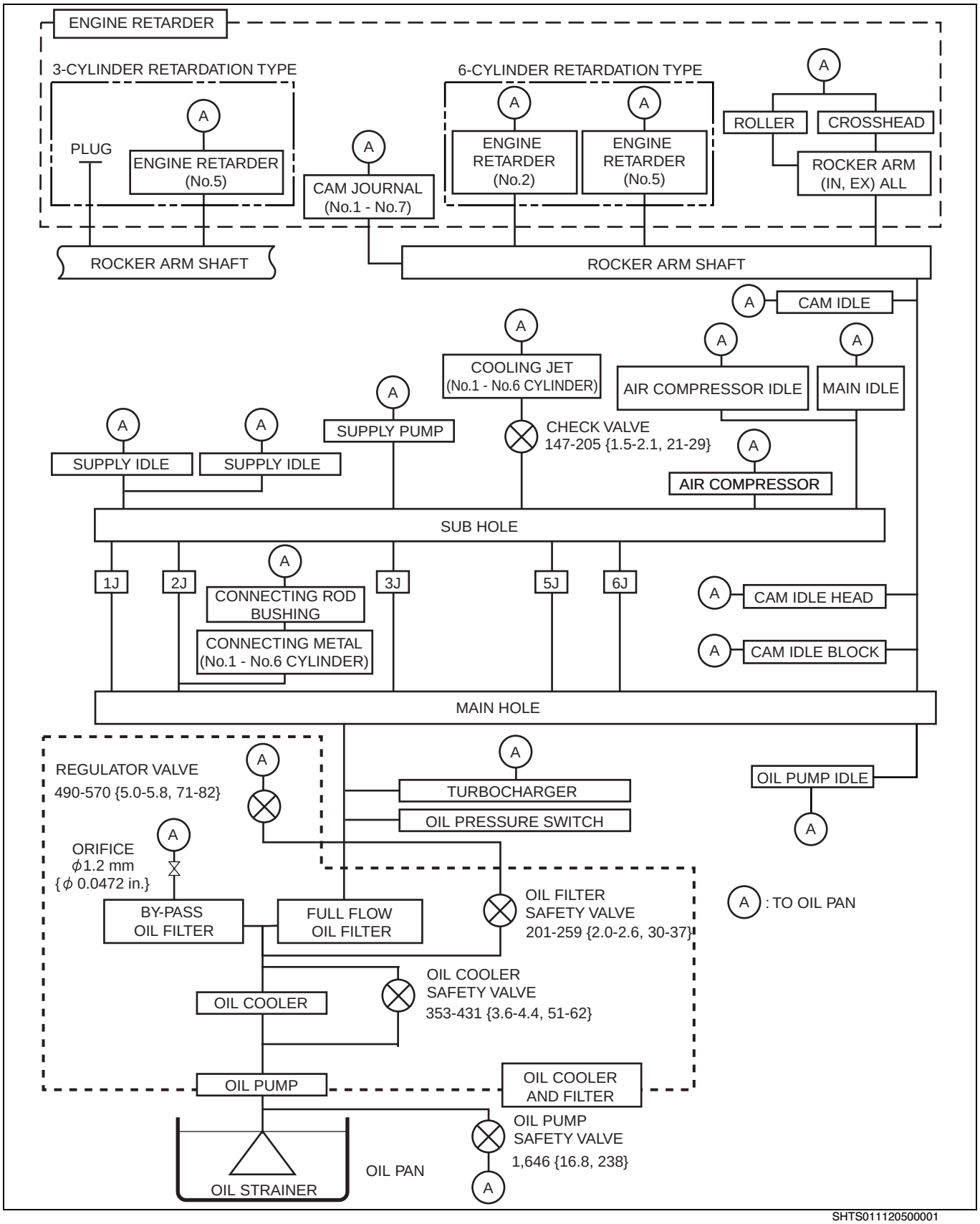
LUBRICATING SYSTEM (A09C)

EN05-001

LUBRICATING SYSTEM

DIAGRAM

EN0111205J100001



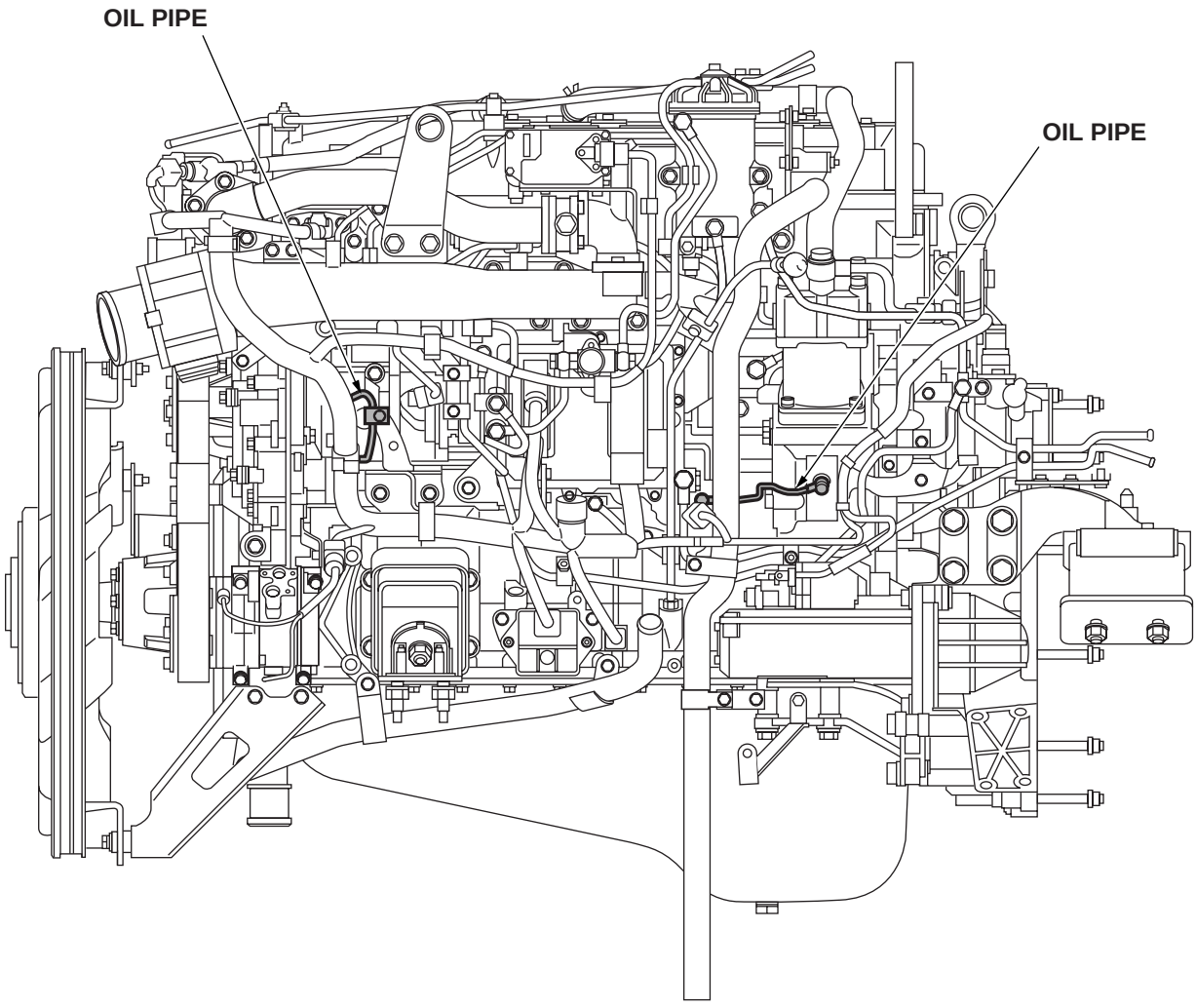
SHTS011120500001

Unit: kPa {kgf/cm^2, lbf/in.^{2}}

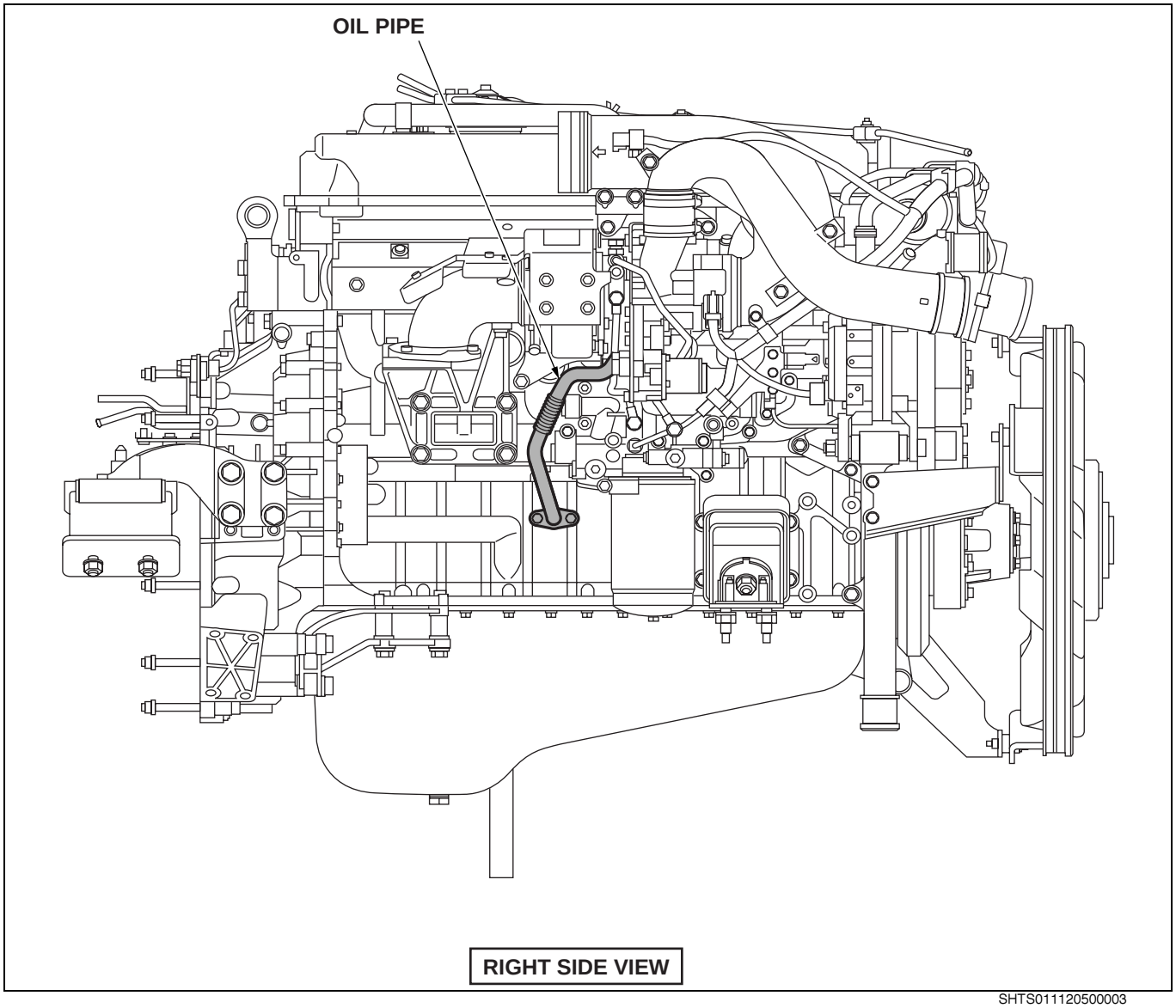
OIL PIPE

COMPONENT LOCATOR

EN0111205D100001



SHTS011120500002



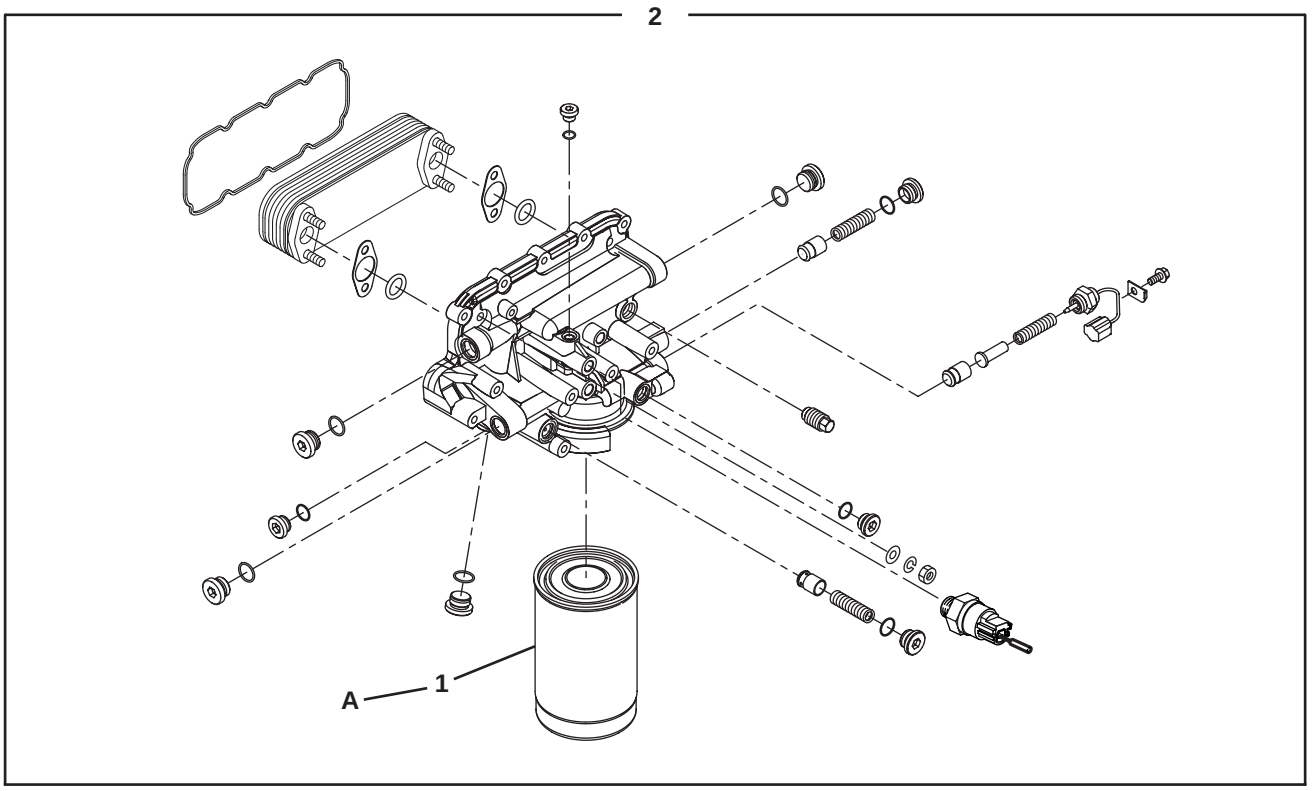
RIGHT SIDE VIEW

SHTS011120500003

OIL FILTER

COMPONENT LOCATOR

EN0111205D100002



SHTS011120500004

1	Oil filter	2	Oil cooler assembly

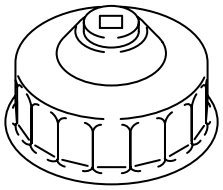
Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

A	39.2-49.0 {400-500, 29-36}		

SPECIAL TOOL

EN0111205K100001

Prior to starting an engine overhaul, it is necessary to have this special tool.

Illustration	Part number	Tool name	Remarks
	S0950-31110	OIL FILTER WRENCH	

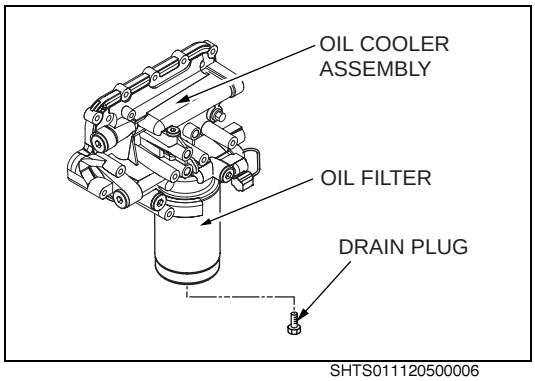
REPLACEMENT

EN0111205H100001

REMOVE THE OIL FILTER.

1. DRAIN ENGINE OIL.

(1) Remove the drain plug of the oil pan and drain engine oil.
Refer to the section **"DISMOUNTING AND MOUNTING"** in the chapter **"ENGINE INTRODUCTION"**.



SHTS011120500006

2. REMOVE THE OIL FILTER.

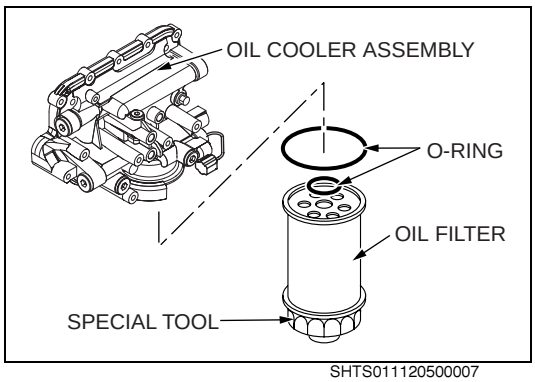
(1) Remove the drain plug of the oil filter downside and drain engine oil.

NOTICE

Disposal of engine oil must comply with the specified procedures (waste disposal) or other environmentally-conscious procedures.

HINT

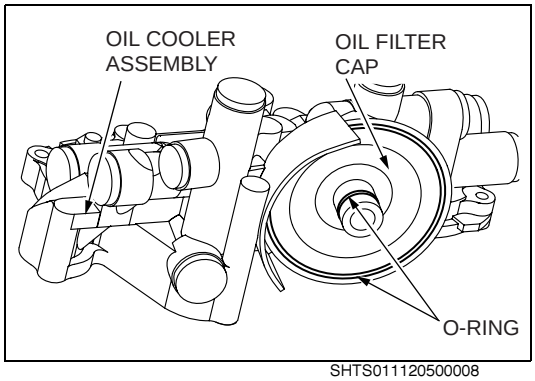
Use a container and a waste as engine oil might drip off during removal of drain plug.



SHTS011120500007

(2) Using the special tool, remove the oil filter and two O-rings from the oil cooler assembly.

SST: Oil filter wrench (S0950-31110)



SHTS011120500008

NOTICE

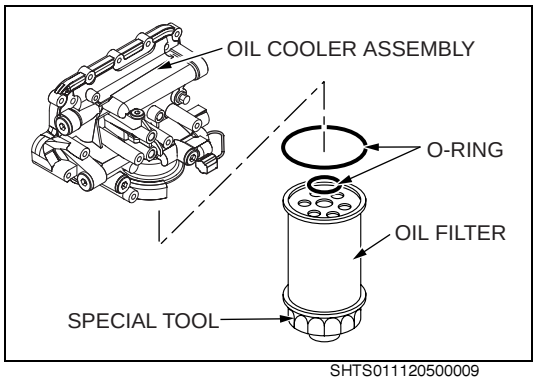
- **Make sure that the O-ring is not on the oil filter cap.**
- **Wipe dirt off the O-ring installation section.**

INSTALL THE OIL FILTER.

1. INSTALL THE OIL FILTER.

(1) Wipe dirt off the O-ring installation section of the oil filter cap side.

(2) Apply engine oil to two O-rings of new oil filter element thinly.

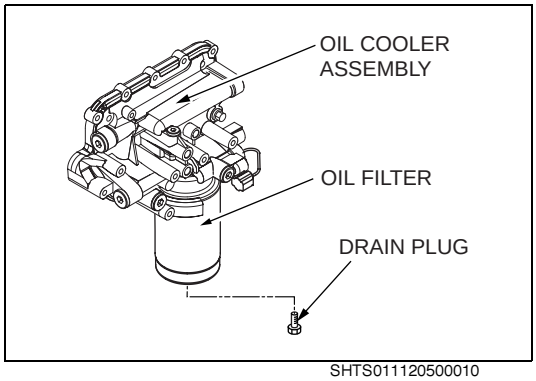


SHTS011120500009

(3) Using the special tool, install the oil filter to the oil cooler assembly.
Tightening Torque:
39.2-49.0 N·m {400-500 kgf·cm, 29-36 lbf·ft}

SST: Oil filter wrench (S0950-31110)

⚠ CAUTION
Be careful not to damage the O-ring.



SHTS011120500010

(4) Install the drain plug to the oil filter.
Tightening Torque:
10-14 N·m {102-144 kgf·cm, 8-10 lbf·ft}

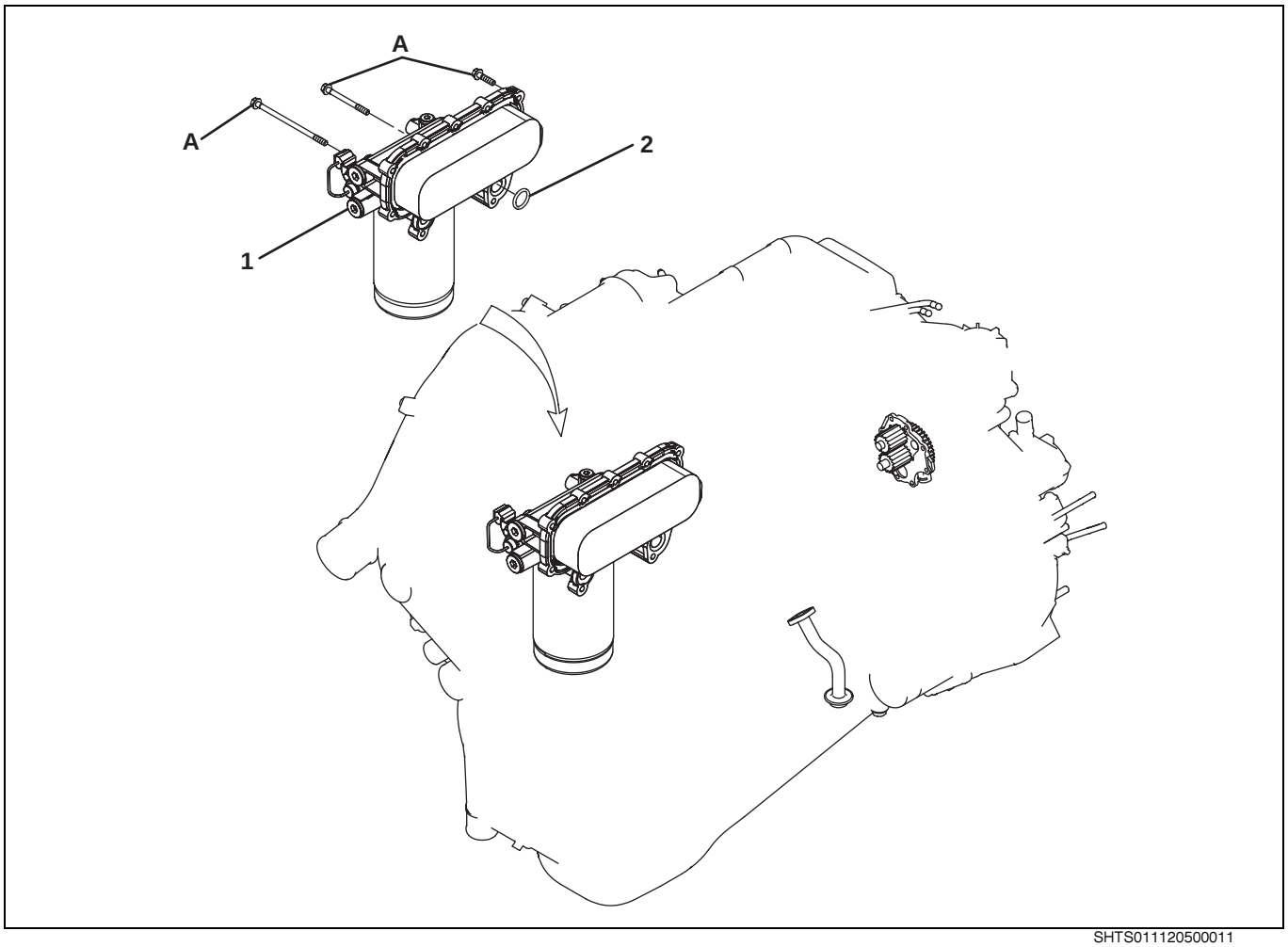
2. FILL ENGINE OIL.

(1) Fill engine oil.
Refer to the section **"DISMOUNTING AND MOUNTING"** in the chapter **"ENGINE INTRODUCTION"**.

OIL COOLER

COMPONENT LOCATOR

EN0111205D100003

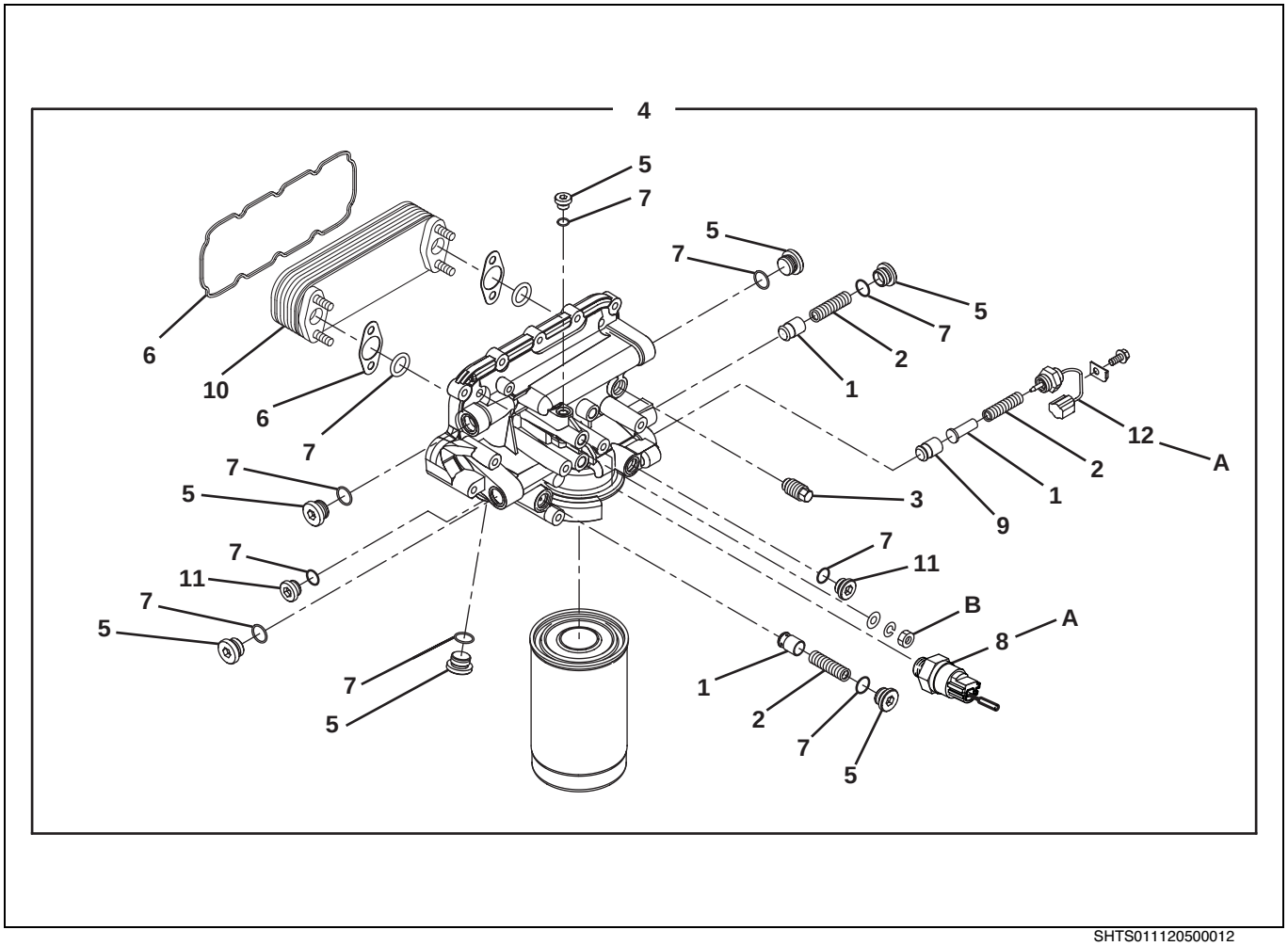


SHTS011120500011

1	Oil cooler assembly	2	O-ring

Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

A	28.5 {290, 21}		



SHTS011120500012

1	Valve	7	O-ring
2	Valve spring	8	Oil pressure switch
3	Drain bolt	9	Safety valve
4	Oil cooler assembly	10	Oil cooler element
5	Hexagon socket head screw	11	Plug
6	Gasket	12	Plug assembly

Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

A	24.5-34.3 {250-350, 18-25}	B	19.6-29.4 {200-300, 15-21}

OVERHAUL

EN0111205H200001

REMOVE THE OIL COOLER ASSEMBLY.

1. DRAIN THE COOLANT.

(1) Drain the coolant.
Refer to the section **"RADIATOR"** in the chapter **"COOLING SYSTEM"**.

2. DRAIN ENGINE OIL.

(1) Remove the drain plug of the oil pan and drain engine oil.
Refer to the section **"DISMOUNTING AND MOUNTING"** in the chapter **"ENGINE INTRODUCTION"**.

3. REMOVE THE OIL FILTER.

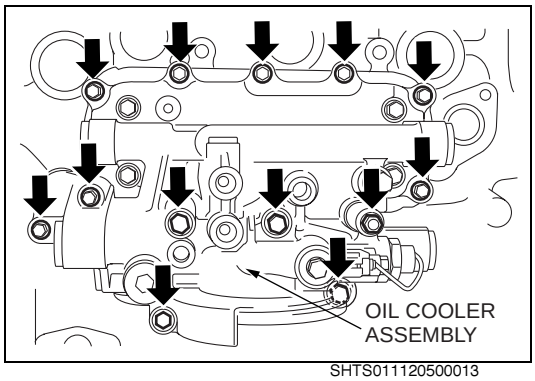
(1) Using the spacial tool, remove the oil filter from the oil cooler assembly.
Refer to the section **"OIL FILTER"**.

4. REMOVE THE TURBOCHARGER.

(1) Remove the turbocharger assembly.
Refer to the section **"TURBOCHARGER"** in the chapter **"TURBOCHARGER"**.

5. REMOVE THE OIL COOLER ASSEMBLY.

(1) Remove the thirteen bolts to remove the oil cooler assembly and three O-rings from the cylinder block.



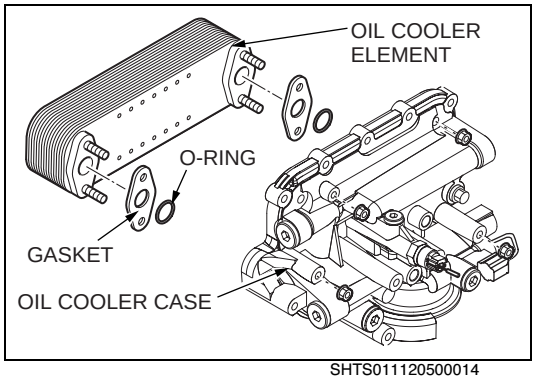
SHTS011120500013

NOTICE

Do not confound the oil cooler assembly installation bolt with the oil cooler element installation bolt.

HINT

Use a container and a waste as engine oil might drip off during removal of oil cooler assembly.

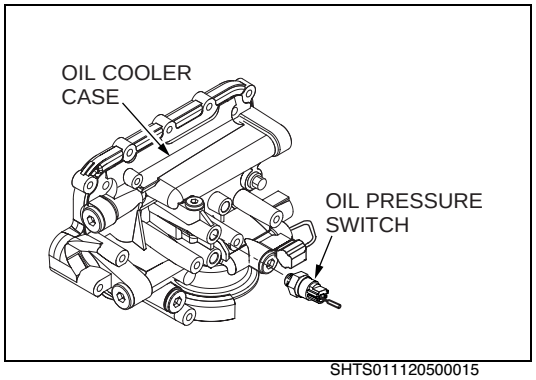


SHTS011120500014

DISASSEMBLE THE OIL COOLER ASSEMBLY.

1. REMOVE THE OIL COOLER ELEMENT.

(1) Remove four nuts to remove the oil cooler element, two gaskets and two O-rings from the oil cooler case.



SHTS011120500015

2. REMOVE THE OIL PRESSURE SWITCH.

(1) Remove the oil pressure switch from the oil cooler case.

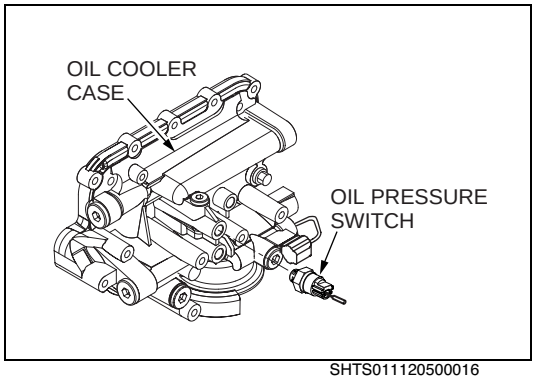
CLEANING THE OIL COOLER ELEMENT

1. CLEANING THE OIL COOLER ELEMENT.

(1) Clean water and oil channels thoroughly with kerosene or cleaning agent.

(2) Conduct a dye penetrant check (red check) and a visual check to inspect the stud-bolted areas and the element for cracks or deformation.

(3) Inject air of approximately 0.5 kgf/cm^2 into the oil channel to check for leakage from each area. If cracks, leakage or deformation is found, replace it with a new element.

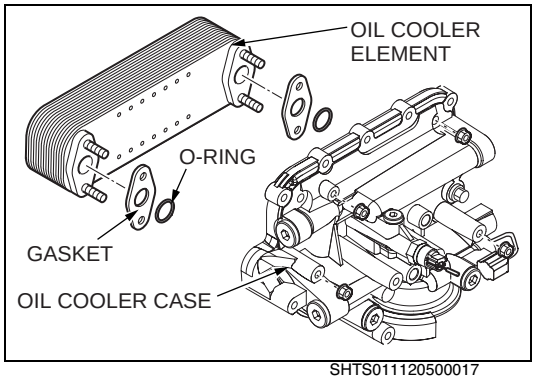


SHTS011120500016

ASSEMBLE THE OIL COOLER ASSEMBLY.

1. INSTALL THE OIL PRESSURE SWITCH.

(1) Install the pressure switch into the oil cooler case.
Tightening Torque:
19.6-29.4 N·m {200-300 kgf·cm, 14.5-21.6 lbf·ft}

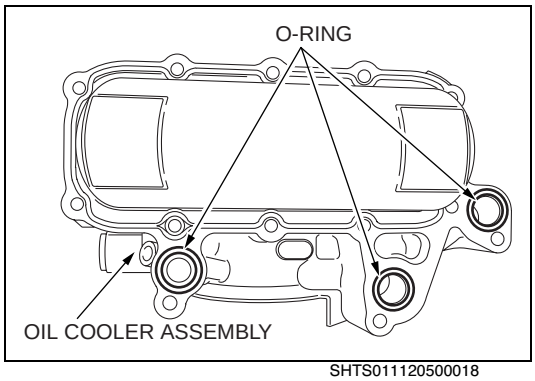


SHTS011120500017

2. INSTALL THE OIL COOLER ELEMENT.

(1) Replace the gaskets and O-rings with new ones. Install the oil cooler element to the oil cooler case, and tighten four nuts.
Tightening Torque:
19.6-29.4 N·m {200-300 kgf·cm, 15-21 lbf·ft}

⚠ CAUTION
Do not damage the oil cooler element.

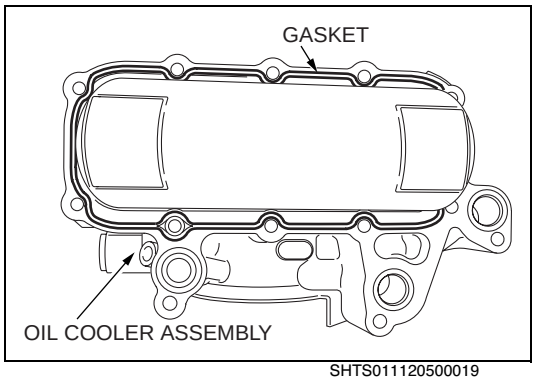


SHTS011120500018

INSTALL THE OIL COOLER ASSEMBLY.

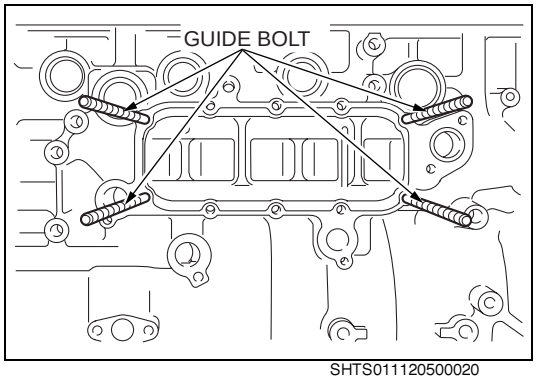
1. INSTALL THE OIL COOLER ASSEMBLY.

(1) Install the new O-rings to the oil cooler assembly.



SHTS011120500019

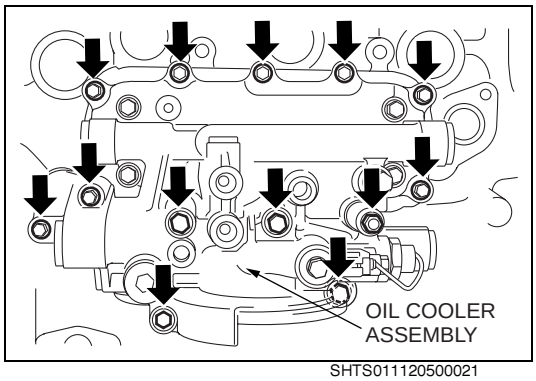
(2) Install the new gasket to the gasket installation groove of the oil cooler element.



SHTS011120500020

(3) Install the guide bolts into the cylinder block horizontally.

NOTICE
Remove two to four guide bolts only after pretightening nine to eleven oil cooler assembly mounting bolts.



SHTS011120500021

(4) Install the oil cooler assembly to the cylinder block, and tighten thirteen bolts.
Tightening Torque:
28.5 N·m {290 kgf·cm, 21 lbf·ft}

2. INSTALL THE TURBOCHARGER.
(1) Install the turbocharger assembly.
Refer to the section **"TURBOCHARGER"** in the chapter **"TURBOCHARGER"**.

3. INSTALL THE OIL FILTER.
(1) Using the spacial tool, install the oil filter to the oil cooler assembly.
Refer to the section **"OIL FILTER"**.

4. FILL ENGINE OIL.
(1) Fill engine oil.
Refer to the section **"DISMOUNTING AND MOUNTING"** in the chapter **"ENGINE INTRODUCTION"**.

5. FILL THE COOLANT.
(1) Fill the coolant.
Refer to the section **"RADIATOR"** in the chapter **"COOLING SYSTEM"**.

INSPECTION AND REPAIR

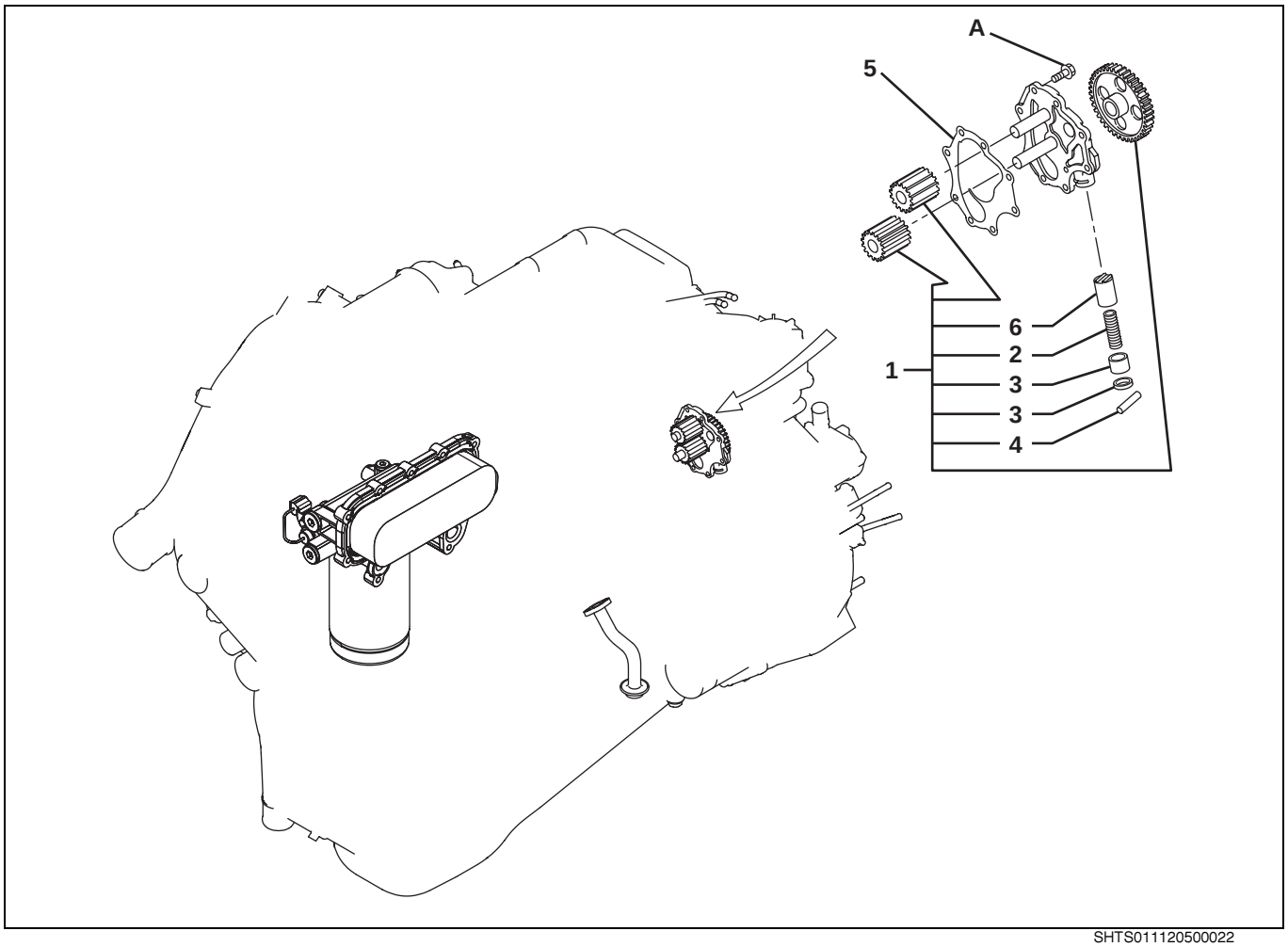
EN0111205H300001

Inspection item	Standard	Limit	Remedy	Inspection procedure
Damage and scratches of the safety valve	**—**	**—**	**Replace, if necessary.**	**Visual check**

OIL PUMP

COMPONENT LOCATOR

EN0111205D100004



SHTS011120500022

1	Oil pump	4	Cotter pin
2	Valve spring	5	Gasket
3	Seat	6	Safety valve

Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

A	28.5 {290, 21}		

OVERHAUL

EN0111205H200002

REMOVE THE OIL PUMP.

1. REMOVE THE FLYWHEEL HOUSING.

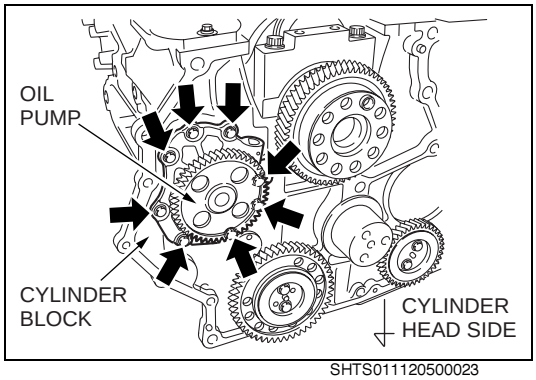
(1) Remove the flywheel housing from the cylinder block.
Refer to the section **"FLYWHEEL HOUSING"** in the chapter **"ENGINE MECHANICAL"**.

2. REMOVE THE OIL PUMP IDLE GEAR.

(1) Remove the oil pump idle gear from the cylinder block.
Refer to the section **"REAR TIMING GEAR AND CAM IDLE GEAR"** in the chapter **"ENGINE MECHANICAL"**.

3. REMOVE THE OIL PUMP.

(1) Remove eight bolts to remove the oil pump from the cylinder block.



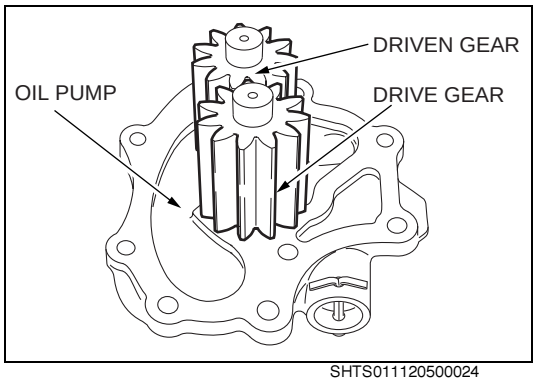
SHTS011120500023

DISASSEMBLE THE OIL PUMP.

1. REMOVE THE DRIVEN GEAR AND THE SAFETY VALVE.

(1) Remove the driven gear from the oil pump.

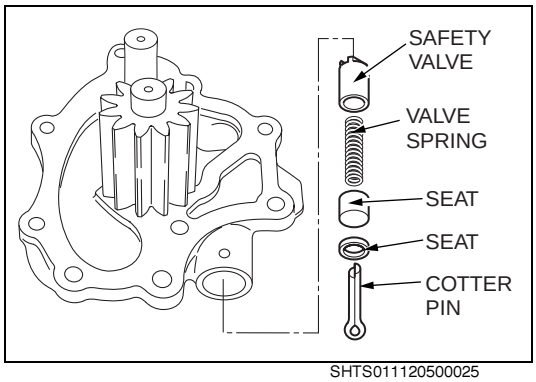
HINT
The drive gear is press-fitted into the shaft, thus cannot be removed.



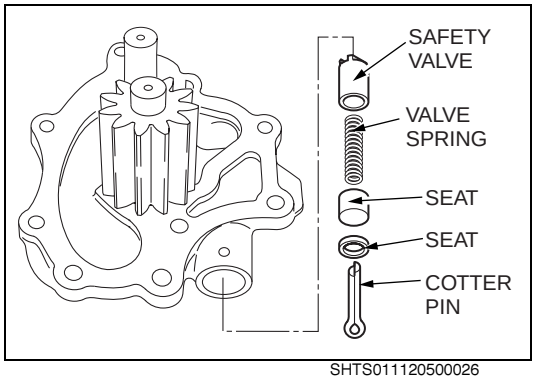
SHTS011120500024

(2) Remove the cotter pin to remove the seats, the valve spring and the safety valve.

⚠ CAUTION
Handle this work step carefully. When removing a cotter pin, the seats and the valve spring might jump out.



SHTS011120500025

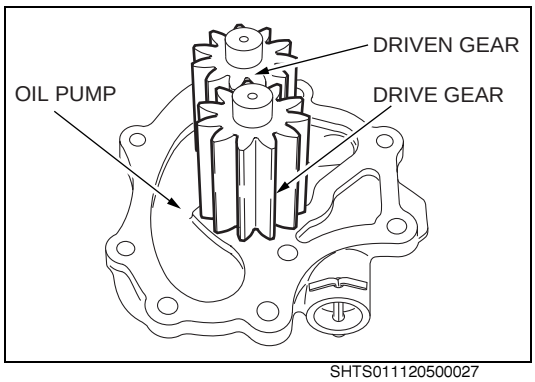


SHTS011120500026

ASSEMBLE THE OIL PUMP.

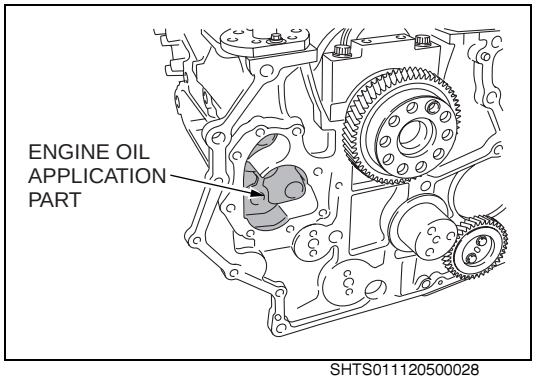
1. ASSEMBLE THE GEAR AND SAFETY VALVE.

(1) Insert the safety valve, the valve spring, the seats in this order and fix them with new cotter pin.



SHTS011120500027

(2) Install the driven gear to the oil pump.



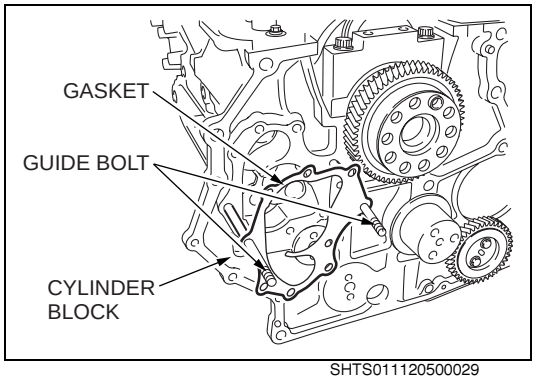
SHTS011120500028

INSTALL THE OIL PUMP.

1. INSTALL THE OIL PUMP.

(1) Apply engine oil to the pump case and bearing of the cylinder block.

⚠ CAUTION
Nonperformance of applying engine oil will cause an engine oil uptake trouble, resulting in seizure or excessive wear.

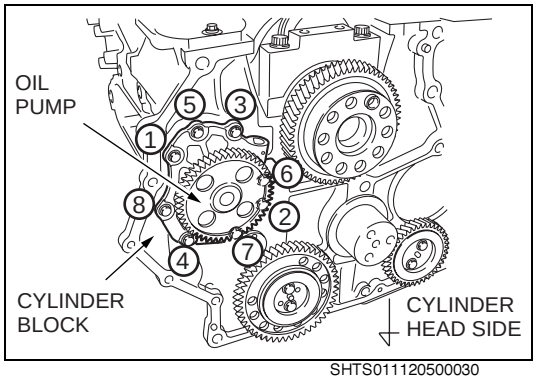


SHTS011120500029

(2) Install two to four guide bolts to the cylinder block horizontally, and set a new gasket to the mounting position on the cylinder block.

⚠ CAUTION
Assembly with an off-positioned gasket will cause a sealing failure, resulting in flow out of all engine oil from the oil pump when the engine stops. A sealing failure will lead to insufficient engine oil uptake, eventually resulting in seizure or excessive wear at an initial speed when the engine restarts.

NOTICE
Remove two to four guide bolts only after pretightening four to six oil pump mounting bolts.

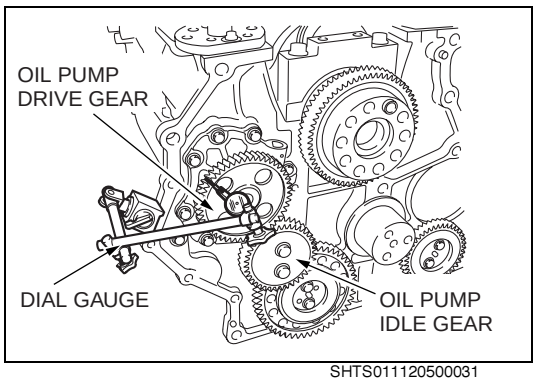


SHTS011120500030

(3) Install the oil pump to the cylinder block and tighten eight bolts in the order shown in the figure.
Tightening Torque:
28.5 N·m {290 kgf·cm, 21 lbf·ft}

2. INSTALL THE OIL PUMP IDLE GEAR.

(1) Install the oil pump idle gear to the cylinder block.
Refer to the section **"REAR TIMING GEAR AND CAM IDLE GEAR"** in the chapter **"ENGINE MECHANICAL"**.



SHTS011120500031

3. CHECK THE BACKLASH.

(1) Use a dial gauge to measure backlash between the oil pump drive gear and the oil pump idle gear. If a measurement reading exceeds the standard value, restart the oil pump mounting procedures.

HINT

After mounting the oil pump, backlash might fluctuate depending on play in the oil pump mounting bolt hole.

Standard (mm {in.})	Limit (mm {in.})
0.020-0.122 {0.0008-0.0048}	0.30 {0.0118}

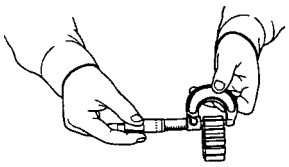
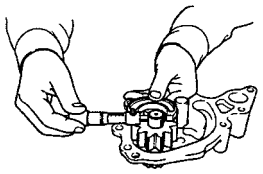
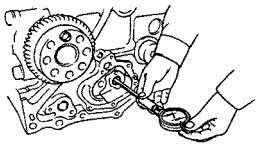
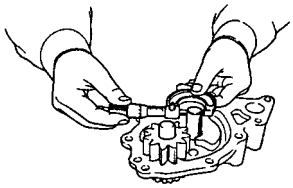
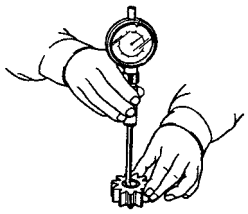
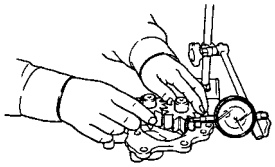
4. INSTALL THE FLYWHEEL HOUSING.

(1) Install the flywheel housing to the cylinder block.
Refer to the section **"FLYWHEEL HOUSING"** in the chapter **"ENGINE MECHANICAL"**.

INSPECTION AND REPAIR

EN0111205H300002

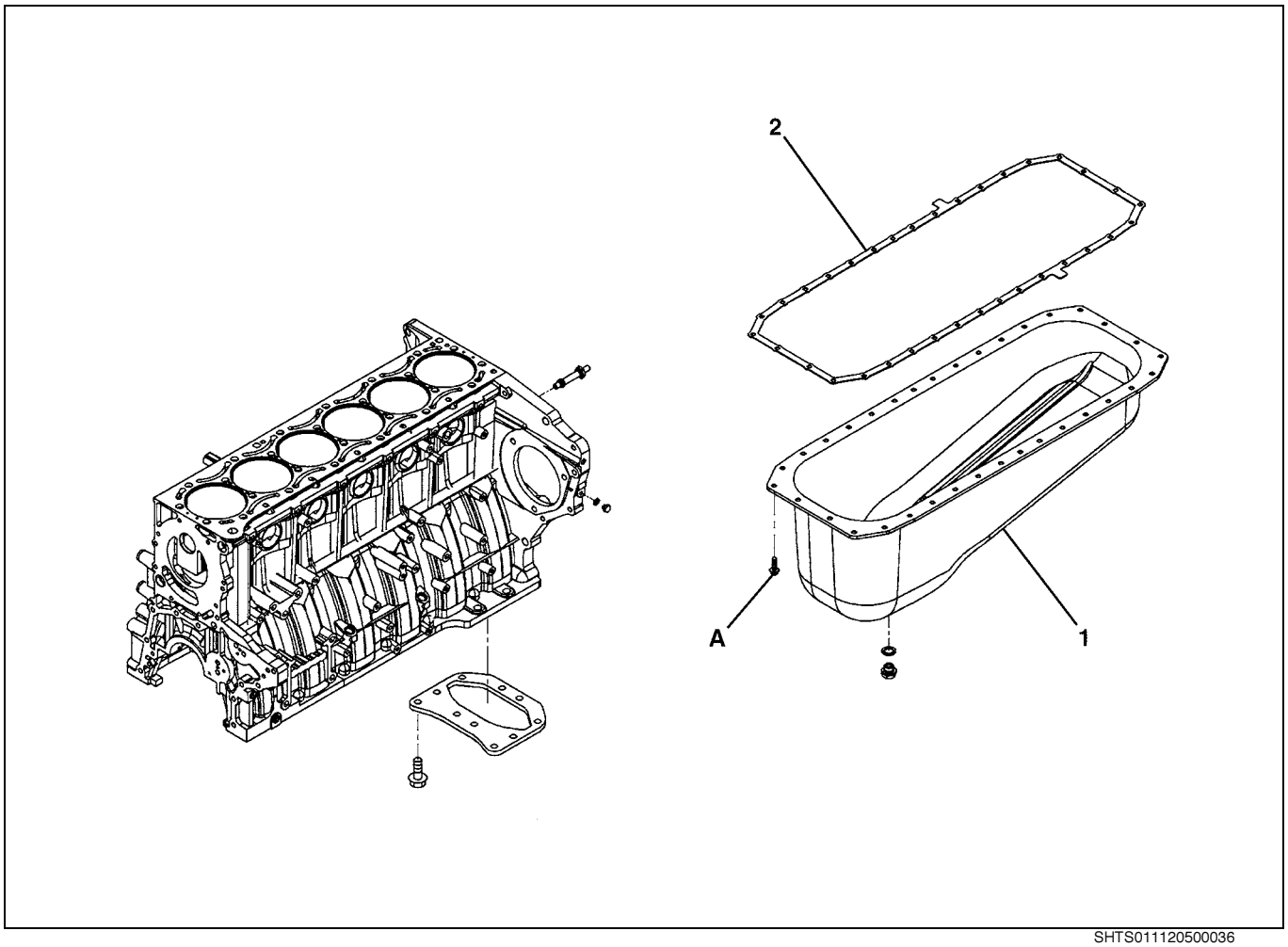
Unit: mm {in.}

Inspection item		Standard	Limit	Remedy	Inspection procedure
Gear width		53 {2.086}	—	—	Measure 
Block side pump body inside depth		53 {2.086}	—	—	
End play		-0.013-0.050 {-0.0005-0.0019}	0.15 {0.0059}	Replace gear or pump.	
Drive gear	Shaft outside diameter	18 {0.709}	—	—	Measure  
	Block side bushing inside diameter	18 {0.709}	—	—	
	Clearance	0.040-0.099 {0.0016-0.0038}	—	Replace gear or bushing.	
Driven gear	Shaft outside diameter	18 {0.709}	—	—	Measure  
	Gear bushing inside diameter	18 {0.709}	—	—	
	Clearance	0.040-0.083 {0.0016-0.0032}	0.15 {0.0059}	Replace pump or bushing.	
Gear backlash		0.072-0.277 {0.0028-0.0109}	0.30 {0.0118}	Replace pump.	Measure 

OIL PAN

COMPONENT LOCATOR

EN0111205D100005



SHTS011120500036

1	Oil pan	2	Gasket

Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

A	30 {305, 22}		

REPLACEMENT

EN0111205H100002

REMOVE THE OIL PAN.

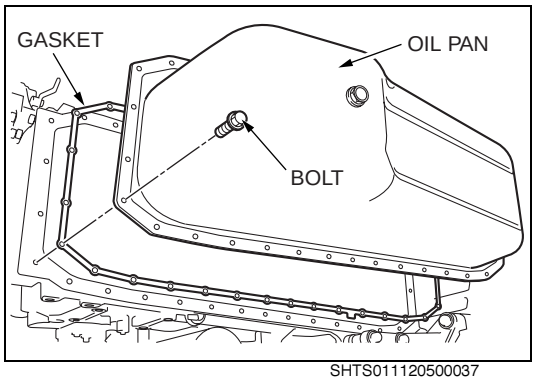
1. DRAIN ENGINE OIL.

(1) Place a container under the drain plug to collect the engine oil.

(2) Remove the drain plug to drain engine oil from the oil pan.

NOTICE

Disposal of engine oil must comply with specified procedures (waste disposal) or other environmentally-conscious procedures.



SHTS011120500037

2. REMOVE THE OIL PAN.

(1) Remove thirty-four bolts to remove the oil pan and a gasket from the cylinder block.

HINT

- **If a gasket is stuck and cannot be removed, use a scraper to strip off the gasket.**
- **Use a container and a waste as engine oil might drip off during removal of oil pan.**

INSTALL THE OIL PAN.

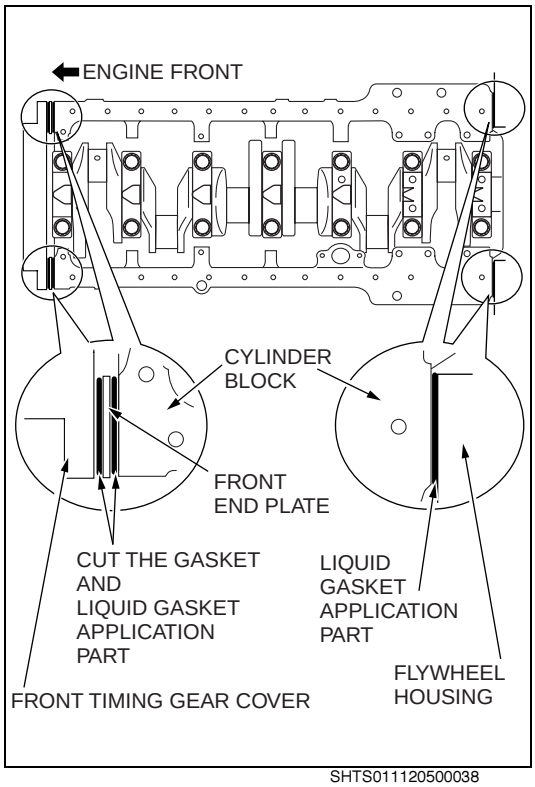
1. INSTALL THE OIL PAN

(1) Use a scraper to cut the excessive material of gaskets on the front timing gear cover and on the end plate so that end faces of the gaskets will be flush with the cylinder block bottom face.

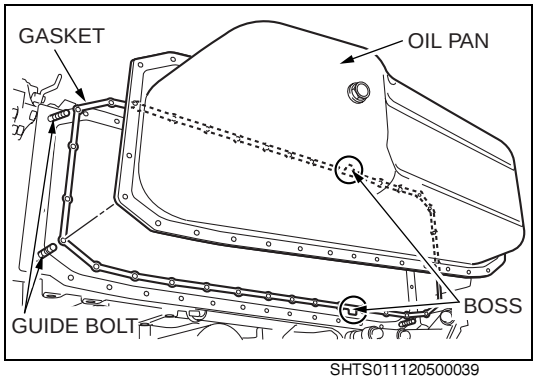
(2) Apply liquid gasket (ThreeBond TB1207C (red) and ThreeBond TB1207D (silver)) to the cylinder block and the front end plate at the frontmost bottom surface and to the cylinder block and the flywheel housing at the rearmost bottom surface.

NOTICE

- **Apply liquid gasket without intermittence.**
- **Apply liquid gasket at a width of 1.5 to 2.5 mm {0.0591 to 0.0984 in.}.**
- **Proceed with remounting works within 20 min. after applying the liquid gasket.**



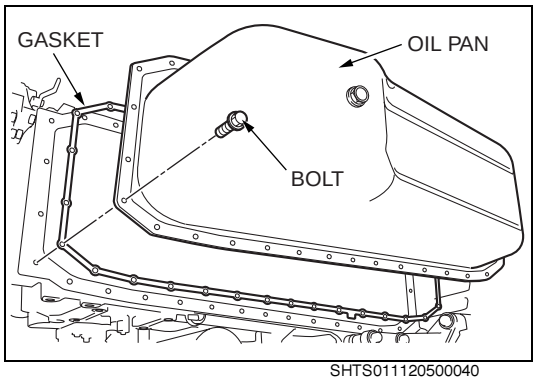
SHTS011120500038



SHTS011120500039

(3) Attach the guide bolts (70 mm {2.7559 in.} or more) to the cylinder block. Set a new gasket to its proper mounting position with its humps positioned in the frontward direction of the engine.

NOTICE
Remove the guide bolts after pretightening the mounting bolts for oil pan.



SHTS011120500040

(4) Install the oil pan to the cylinder block, and tighten thirty-four bolts.
Tightening Torque:
30 N·m {305 kgf·cm, 22 lbf·ft}

⚠ CAUTION
The gasket for the oil pan is fragile. Handle this gasket carefully.

2. FILL ENGINE OIL.

(1) Check engine oil level, and refill the engine oil, if the engine oil level is low.
Refer to the section **"DISMOUNTING AND MOUNTING"** in the chapter **"ENGINE INTRODUCTION"**.

LUBRICATION CHECK AFTER LUBRICATION OVERHAUL

1. CHECKING THE VALVE TRAIN

NOTICE

- **Conduct this check after every lubrication overhaul.**
- **Conduct this check at a coolant temperature of approximately 60°C {140°F}.**

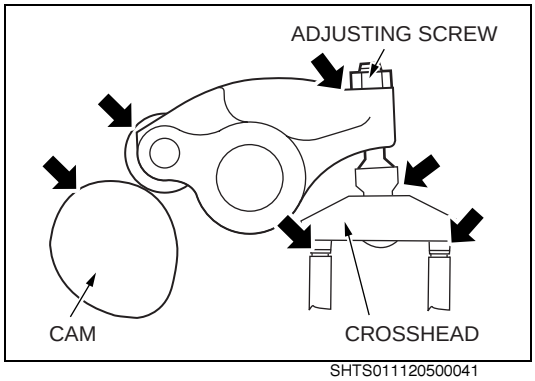
(1) Remove the head cover.
Refer to the section **"HEAD COVER"** in the chapter **"ENGINE MECHANICAL"**.

NOTICE

Cut a head cover into half (enough to cover the camshaft) to make a jig for avoiding spatter of engine oil. Attach this jig before check.

(2) Adjust an engine speed to the standard idling speed (550 r/min).
(3) Check that oil is supplied to the predetermined areas on all rocker arms (see a list below) within 10 seconds after the engine starts.

a. Roller and cam surface
b. Top surface of the spring upper seat and the head of the crosshead, via adjust screws



SHTS011120500041

⚠ CAUTION

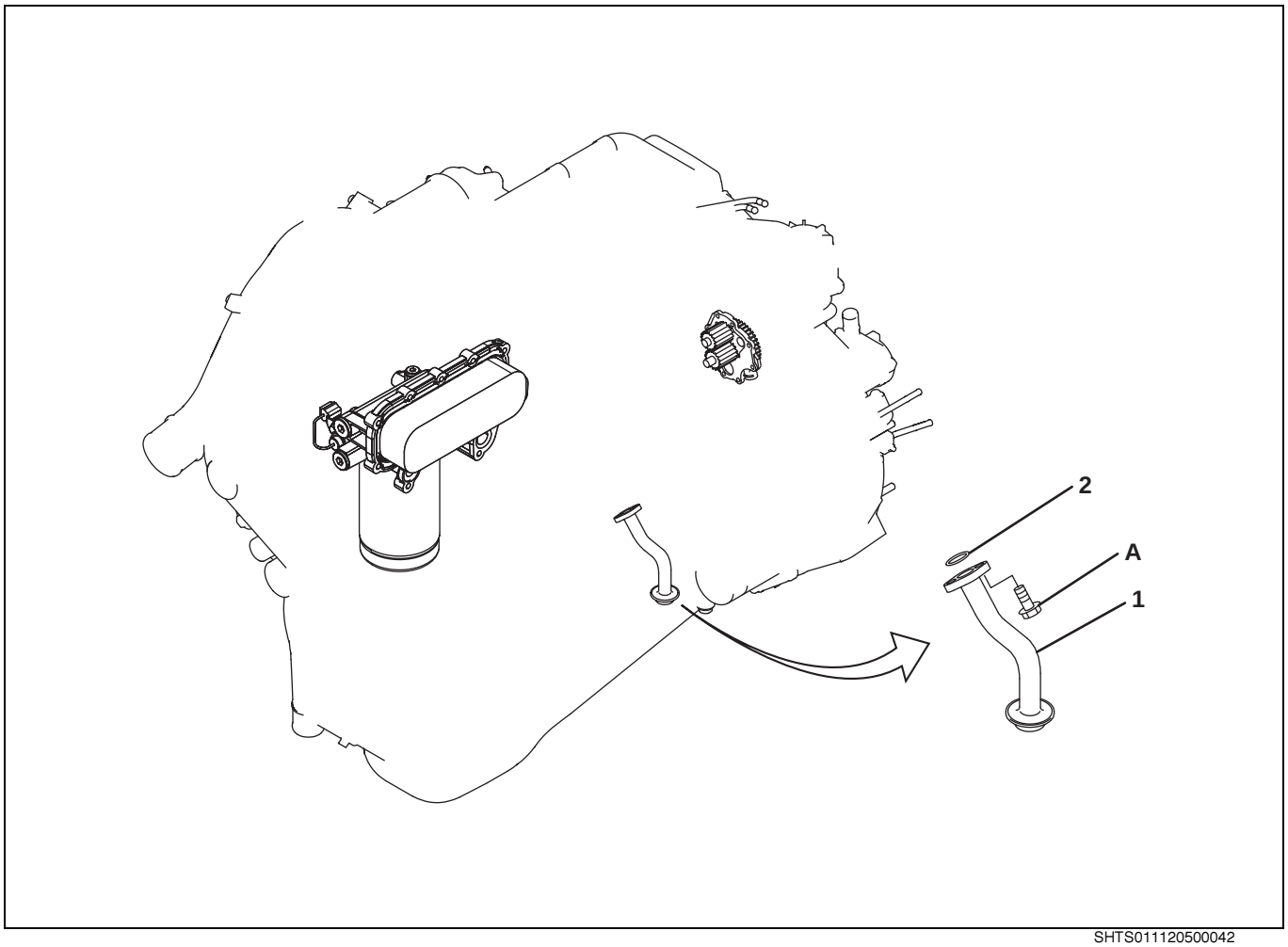
If oil is not supplied or if it takes long time until oil is supplied, oil channels might have been blocked. This oiling trouble will cause seizure, excessive wear, noise or other troubles.

(4) Install the head cover.
Refer to the section **"HEAD COVER"** in the chapter **"ENGINE MECHANICAL"**.

OIL STRAINER AND PLATE

COMPONENT LOCATOR

EN0111205D100006

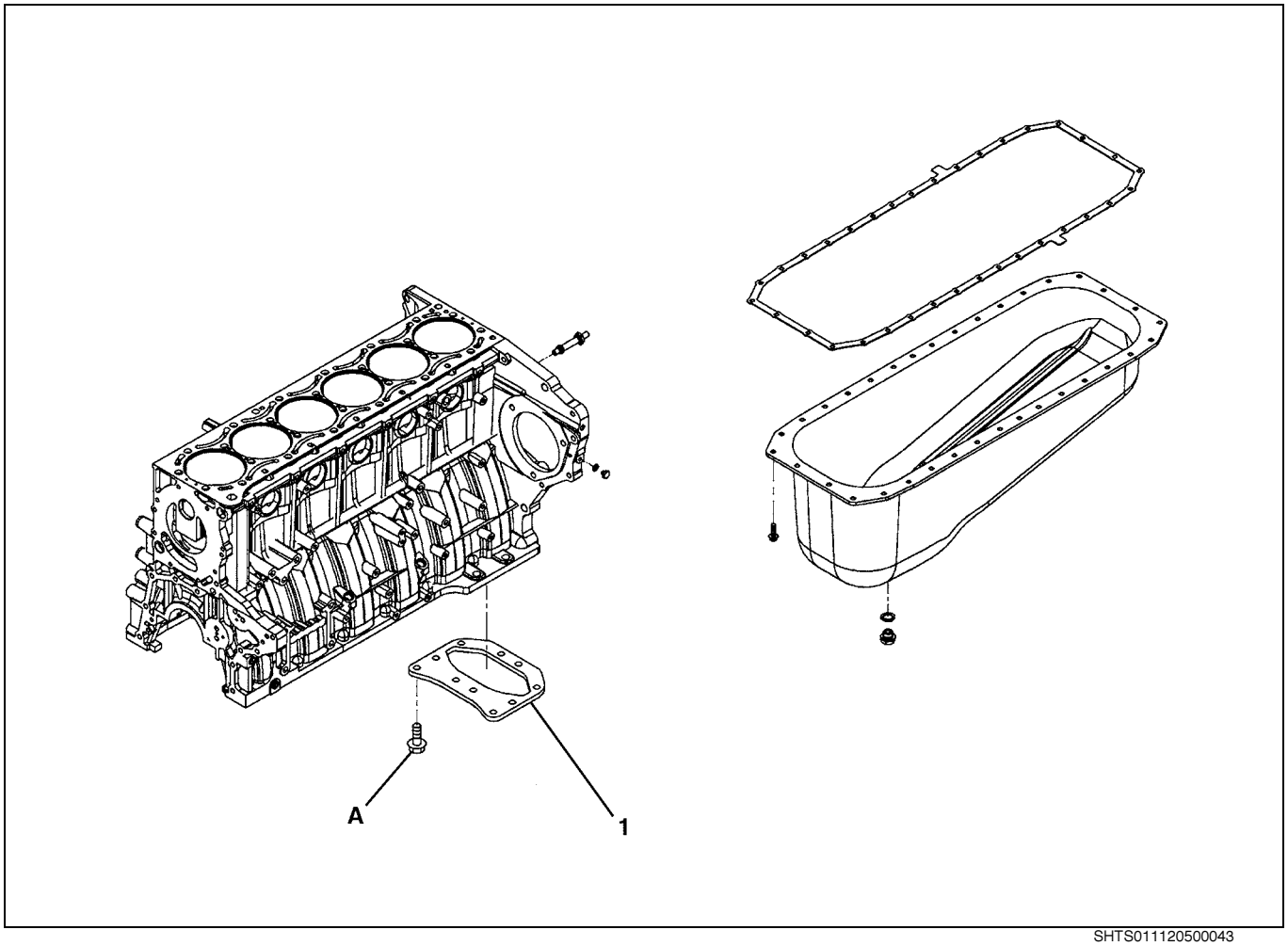


SHTS011120500042

1 Oil strainer	2 O-ring

Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

A 28.5 {290, 21}	



SHTS011120500043

1 Plate	

Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

A 97 {990, 72}	

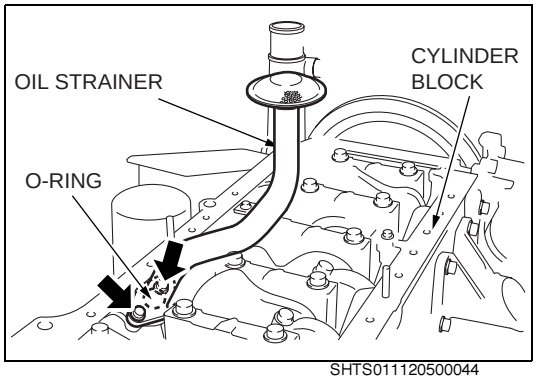
REPLACEMENT

EN0111205H100003

REMOVE THE OIL STRAINSER AND PLATE.

1. REMOVE THE OIL PAN.

(1) Remove the oil pan from the cylinder block.
Refer to the section **"OIL PAN"**.



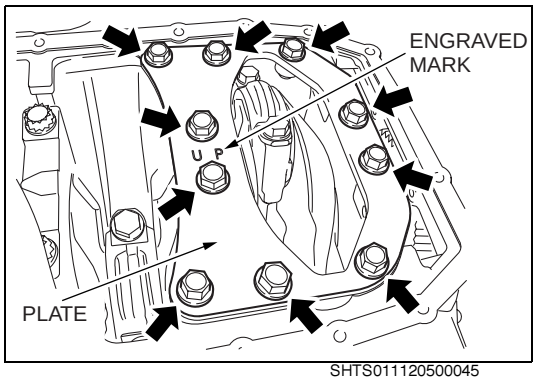
SHTS011120500044

2. REMOVE THE OIL STRAINER.

(1) Remove two bolts to remove an O-ring and the oil strainer from the cylinder block.

HINT

Use a container and a waste as engine oil might drip off during removal of oil strainer.

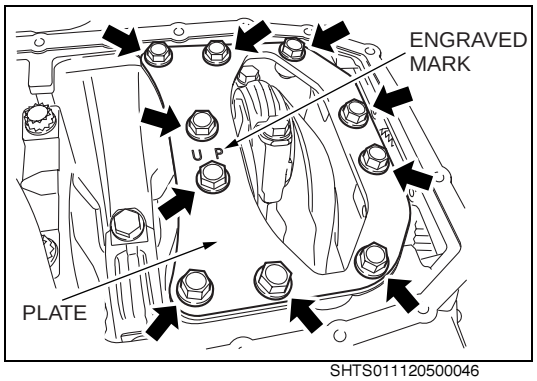


SHTS011120500045

3. REMOVE THE PLATE.

(1) Remove ten bolts to remove the plate from the cylinder block.

INSTALL THE OIL STRAINER AND PLATE.



SHTS011120500046

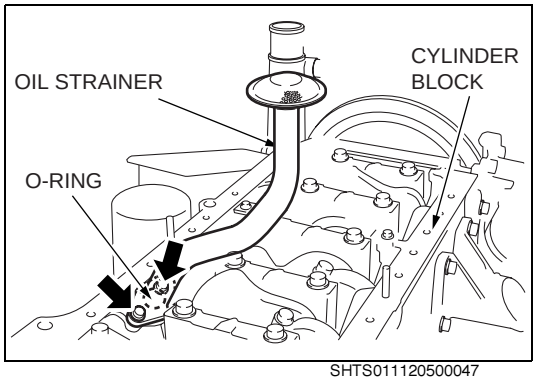
1. INSTALL THE PLATE.

(1) Install the plate to the cylinder block, and tighten ten bolts.

Tightening Torque:
97 N·m {990 kgf·cm, 72 lbf·ft}

NOTICE

- **Make sure that a engraved mark "UP" faces up before installing the plate.**
- **Make sure that the plate has been installed before proceeding with a next step.**



SHTS011120500047

2. INSTALL THE OIL STRAINER.

(1) Replace an old O-ring with a new one. Pretighten two bolts to preinstall the oil strainer. Then fully tighten the bolts at a specified torque.

Tightening Torque:
28.5 N·m {290 kgf·cm, 21 lbf·ft}

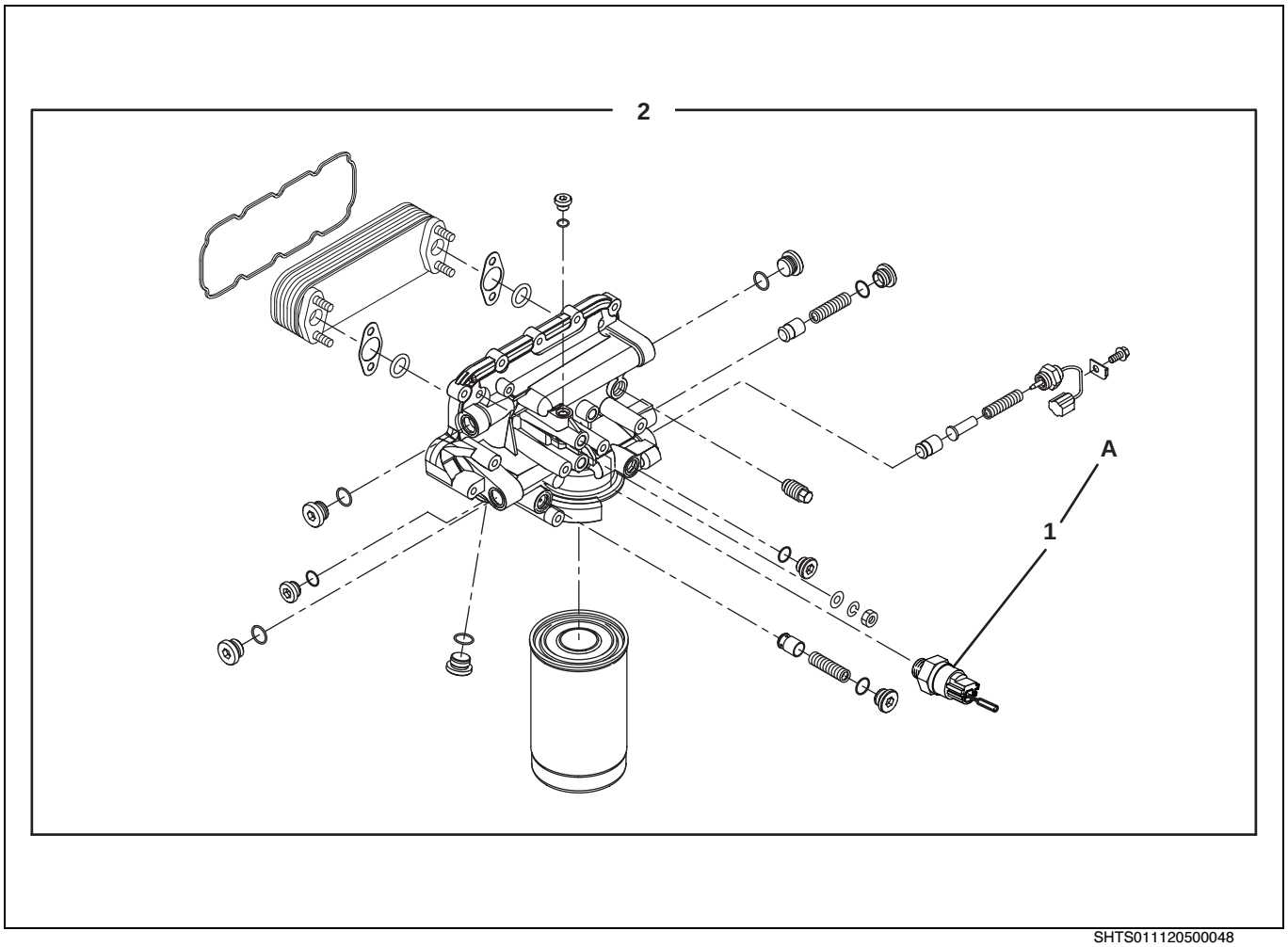
3. INSTALL THE OIL PAN.

(1) Install the oil pan to the cylinder block.
Refer to the section **"OIL PAN"**.

OIL PRESSURE SWITCH

COMPONENT LOCATOR

EN0111205D100007



SHTS011120500048

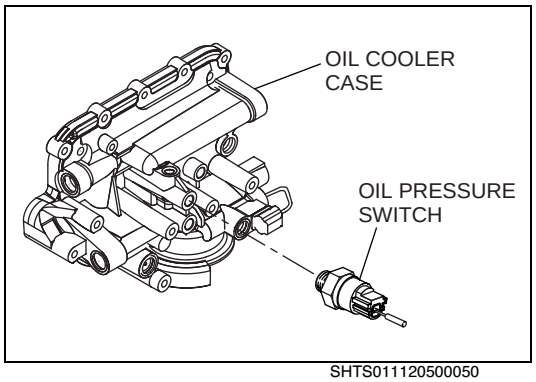
1	Oil pressure switch	2	Oil cooler assembly

Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

A	24.5-34.3 {250-350, 18-25}		

REPLACEMENT

EN0111205H100004



SHTS011120500050

REMOVE THE OIL PRESSURE SWITCH.

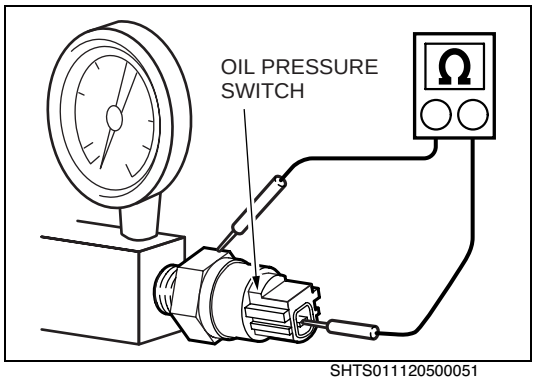
1. REMOVE THE OIL PRESSURE SWITCH.

(1) Disconnect the connector of the oil pressure switch.

(2) Remove the oil pressure switch from the oil cooler case.

HINT

Use a container and a waste as engine oil might drip off during removal of oil pressure switch.



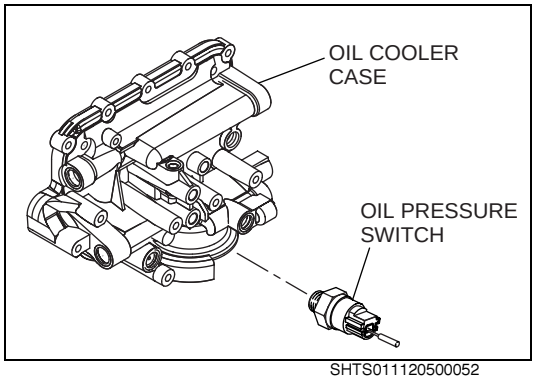
SHTS011120500051

COMPONENT CHECK

1. CHECK THE ELECTRICAL CONTINUITY.

(1) Apply air pressure or oil pressure and use a circuit tester to measure the electrical continuity between a terminal and a body. If a trouble is found, make replacement.

Pressure	Electrical continuity
At no load or at less than 39 kPa {0.4 kgf/cm^2, 5.7 lbf/in.^{2}}	Proper continuity
At 39 kPa {0.4 kgf/cm^2, 5.7 lbf/in.^{2}} or more	No continuity



SHTS011120500052

INSTALL THE OIL PRESSURE SWITCH.

1. INSTALL THE OIL PRESSURE SWITCH.

(1) Make sure that an O-ring is attached to the oil pressure switch. Install the oil pressure switch to the oil cooler case.
Tightening Torque:
24.5-34.3 N·m {250-350 kgf·cm, 18-25 lbf·ft}

(2) Connect the connector of the oil pressure switch.

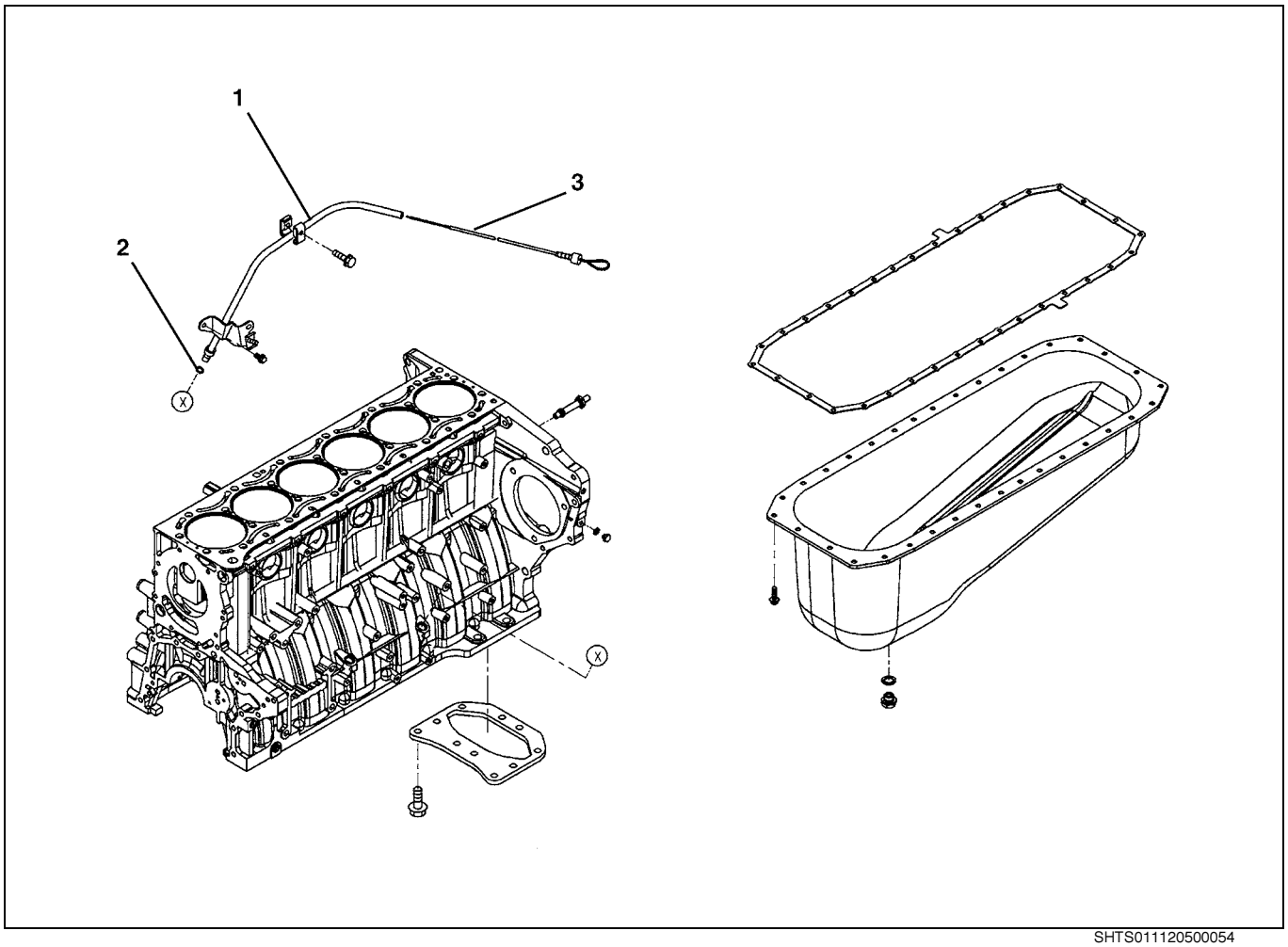
2. FILL ENGINE OIL.

(1) Check engine oil level, and refill the engine oil, if the engine oil level is low.
Refer to the section **"DISMOUNTING AND MOUNTING"** in the chapter **"ENGINE INTRODUCTION"**.

OIL LEVEL GAUGE AND GUIDE

COMPONENT LOCATOR

EN0111205D100008



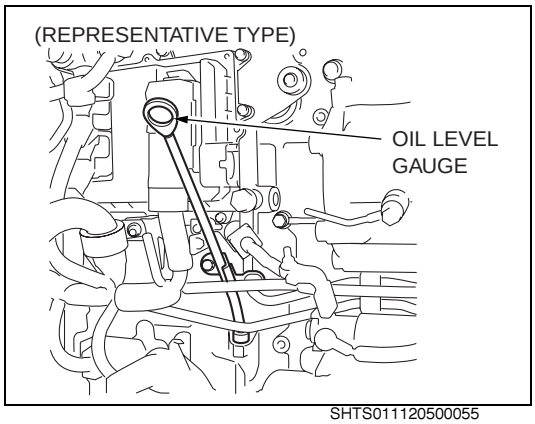
SHTS011120500054

1	Oil level gauge guide	3	Oil level gauge
2	O-ring		

REPLACEMENT

EN0111205H100005

REMOVE THE OIL LEVEL GAUGE AND THE GUIDE.



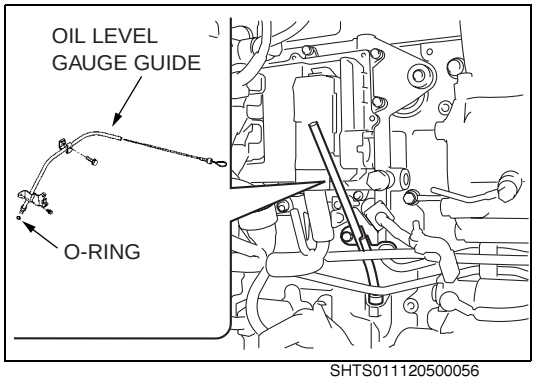
SHTS011120500055

1. REMOVE THE OIL LEVEL GAUGE.

(1) Pull off the oil level gauge from the oil level gauge guide.

HINT

Use a container and a waste as engine oil might drip off during removal of oil level gauge.



SHTS011120500056

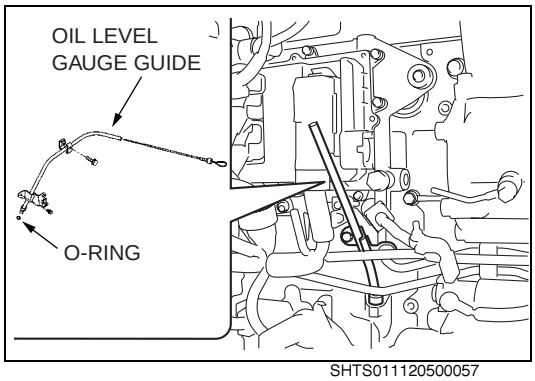
2. REMOVE THE OIL LEVEL GAUGE GUIDE.

(1) Remove a bolt to remove an O-ring and the oil level gauge guide from the cylinder block.

HINT

Use a container or a waste as engine oil might drip off during removal of oil level gauge guide.

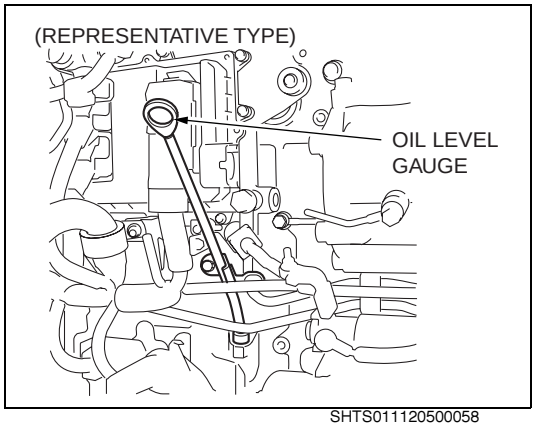
INSTALL THE OIL LEVEL GAUGE AND THE GUIDE.



SHTS011120500057

1. INSTALL THE OIL LEVEL GAUGE GUIDE.

(1) Replace an old O-ring with a new one. Install the oil level gauge guide to the cylinder block, and tighten a bolt.



SHTS011120500058

2. INSTALL THE OIL LEVEL GAUGE.

(1) Insert the oil level gauge into the oil level gauge guide.

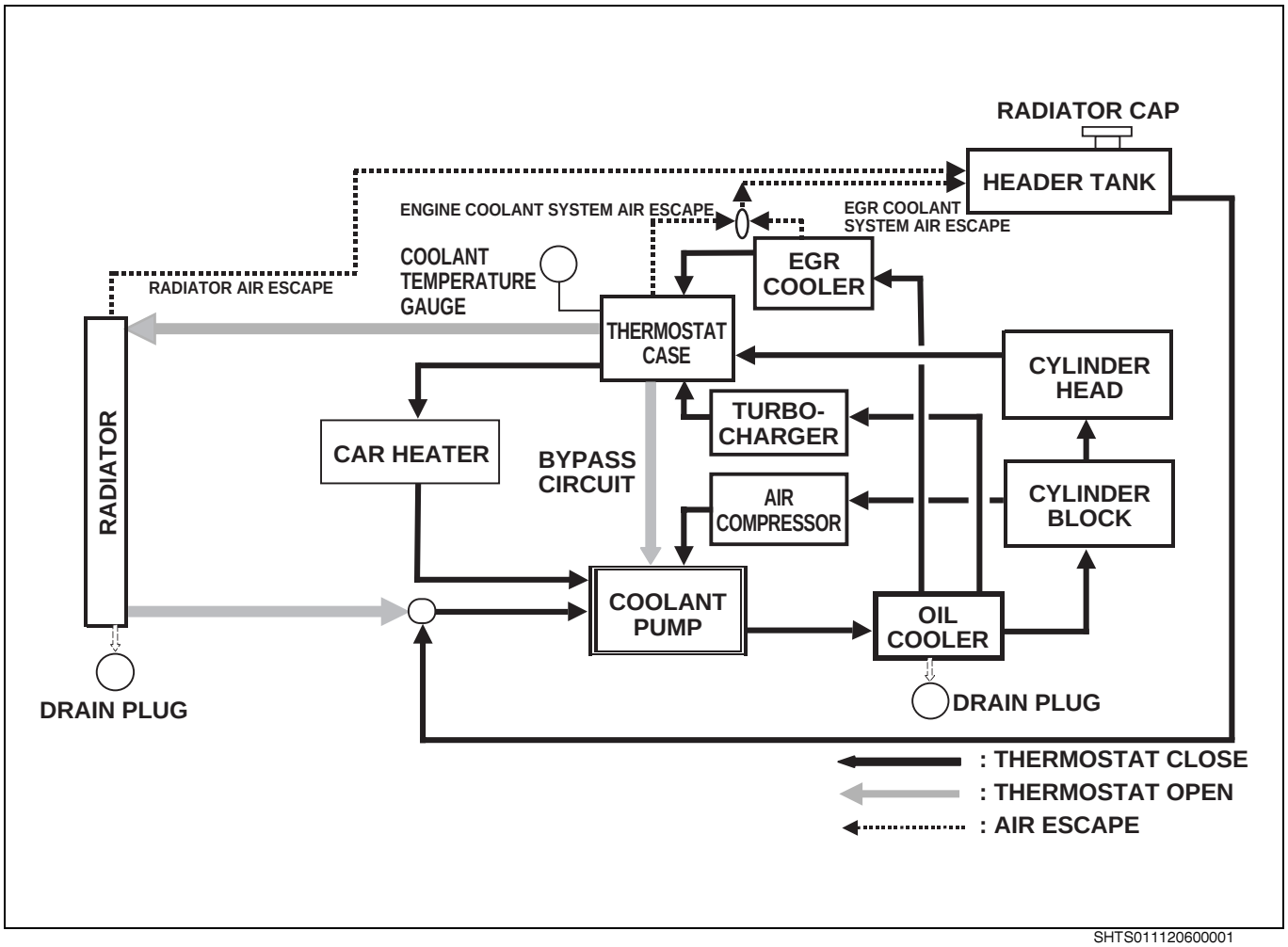
COOLING SYSTEM (A09C)

EN06-001

COOLING SYSTEM

DIAGRAM

EN0111206J100001

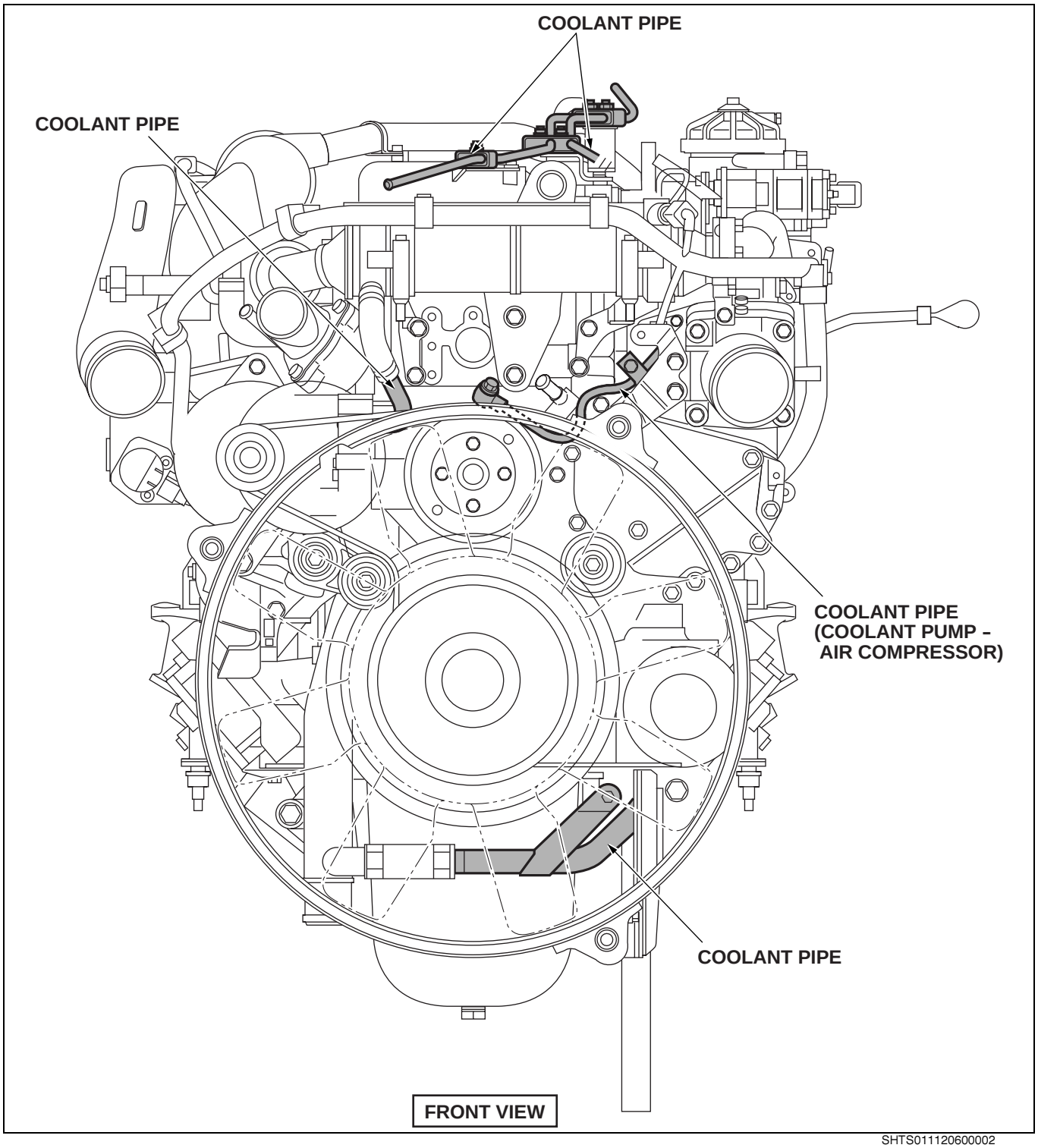


SHTS011120600001

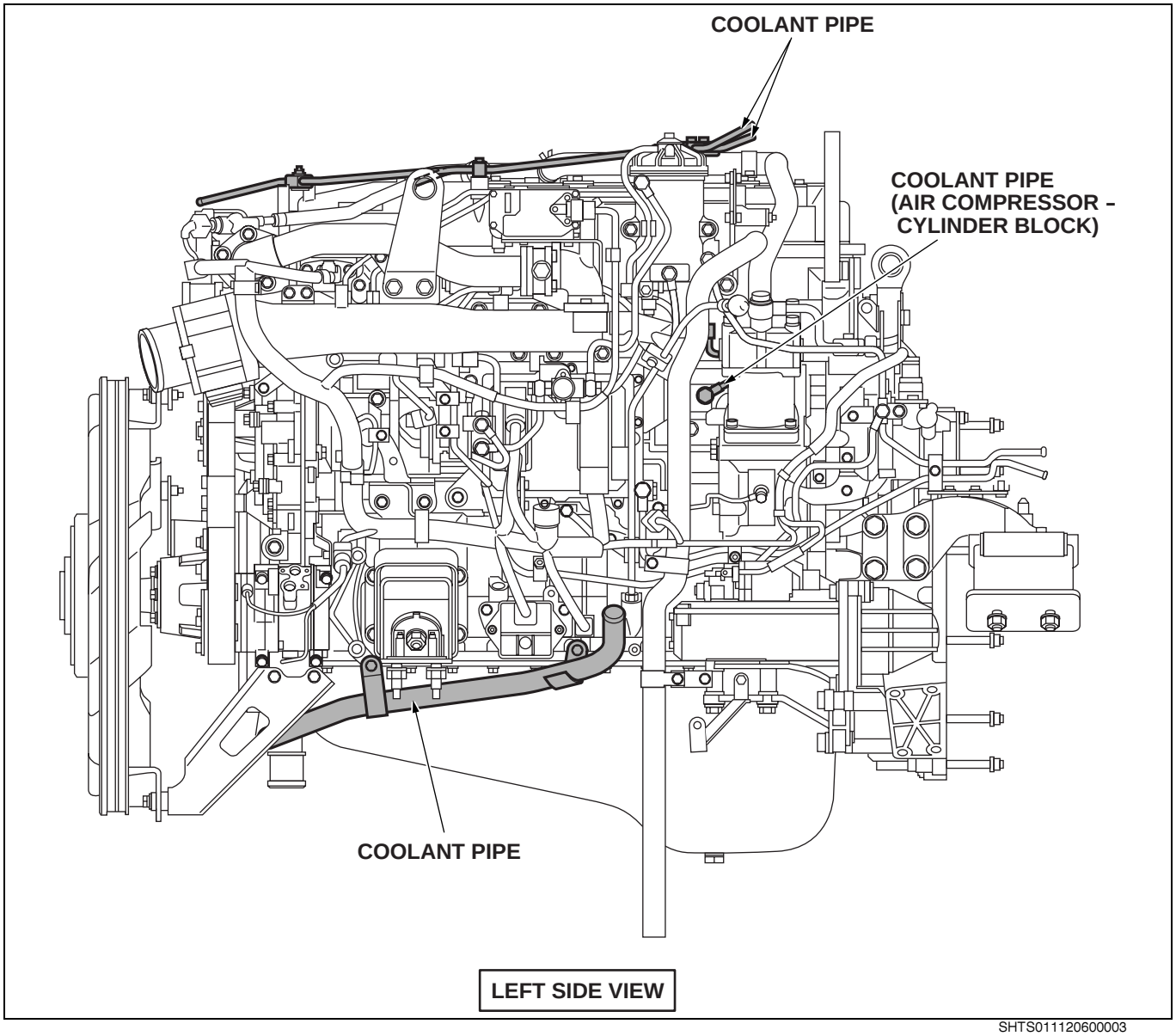
COOLANT PIPE

COMPONENT LOCATOR

EN0111206D100001

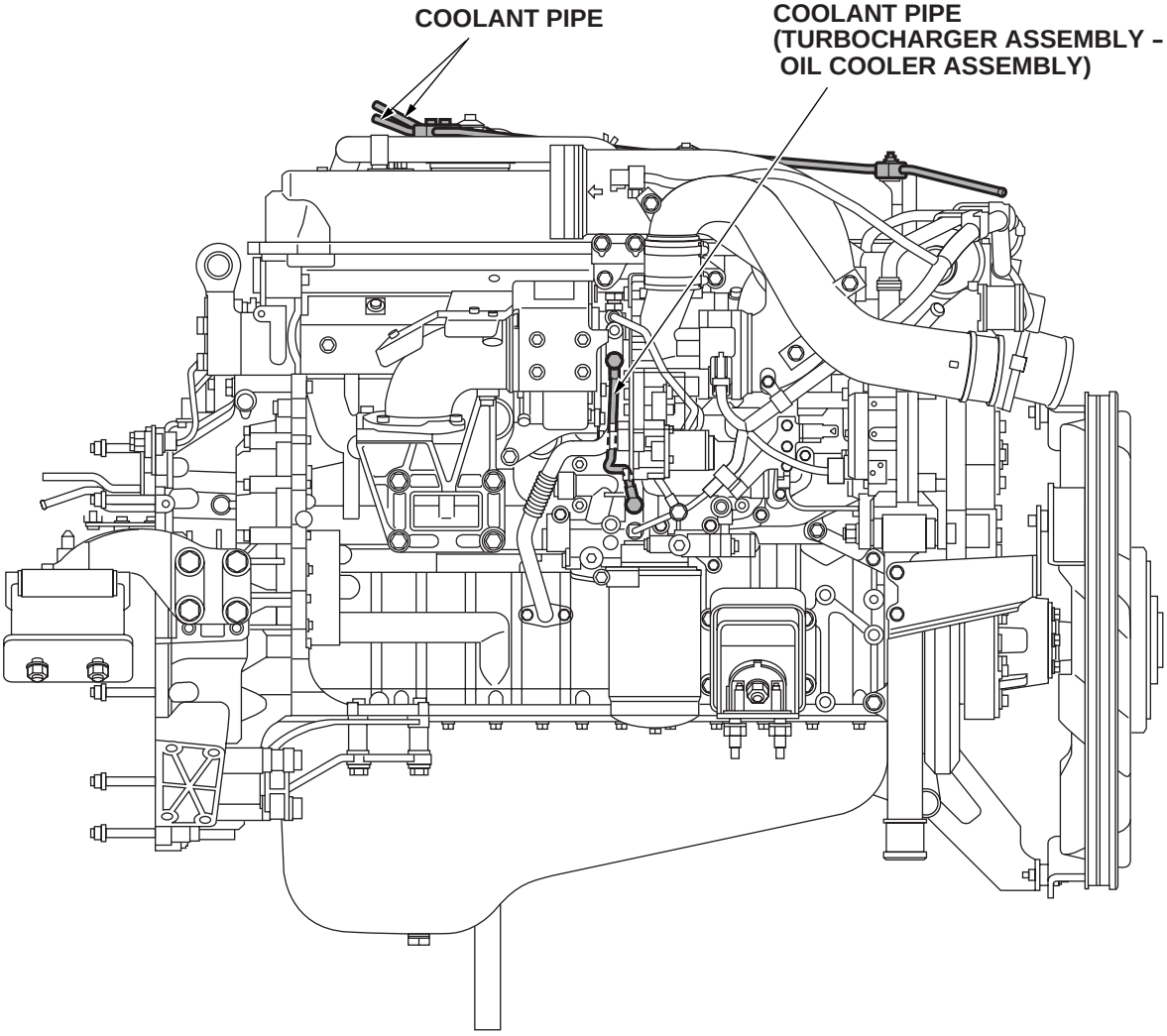


SHTS011120600002



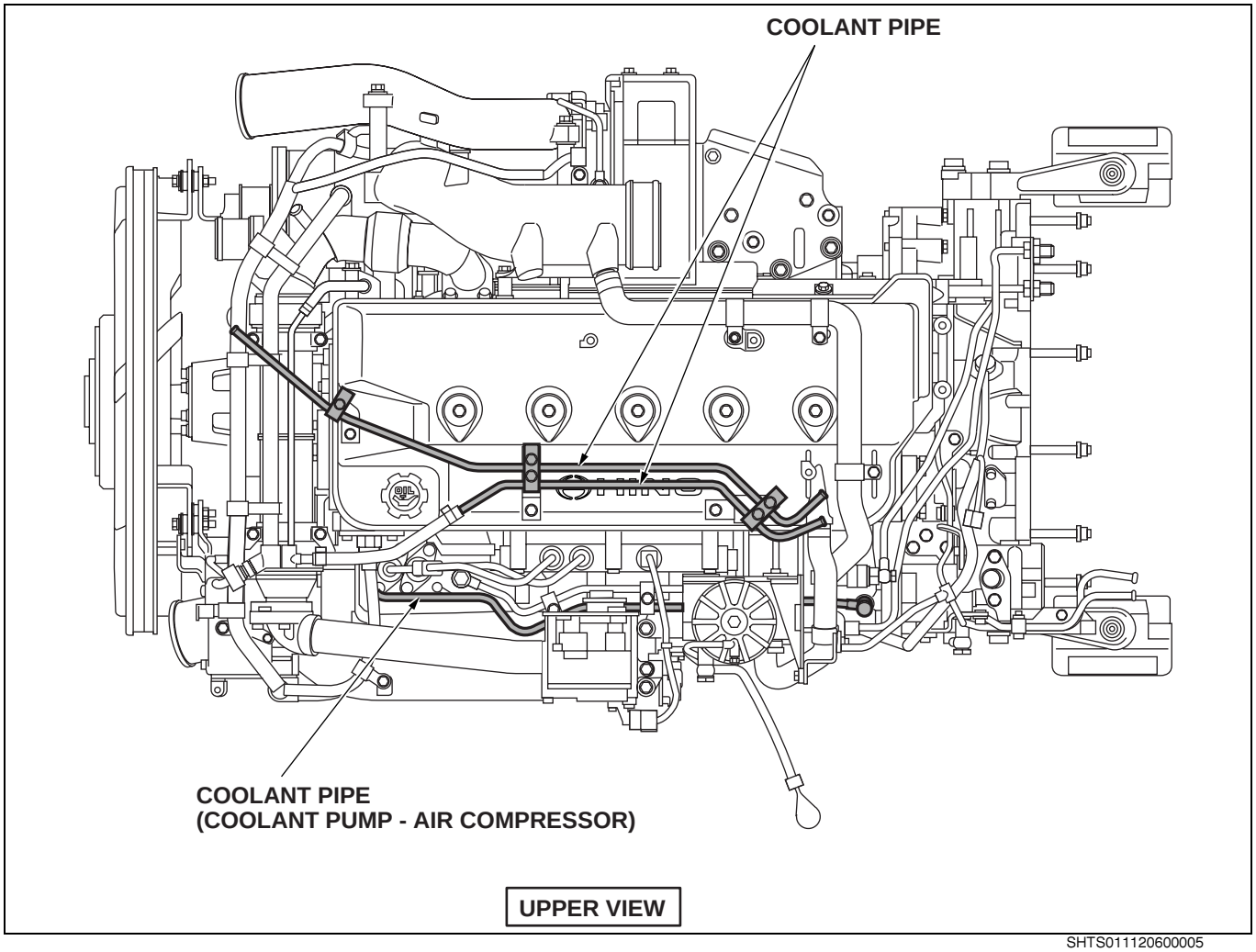
LEFT SIDE VIEW

SHTS011120600003



RIGHT SIDE VIEW

SHTS011120600004

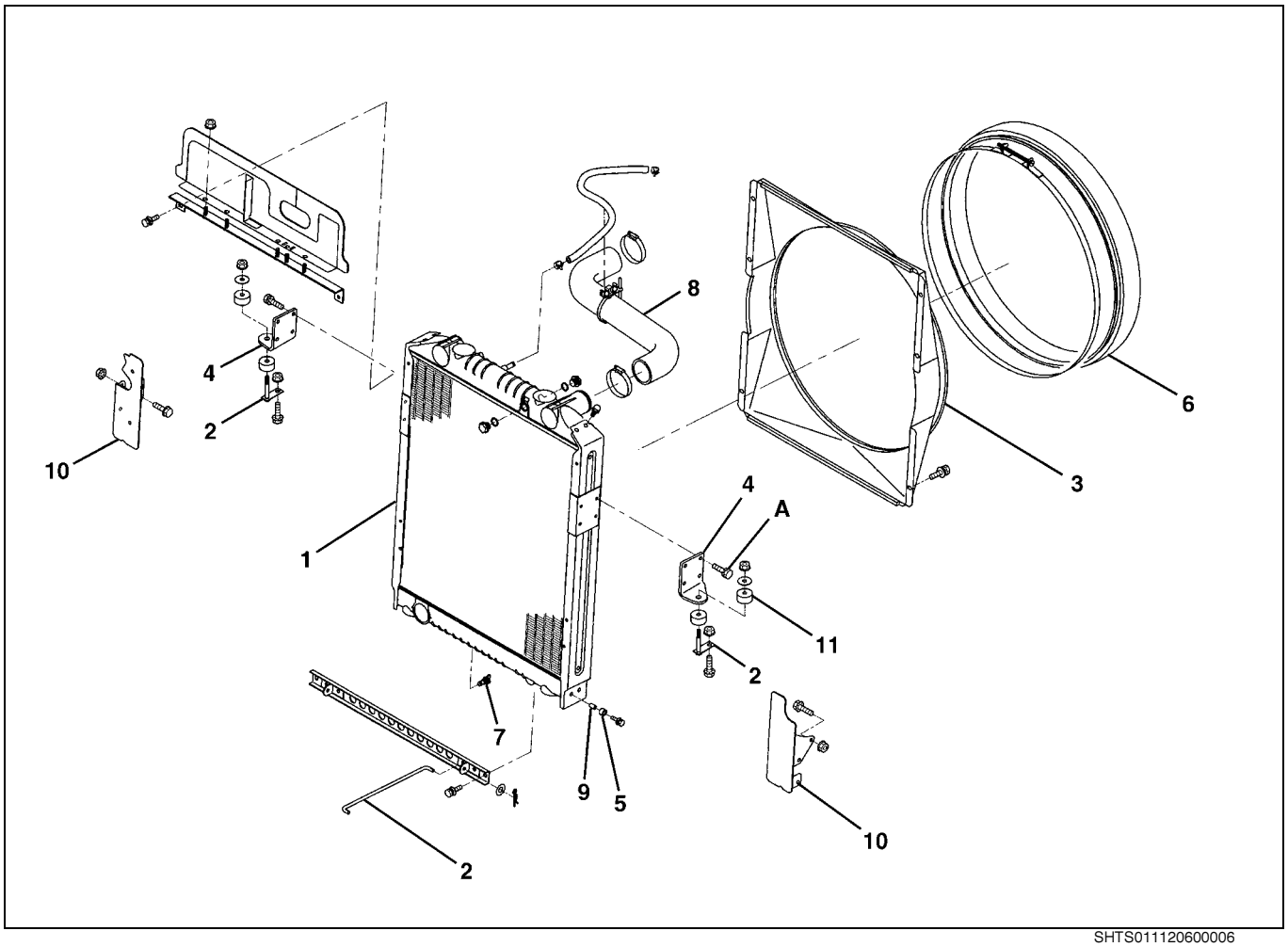


SHTS011120600005

RADIATOR

COMPONENT LOCATOR

EN0111206D100002



SHTS011120600006

1	Radiator assembly	7	Drain cock
2	Stay	8	Radiator hose
3	Fan shroud	9	Distance piece
4	Bracket	10	Baffle plate
5	Fixing cushion	11	Cushion
6	Seal ring (Rubber)		

Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

A	18-26 {185-265, 14-19}		

INSPECTION

EN0111206H300001

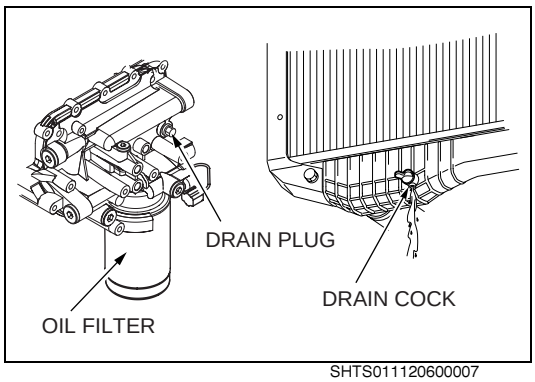
INSPECTION BEFORE MAINTENANCE

1. INSPECT THE RADIATOR.

(1) Visually check the radiator for water leakage, cracks, damages and other troubles. If a trouble would be found, replace the radiator. If coolant decreases at a short interval and needs to be frequently filling, check the radiator, hoses and pipes for water leakage.

OVERHAUL

EN0111206H200001



SHTS011120600007

REMOVE THE RADIATOR.

1. DRAIN THE COOLANT.

(1) Drain the coolant out of the drain plug of oil cooler and the drain cock of the radiator.

⚠ CAUTION

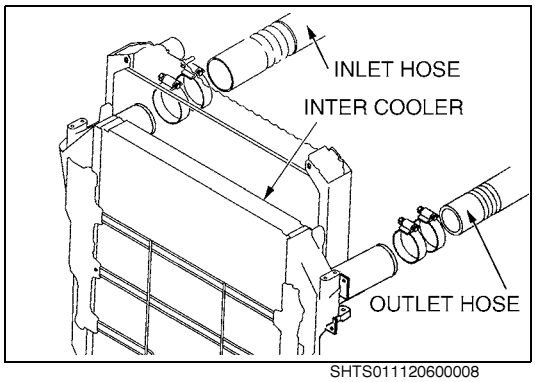
To avoid the danger of burns and scalds, do not drain the coolant while the engine and radiator are hot.

NOTICE

Disposal of coolant must comply with specified procedures (waste disposal) or other environmentally-conscious procedures.

HINT

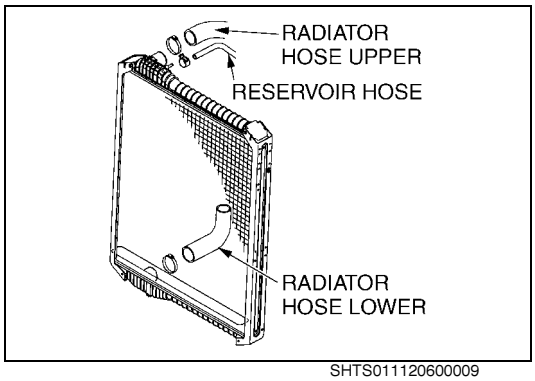
- **Coolant can be drained quicker by removing the radiator cap.**
- **Connection of a reasonable hose to the oil cooler drain pipe would aid in avoiding spatters of coolant during drainage.**



SHTS011120600008

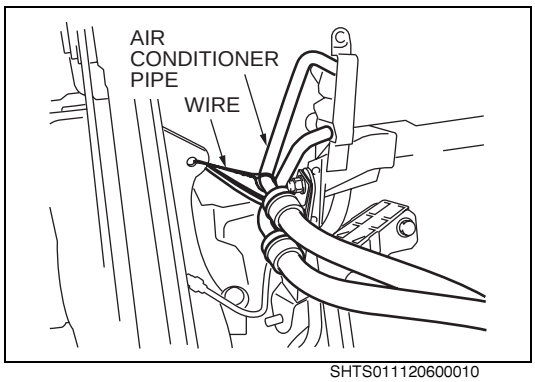
2. DISCONNECT THE HOSES.

(1) Loosen the clamps and disconnect the inter cooler hoses (in and out).



SHTS011120600009

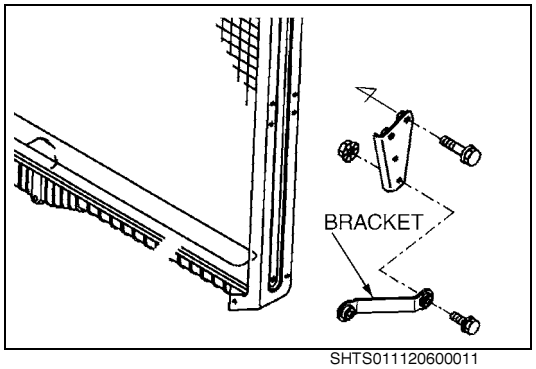
(2) Remove clamp and disconnect the reservoir hose.
(3) Loosen the clamps and disconnect the radiator hoses (upper and lower).



SHTS011120600010

3. MOVE THE AIR CONDITIONER PIPE.

(1) Remove the nut to remove the air conditioner pipe bracket.
(2) Use a piece of wire to temporarily fixate the air conditioner pipe on the vehicle.



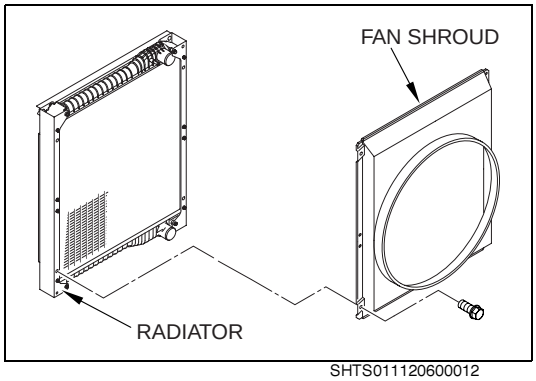
SHTS011120600011

4. REMOVE THE RADIATOR.

NOTICE

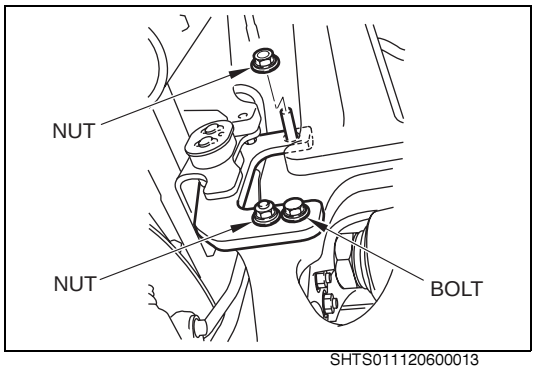
Proceed with the steps below after protecting the radiator core with a cardboard to prevent damages to the radiator core.

(1) Remove the brackets (right and left) from the lower area of the radiator.



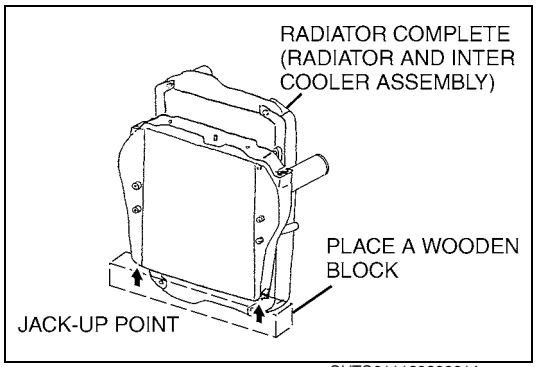
SHTS011120600012

(2) Remove bolts on the fan shroud.



SHTS011120600013

(3) Remove the nuts and bolts (left and right) of the stay.

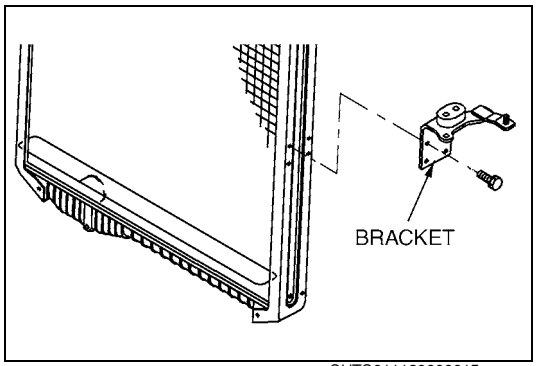


SHTS011120600014

(4) Use a jack to lift the radiator and inter cooler assembly to a height of approximately 100 mm {3.937 in.}, in order to remove a bolt on the bracket on the side face of the radiator.

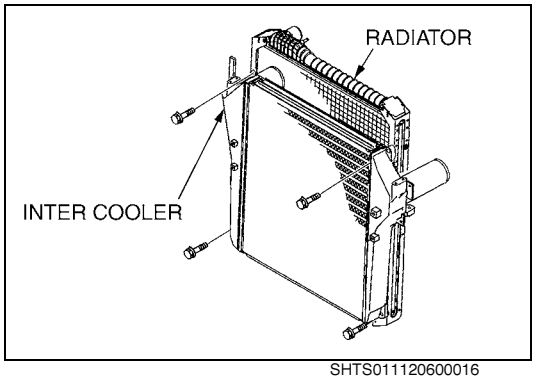
⚠ CAUTION

The radiator is a plastic tank. Do not use it as a jack-up point. Place a wooden block on both sides of the inter cooler tank at the same time, and lift up.



SHTS011120600015

(5) Remove the bolts of the bracket.



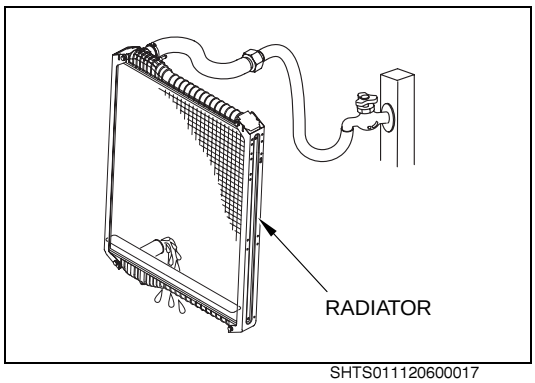
SHTS011120600016

(6) Lower a jack and remove bolts securing the inter cooler onto the radiator.

(7) Pull the fan shroud in the direction toward the engine side to ensure a clearance. Then, remove the radiator in the upward direction.

⚠ CAUTION

- **In this step, pull off the radiator with a reasonable care as the radiator lower pipe might be caught by the fan shroud or other parts.**
- **Handle this work step carefully not to damage fins in the radiator core.**



SHTS011120600017

COMPONENT CHECK

1. CHECKING FOR CLOGGING, CONTAMINATION AND DAMAGE.

(1) Pressurize tap water and inject it into the radiator through an opening on the top of the radiator. Observe the water flowing out from an opening at the bottom of the radiator, and determine whether the radiator is clogged. If a trouble is found (e.g. only a small amount of water is running out in contrary to high-pressure water injection), replace the radiator.

(2) Check the radiator core for crush or contamination. If a trouble is found, clean, correct or replace the radiator.

INSTALL THE RADIATOR.

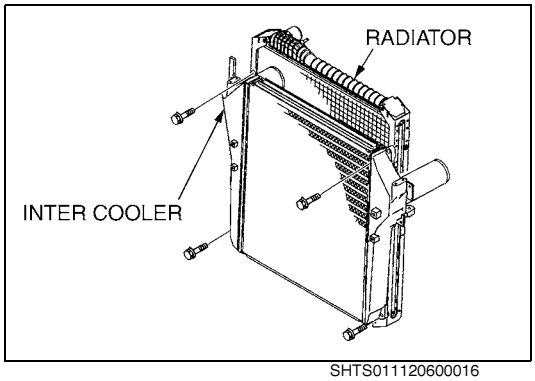
1. INSTALL THE RADIATOR.

(1) Pull in the fan shroud in the direction toward the engine side to ensure a clearance. Then, insert the radiator from the upward direction.

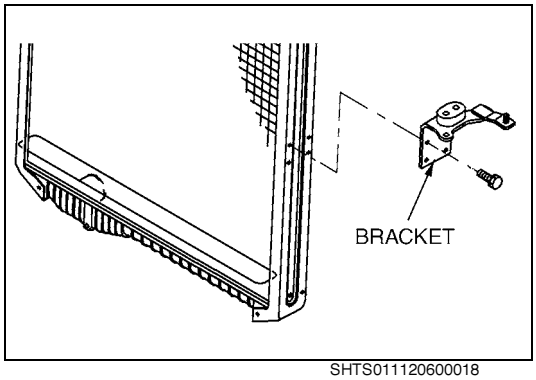
⚠ CAUTION

Handle this work step carefully not to damage fins in the radiator core.

(2) Combine the radiator and the inter cooler with the bolts.
Tightening Torque:
14-20 N·m {143-204 kgf·cm, 10-15 lbf·ft}



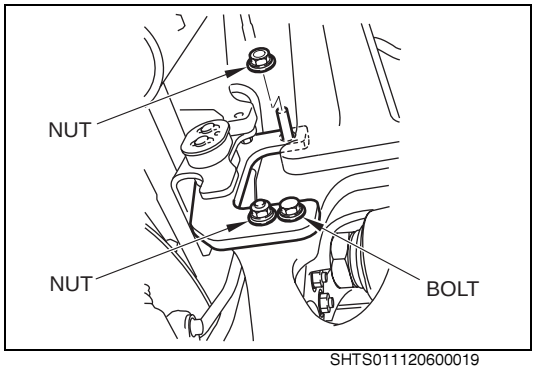
SHTS011120600016



SHTS011120600018

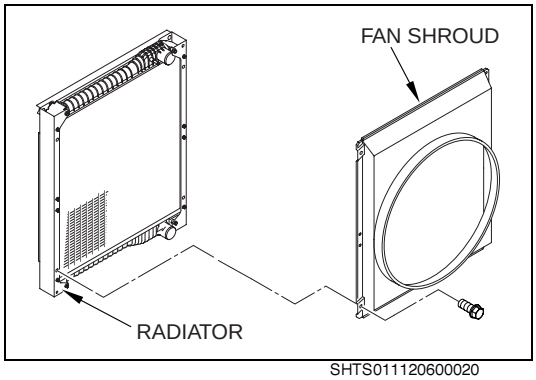
(3) Use a jack to lift the radiator and inter cooler assembly to a height of approximately 100 mm {3.937 in.}, in order to install the bracket on the side face of the radiator, and tighten the bolts.
Tightening Torque:
18-26 N·m {185-265 kgf·cm, 14-19 lbf·ft}

⚠ CAUTION
The radiator is a plastic tank. Do not use it as a jack-up point. Place a wooden block on both sides of the intercooler tank at the same time, and lift up.



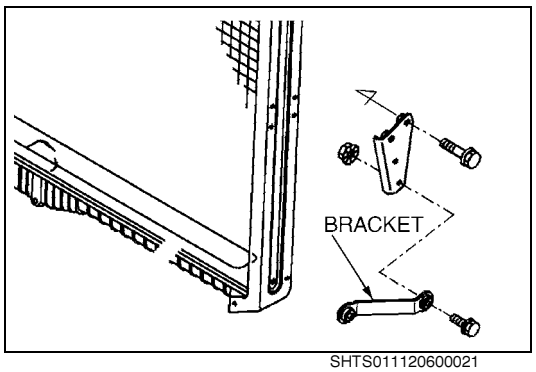
SHTS011120600019

(4) Install the bracket with two nuts and a bolt to fix the vehicle, the radiator and the inter cooler.
Tightening Torque:
18-26 N·m {185-265 kgf·cm, 14-19 lbf·ft}



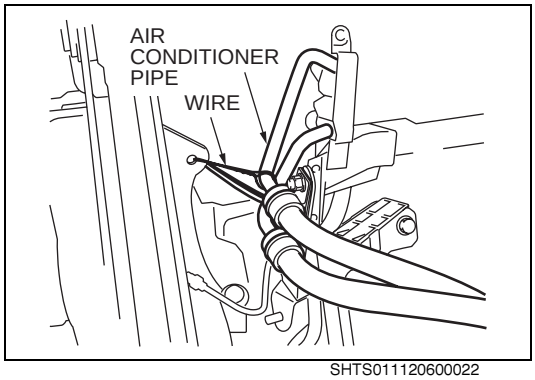
SHTS011120600020

(5) Install the fan shroud with the bolts.



SHTS011120600021

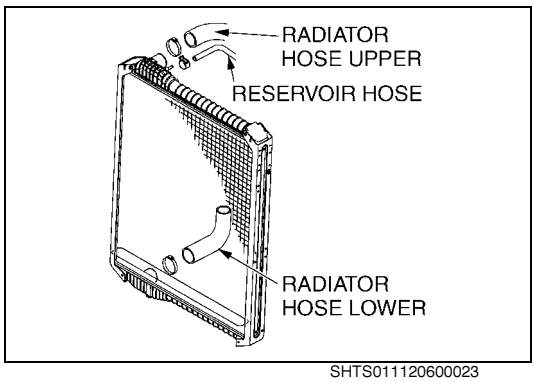
(6) Install the brackets (right and left) to the lower area of the radiator.
Tightening Torque:
19-25 N·m {194-255 kgf·cm, 14-18 lbf·ft}



SHTS011120600022

2. CONNECT THE HOSES.

(1) Place the air conditioner pipe assembly temporarily fixated onto the vehicle, back to its original position. Secure the bracket.

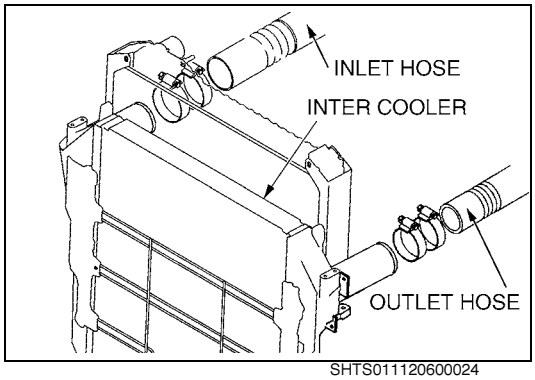


SHTS011120600023

(2) Insert the radiator hoses (upper and lower) and fix them with the clamps.

Tightening Torque:
4.0-5.0 N·m {41-51 kgf·cm, 3-4 lbf·ft}

(3) Insert the reservoir hose and fix it with the clamp.



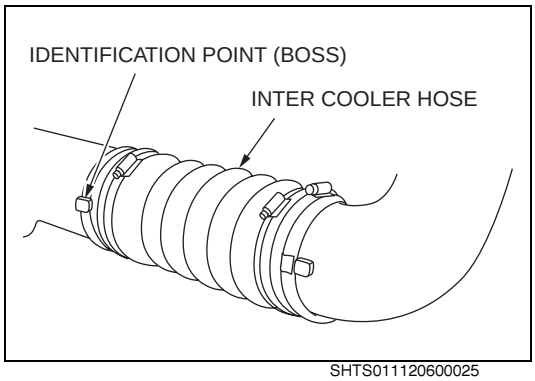
SHTS011120600024

(4) Insert the inter cooler hoses (inlet and outlet) until they contact with individual alignment marks (bosses), and fasten new clamps.

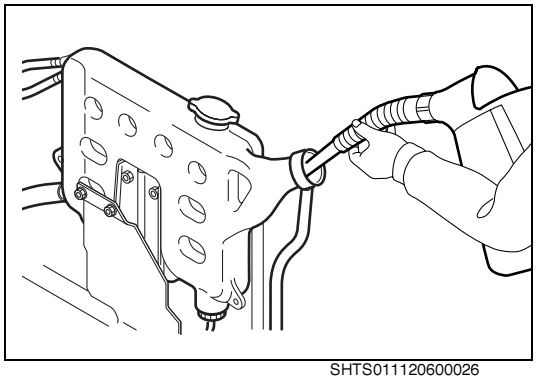
Tightening Torque:
6 N·m {60 kgf·cm, 4 lbf·ft}

NOTICE

- **If cracks or peeling would be found in the inner surface of the inter cooler hoses, should be replace it.**
- **When inserting the inter cooler hoses, do not apply soap water or adhesives to the inner surface of a hose or the mating sleeve.**



SHTS011120600025


SHTS011120600026

3. FILL THE COOLANT.

(1) Gradually fill coolant through the coolant inlet in the header tank.

NOTICE

Rapid filling will obstruct smooth air vent in the cooling piping and increase the filling time.

Coolant volume: 33.5 L

(2) Fill coolant in the header tank to the "FULL"" level.

(3) Fully close the radiator cap.

(4) Set an engine speed slightly higher than a regular idling speed.

(5) Increase a coolant temperature to the extent that the coolant temperature gauge indicates a middle level by racing the engine three to five times (idle to 1,800 r/min or more). Keep running the engine for additional 10 min. to purge air from the radiator and from inside the engine.

(6) Stop the engine and wait until the engine cools down. Check the coolant levels in the header tank. Fill coolant to make up for a decrease in coolant (used for air purge).

⚠ CAUTION

Do not open the radiator cap when hot.

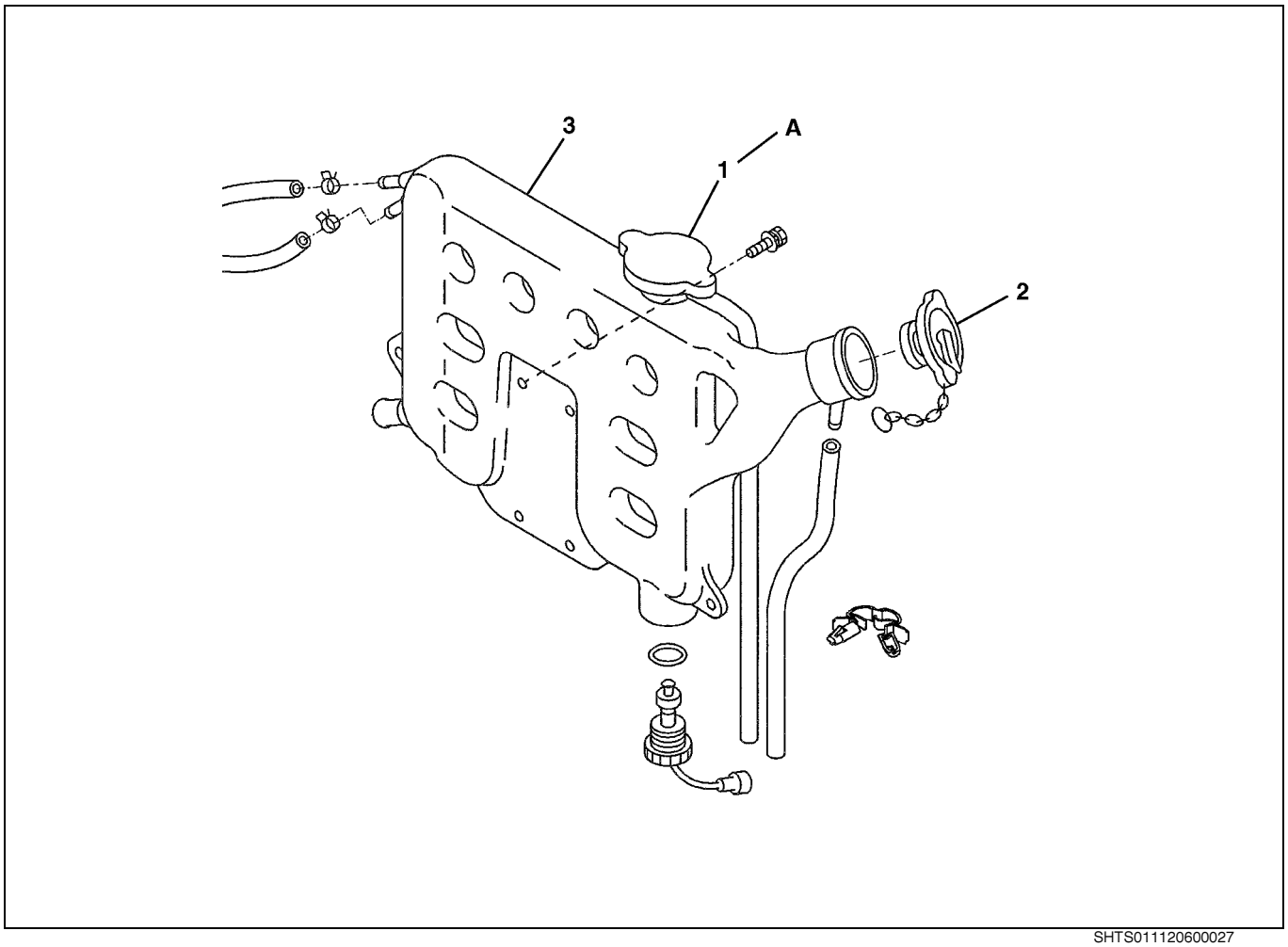
NOTICE

- **An excessive increase of the engine speed would cause breakdown of engine components or shorten the service life.**
- **Air-contained coolant would cause overheat or leakage from the coolant pump.**
- **Check that no leakage (engine oil, etc.) or noise would be observed from the fuel system and/or the cooling system.**

RADIATOR CAP

COMPONENT LOCATOR

EN0111206D100003



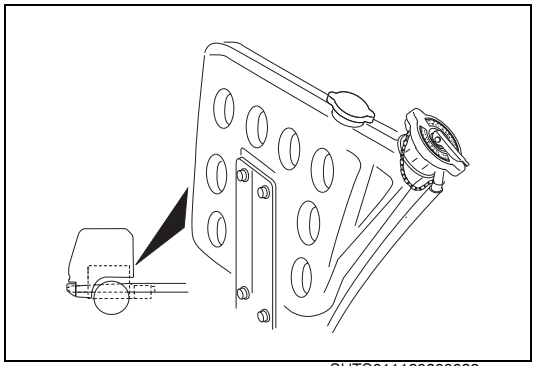
SHTS011120600027

1	Radiator cap (For prevent the overflow)	3	Header tank
2	Radiator cap (For feeding coolant)		

A: This cap will not be necessary to be removed and be sealed to prevent from mistaking to feed coolant with a wire.

REPLACEMENT

EN0111206H100001



SHTS011120600028

REMOVE THE RADIATOR CAP (FOR PREVENT THE OVERFLOW).

1. REMOVE THE RADIATOR CAP.

(1) Make sure that the engine is not hot.

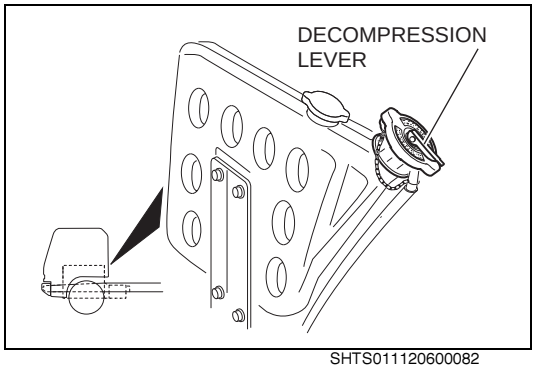
(2) Turn the radiator cap counterclockwise to remove it.

⚠ CAUTION

- **Do not open the radiator cap when hot.**
- **Retighten the cap if a large volume of vapor comes out. Wait until a coolant temperature is low enough to proceed with works.**

HINT

If coolant would be worm, wear two to three pairs of thick gloves before proceeding with works.



SHTS011120600082

REMOVE THE RADIATOR CAP (FOR FEEDING COOLANT).

1. REMOVE THE RADIATOR CAP.

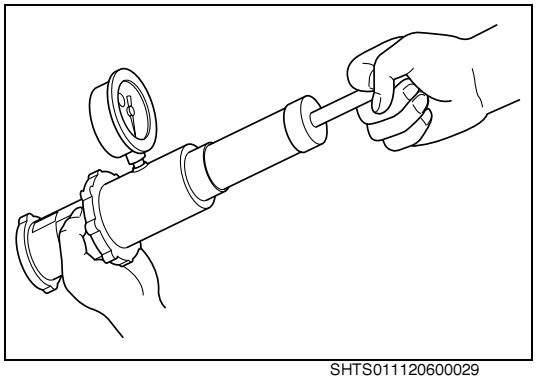
(1) Make sure that the engine is not hot.
(2) Set the decompression lever in the center of the cap in the upright position.
(3) Turn the radiator cap counterclockwise to remove it.

⚠ CAUTION

- **Do not open the radiator cap when hot.**
- **Retighten the cap if a large volume of vapor comes out. Wait until a coolant temperature is low enough to proceed with works.**

HINT

If coolant would be worm, wear two to three pairs of thick gloves before proceeding with works.


SHTS011120600029

COMPONENT CHECK

1. CHECK THE VALVE OPENING PRESSURE.

(1) Using a radiator cap tester, measure the valve opening pressure of the radiator cap. If a measurement reading would be out of the standard value, replace the radiator cap with a new one.

Standard value:
For prevent the overflow: 39-59 kPa {0.4-0.6 kgf/cm^2, 6-8 lbf/in.^{2}}
For feeding coolant: 69-88 kPa {0.7-0.9 kgf/cm^2, 10-13 lbf/in.^{2}}

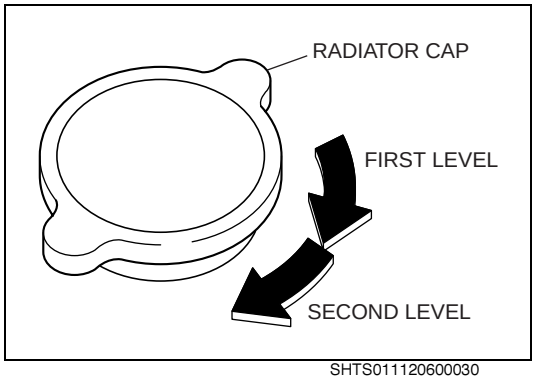
2. CHECK THE WATER LEAKAGE OF THE COOLING SYSTEM.

(1) Make sure that the coolant level is correct value.
(2) Using a radiator cap tester, pressurize the radiator and check to see that there is no water or no air leakage. If leakage would occur, repair or replace the radiator with a new one.

⚠ CAUTION

Be careful, do not to apply a pressure more than below mentioned value to the radiator.

Standard value: 100 kPa {1 kgf/cm^2, 15 lbf/in.^{2}}



SHTS011120600030

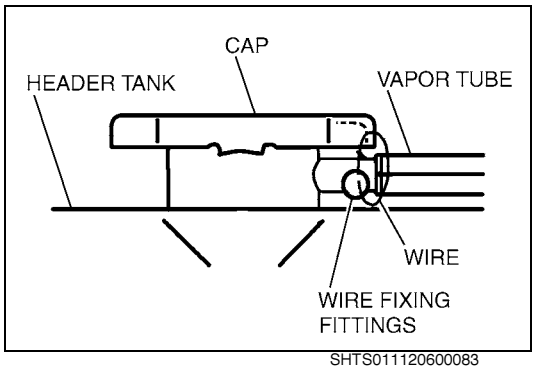
INSTALL THE RADIATOR CAP (FOR PREVENT THE OVERFLOW).

1. INSTALL THE RADIATOR CAP.

(1) Turn the radiator cap clockwise to the second level to fit it tight.

⚠ CAUTION

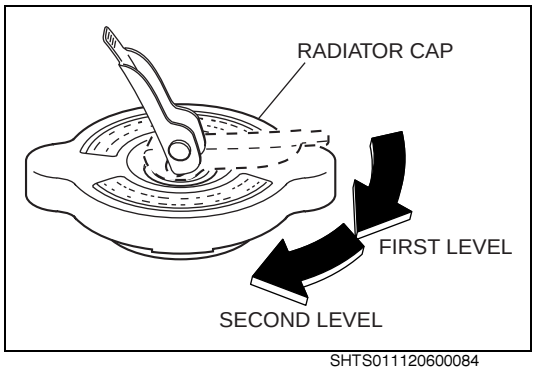
Improper installation of the radiator cap would cause overheating and spurt out hot water.



SHTS011120600083

(2) Connect hole of radiator cap with vapor tube by a wire and finally pass an end of the wire into wire fixing fittings.

(3) Make sure to caulk the wire fixing fittings.



SHTS011120600084

INSTALL THE RADIATOR CAP (FOR FEEDING COOLANT).

1. INSTALL THE RADIATOR CAP.

(1) Turn the radiator cap clockwise to the second level to fit it tight.

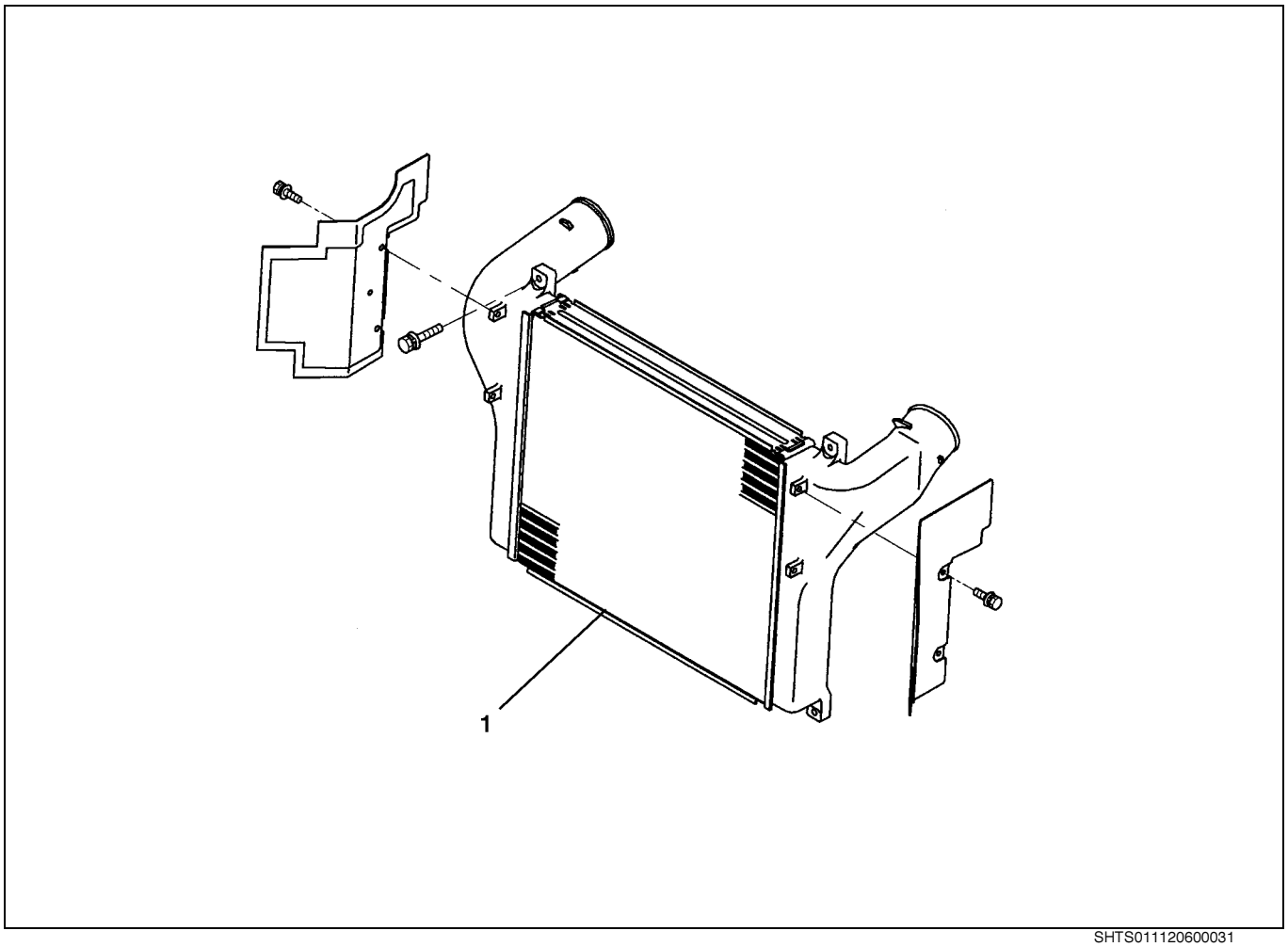
⚠ CAUTION

Improper installation of the radiator cap would cause overheating and spurt out hot water.

INTER COOLER

COMPONENT LOCATOR

EN0111206D100004



SHTS011120600031

1 Inter cooler	

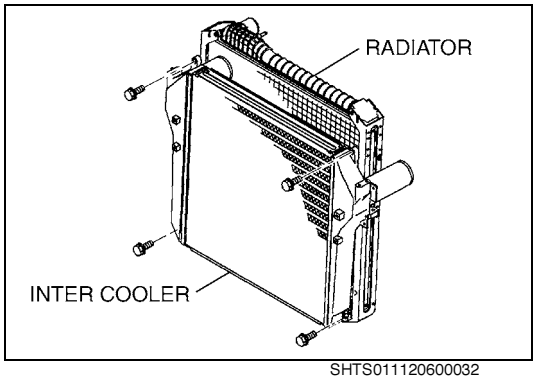
OVERHAUL

EN0111206H100002

REMOVE THE INTER COOLER.

1. REMOVE THE RADIATOR.

(1) Remove the radiator together with the inter cooler.
Refer to the section **"RADIATOR"**.



SHTS011120600032

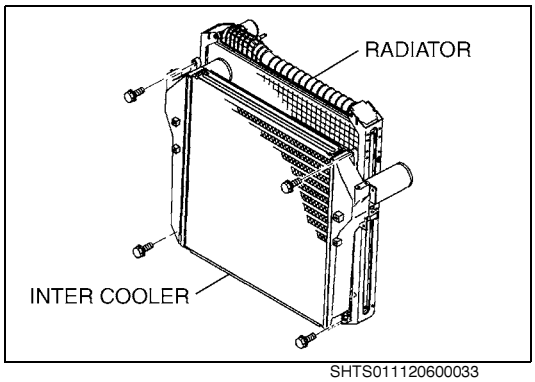
2. REMOVE THE INTER COOLER.

(1) After removal of the radiator, remove the inter cooler from the radiator.

COMPONENT CHECK

1. INSPECT THE INTER COOLER.

(1) Check the radiator core for crush or contamination. If a trouble is found, clean, correct or replace the radiator.



SHTS011120600033

INSTALL THE INTER COOLER.

1. INSTALL THE INTER COOLER.

(1) Install the inter cooler to the radiator, and tighten the bolts.
Tightening Torque:
14-20 N·m {143-204 kgf·cm, 10-15 lbf·ft}

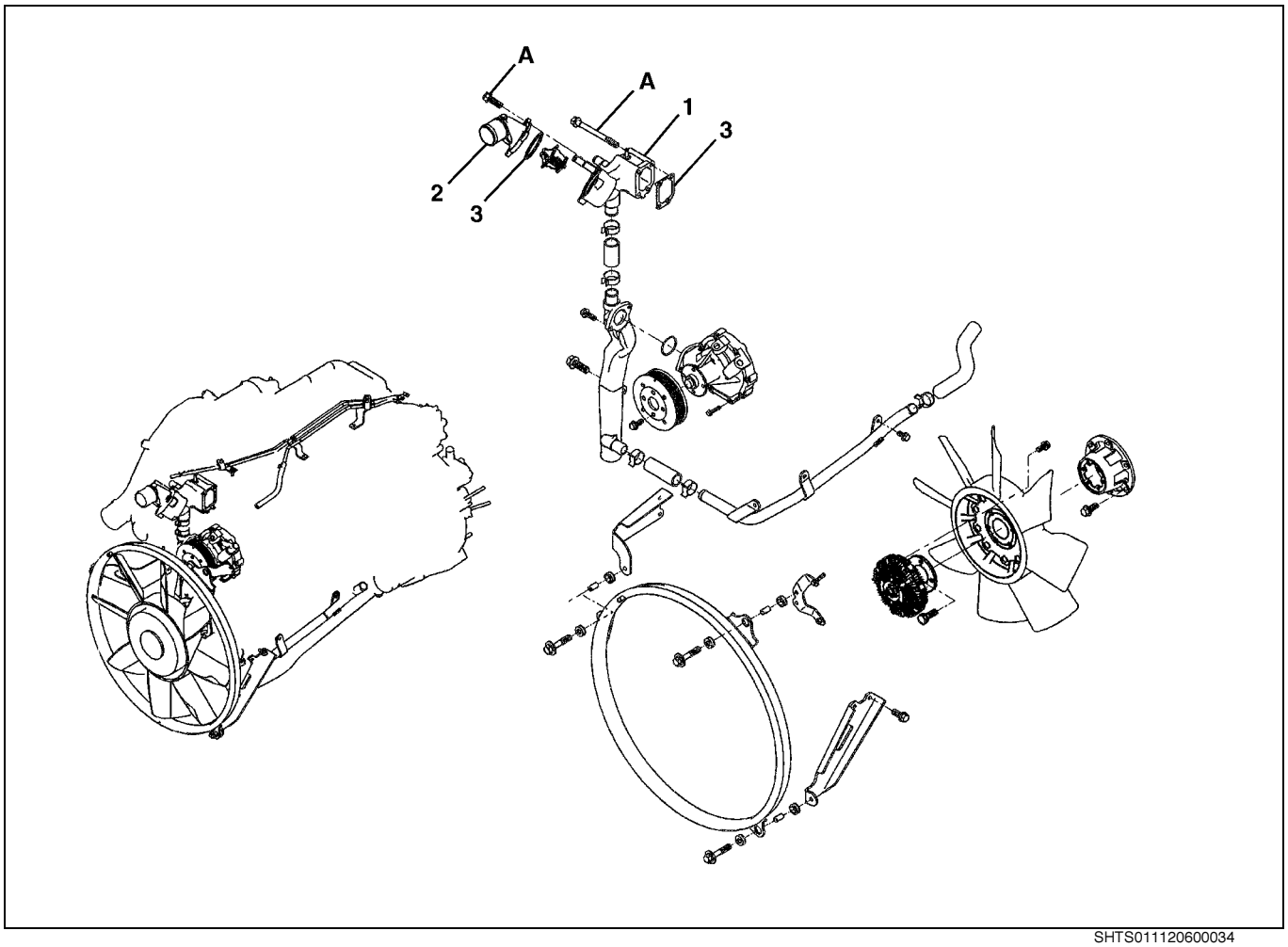
2. INSTALL THE RADIATOR.

(1) Install the radiator together with the inter cooler.
Refer to the section **"RADIATOR"**.

THERMOSTAT CASE AND THERMOSTAT

COMPONENT LOCATOR

EN0111206D100005



SHTS011120600034

1	Thermostat case	3	Gasket
2	Thermostat case cover		

Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

A	55 {560, 41}		

OVERHAUL

EN0111206H200002

REMOVE THE THERMOSTAT CASE.

1. REMOVE THE V-RIBBED BELT.

(1) Remove the V-ribbed belt.
Refer to the section **"V-RIBBED BELT"** in the chapter **"ALTERNATOR"**.

2. REMOVE THE AIR COMPRESSOR SUCTION HOSE.

(1) Remove the air compressor suction hose.
Refer to the section **"AIR COMPRESSOR"** in the chapter **"AIR COMPRESSOR"**.

3. REMOVE THE INTAKE PIPE (EXHAUST SIDE).

(1) Remove the U-turn pipe and the boost pipe.
Refer to the section **"INTAKE PIPE (EXHAUST SIDE)"** in the chapter **"AIR INTAKE SYSTEM"**.

4. REMOVE THE ALTERNATOR.

(1) Remove the alternator.
Refer to the section **"ALTERNATOR"** in the chapter **"ALTERNATOR"**.

5. DISCONNECT THE HARNESS.

(1) Disconnect the connector of the coolant temperature sensor.
Refer to the section **"COOLANT TEMPERATURE SENSOR"**.

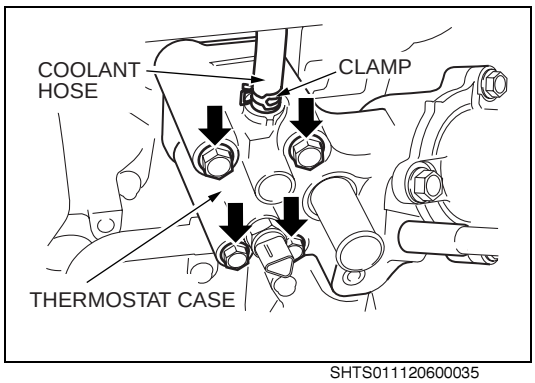
6. REMOVE THE COOLANT HOSE.

(1) Remove the coolant hose between the cooling pump and the EGR cooler.
Refer to the section **"EGR VALVE AND COOLER"** in the chapter **"EMISSION CONTROL"**.

(2) Remove the coolant hose between the coolant pump and the coolant pipe.
Refer to the section **"CYLINDER HEAD ASSEMBLY"** in the chapter **"ENGINE MECHANICAL"**.

7. REMOVE THE COOLANT PIPE.

(1) Remove the coolant pipe between the thermostat case and the turbocharger assembly.
Refer to the section **"TURBOCHARGER"** in the chapter **"TURBOCHARGER"**.

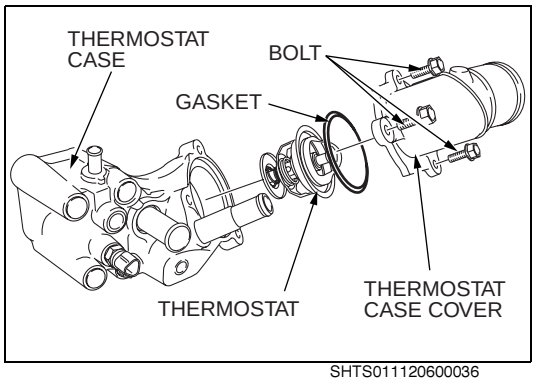


SHTS011120600035

8. REMOVE THE THERMOSTAT CASE.

(1) Remove the clamp and pull out the coolant hose from the thermostat case.

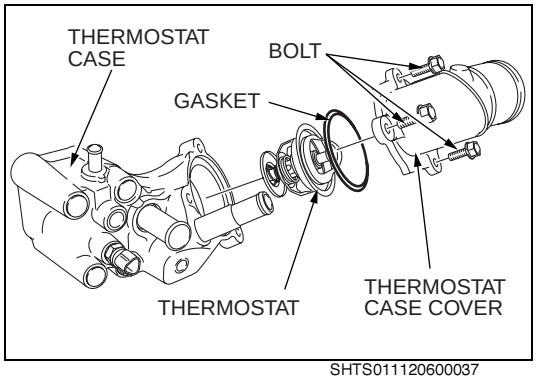
(2) Remove four bolts to remove the thermostat case and gasket from the cylinder head.



SHTS011120600036

9. REMOVE THE THERMOSTAT.

(1) Remove three bolts to remove the thermostat case cover and the thermostat from the thermostat case.

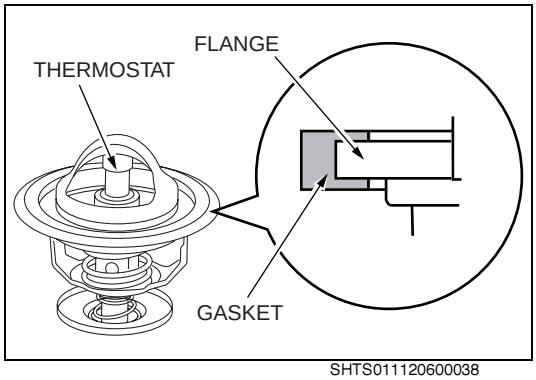


SHTS011120600037

INSTALL THE THERMOSTAT CASE.

1. INSTALL THE THERMOSTAT.

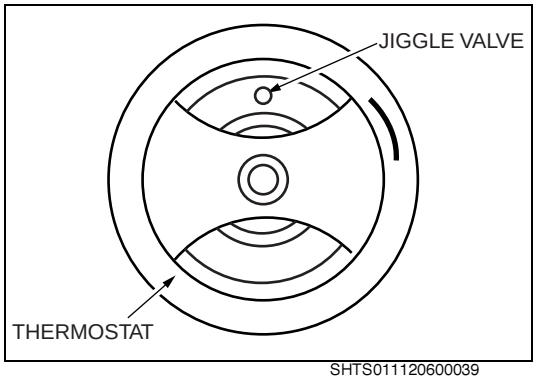
(1) Install the thermostat case cover and thermostat to the thermostat case, and tighten three bolts.
Tightening Torque:
55 N·m {560 kgf·cm, 41 lbf·ft}



SHTS011120600038

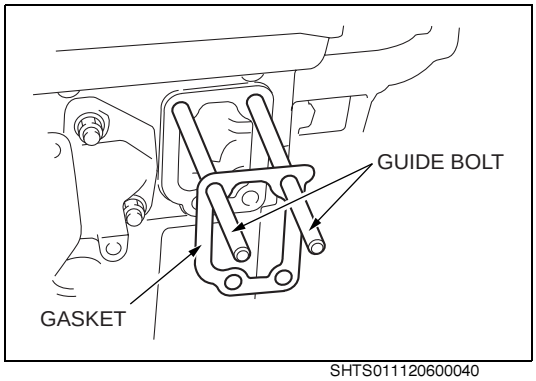
NOTICE

- **Improper mounting of the gasket will cause water leakage. Make sure that the gasket engages with a flange of the thermostat.**



SHTS011120600039

- **Position the jiggle valve on the top when assembling the thermostat.**



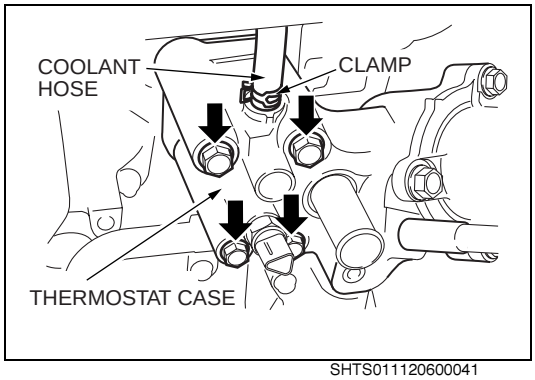
SHTS011120600040

2. INSTALL THE THERMOSTAT CASE.

(1) Install two guide bolts to the cylinder head and match the new gasket with the installation position.

NOTICE

Remove two guide bolts only after pre tightening two thermostat case mounting bolts.



SHTS011120600041

(2) Install the thermostat case to the cylinder head, and tighten four bolts.

Tightening Torque:
55 N·m {560 kgf·cm, 41 lbf·ft}

(3) Insert the coolant hose into the thermostat case and fix it with the clamp.

3. INSTALL THE COOLANT PIPE.

(1) Install the coolant pipe between the thermostat case and the turbocharger assembly.
Refer to the section **"TURBOCHARGER"** in the chapter **"TURBOCHARGER"**.

4. INSTALL THE COOLANT HOSE.

(1) Install the coolant hose to the coolant pipe.
Refer to the section **"CYLINDER HEAD ASSEMBLY"** in the chapter **"ENGINE MECHANICAL"**.

(2) Install the coolant hose to the EGR cooler.
Refer to the section **"EGR VALVE AND COOLER"** in the chapter **"EMISSION CONTROL"**.

5. CONNECT THE HARNESS.

(1) Connect the connector of the coolant temperature sensor.
Refer to the section **"COOLANT TEMPERATURE SENSOR"**.

6. INSTALL THE ALTERNATOR.

(1) Install the alternator.
Refer to the section **"ALTERNATOR"** in the chapter **"ALTERNATOR"**.

7. INSTALL THE INTAKE PIPE (EXHAUST SIDE).

(1) Install the U-turn pipe and the boost pipe.
Refer to the section **"INTAKE PIPE (EXHAUST SIDE)"** in the chapter **"AIR INTAKE SYSTEM"**.

8. INSTALL THE AIR COMPRESSOR SUCTION HOSE.

(1) Install the air compressor suction hose.
Refer to the section **"AIR COMPRESSOR"** in the chapter **"AIR COMPRESSOR"**.

9. INSTALL THE V-RIBBED BELT.

(1) Install the V-ribbed belt.
Refer to the section **"V-RIBBED BELT"** in the chapter **"ALTERNATOR"**.

INSPECTION AND REPAIR

EN0111206H300002

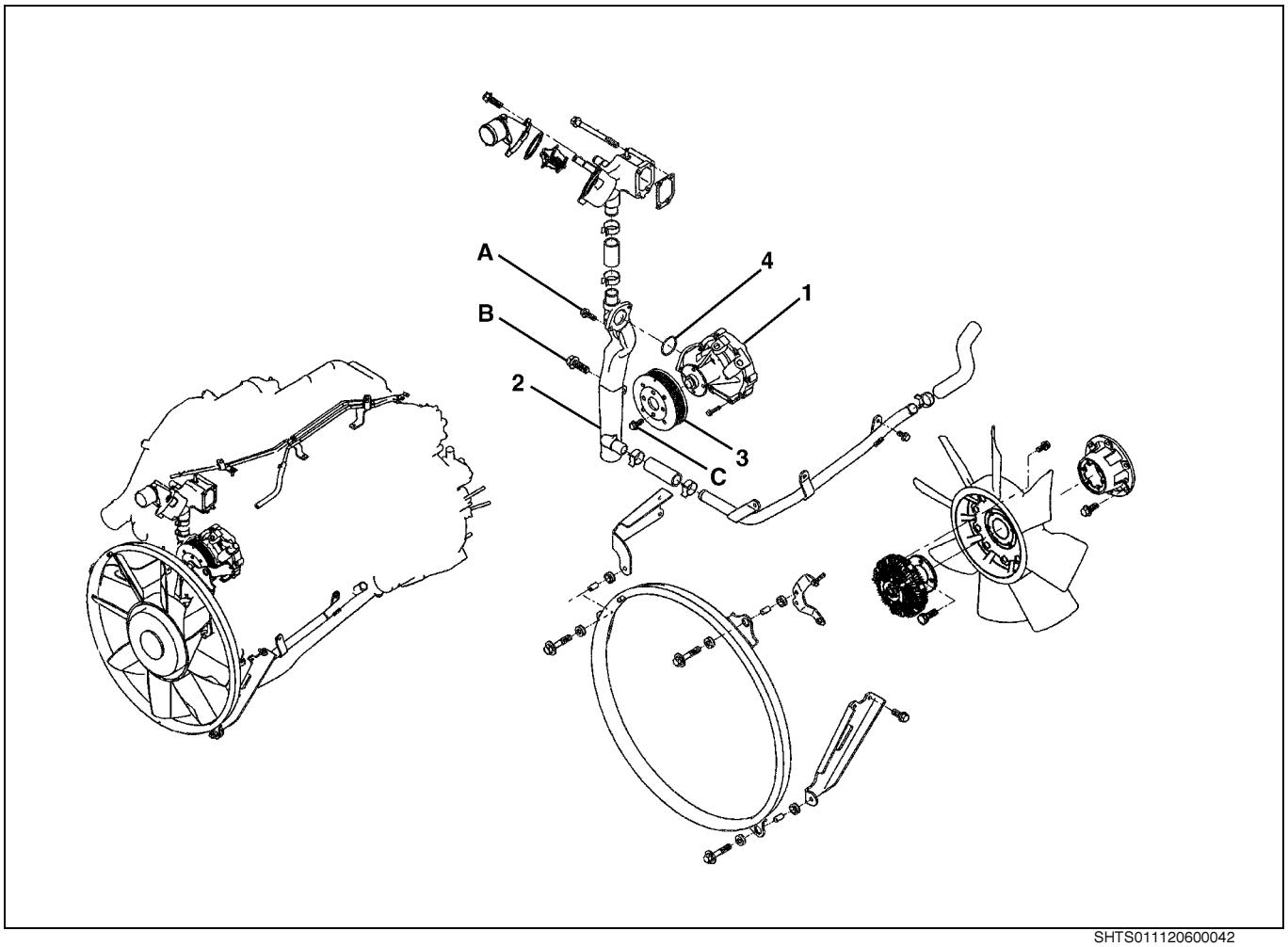
Unit: mm {in.}

Inspection item	Standard	LImit	Remedy	Inspection procedure
Thermostat valve opening temperature	**80-84°C {176-183.2°F}**	**—**	**Replace.**	**Visual check**
Valve lift	**More than 10 {0.0019}**	**—**	**Replace.**	**Measure**

COOLANT PUMP

COMPONENT LOCATOR

EN0111206D100006



SHTS011120600042

1	Coolant pump	3	Coolant pump pulley
2	Coolant pipe (Coolant pump downside)	4	O-ring

Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

A	28.5 {290, 21}	C	55 {560, 41}
B	97 {990, 72}		

REPLACEMENT

EN0111206H100003

REMOVE THE COOLANT PUMP.

1. DRAIN THE COOLANT.

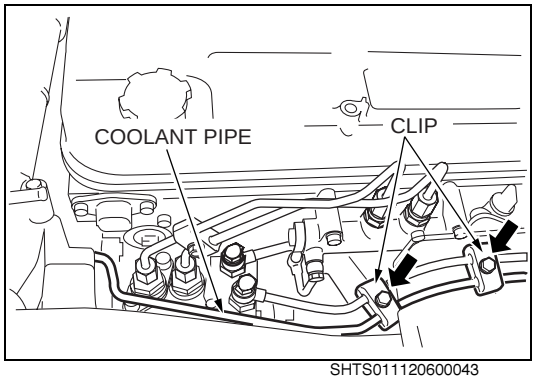
(1) Drain the coolant.
Refer to the section **"RADIATOR"**.

2. REMOVE THE COOLING FAN AND RING.

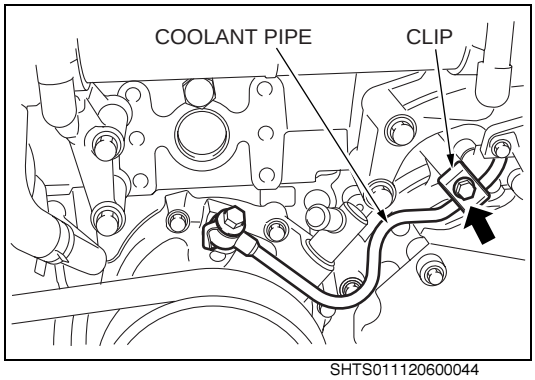
(1) Remove the cooling fan and ring.
Refer to the section **"COOLING FAN AND FAN CLUTCH"**.

3. REMOVE THE V-RIBBED BELT.

(1) Remove the V-ribbed belt.
Refer to the section **"V-RIBBED BELT"** in the chapter **"ALTERNATOR"**.



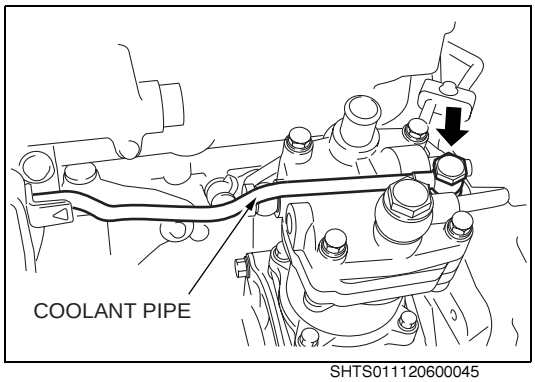
SHTS011120600043



SHTS011120600044

4. REMOVE THE COOLANT PIPE.

(1) Remove three clips securing the coolant pipe.

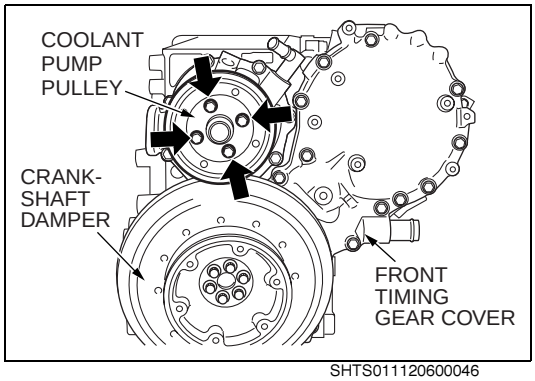


SHTS011120600045

(2) Remove the union bolt to remove the coolant pipe between the coolant pump and the air compressor.

HINT

Use a container and a waste as coolant might drip off during removal of coolant pipe.



SHTS011120600046

5. REMOVE THE COOLANT PUMP PULLEY.

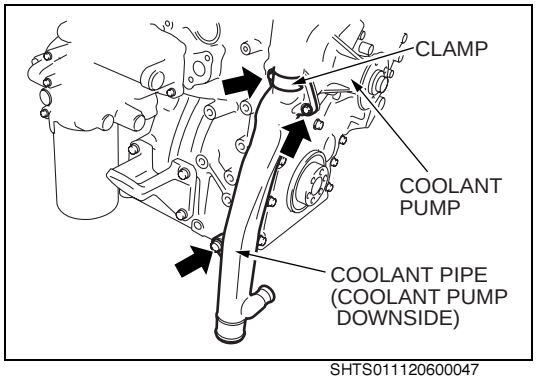
(1) Remove four bolts to remove the coolant pump pulley from the coolant pump.

6. REMOVE THE INTAKE PIPE (EXHAUST SIDE).

(1) Remove the U-turn pipe and the boost pipe.
Refer to the section **"INTAKE PIPE (EXHAUST SIDE)"** in the chapter **"AIR INTAKE SYSTEM"**.

7. REMOVE THE ALTERNATOR.

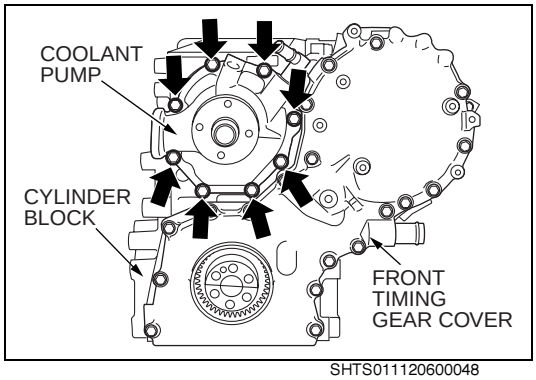
(1) Remove the alternator.
Refer to the section **"ALTERNATOR"** in the chapter **"ALTERNATOR"**.



SHTS011120600047

8. REMOVE THE COOLANT PIPE.

(1) Remove three bolts, clamp and O-ring to remove the coolant pipe (coolant pump downside) from the coolant pump.



SHTS011120600048

9. REMOVE THE COOLANT PUMP.

(1) Remove eight bolts to remove the coolant pump from the cylinder block.

(2) Use a scraper to remove dirt from the mating surface between the coolant pump and the cylinder block.

NOTICE

- **Do not damage the mating surface.**
- **Remove liquid gasket with a scraper carefully so that removed liquid gasket will not fall into the pump chamber in the cylinder block.**

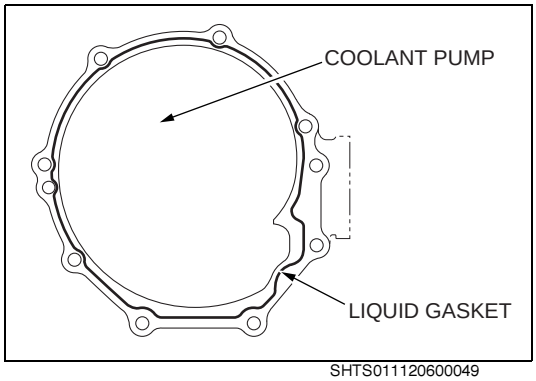
INSTALL THE COOLANT PUMP.

1. INSTALL THE COOLANT PUMP.

(1) Apply liquid gasket (ThreeBond TB1207B, black) to the coolant pump as shown in the figure.

NOTICE

- **Apply liquid gasket at a width of 1.5 to 2.5 mm {0.0591 to 0.0984 in.}**
- **Apply liquid gasket without intermittence.**
- **Proceed with a next step within 20 min. after applying liquid gasket.**

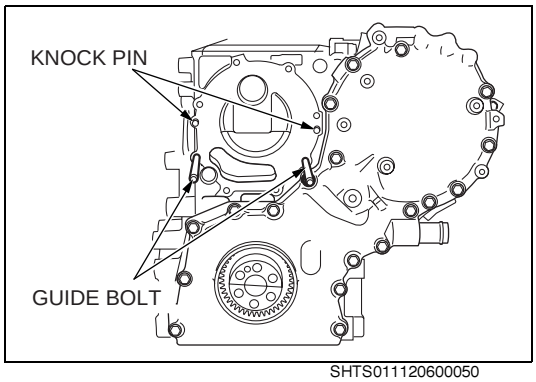


SHTS011120600049

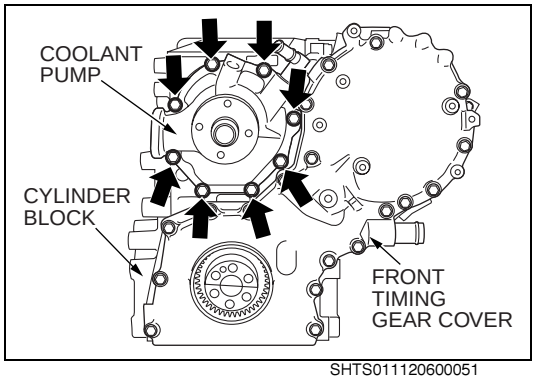
(2) Fasten two to four guide bolts to the cylinder block horizontally.

NOTICE

- **Remove the guide bolts when after pre tightening six coolant pump mounting bolts.**
- **Note that there are knock pins on the coolant pump mounting surface of the cylinder block.**

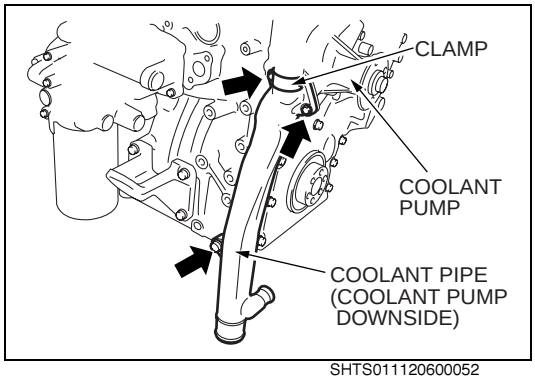


SHTS011120600050



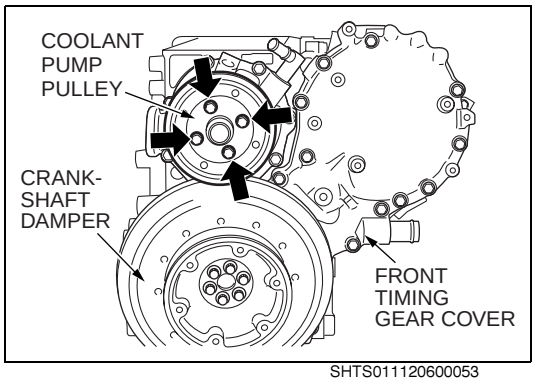
SHTS011120600051

(3) Install the coolant pump, and tighten eight bolts.
Tightening Torque:
28.5 N·m {290 kgf·cm, 21 lbf·ft}



SHTS011120600052

2. INSTALL THE COOLANT PUMP.
(1) Replace the O-ring with new one and install the coolant pipe (coolant pump downside) with three bolts and clamp.
Tightening Torque:
Coolant pump side: 28.5 N·m {290 kgf·cm, 21 lbf·ft}
Cylinder block side: 97 N·m {990 kgf·cm, 72 lbf·ft}

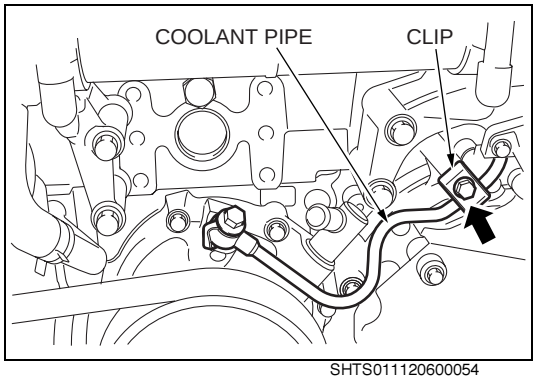


SHTS011120600053

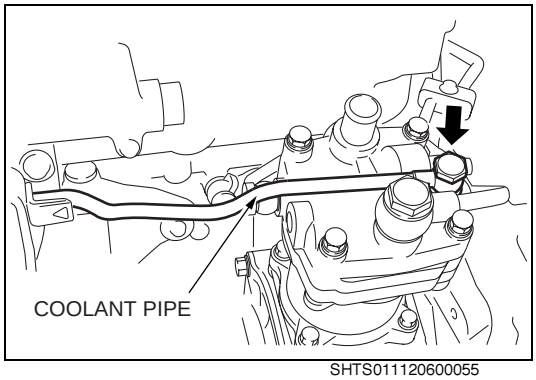
3. INSTALL THE COOLANT PUMP PULLEY.
(1) Install the coolant pump pulley to the coolant pump, and tighten four bolts.
Tightening Torque:
55 N·m {560 kgf·cm, 41 lbf·ft}

4. INSTALL THE ALTERNATOR.
(1) Install the alternator.
Refer to the section **"ALTERNATOR"** in the chapter **"ALTERNATOR"**.

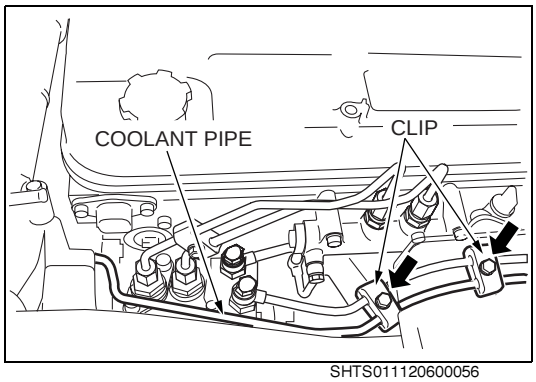
5. INSTALL THE INTAKE PIPE (EXHAUST SIDE).
(1) Install the U-turn pipe and boost pipe.
Refer to the section **"INTAKE PIPE (EXHAUST SIDE)"** in the chapter **"AIR INTAKE SYSTEM"**.



SHTS011120600054



SHTS011120600055



SHTS011120600056

6. INSTALL THE COOLANT PIPE.

(1) Replace the gasket with a new one. Install the coolant pipe between the coolant pump and the air compressor with a union bolt.

(2) Fasten three clips to secure the fuel pipe and the coolant pipe above the intake pipe (intake side).

7. INSTALL THE V-RIBBED BELT.

(1) Install the V-ribbed belt.
Refer to the section **"V-RIBBED BELT"** in the chapter **"ALTERNATOR"**.

8. INSTALL THE COOLING FAN AND RING.

(1) Install the cooling fan and ring.
Refer to the section **"COOLING FAN AND FAN CLUTCH"**.

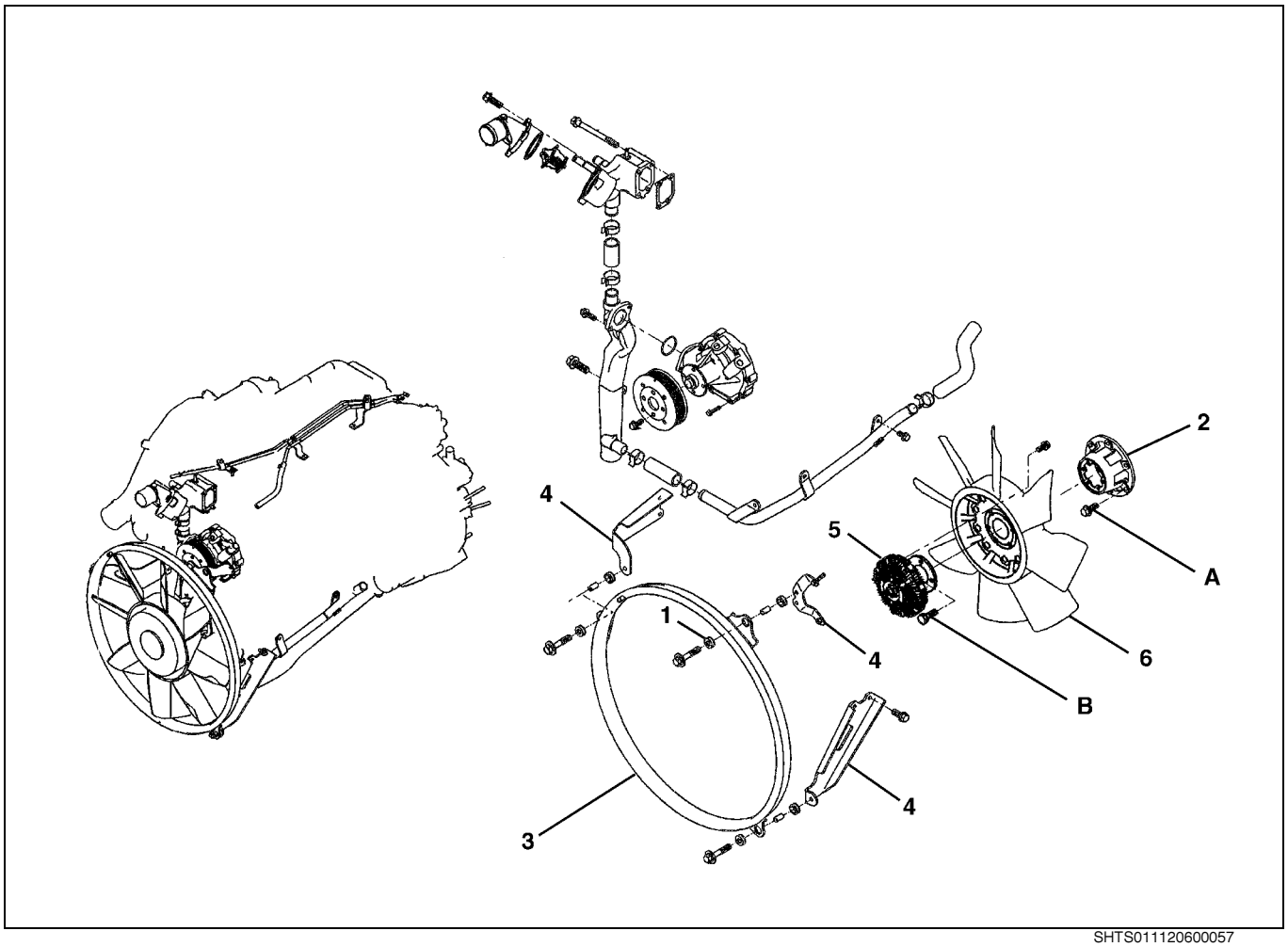
9. FILL THE COOLANT.

(1) Fill the coolant.
Refer to the section **"RADIATOR"**.

COOLING FAN AND FAN CLUTCH

COMPONENT LOCATOR

EN0111206D100007



SHTS011120600057

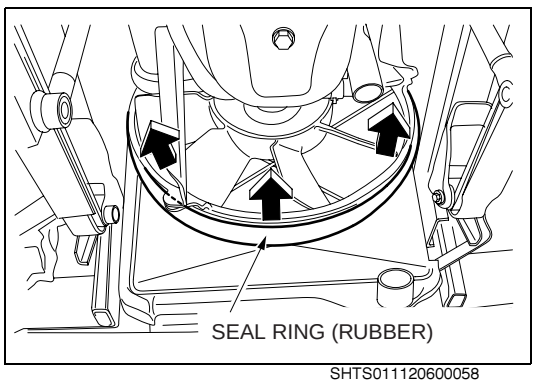
1	Silent block	4	Bracket
2	Cooling fan coupling	5	Fan clutch
3	Fan shroud	6	Cooling fan

Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

A	47 {480, 35}	B	55 {560, 40}

OVERHAUL

EN0111206H100004



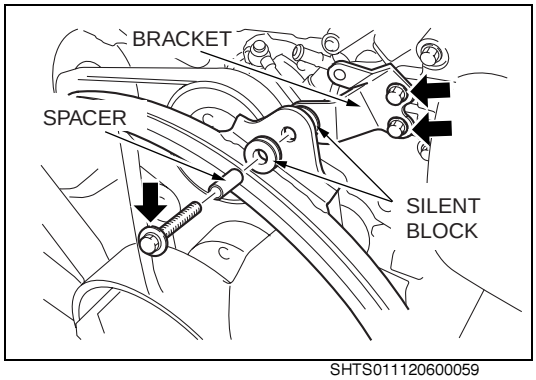
SHTS011120600058

REMOVE THE COOLING FAN ASSEMBLY.

1. REMOVE THE COOLING FAN AND THE FAN SHROUD RING.

NOTICE
Proceed with the steps below after protecting the radiator core with a cardboard to prevent damages to the radiator core.

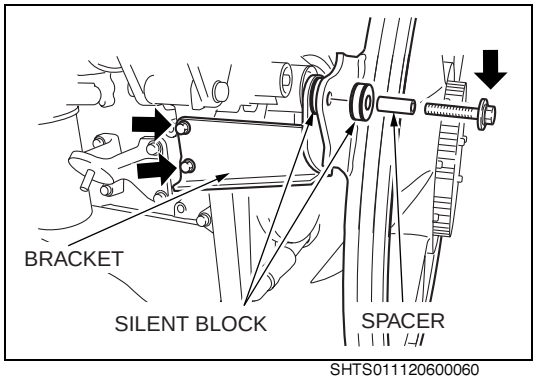
(1) Gradually move the seal ring (rubber) from the fan shroud ring to the engine side.



SHTS011120600059

(2) Remove the bolt to remove two silent blocks and the spacer.

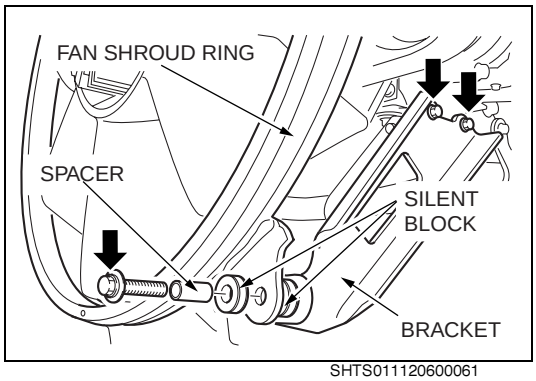
(3) Remove two bolts to remove the bracket (upper right) from the cylinder head.



SHTS011120600060

(4) Remove three bolts to remove the spacer and two silent blocks.

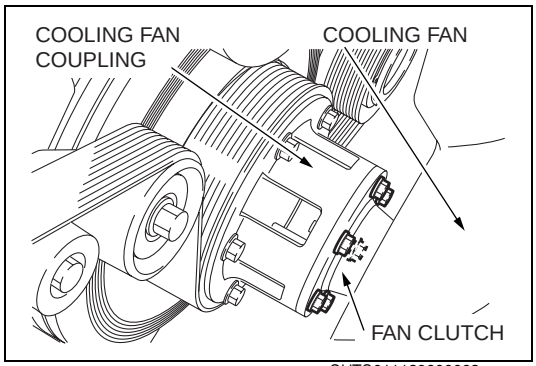
(5) Remove two bolts to remove the bracket (lower left) from the cylinder block.



SHTS011120600061

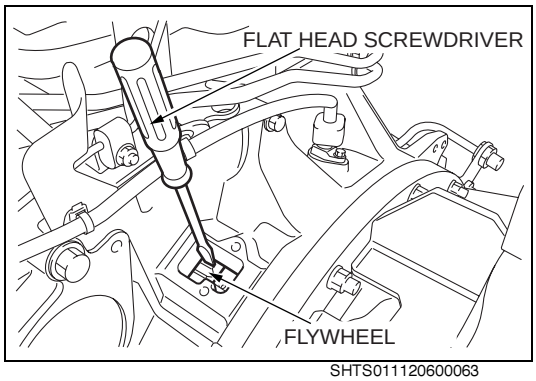
(6) Remove three bolts to remove the spacer, two silent blocks and the fan shroud ring.

(7) Remove two bolts to remove the bracket (lower right) from the cylinder block.



SHTS011120600062

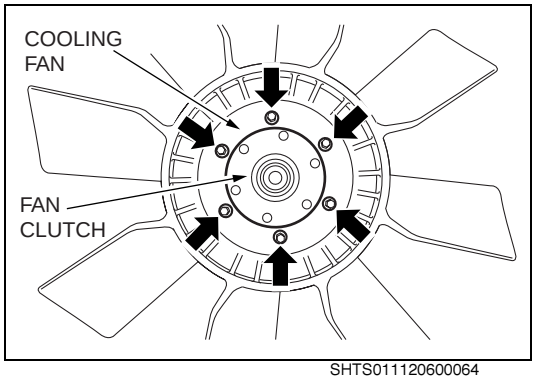
(8) Remove six bolts to remove the cooling fan with the fan clutch from the cooling fan coupling.



SHTS011120600063

HINT

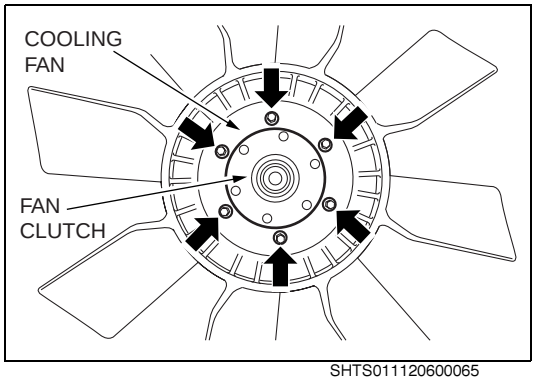
Insert a large flat head screwdriver into the flywheel gear through an access hole in the flywheel housing, to prevent synchronous rotations of the crankshaft.



SHTS011120600064

2. REMOVE THE FAN CLUTCH.

(1) Remove six bolts to remove the fan clutch from the cooling fan.

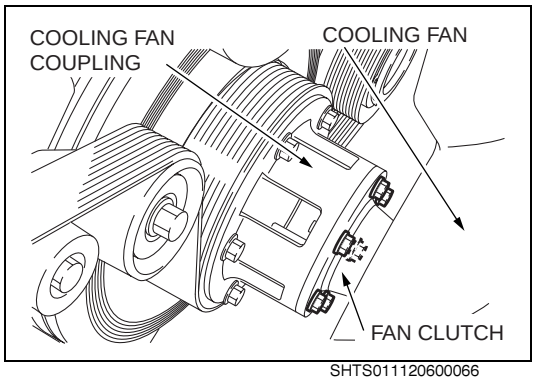


SHTS011120600065

INSTALL THE COOLING FAN ASSEMBLY.

1. INSTALL THE FAN CLUTCH.

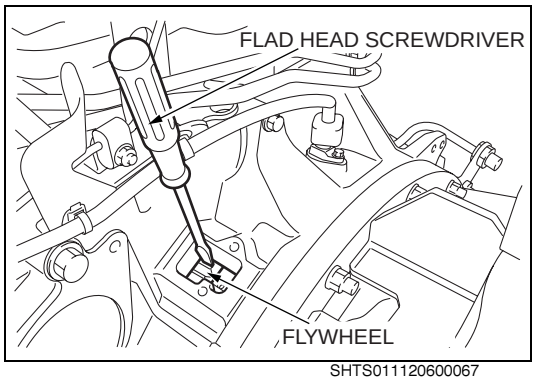
(1) Install the fan clutch to the cooling fan, and tighten six bolts.
Tightening Torque:
55 N·m {560 kgf·cm, 40 lbf·ft}



SHTS011120600066

2. INSTALL THE COOLING FAN AND THE FAN SHROUD RING.

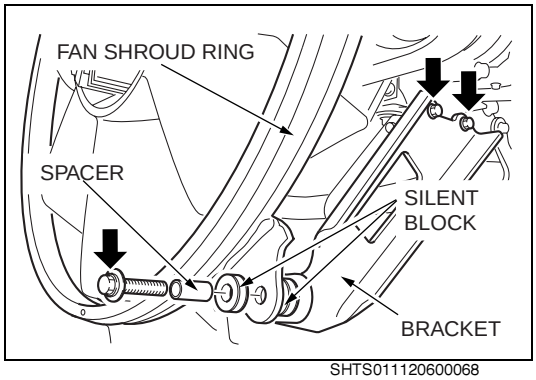
(1) Install the cooling fan and the fan clutch to the cooling fan coupling, and tighten six bolts.
Tightening Torque:
47 N·m {480 kgf·cm, 35 lbf·ft}



SHTS011120600067

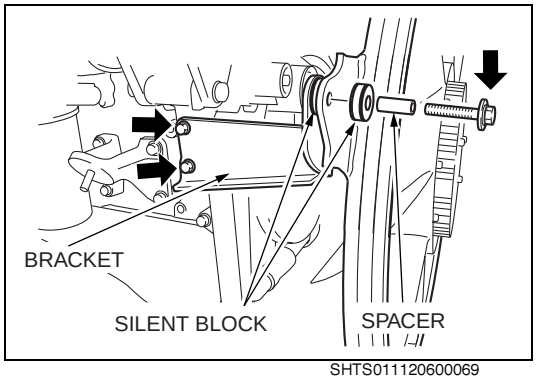
HINT

Insert a large flat head screwdriver into the flywheel gear through an access hole in the flywheel housing, to prevent synchronous rotations of the crankshaft.



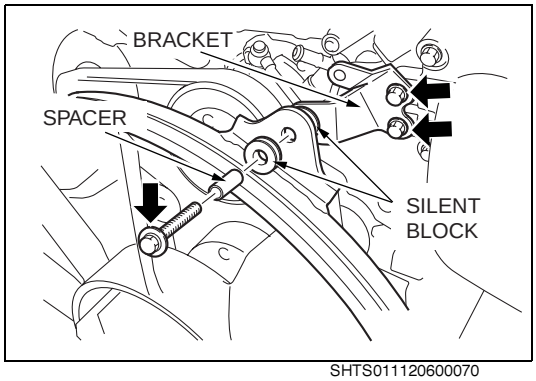
SHTS011120600068

(2) Install the bracket (lower right) to the cylinder block with two bolts.
(3) Install the fan shroud ring, attach two silent blocks and a spacer, and tighten a bolt.



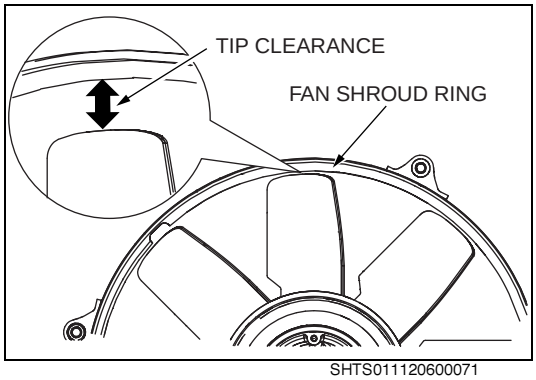
SHTS011120600069

(4) Install the bracket (lower left) to the cylinder block with two bolts.
(5) Install the fan shroud ring, attach two silent blocks and a spacer, and tighten a bolt.



SHTS011120600070

(6) Install the bracket (upper right) to the cylinder head with two bolts.
(7) Install the fan shroud ring, attach the spacer and two silent block, and tighten two bolts.

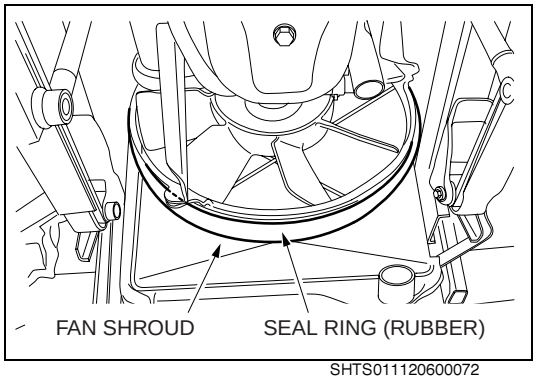


SHTS011120600071

(8) Check that the cooling fan does not interfere with the fan shroud ring and that a tip clearance falls within the standard value. If the standard value is not met, adjust and correct the bracket mounting position.

HINT
Adjust a tip clearance by correcting play in the bolt hole in the bracket.

Standard value: 5-11 mm {0.1969-0.4330 in.}

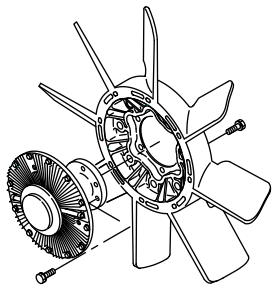


SHTS011120600072

(9) Install the seal ring (rubber) on the fan shroud ring.

INSPECTION AND REPAIR

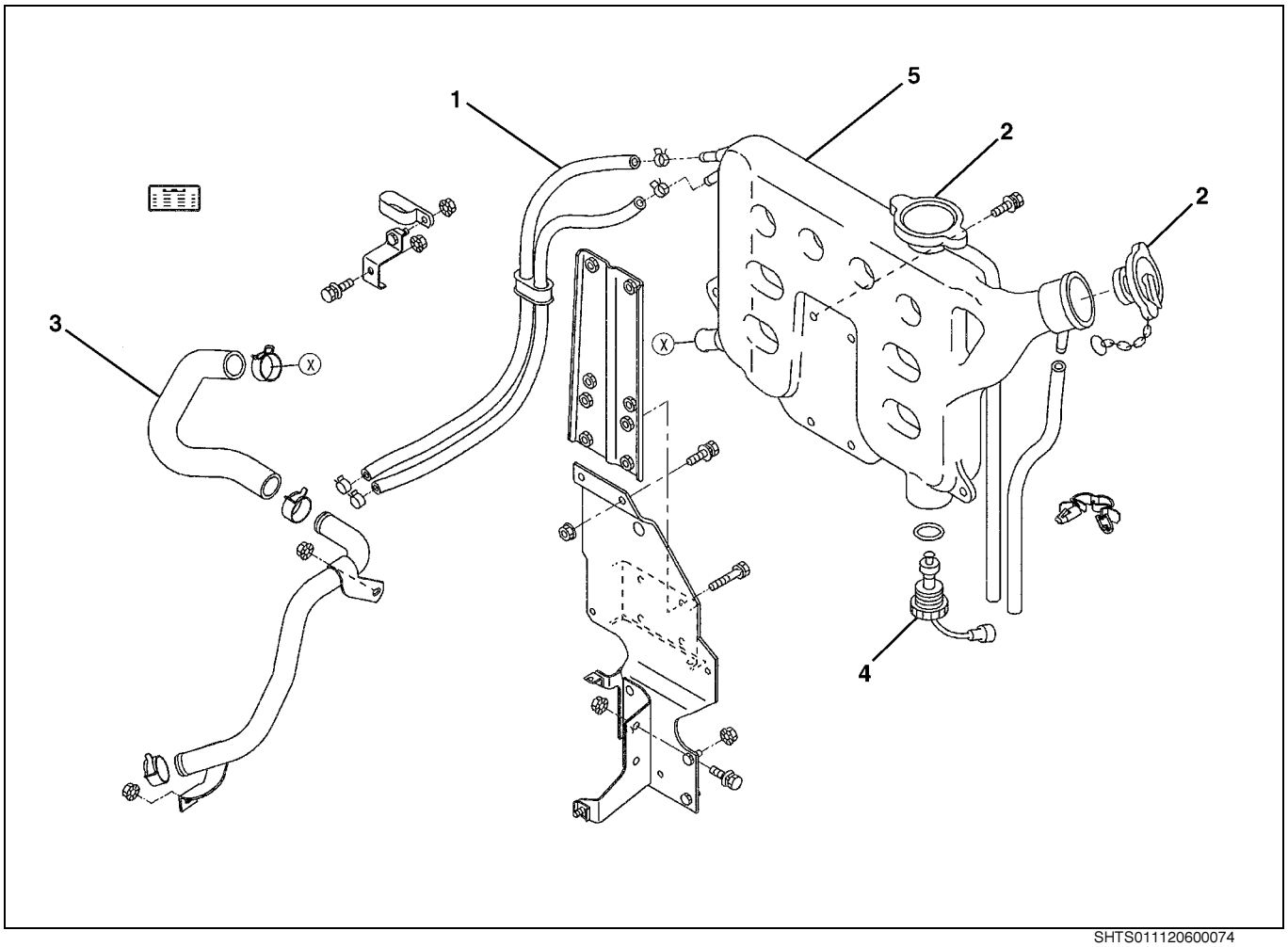
EN0111206H300003

Inspection item	Standard	Limit	Remedy	Inspection procedure
Fan clutch deformation and damage	—	—	**Replace, if necessary.**	**Visual check** 

HEADER TANK AND WATER LEVEL SWITCH

COMPONENT LOCATOR

EN0111206D100008



SHTS011120600074

1	Coolant hose	4	Water level switch
2	Radiator cap	5	Header tank
3	Coolant pipe		

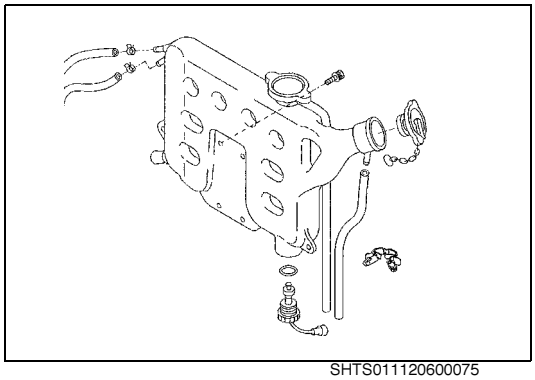
REPLACEMENT

EN0111206H100005

REMOVE THE HEADER TANK.

1. DRAIN THE COOLANT.

(1) Drain the coolant.
Refer to the section **"RADIATOR"**.



SHTS011120600075

2. REMOVE THE HEADER TANK.

(1) Remove the clamp to disconnect four coolant hoses from the header tank.

NOTICE

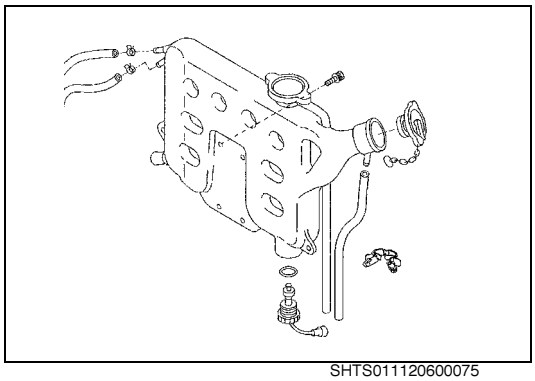
Before disconnection, check that a mark is indicated on each hose. If a mark is fading, re-indicate a mark before disconnection.

HINT

Use a container and a waste as coolant might drip off during removal of hose.

(2) Disconnect the connector of the water level switch.
(3) Remove the bolt and nut to remove the header tank.

INSTALL THE HEADER TANK.



SHTS011120600075

1. INSTALL THE HEADER TANK.

(1) Install the header tank with the bolt and nut.
(2) Connect the connector of the water level switch.
(3) Insert two escape hoses, one reserve hose and one radiator hose into the header tank as shown in the figure and fix them with the clamp.

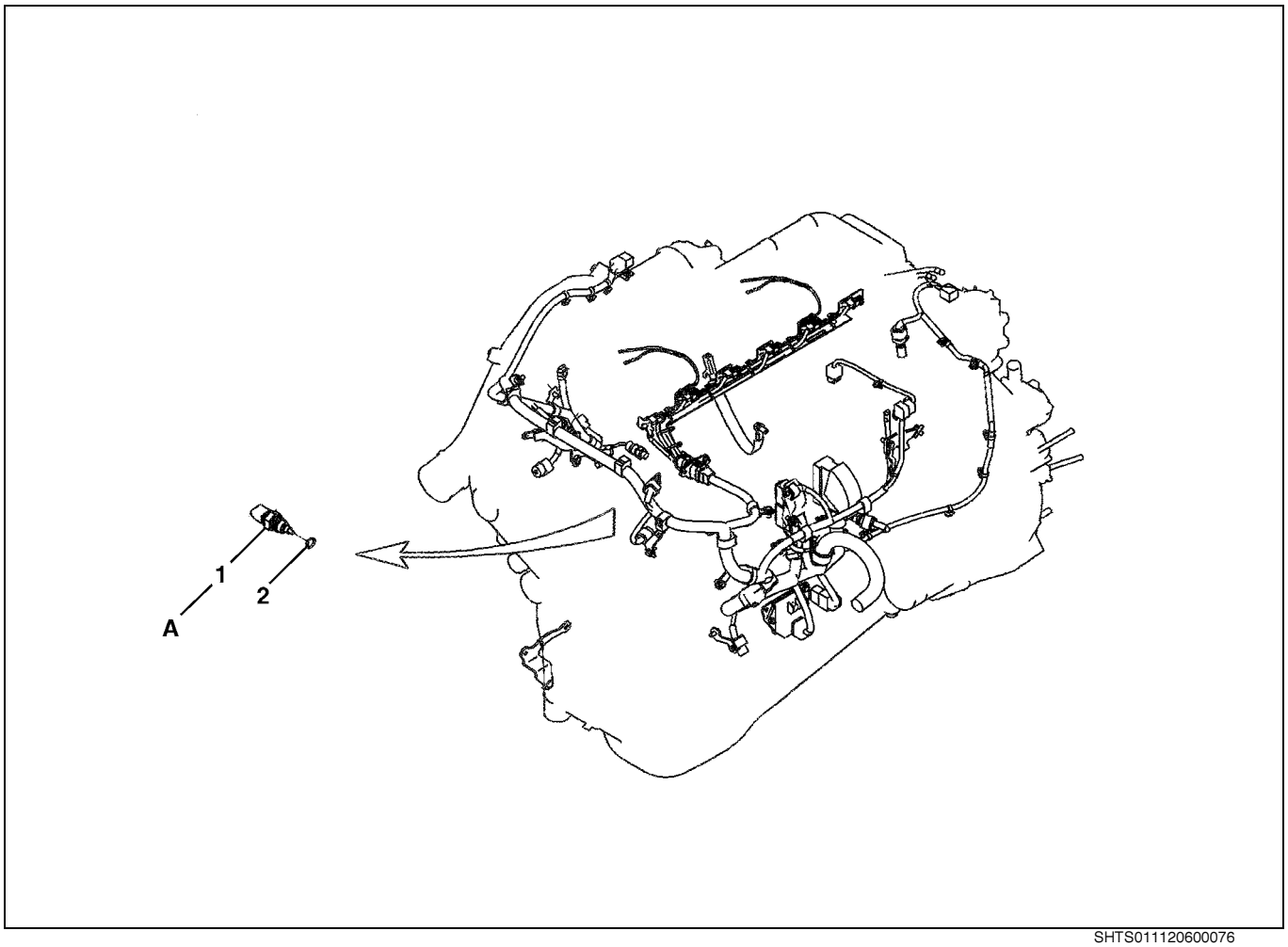
2. FILL THE COOLANT.

(1) Fill the coolant.
Refer to the section **"RADIATOR"**.

COOLANT TEMPERATURE SENSOR

COMPONENT LOCATOR

EN0111206D100009



SHTS011120600076

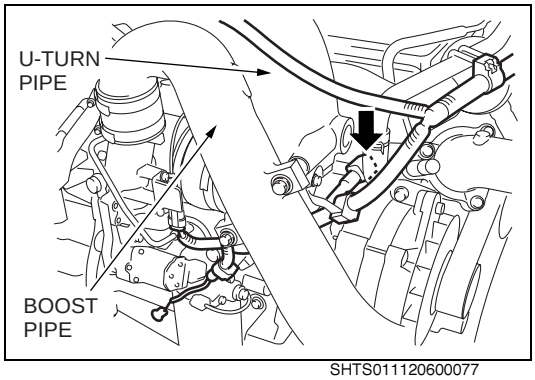
1	Coolant temperature sensor	2	O-ring

Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

A	26.95-31.85 {275-325, 20-23}		

REPLACEMENT

EN0111206H100006



SHTS011120600077

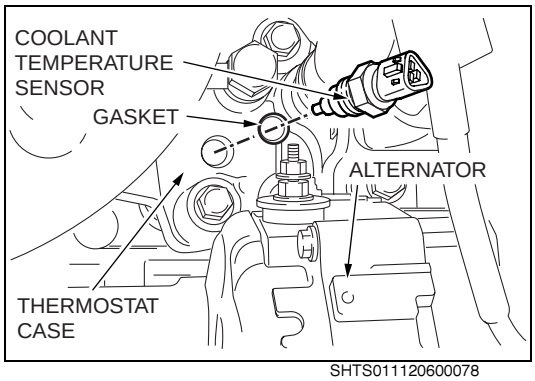
REMOVE THE COOLANT TEMPERATURE SENSOR.

1. REMOVE THE COOLANT TEMPERATURE SENSOR.

(1) Disconnect the connector of the coolant temperature sensor.

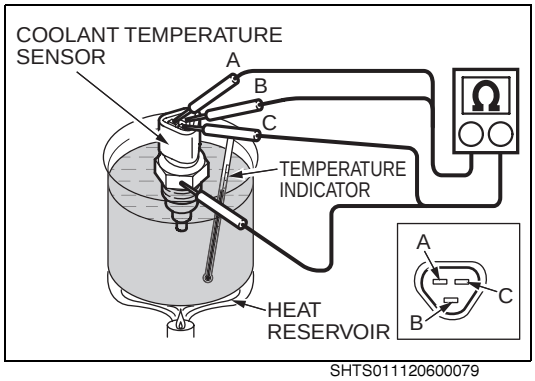
HINT

Use a container and a waste as coolant might drip off during removal of coolant temperature sensor.



SHTS011120600078

(2) Remove the coolant temperature sensor and gasket from the thermostat case.



SHTS011120600079

COMPONENT CHECK

1. CHECK A RESISTANCE.

(1) Use water or engine oil to heat/cool the coolant temperature sensor.

⚠ CAUTION

If engine oil is used in this step, a temperature must not exceed 120°C {248°F}. Otherwise, hazardous gas might be generated.

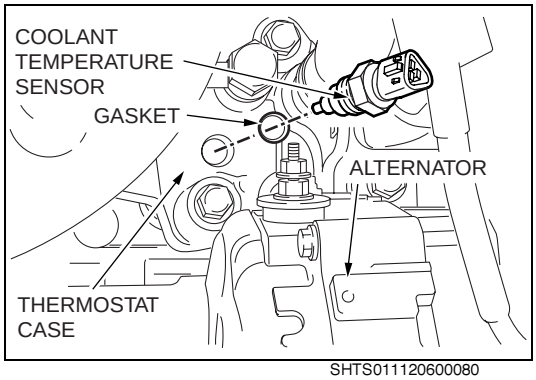
(2) Use a circuit tester to measure the resistance between terminals. If a measurement reading would be out of the standard value, replace it with a new one.

Between terminals A and C

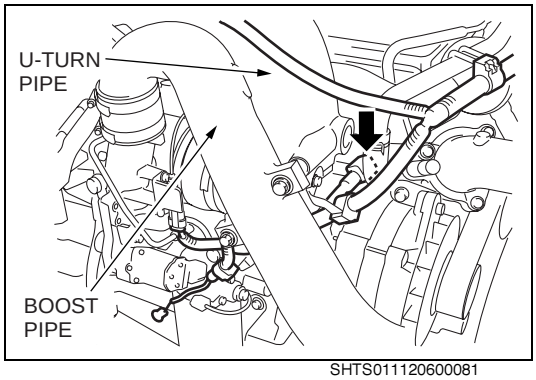
Temperature (°C {°F})	Standard value (Ω)
-20 {-4}	13.84-16.33
20 {68}	2.32-2.59
80 {176}	0.31-0.326
110 {230}	0.1399-0.1435

Between terminal B and body

Temperature (°C {°F})	Standard value (Ω)
75 {167}	79-92
100 {212}	35.5-42.5



SHTS011120600080



SHTS011120600081

INSTALL THE COOLANT TEMPERATURE SENSOR.

1. INSTALL THE COOLANT TEMPERATURE SENSOR.

(1) Replace the gasket with new one and install the coolant temperature sensor to the thermostat.
Tightening Torque:
26.95-31.85 N·m {275-325 kgf·cm, 20-23 lbf·ft}

(2) Connect the connector of the coolant temperature sensor.

2. FILL THE COOLANT.

(1) Check the coolant level, fill the coolant, if the coolant level would be low.
Refer to the section **"RADIATOR"**.

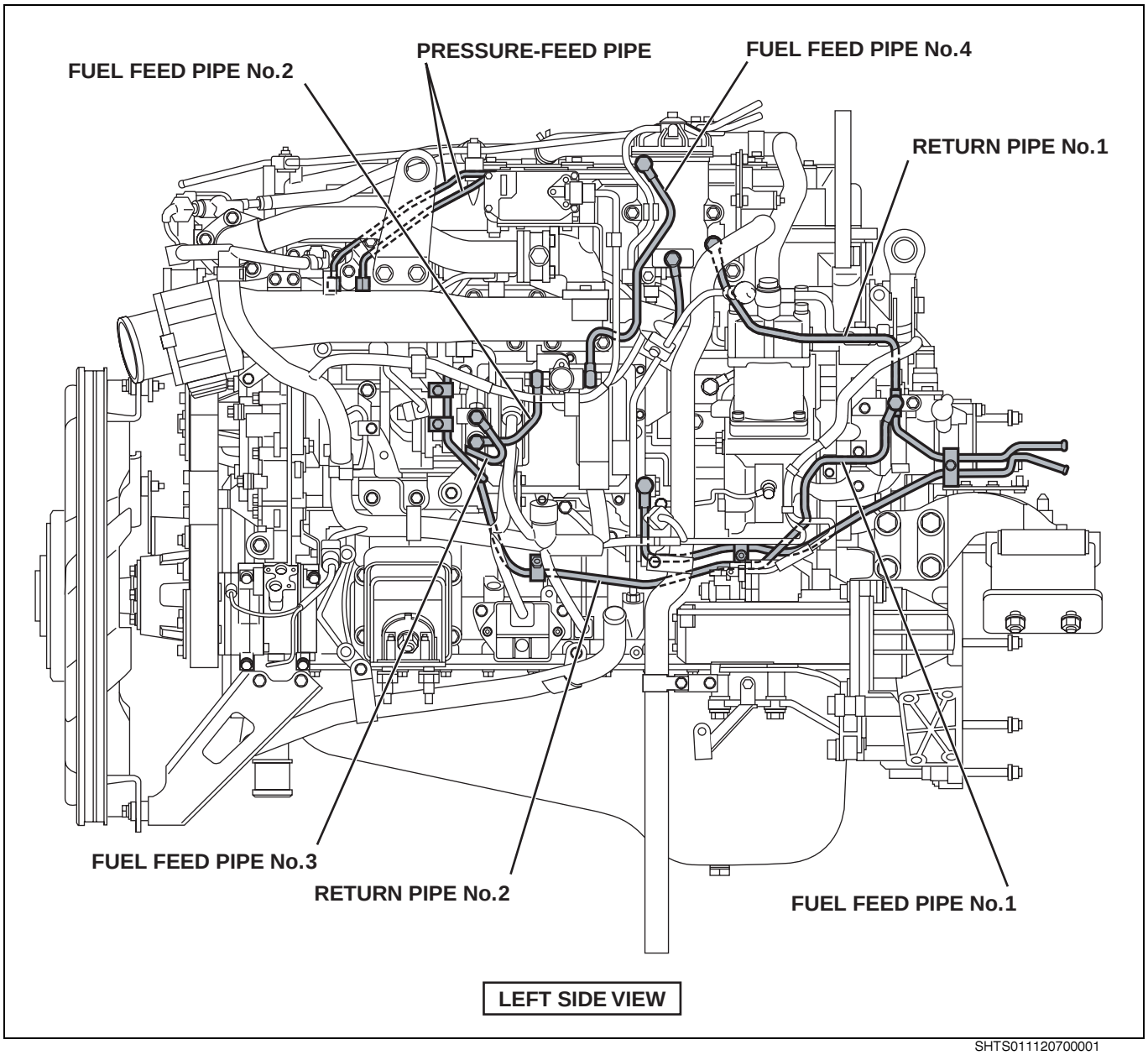
FUEL SYSTEM (A09C)

EN07-001

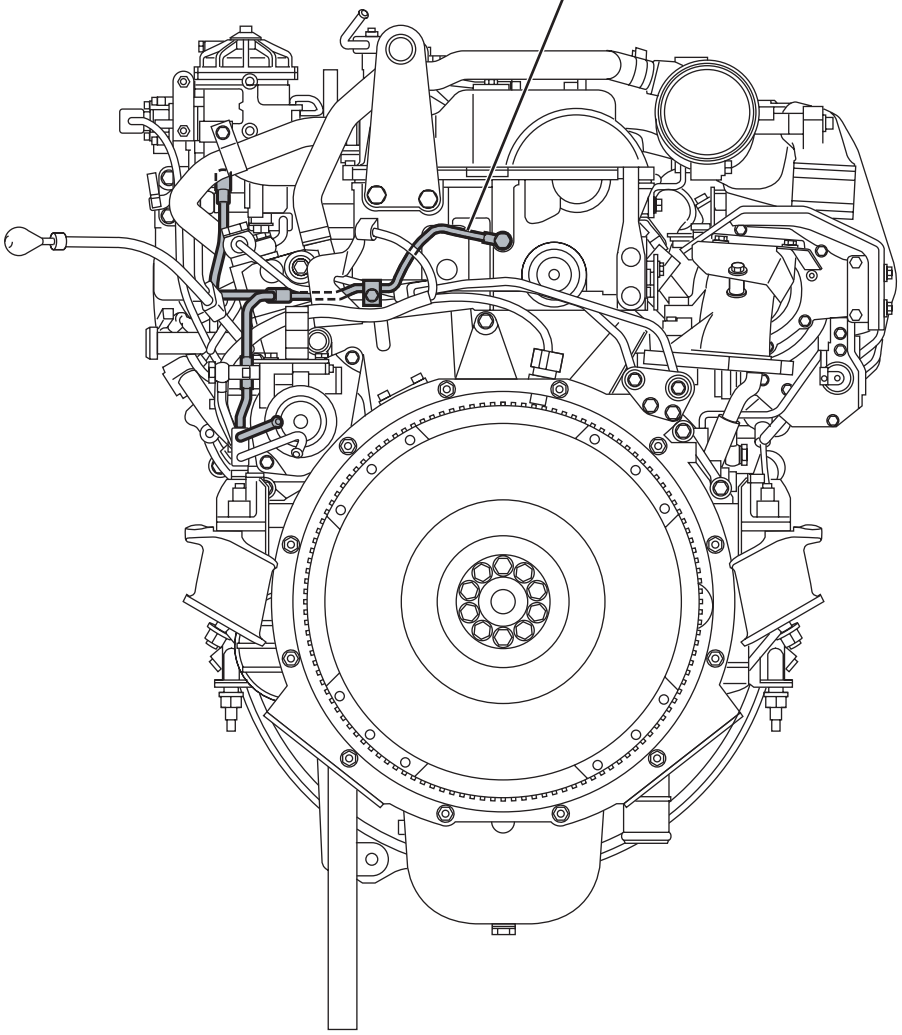
FUEL PIPE

COMPONENT LOCATOR

EN0111207D100001



SHTS011120700001



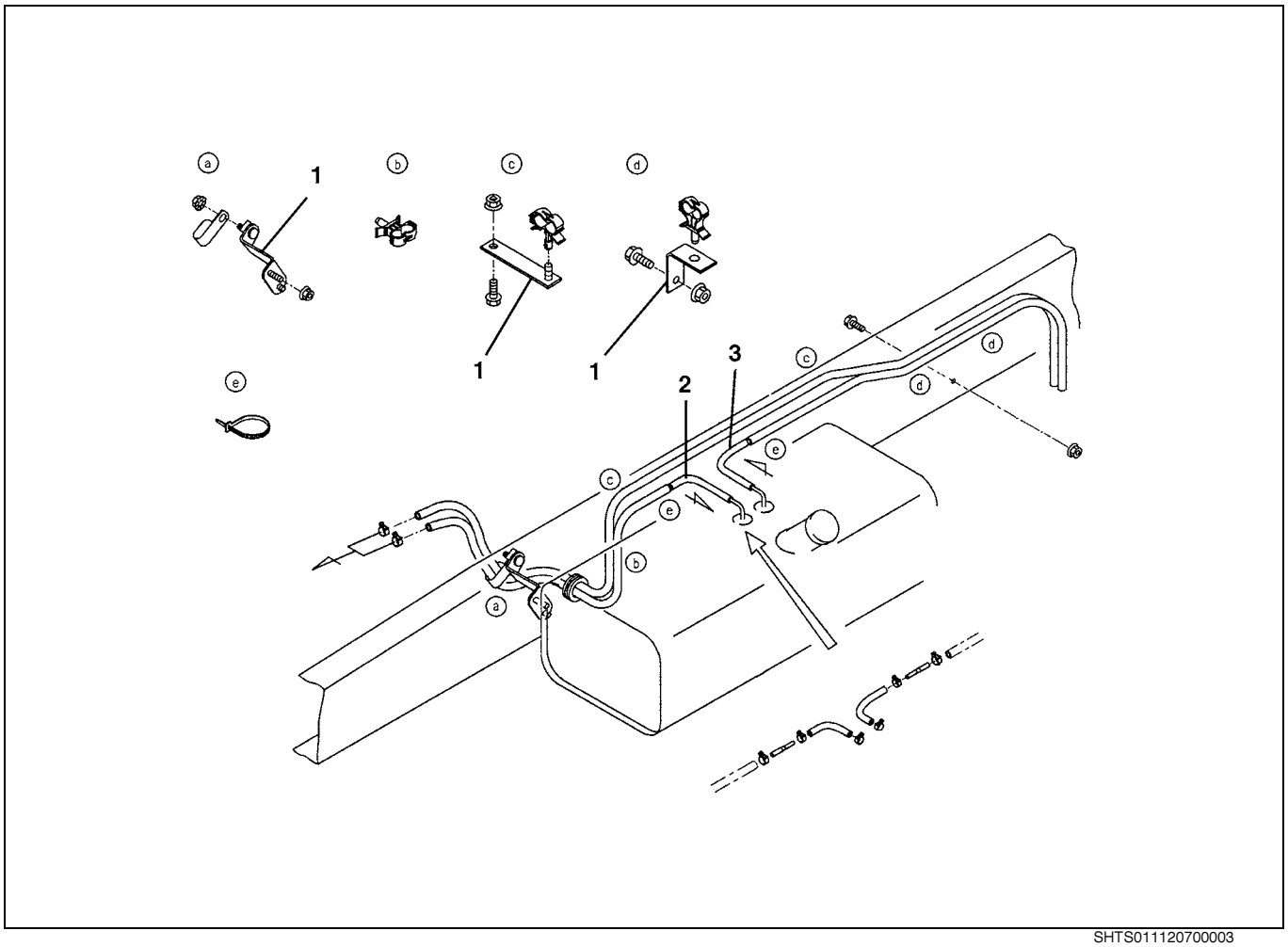
BACK VIEW

SHTS011120700002

FUEL TANK

COMPONENT LOCATOR

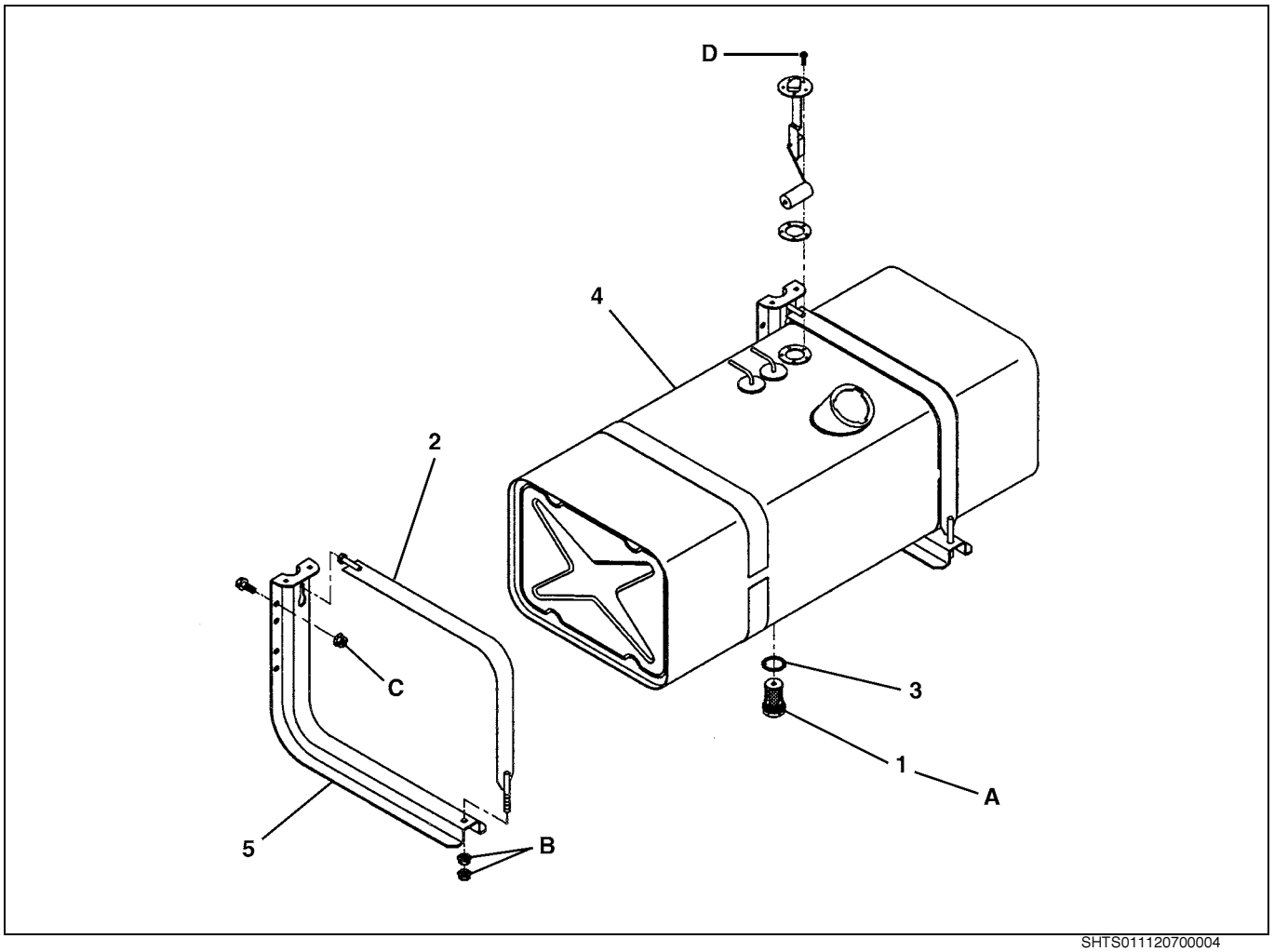
EN0111207D100002



SHTS011120700003

1	Bracket	3	Feed hose
2	Return hose		

200L



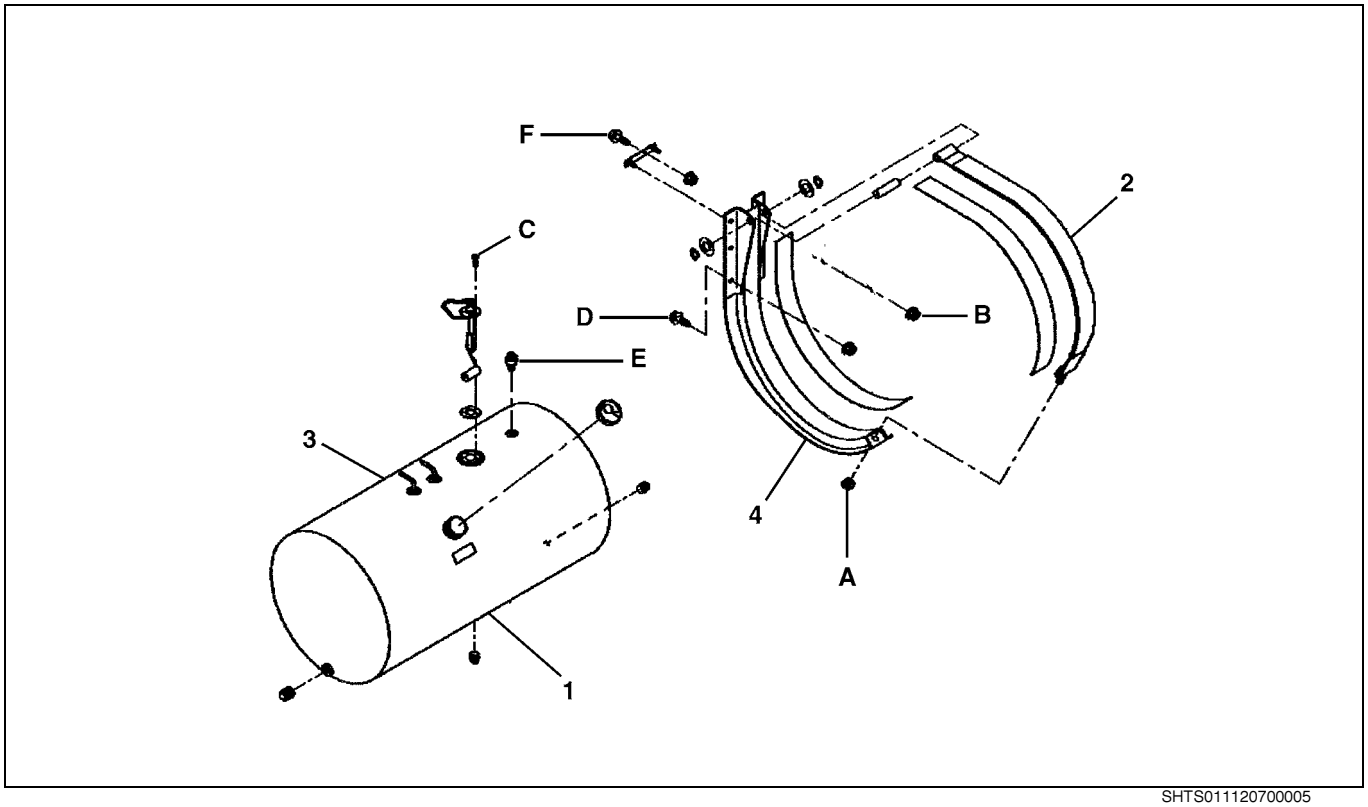
SHTS011120700004

1	Drain plug	4	Fuel tank assembly
2	Fuel tank band	5	Fuel tank support
3	Gasket		

Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

A	89-121 {907-1,233, 65-89}	C	73-109 {744-1,111, 53-80}
B	19.6-39.2 {200-400, 15-28} (Outside) 10-13 {101-132, 7-9} (Inside)	D	1.5-2.5 {15-25, 1.1-1.8}

400L



SHTS011120700005

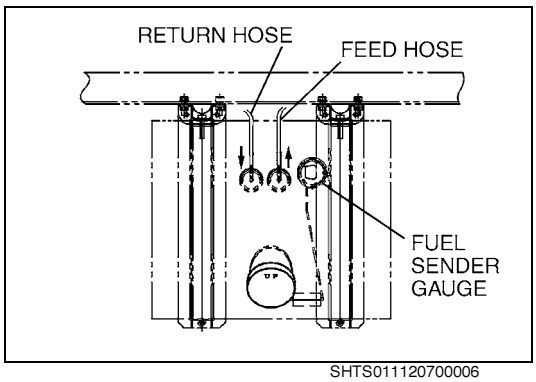
1	Drain plug	3	Fuel tank assembly
2	Fuel tank band	4	Fuel tank support

Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

A	50-70 {509-713, 36-51}	D	96-144 {978-1,468, 70-106}
B	73-109 {744-1,111, 53-80}	E	20-30 {203-305, 14-22}
C	1.5-2.5 {15-25, 1.1-1.8}	F	21.5-31.5 {219-321, 15.8-23.2}

REPLACEMENT

EN0111207H100001



SHTS011120700006

REMOVE THE FUEL TANK.

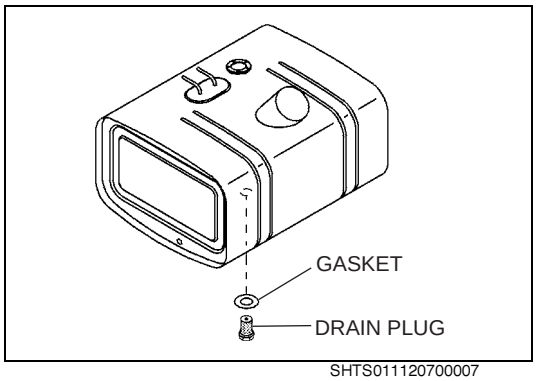
1. REMOVE THE FUEL TANK.

(1) Disconnect the connector of the fuel sender gauge.

(2) Indicate an alignment mark, and disconnect the feed hose and the return hose.

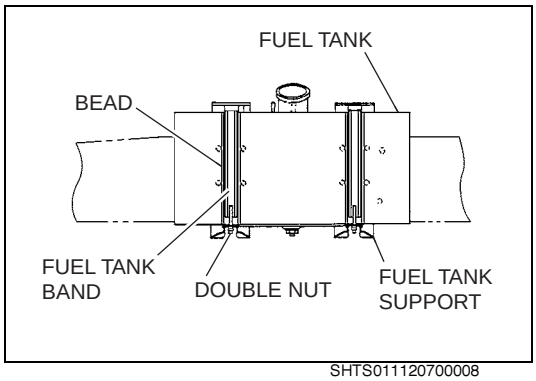
HINT

Use a cover to prevent fuel leak and contamination during removal works.



SHTS011120700007

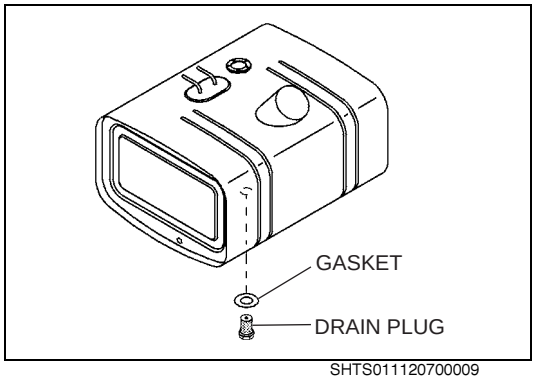
(3) Disconnect the drain hose and drain fuel.



SHTS011120700008

(4) Remove the double nut to remove the fuel tank band.

(5) Remove the fuel tank from the fuel tank support.

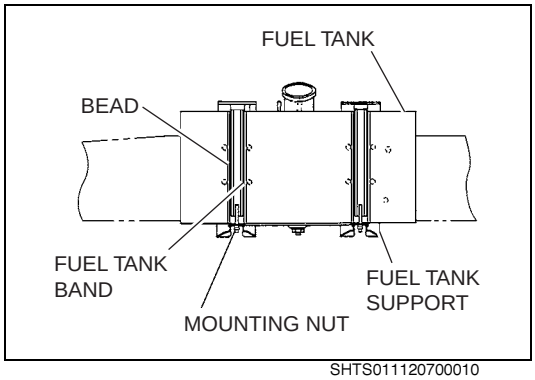


SHTS011120700009

INSTALL THE FUEL TANK.

1. INSTALL THE FUEL TANK.

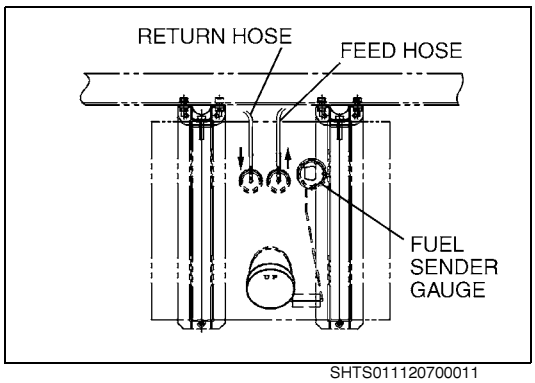
(1) Clean the drain plug filter and replace an old gasket with a new one. Install the drain plug.
Tightening Torque:
89-121 N·m {907-1,233 kgf·cm, 65-89 lbf·ft}



SHTS011120700010

(2) Place the fuel tank on the support.
(3) Install the band and tighten the double nut.
Tightening Torque:
Outside: 19.6-39.2 N·m {200-400 kgf·cm, 15-28 lbf·ft}
Inside: 10-13 N·m {101-132 kgf·cm, 7-9 lbf·ft}

HINT
Align the fuel tank band with the fuel tank bead.



SHTS011120700011

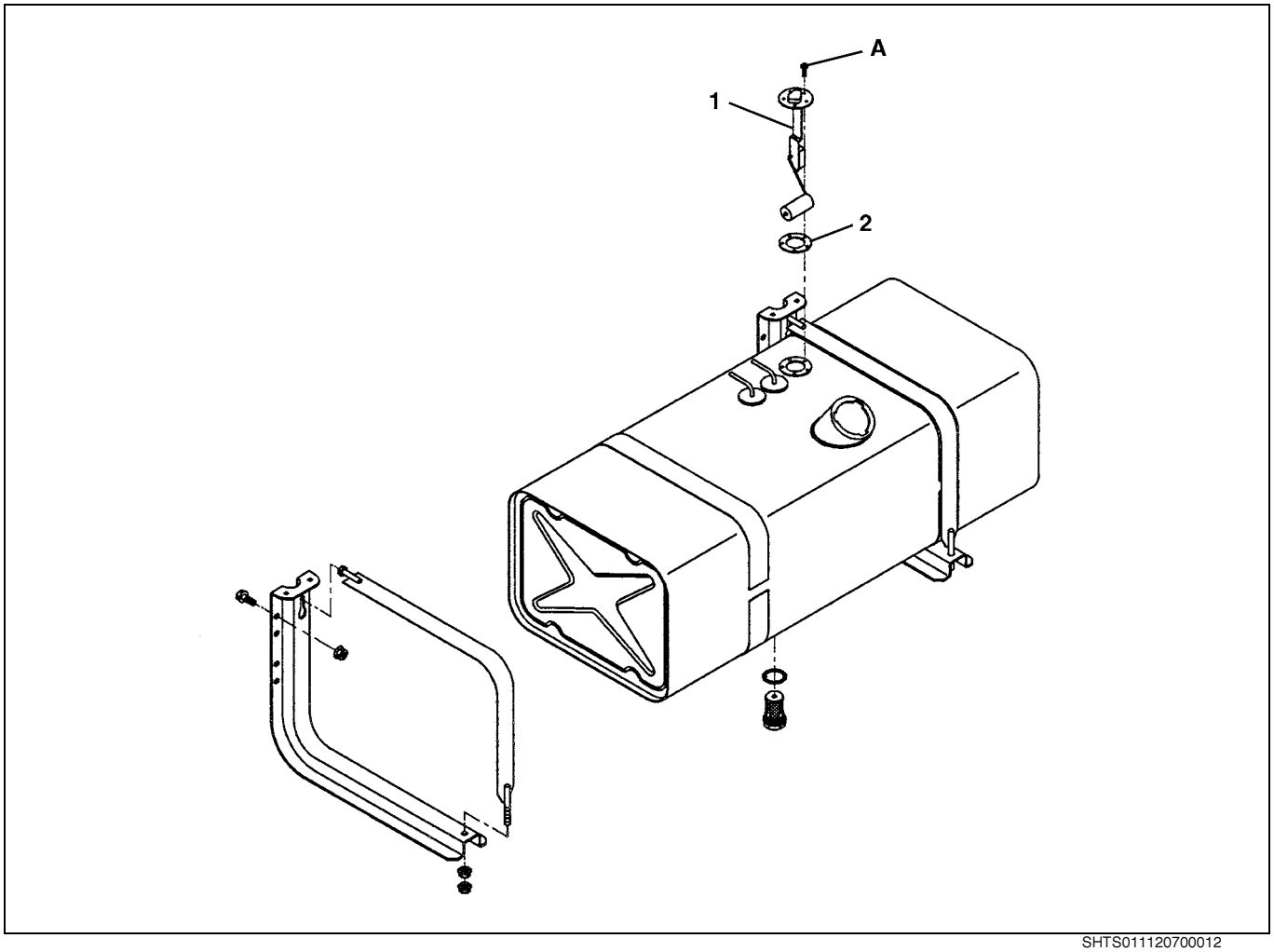
(4) Connect the connector of the fuel sender gauge.
(5) Make alignment with an alignment mark, and connect the feed hose and the return hose.

NOTICE
Make sure that bolts are inserted in the certain direction if the support has been removed.

FUEL SENDER GAUGE

COMPONENT LOCATOR

EN0111207D100003



SHTS011120700012

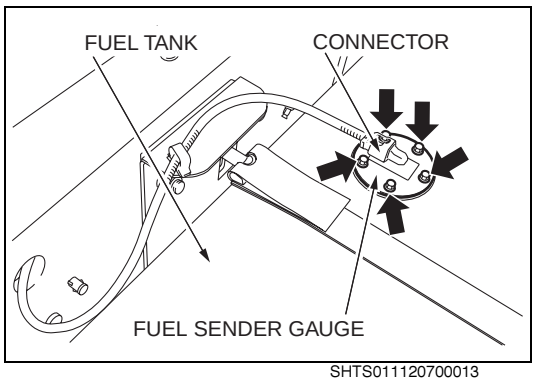
1 Fuel sender gauge	2 Gasket

Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

A 1.5-2.5 {15-25, 1.1-1.8}	

REPLACEMENT

EN0111207H100002



SHTS011120700013

REMOVE THE FUEL SENDER GAUGE.

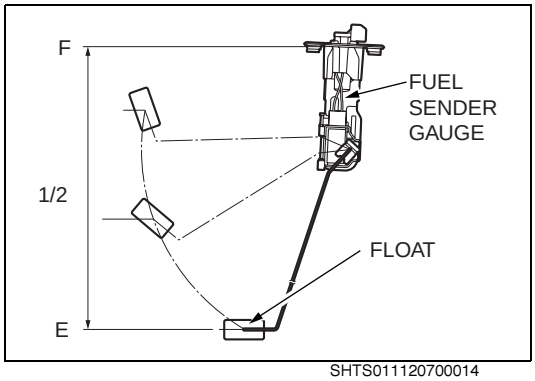
1. DISCONNECT THE HARNESS.
(1) Disconnect the connector of the fuel sender gauge.

2. REMOVE THE FUEL SENDER GAUGE.
(1) Remove five bolts to remove the fuel sender gauge and a gasket from the fuel tank.

HINT
Use a container and a waste as fuel might drip off during removal of fuel sender gauge.

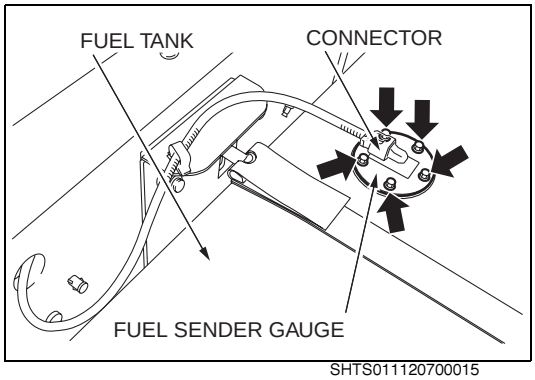
COMPONENT CHECK

1. CHECK A RESISTANCE.
(1) Check that a float of the fuel sender gauge moves smoothly.
(2) Use a circuit tester to measure the resistance between terminals while moving the float from the E point to the F point. If a measurement reading exceeds the standard value, make replacement.



SHTS011120700014

Level	Standard value (Ω)
E	146.5-153.5
1/2	29.5-32.5
F	0+1.2



SHTS011120700015

INSTALL THE FUEL SENDER GAUGE.

1. INSTALL THE FUEL SENDER GAUGE.
(1) Replace an old gasket with a new one. Install the fuel sender gauge to the fuel tank, and tighten five bolts.
Tightening Torque:
1.5-2.5 N·m {15-25 kgf·cm, 1.1-1.8 lbf·ft}

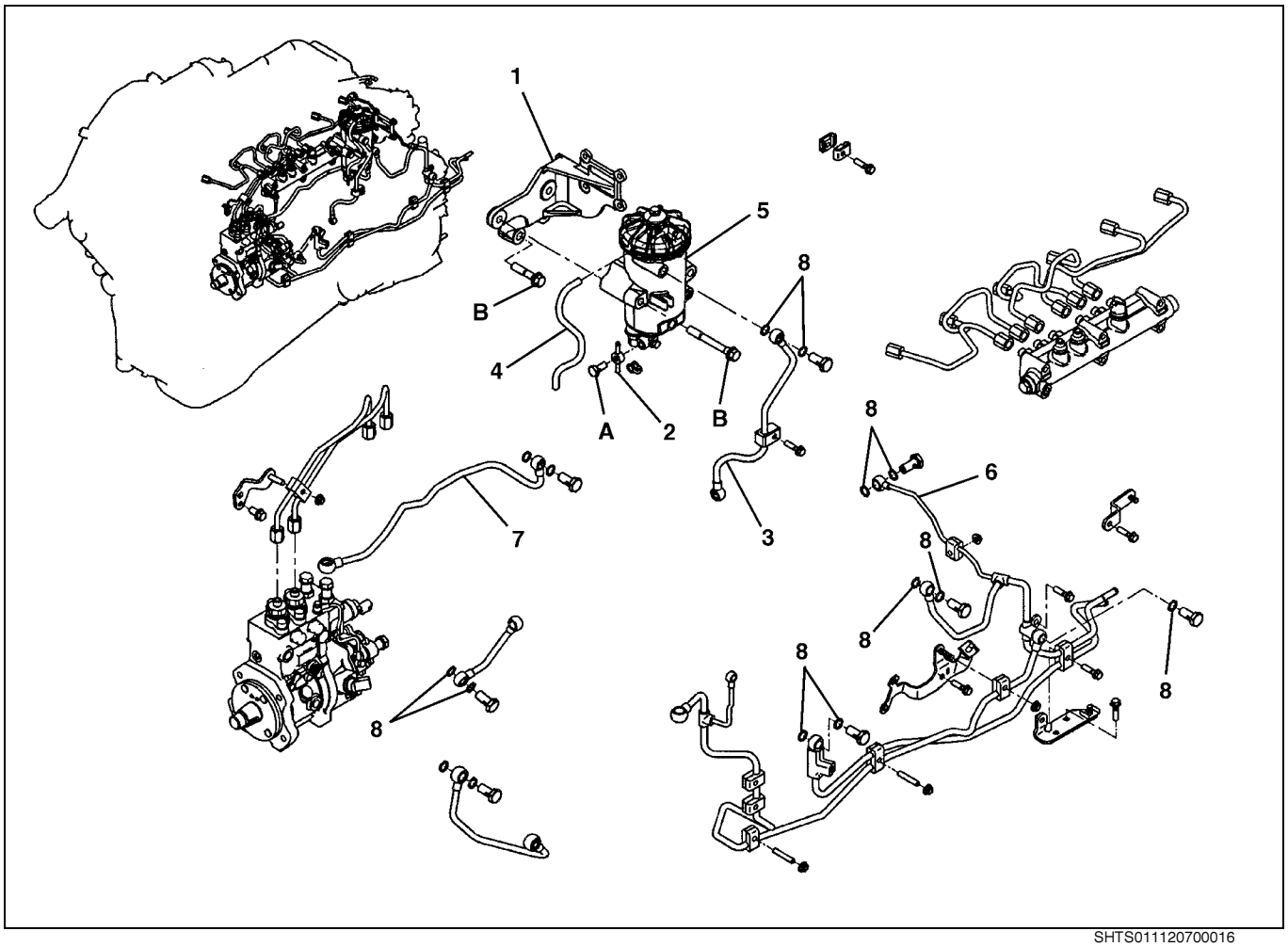
NOTICE
- **The orientation must be checked for positioning so that there will be no interference with the buffer plate on the inner tank wall during installation works.**
- **After installation, start the engine for tryout to check that no fuel leak is observed from the fuel sender gauge.**

2. CONNECT THE HARNESS.
(1) Connect the connector of the fuel sender gauge.

FUEL FILTER AND CASE

COMPONENT LOCATOR

EN0111207D100004

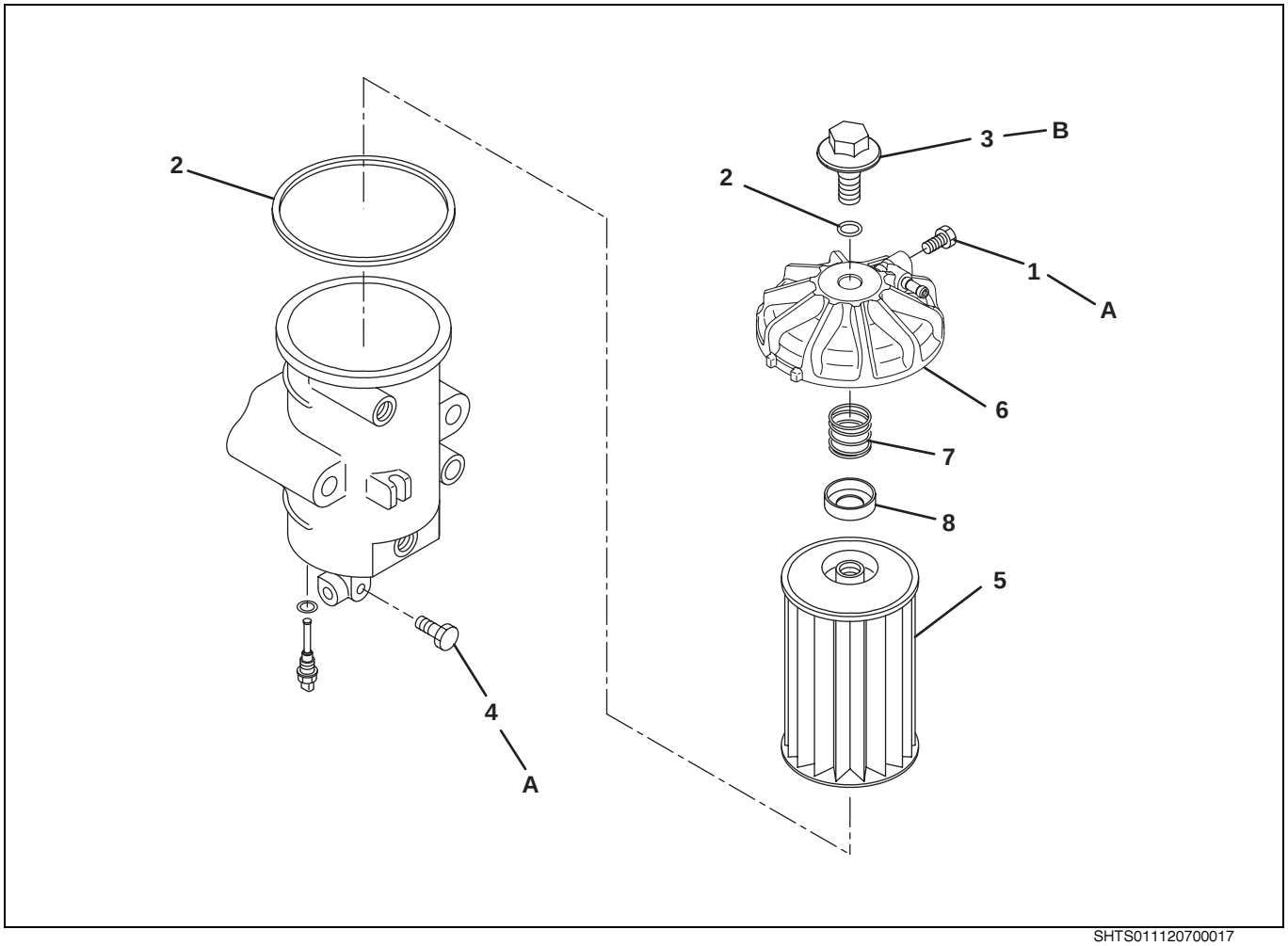


SHTS011120700016

1	Bracket	5	Fuel filter
2	Drain pipe	6	Return pipe No.1
3	Fuel feed pipe No.4	7	Fuel feed pipe No.5
4	Tube	8	Gasket

Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

A	6.9 {70, 5}	B	97 {990, 72}



SHTS011120700017

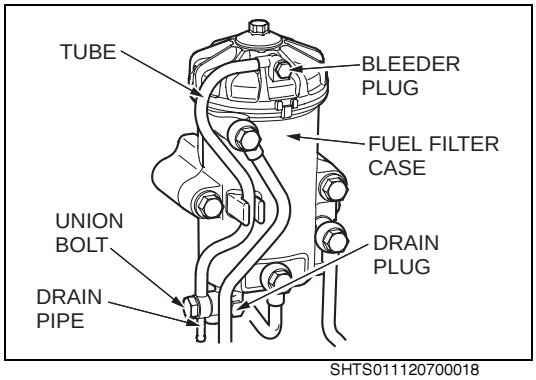
1	Bleeder plug	5	Element
2	O-ring	6	Cap
3	Center bolt	7	Spring
4	Drain plug	8	Holder

Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

A	4.9-8.9 {50-90, 3.7-6.5}	B	24.5-34.3 {250-350, 18-25}

OVERHAUL

EN0111207H200001



SHTS011120700018

DRAIN WATER FROM THE FUEL FILTER.

1. DRAIN WATER FROM THE FUEL FILTER.

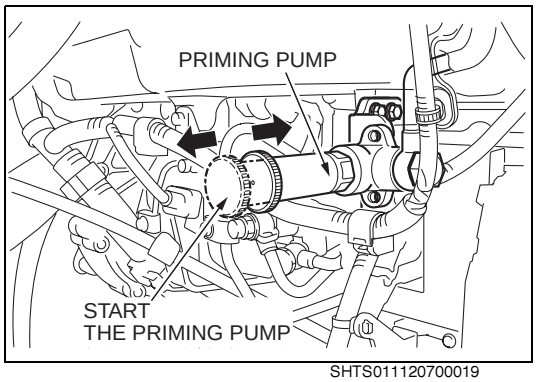
(1) Place a container under the drain pipe so that drained water will be collected in the container.

(2) Loosen the bleeder plug and the drain plug, and drain the water trapped at the bottom of the fuel filter case.

NOTICE

- **Drained water contains some fuel. Disposal of drained water must comply with applicable laws and regulations established in each region or country.**
- **Note that water-contained fuel will cause malfunctions and damages to an engine.**

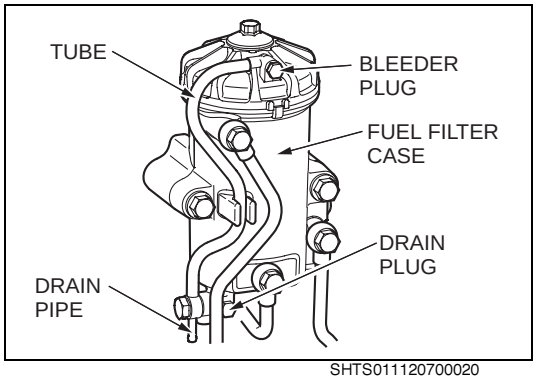
(3) Tighten the drain plug.
Tightening Torque:
4.9-8.9 N·m {50-90 kgf·cm, 3.7-6.5 lbf·ft}



SHTS011120700019

(4) Start the priming pump to bleed air from systems.

NOTICE
Make sure that the bleeder plug is loosened on the fuel filter.

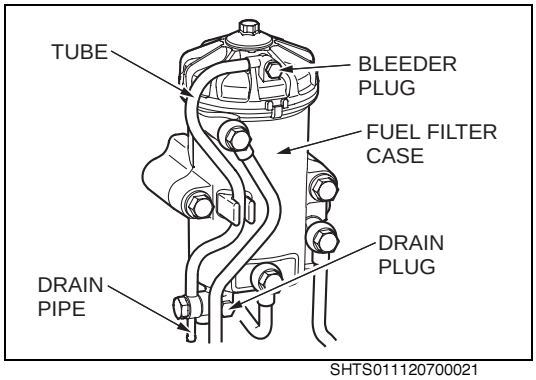


SHTS011120700020

(5) Tighten the bleeder plug on the fuel filter.
Tightening Torque:
4.9-8.9 N·m {50-90 kgf·cm, 3.7-6.5 lbf·ft}

NOTICE
After completion of these steps, start the engine for tryout to check that no fuel leak is observed from the fuel filter.

AIR BLEEDING FROM THE FUEL SYSTEM



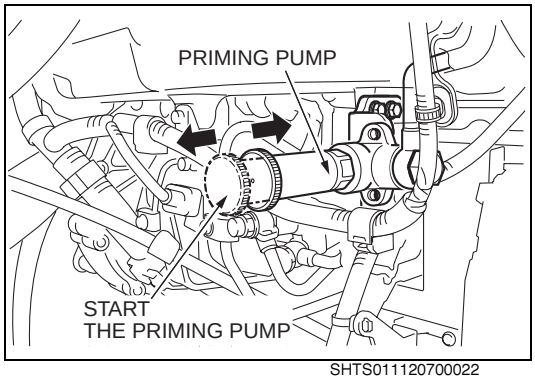
SHTS011120700021

1. BLEED AIR FROM THE FUEL SYSTEM.

(1) Place a container under the drain pipe so that drained fuel will be collected in this container.

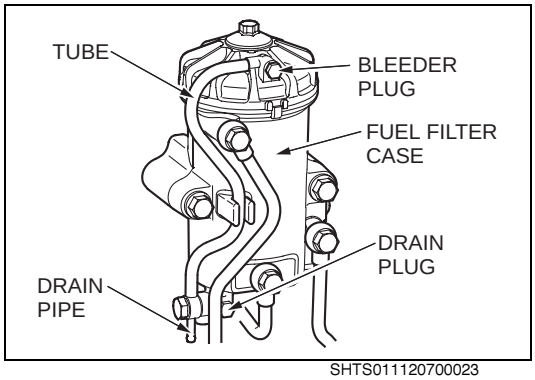
NOTICE
Disposal of drained fuel must comply with applicable laws and regulations established in each region or country.

(2) Loosen the bleeder plug on the fuel filter.



SHTS011120700022

(3) Turn the priming pump counterclockwise to allow it to pop out. Move the priming pump back and forth.
(4) Repeat the back-and-forth motions of the priming pump until fuel flows out from the pipe with no air bubbles.



SHTS011120700023

(5) Tighten the bleeder plug on the fuel filter.
Tightening Torque:
4.9-8.9 N·m {50-90 kgf·cm, 3.7-6.5 lbf·ft}

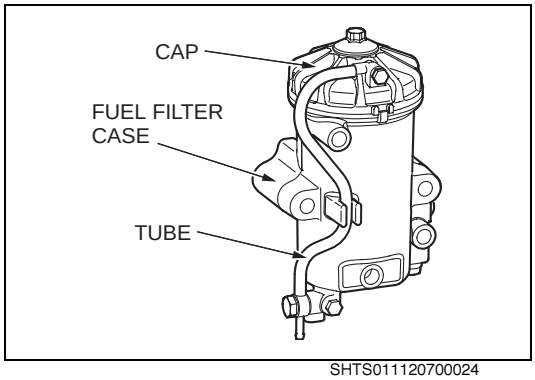
(6) Move the priming pump again at least 20 more times.
(7) Hold the priming pump to its fully retracted position and turn the priming pump clockwise to the end.

NOTICE

- **Make sure that the priming pump is secured tight.**
- **After completion of these steps, start the engine for tryout to check that no fuel leak is observed from the fuel filter.**

REPLACE THE ELEMENT.

1. REPLACE THE ELEMENT.
(1) Pull off a tube from the cap.

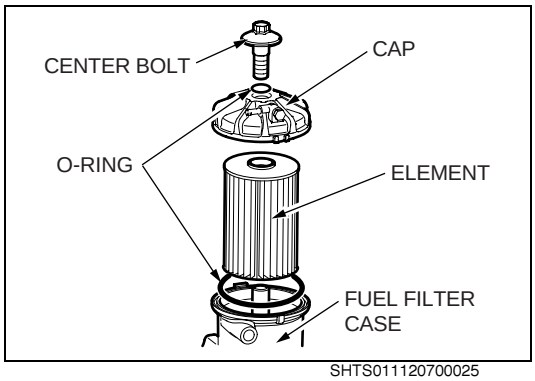


SHTS011120700024

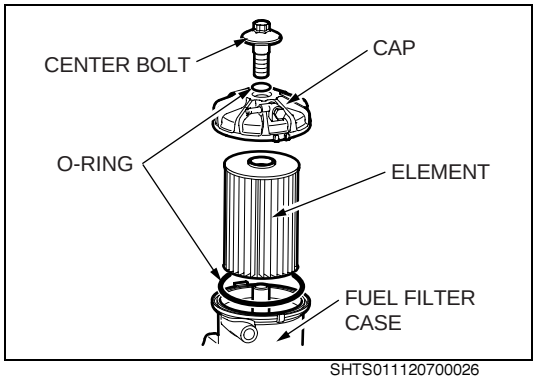
(2) Remove a center bolt to remove two O-rings and a cap from the fuel filter case.
(3) Remove the element.

NOTICE

- **Use a pan to collect the fuel from the fuel filter case.**
- **Note that unfiltered fuel will remain within the fuel filter case if the element is replaced without completely draining the fuel from the fuel filter.**



SHTS011120700025



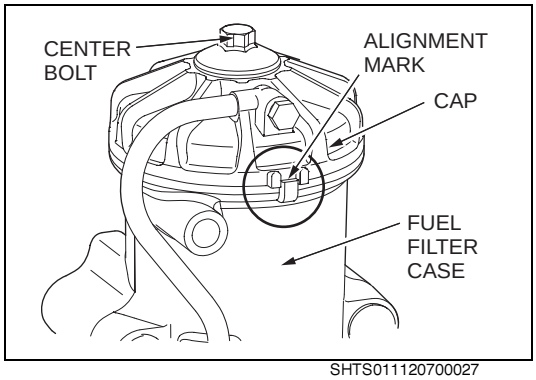
SHTS011120700026

2. INSTALL THE ELEMENT.

(1) Remove dirt from the element fitting area inside the fuel filter case and inside the cap.

(2) Replace an old element with a new one. Insert a new element in the fuel filter case.

(3) Apply fuel onto new O-rings. Install O-rings to a groove on the fuel filter case and to the center bolt seat.

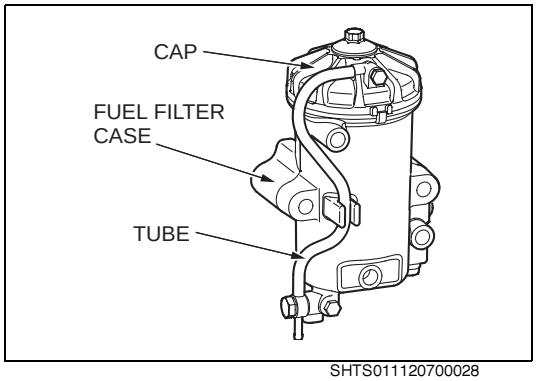


SHTS011120700027

(4) After positioning to an alignment mark, set the cap onto the fuel filter case. Tighten a center bolt.
Tightening Torque:
24.5-34.3 N·m {250-350 kgf·cm, 18-25 lbf·ft}

NOTICE

- **Carefully attach the O-rings so that they will not be curled or damaged.**
- **Make sure that O-rings fully contact with the seal surface.**



SHTS011120700028

(5) Insert a tube in the cap.

REMOVE THE FUEL FILTER AND CASE.

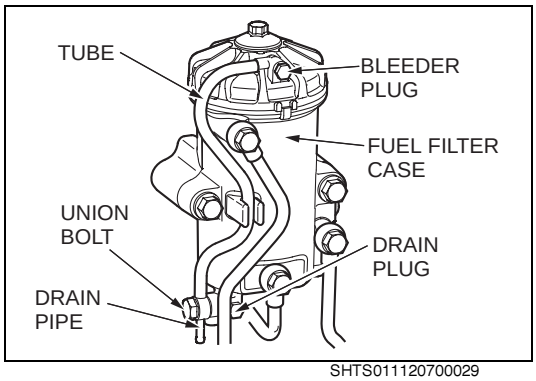
1. DRAIN THE FUEL.

(1) Place a container under the drain pipe so that drained fuel will be collected in this container.

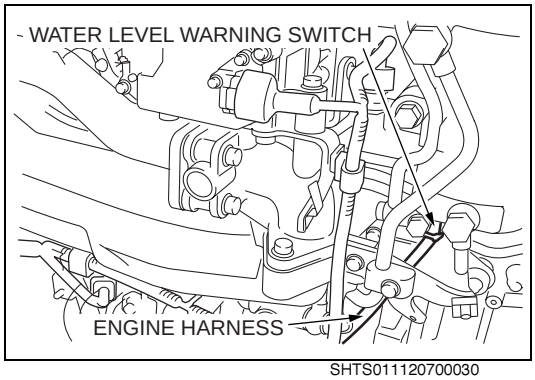
(2) Loosen the drain plug, the bleeder plug and a union bolt on the drain pipe. Drain fuel from the fuel filter case.

NOTICE

- **Disposal of drained fuel must comply with applicable laws and regulations established in each region or country.**
- **Drain all fuel contained in the filter in this step. Replacement of the element without draining all fuel will leave unfiltered fuel within the filter. This will cause such unfiltered residual fuel to flow into the engine.**



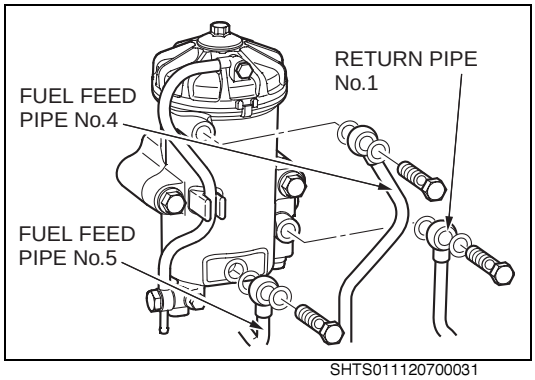
SHTS011120700029



SHTS011120700030

2. DISCONNECT THE HARNESS.

(1) Disconnect the connector of the water level warning switch.



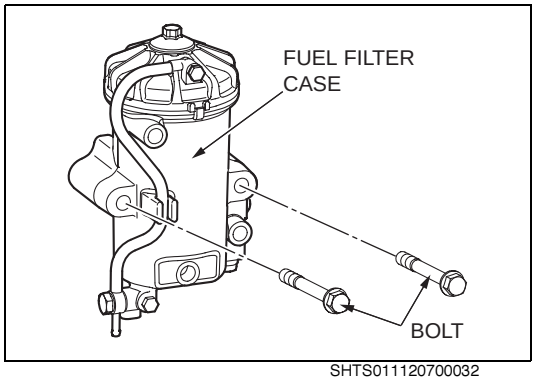
SHTS011120700031

3. REMOVE THE FUEL FILTER CASE.

(1) Remove three union bolts. Disconnect the fuel feed pipes No.4 and No.5 and the return pipe No.1 from the fuel filter case.

HINT

Use a container and a waste as fuel might drip off during disconnection of fuel pipe.

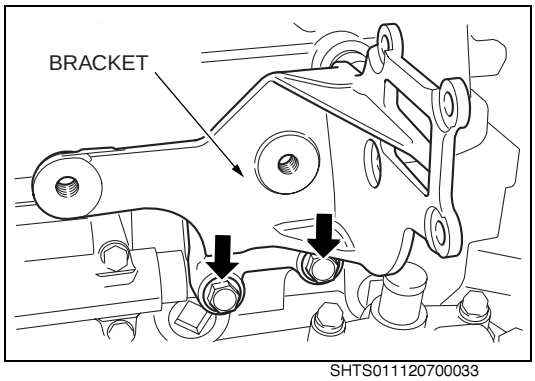


SHTS011120700032

(2) Remove two bolts to remove the fuel filter case.

NOTICE

Take this step carefully not to spill undrained fuel remaining within the fuel filter case.

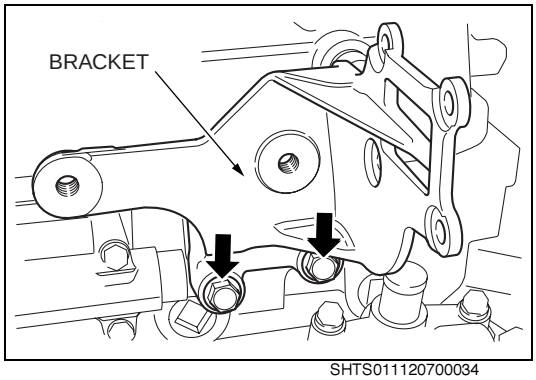


SHTS011120700033

(3) Remove two bolts to remove the bracket from the cylinder head.

HINT

Take this step only if a trouble is found.



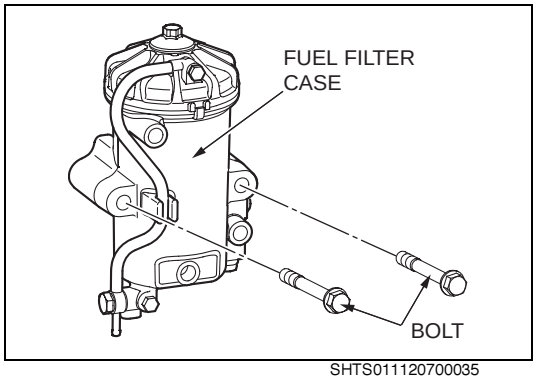
SHTS011120700034

INSTALL THE FUEL FILTER AND CASE.

1. INSTALL THE FUEL FILTER CASE.

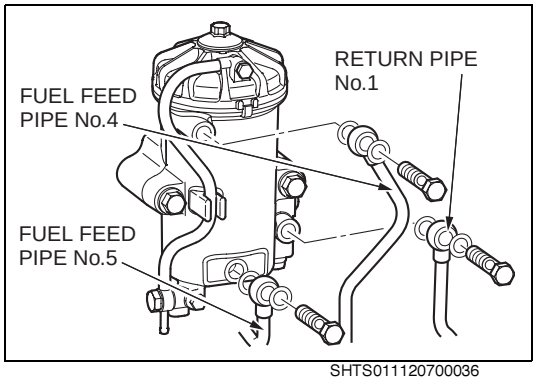
(1) Install the bracket to the cylinder head, and tighten two bolts.
Tightening Torque:
97 N·m {990 kgf·cm, 72 lbf·ft}

HINT
Omit this step if the bracket has not been removed.



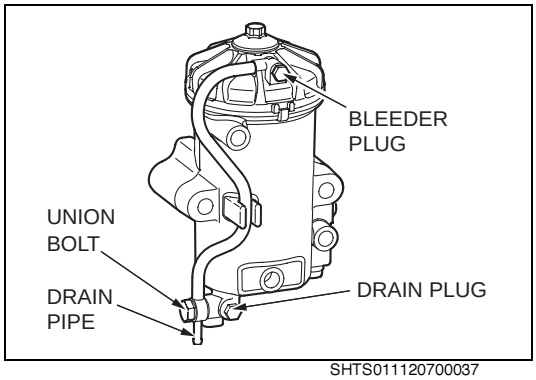
SHTS011120700035

(2) Install the fuel filter case, and tighten two bolts.
Tightening Torque:
97 N·m {990 kgf·cm, 72 lbf·ft}



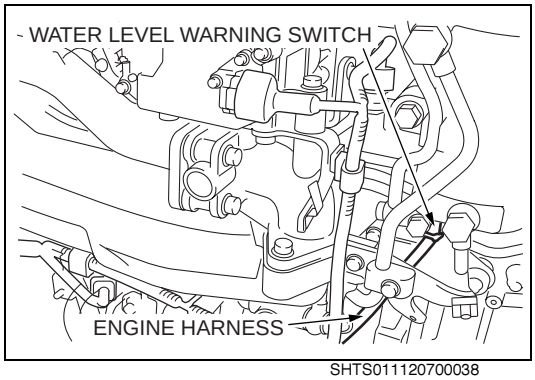
SHTS011120700036

(3) Replace an old gasket with a new one. Connect the fuel feed pipes No.4 and No.5 and the return pipe No.1 to the fuel filter case.



SHTS011120700037

(4) Tighten the drain plug, the bleeder plug and a union bolt on the drain pipe.
Tightening Torque:
Drain plug: 4.9-8.9 N·m {50-90 kgf·cm, 3.7-6.5 lbf·ft}
Bleeder plug: 4.9-8.9 N·m {50-90 kgf·cm, 3.7-6.5 lbf·ft}
Union bolt: 6.9 N·m {70 kgf·cm, 5 lbf·ft}



SHTS011120700038

2. CONNECT THE HARNESS.

(1) Connect the connector of the water level warning switch.

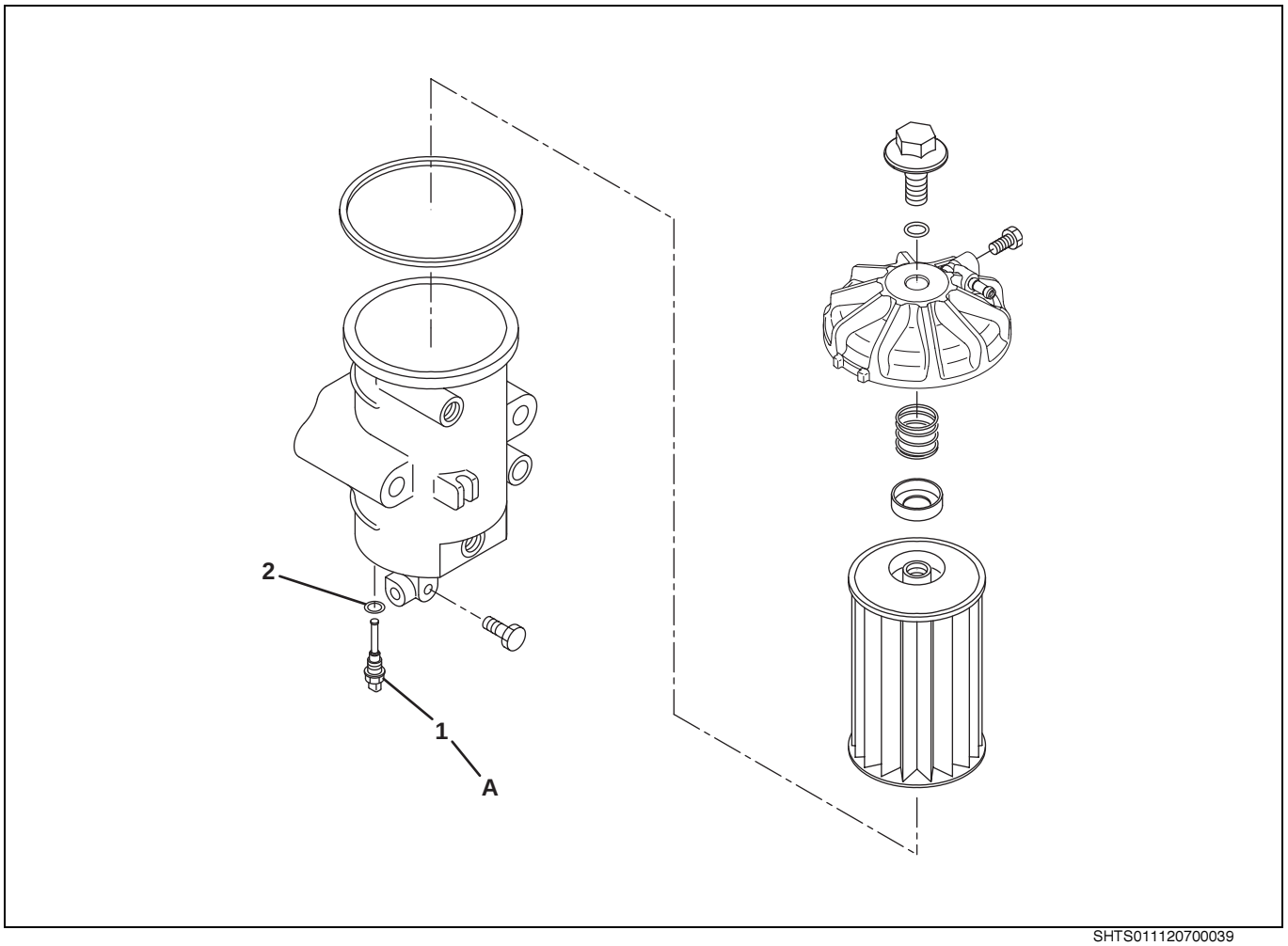
3. BLEED AIR FROM THE FUEL SYSTEM.

(1) Start the priming pump to bleed air from the fuel system. Refer to the section **"FUEL FILTER AND CASE"**.

WATER LEVEL WARNING SWITCH

COMPONENT LOCATOR

EN0111207D100005



SHTS011120700039

1 Water level warning switch	2 O-ring

Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

A 2-3 {20-30, 1.5-2.2}	

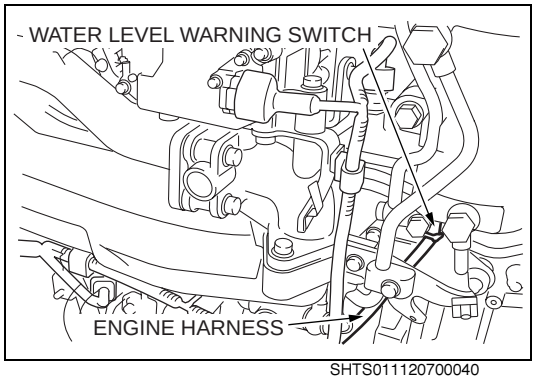
REPLACEMENT

EN0111207H100003

REMOVE THE WATER LEVEL WARNING SWITCH.

1. DRAIN THE FUEL.

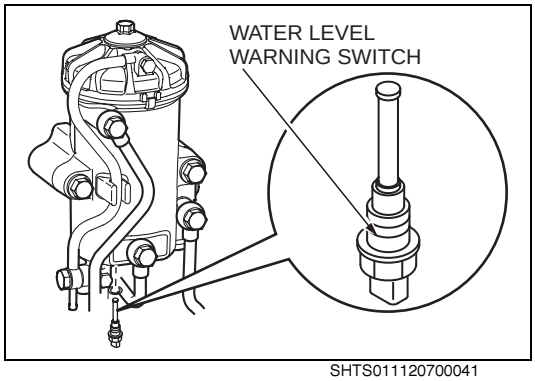
(1) Loosen the drain plug, the bleeder plug and a union bolt on the drain pipe. Drain fuel from the fuel filter case.
Refer to the section **"FUEL FILTER AND CASE"**.



SHTS011120700040

2. DISCONNECT THE HARNESS.

(1) Disconnect the connector of the water level warning switch.



SHTS011120700041

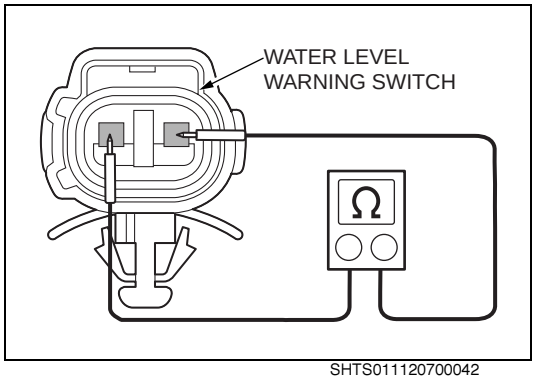
3. REMOVE THE WATER LEVEL WARNING SWITCH.

(1) Remove the water level warning switch from the fuel filter case.

HINT

Use a container and a waste as fuel might drip off during removal of water level warning switch.

COMPONENT CHECK

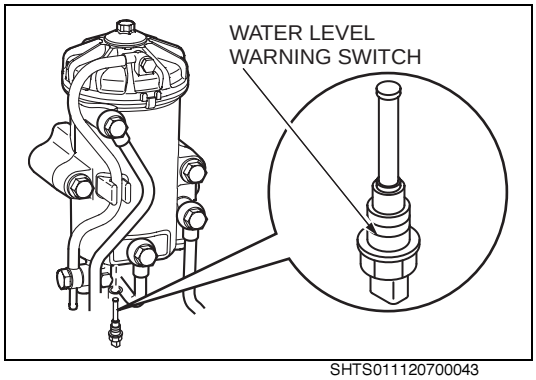


SHTS011120700042

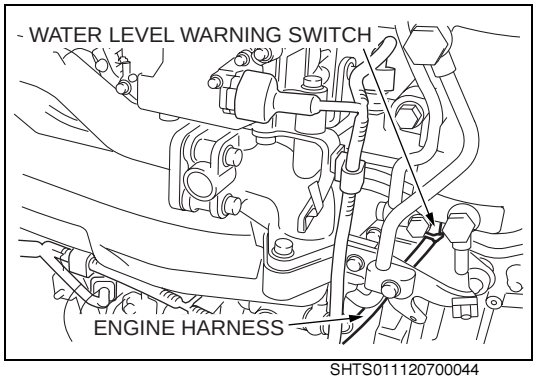
1. CHECK THE ELECTRICAL CONTINUITY.

(1) Manually move a float of the water level warning switch up and down. Use a circuit tester to measure the electrical continuity between terminals. If a trouble is found, make replacement.

Float position	Electrical continuity
Up	Proper continuity
Down	No continuity



SHTS011120700043



SHTS011120700044

INSTALL THE WATER LEVEL WARNING SWITCH.

1. INSTALL THE WATER LEVEL WARNING SWITCH.

(1) Check that an O-ring is installed to the water level warning switch. Install the water level warning switch to the fuel filter case.
Tightening Torque:
2-3 N·m {20-30 kgf·cm, 1.5-2.2 lbf·ft}

NOTICE
After installing, start the engine for tryout to check that no fuel leak is observed from the water level warning switch.

(2) Connect the connector of the water level warning switch.

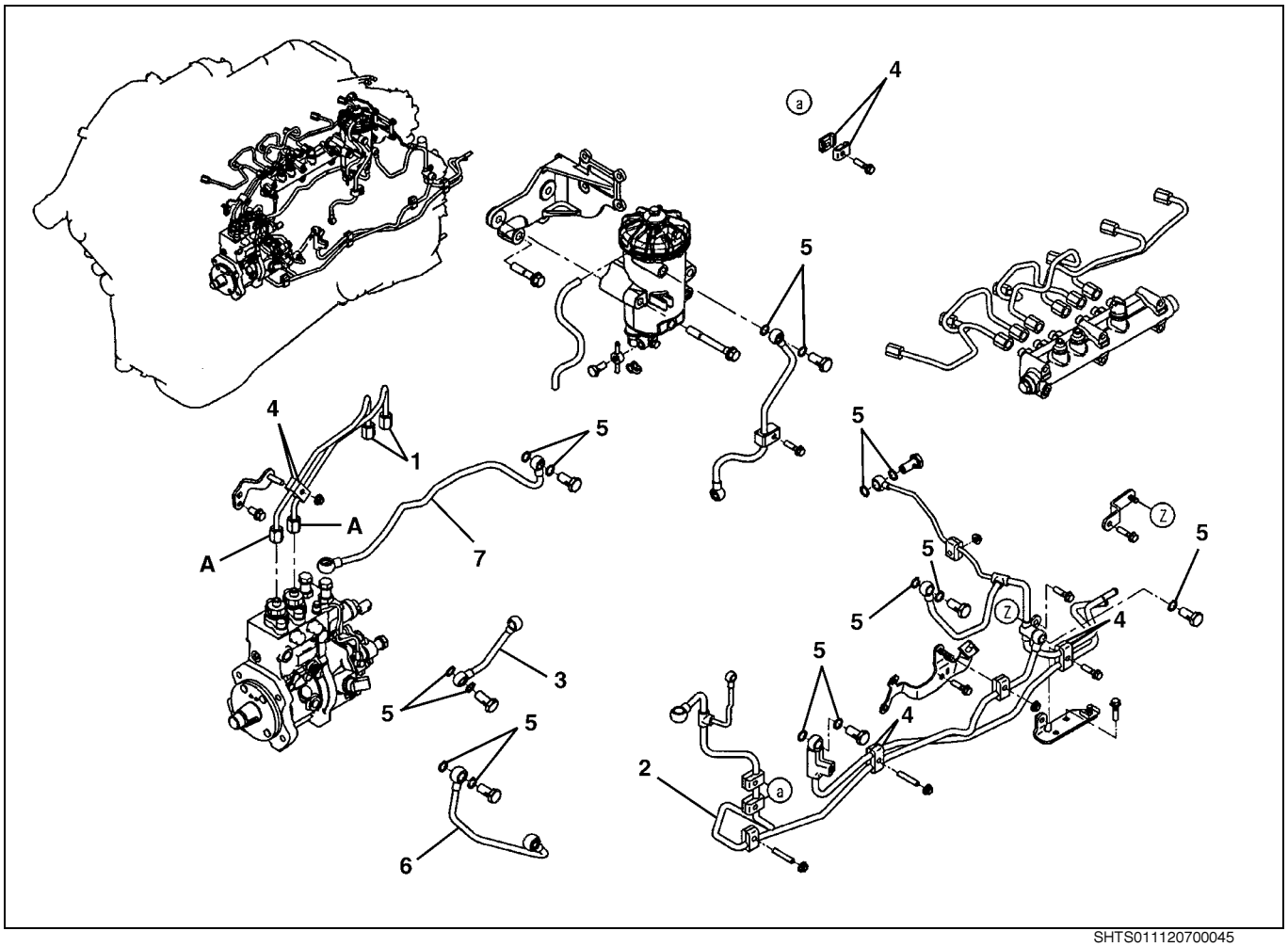
2. BLEED AIR FROM THE FUEL SYSTEM.

(1) Start the priming pump to bleed air from the fuel system. Refer to the section **"FUEL FILTER AND CASE"**.

SUPPLY PUMP

COMPONENT LOCATOR

EN0111207D100006

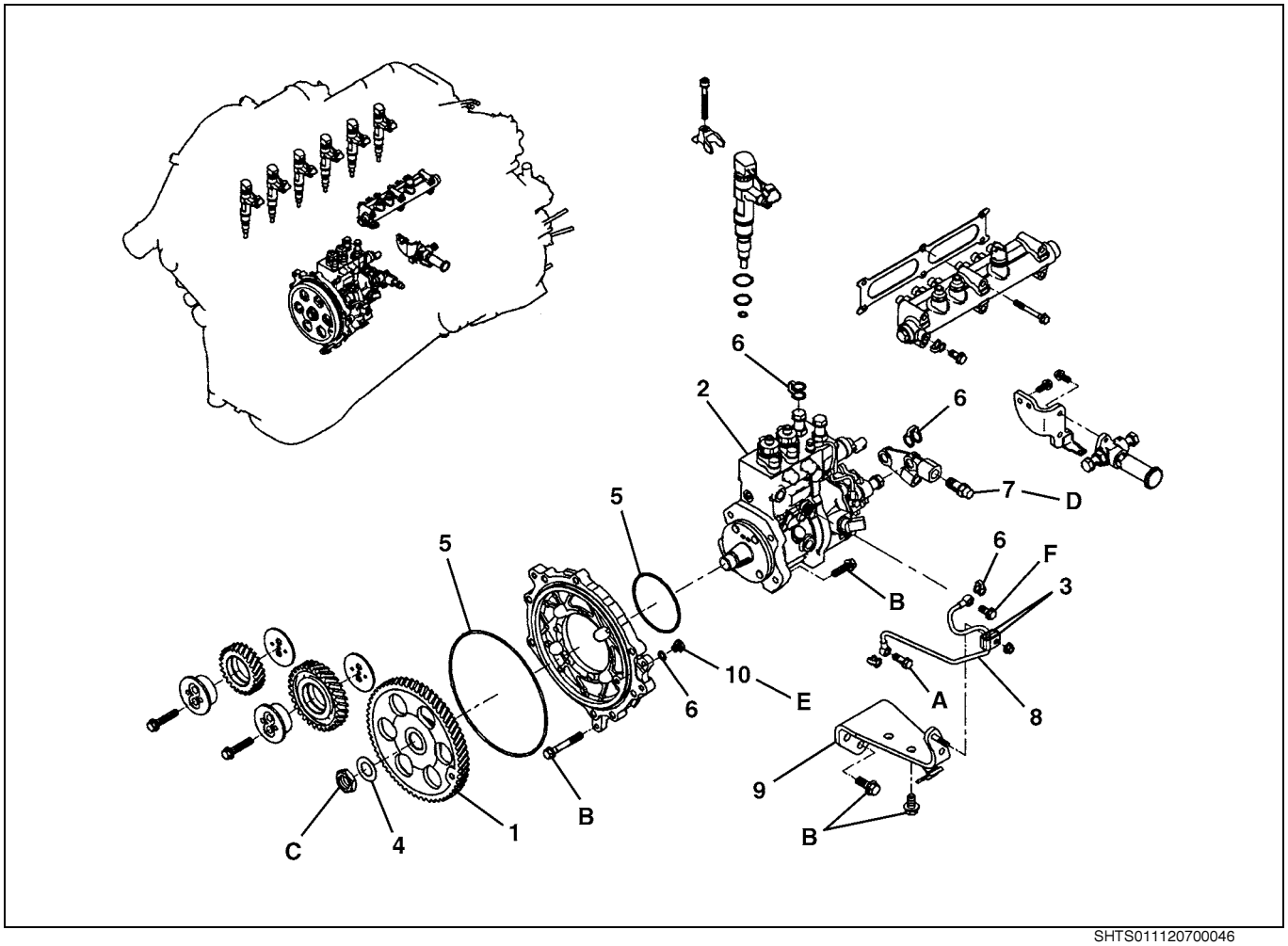


SHTS011120700045

1	Pressure-feed pipe	5	Gasket
2	Return pipe No.2	6	Fuel feed pipe No.3
3	Fuel feed pipe No.2	7	Fuel feed pipe No.5
4	Clip		

Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

A	32 {330, 24}		

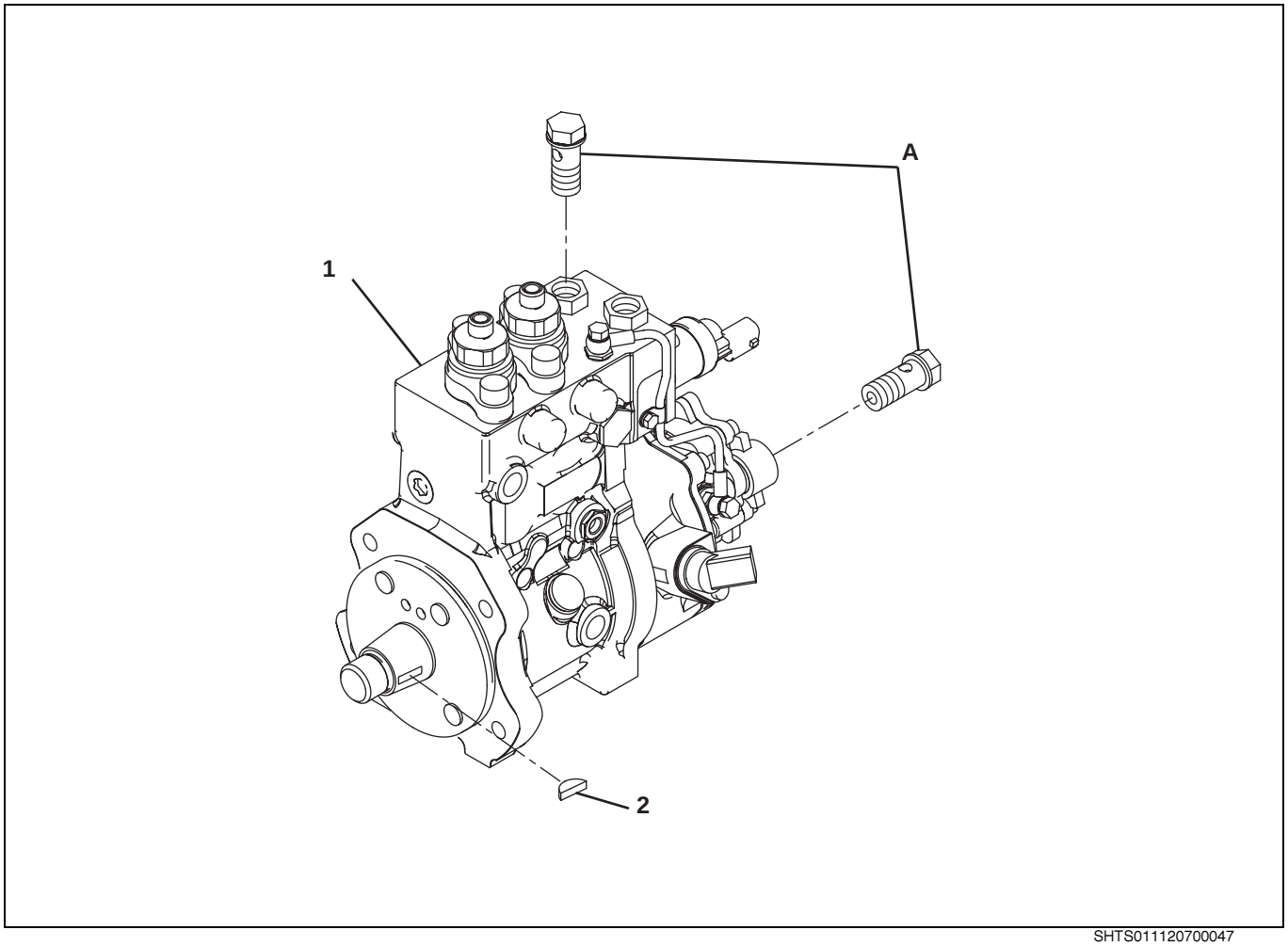


SHTS011120700046

1	Supply pump drive gear	6	Gasket
2	Supply pump	7	Fuel strainer
3	Clip	8	Oil pipe
4	Washer	9	Bracket
5	O-ring	10	Timing check window plug

Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

A	20 {204, 15}	D	29 {300, 21}
B	55 {560, 41}	E	13 {130, 10}
C	250 {2,550, 184}	F	12.5 {128, 9}



SHTS011120700047

1 Supply pump	**2 Key**

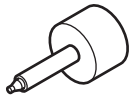
Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

A 27 {275, 20}	

SPECIAL TOOL

EN0111207K100001

Prior to starting an engine overhaul, it is necessary to have this special tool.

Illustration	Part number	Tool name	Remarks
	S0951-22530	INJECTION PUMP TOOL	

REPLACEMENT

EN0111207H100004

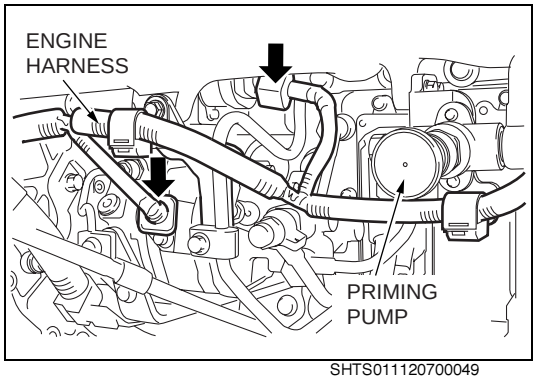
REMOVE THE SUPPLY PUMP.

1. DRAIN THE FUEL.

(1) Loosen the drain plug, the bleeder plug and a union bolt on the drain pipe. Drain fuel from the fuel filter case.
Refer to the section **"FUEL FILTER AND CASE"**.

2. DISCONNECT THE HARNESS.

(1) Disconnect the connectors from the engine speed sub sensor and the supply pump.



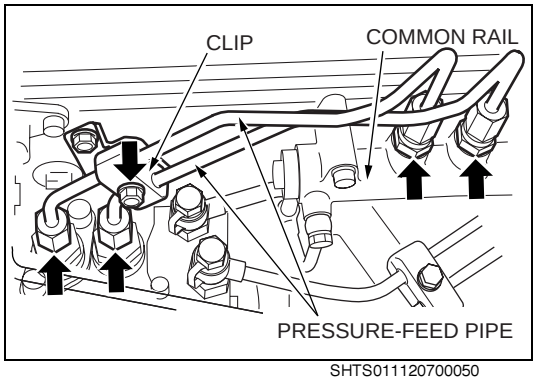
SHTS011120700049

3. DISCONNECT THE FUEL PIPE AND THE OIL PIPE.

(1) Remove a nut to remove the clip.
(2) Loosen nuts to disconnect two pressure-feed pipes.

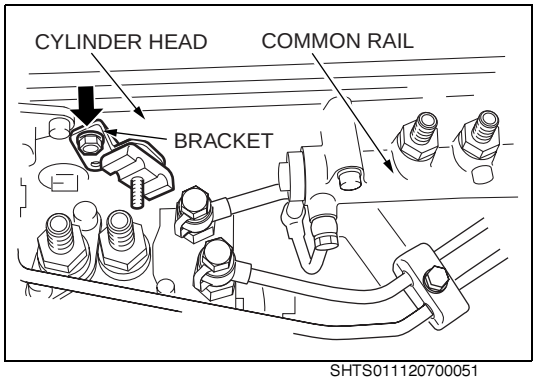
HINT

Use a container and a waste as fuel might drip off during disconnection of pressure-feed pipes.



SHTS011120700050

(3) Remove a bolt to remove the bracket from the cylinder head.

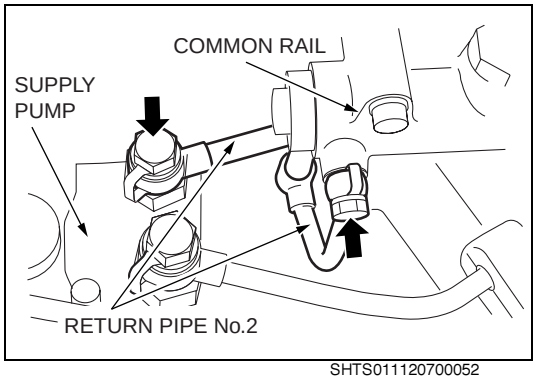


SHTS011120700051

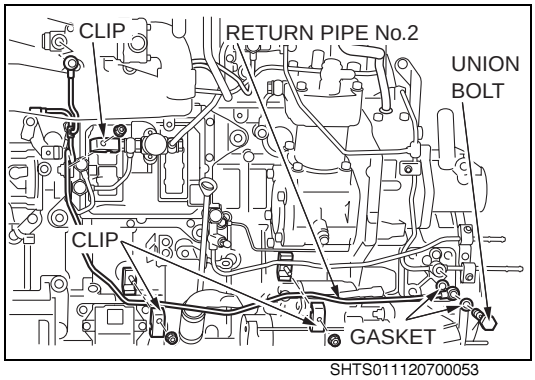
(4) Remove two union bolts and gaskets. Disconnect the return pipe No.2 from the supply pump and from the common rail.

HINT

Use a container and a waste as fuel might drip off during disconnection of fuel pipe.



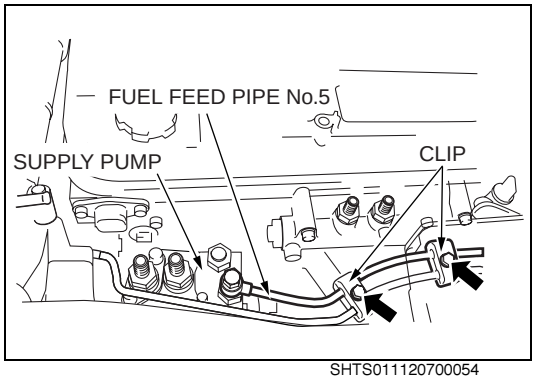
SHTS011120700052



SHTS011120700053

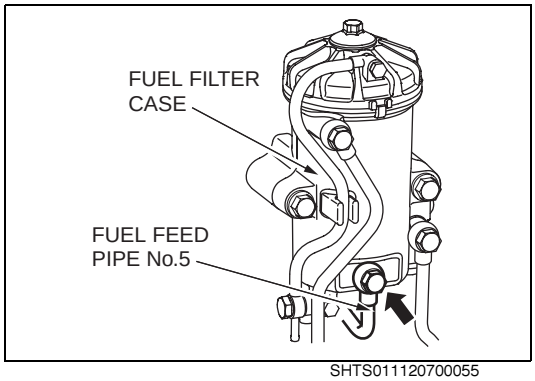
(5) Remove three nuts and three clips.
(6) Remove a union bolt to disconnect the return pipe No.2 and remove gaskets.

HINT
Use a container and a waste as fuel might drip off during disconnection of fuel pipe.



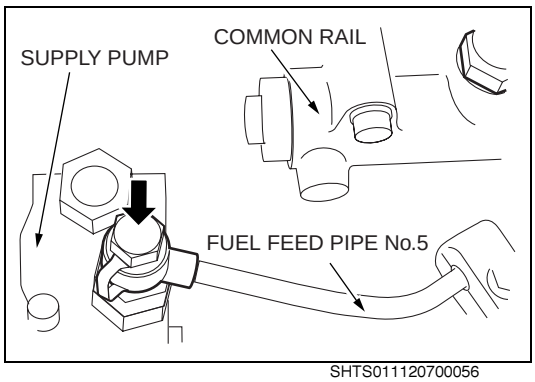
SHTS011120700054

(7) Remove two clips securing the fuel feed pipe No.5 between the fuel filter case and the supply pump.



SHTS011120700055

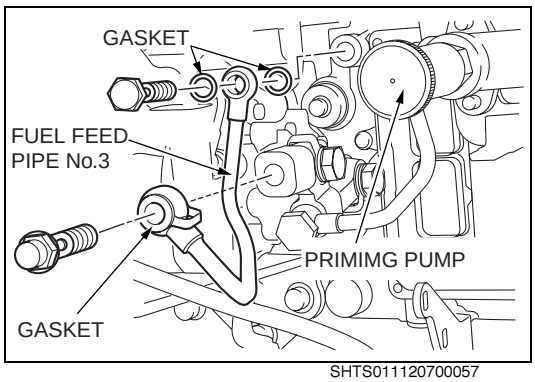
(8) Remove a union bolt to disconnect the fuel feed pipe No.5 from the fuel filter case.



SHTS011120700056

(9) Remove a union bolt to disconnect the fuel feed pipe No.5 between the fuel filter case and the supply pump.

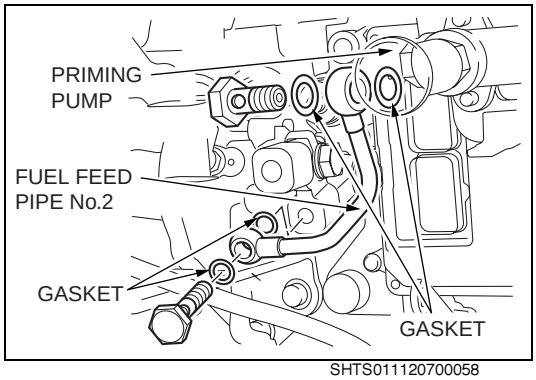
HINT
Use a container and a waste as fuel might drip off during disconnection of fuel pipe.



SHTS011120700057

(10) Remove two union bolts to disconnect the fuel feed pipe No.3 and remove gaskets.

HINT
Use a container and a waste as fuel might drip off during disconnection of fuel pipe.

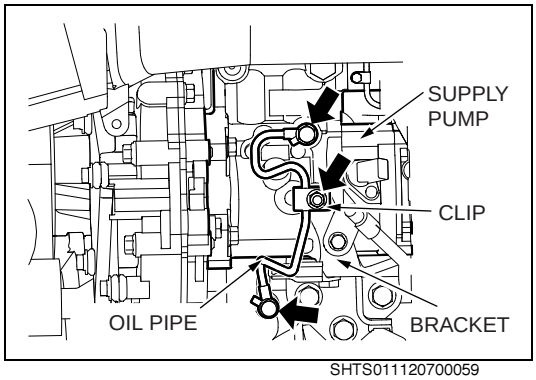


SHTS011120700058

(11) Remove two union bolts to disconnect the fuel feed pipe No.2 and remove gaskets.

HINT

Use a container and a waste as fuel might drip off during disconnection of fuel pipe.

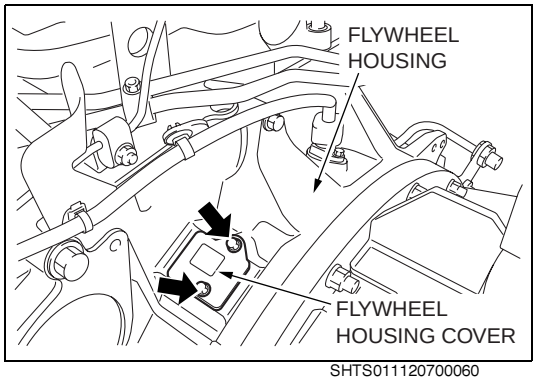


SHTS011120700059

(12) Remove a nut to remove a clip from the bracket.
(13) Remove two union bolts to disconnect the oil pipe and remove gaskets from the supply pump.

HINT

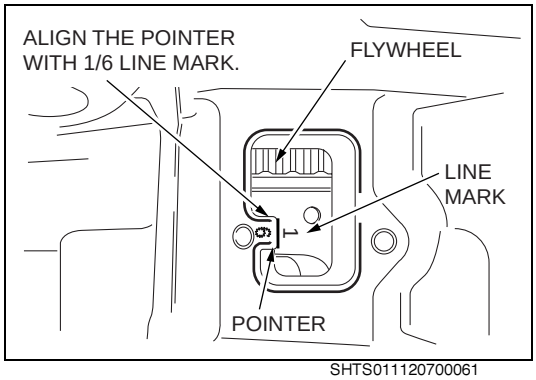
Use a container and a waste as engine oil might drip off during disconnection of oil pipe.



SHTS011120700060

4. REMOVE THE FLYWHEEL HOUSING COVER.

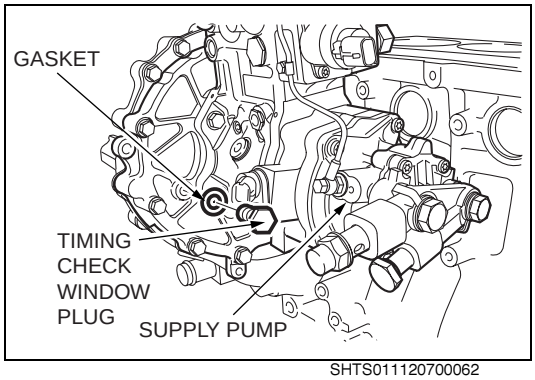
(1) Remove two bolts to remove the flywheel housing cover from the flywheel housing.



SHTS011120700061

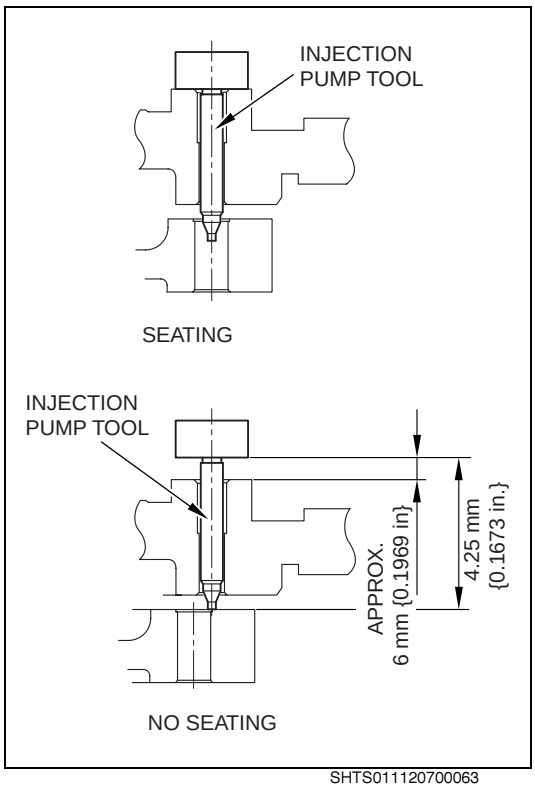
5. SETTING THE TOP DEAD CENTER ON THE COMPRESSION STROKE OF THE CYLINDER No.1 (WHEN THE SUPPLY PUMP IS INSTALLED)

(1) Turn the crankshaft in the engine rotation direction (clockwise as viewed from the cooling fan) and position the "1/6" line mark shown on the outer peripheries of the crankshaft damper and of the flywheel, in alignment with the pointer.



SHTS011120700062

(2) Remove the timing check window plug and a gasket from the supply pump.

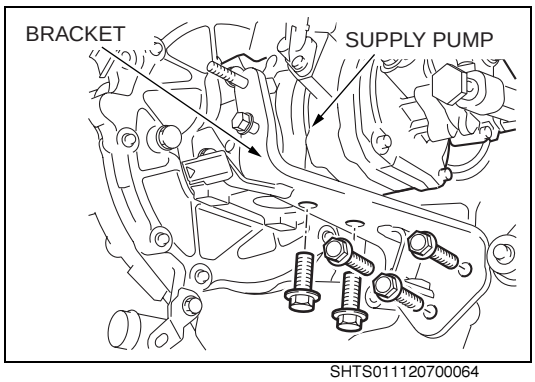


SHTS011120700063

(3) Insert a special tool in the timing check window and check that the seat surface of the special tool is sitting on the supply pump.
SST: Injection pump tool (S0951-22530)

NOTICE

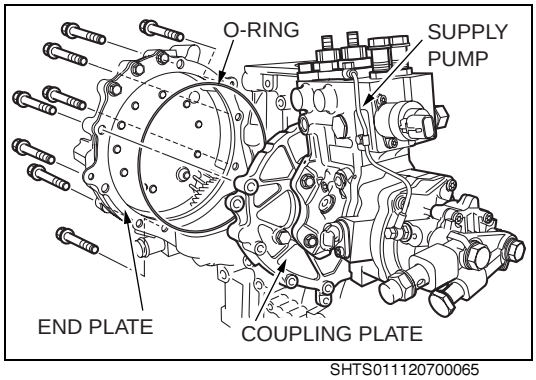
- **A failure in seating implies that the seat surface is contacting with an area other than the rotation stopper in the coupling flange. Do not apply an excessive force to push the tool in.**
- **If no seating is observed, the cylinder No.6 is set to the top dead center on the compression stroke. Make one additional turn of the crankshaft and check with a special tool again.**



SHTS011120700064

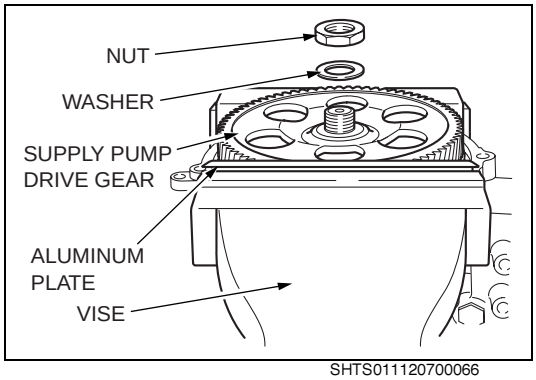
6. REMOVE THE SUPPLY PUMP.

(1) Remove five bolts to remove the bracket.



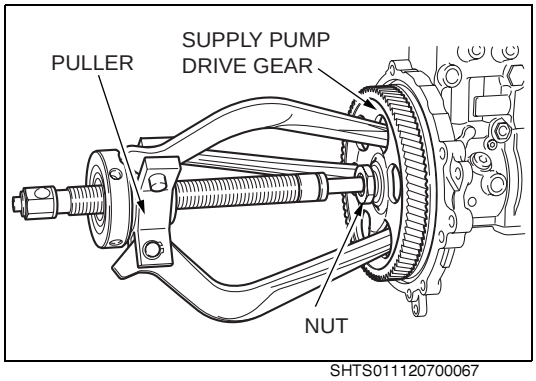
SHTS011120700065

(2) Remove eight bolts to remove the supply pump and an O-ring from the end plate of the front timing gear cover.



SHTS011120700066

(3) Set an aluminum sheet in a vise. Use this vise to fixate the supply pump drive gear. Remove a nut to remove the supply pump drive gear and the washer from the supply pump.

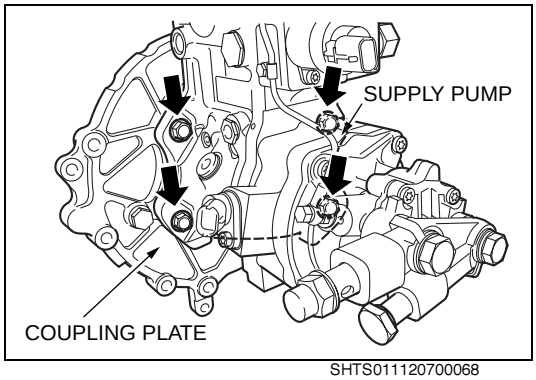


SHTS011120700067

(4) After lightly tightening a nut, use a commercially available puller to remove the supply pump drive gear from the supply pump.

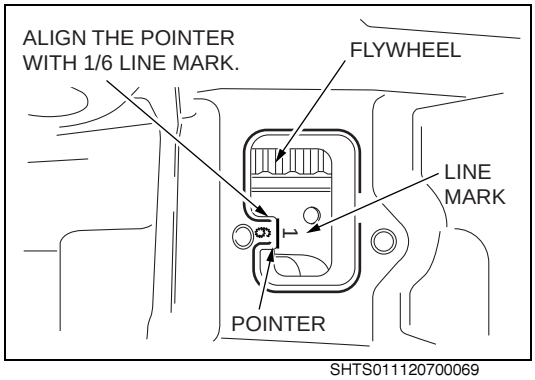
HINT

- **Tighten a nut lightly before start of removal works in order to prevent accidental drop-off of the supply pump drive gear.**
- **The supply pump drive gear can be easily pulled off by hammering the puller head.**



SHTS011120700068

(5) Remove four bolts to remove the supply pump and an O-ring from the coupling plate.

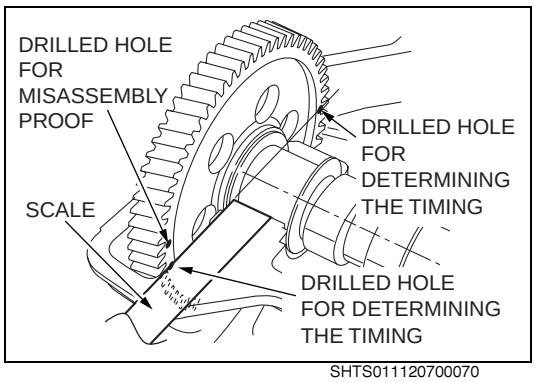


SHTS011120700069

INSTALL THE SUPPLY PUMP.

1. SETTING THE TOP DEAD CENTER ON THE COMPRESSION STROKE OF THE CYLINDER No.1 (WHEN THE SUPPLY PUMP IS NOT INSTALLED)

(1) Turn the crankshaft in the engine rotation direction (clockwise as viewed from the cooling fan) and position the "1/6" line mark shown on the outer peripheries of the crankshaft damper and of the flywheel, in alignment with the pointer.



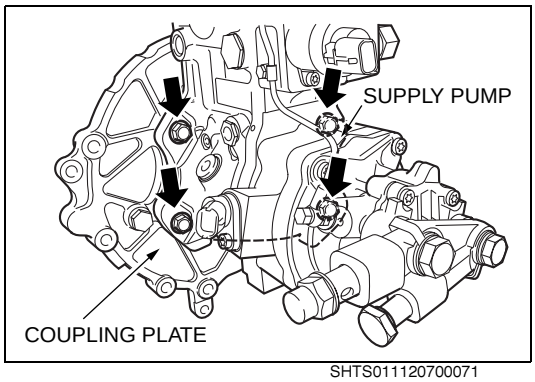
SHTS011120700070

(2) When placing the camshaft assembly, position two drilled holes located at an angle of 180° (drilled holes for determining the timing) to be in parallel to the top surface of the cylinder head.

NOTICE

Place a transparent plastic scale or an edged scale on the top face of the cylinder head and on the side face of the camshaft gear, and check that drilled holes for misassembly-proof lie at a height above the scale.

(3) If drilled holes for misassembly-proof lie at a height below the top face of the cylinder head, the cylinder No.6 is set at the top dead center on the compression stroke. Make one additional rotation of the crankshaft again and check that drilled holes for misassembly-proof on the camshaft lie at a height above the top face of the cylinder head.

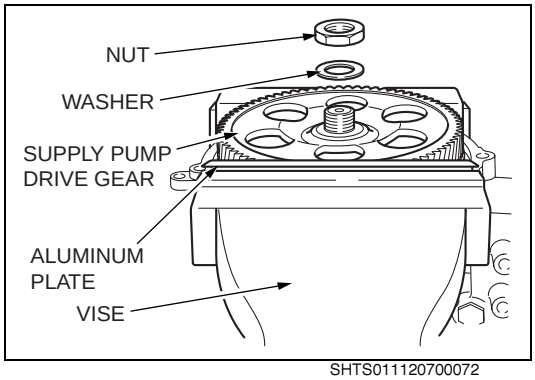


SHTS011120700071

2. INSTALL THE SUPPLY PUMP.

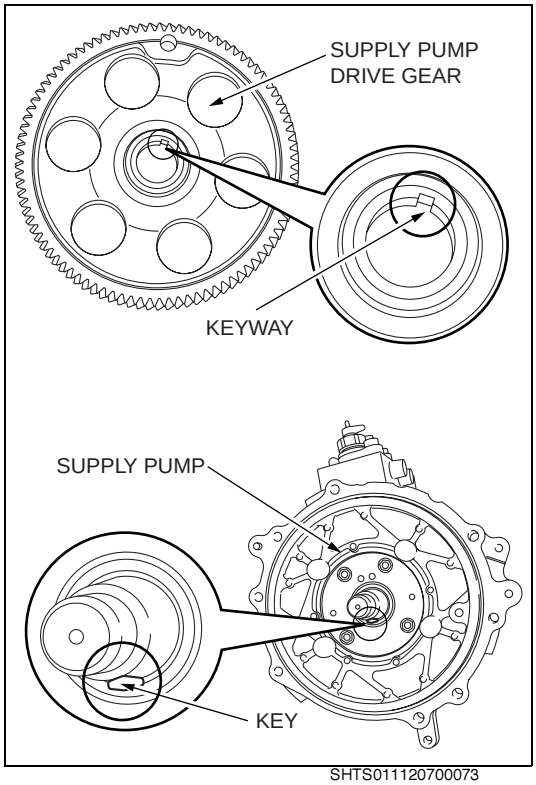
(1) Check that the cylinder No.1 is set at the top dead center on the compression stroke.

(2) Replace an old O-ring with a new one. Install the supply pump to the coupling plate, and tighten four bolts.
Tightening Torque:
55 N·m {560 kgf·cm, 41 lbf·ft}



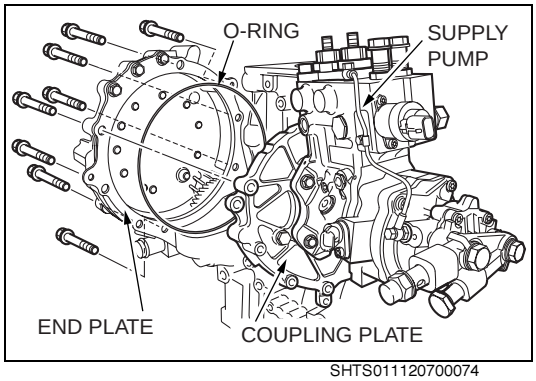
SHTS011120700072

(3) Set an aluminum sheet in a vise. Use this vise to fixate the supply pump drive gear. Attach a washer and tighten a nut to secure the supply pump drive gear and the washer.
Tightening Torque:
250 N·m {2,550 kgf·cm, 184 lbf·ft}



SHTS011120700073

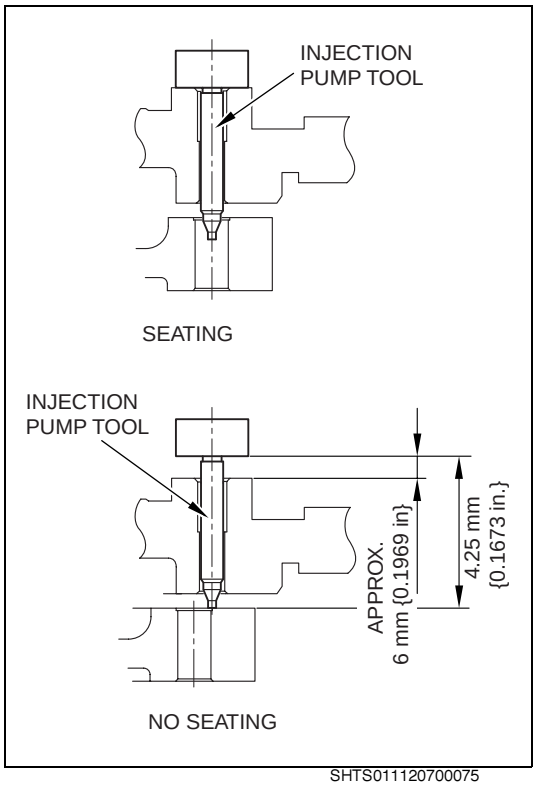
NOTICE
In this step, align the shaft key with a keyway on the supply pump drive gear.



SHTS011120700074

(4) Replace an old O-ring with a new one. Install the supply pump and the coupling plate to the end plate of the front timing cover, and tighten eight bolts.
Tightening Torque:
55 N·m {560 kgf·cm, 41 lbf·ft}

NOTICE
- **Attach an O-ring carefully so that it will not be curled or damaged.**
- **The coupling plate has two knock pins.**



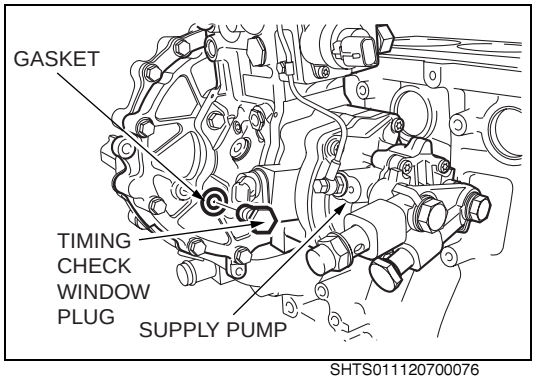
SHTS011120700075

(5) Insert the special tool in the timing check window and check that the seat surface of the special tool is sitting on the supply pump.
SST: Injection pump tool (S0951-22530)

⚠ CAUTION
No seating implies that the seat surface is contacting with an area other than the rotation stopper in the coupling flange. Do not apply an excessive force to push the tool in.

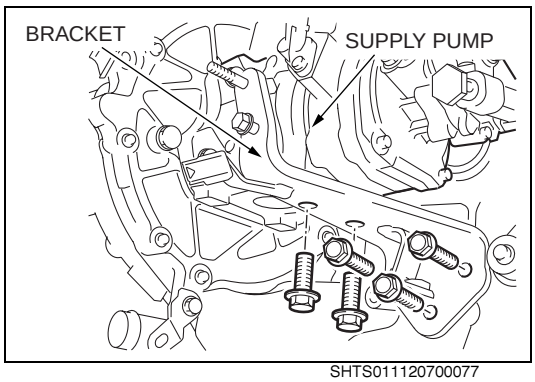
HINT
The timing is correct if the coupling plate mounting bolt can be tightened in assembling the supply pump with the special tool remaining seated.

(6) If the seat surface of the special tool is not sitting properly, the timing is not correct. In such case, restart the remounting procedures.



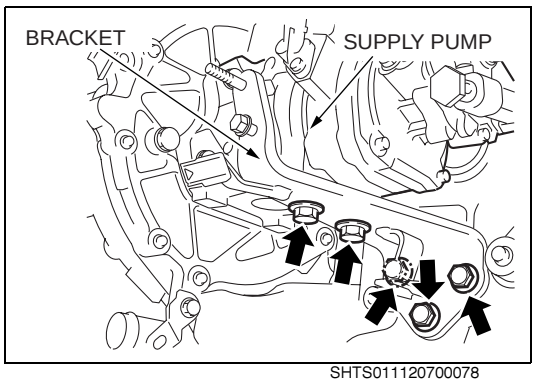
SHTS011120700076

(7) After checking the timing, replace an old gasket with a new one and install the timing check window plug.
Tightening Torque:
13 N·m {130 kgf·cm, 10 lbf·ft}



SHTS011120700077

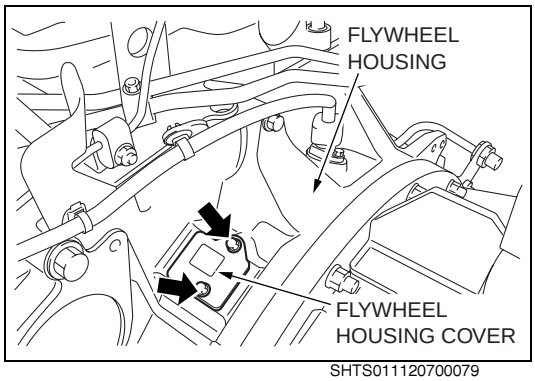
(8) Tight the five bolts by using finger torque, to install the bracket to the supply pump and the cylinder block.



SHTS011120700078

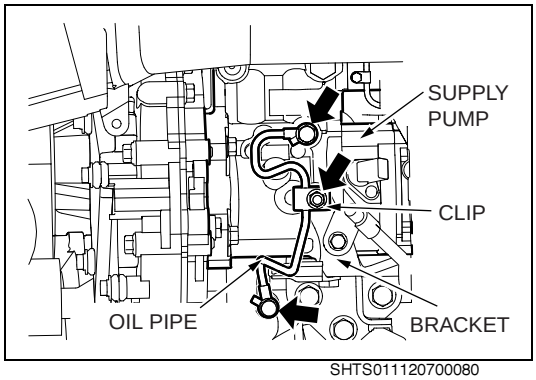
(9) Tight the five bolts at a specified torque.
Tightening Torque:
55 N·m {560 kgf·cm, 41 lbf·ft}

NOTICE
Properly adjust the positions of the supply pump and the bracket in order to prevent an excessive force from being applied to the bracket.



SHTS011120700079

3. INSTALL THE FLYWHEEL HOUSING COVER.
(1) Install the flywheel housing cover to the flywheel housing, and tighten two bolts.
Tightening Torque:
25 N·m {255 kgf·cm, 18 lbf·ft}

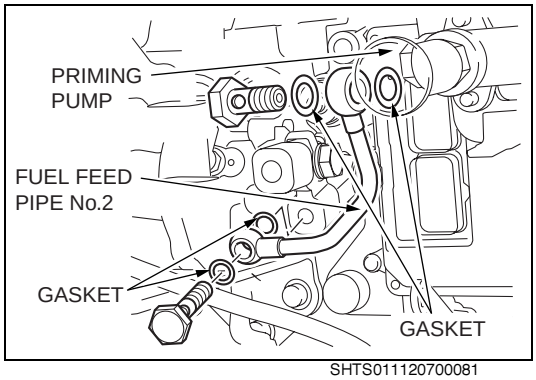


SHTS011120700080

4. CONNECT THE FUEL PIPE AND THE OIL PIPE.

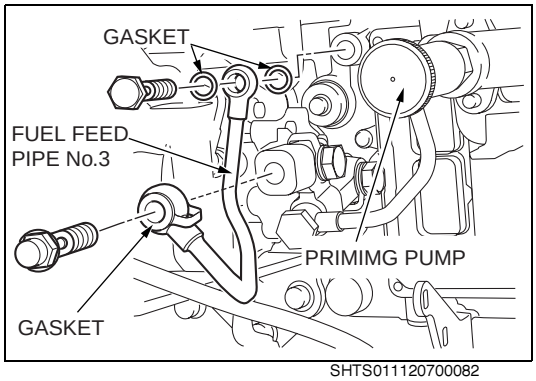
(1) Replace old gaskets with new ones. Connect the oil pipe, and tighten two union bolts.
Tightening Torque:
Supply pump side: 12.5 N·m {128 kgf·cm, 9 lbf·ft}
Cylinder block side: 20 N·m {204 kgf·cm, 15 lbf·ft}

(2) Install a clip to secure the oil pipe.



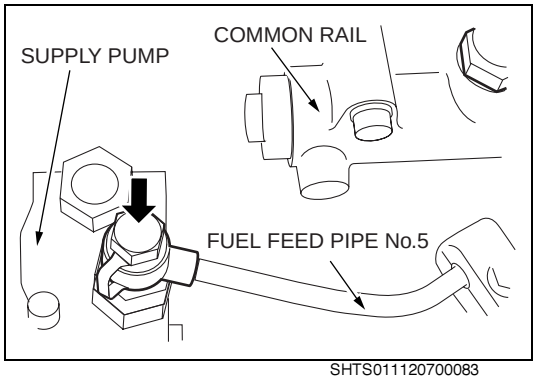
SHTS011120700081

(3) Replace old gaskets with new ones. Connect the fuel feed pipe No.2, and tighten two union bolts.
Tightening Torque:
Supply pump side: 25 N·m {255 kgf·cm, 18 lbf·ft}
Priming pump side: 27 N·m {275 kgf·cm, 20 lbf·ft}



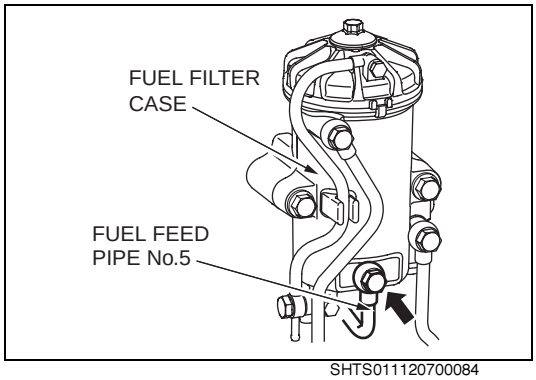
SHTS011120700082

(4) Replace old gaskets with new ones. Connect the fuel feed pipe No.3, and tighten two union bolts.
Tightening Torque:
Fuel strainer side: 27 N·m {275 kgf·cm, 21 lbf·ft}
Engine ECU cooler side: 25 N·m {255 kgf·cm, 20 lbf·ft}



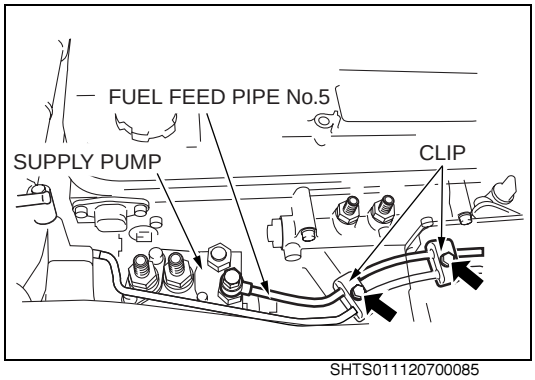
SHTS011120700083

(5) Replace an old gasket with a new one. Connect the fuel feed pipe No.5, and tighten a union bolt.
Tightening Torque:
27 N·m {275 kgf·cm, 20 lbf·ft}



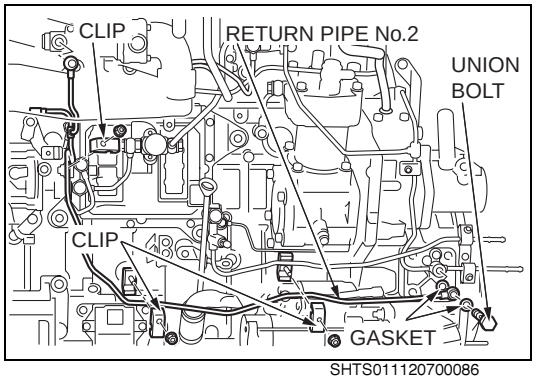
SHTS011120700084

(6) Connect the fuel feed pipe No.5 to the fuel filter case, and tighten a union bolt.



SHTS011120700085

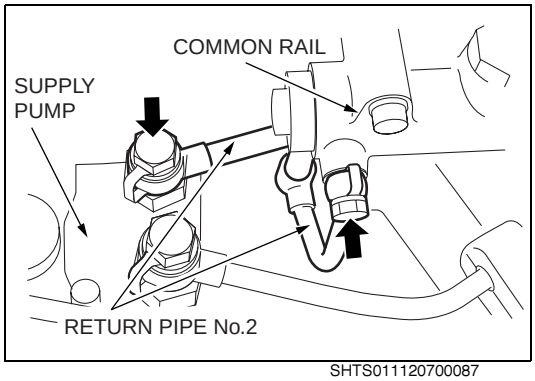
(7) Install two clips to secure the fuel feed pipe No.5.



SHTS011120700086

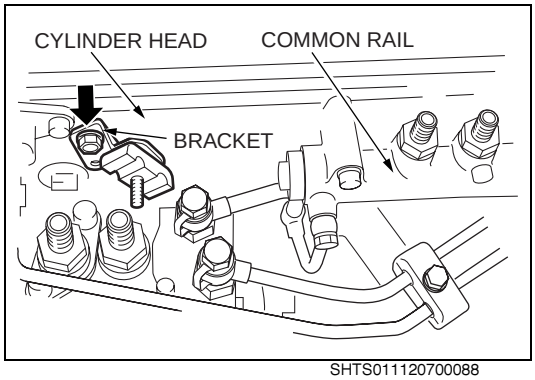
(8) Replace old gaskets with new ones. Connect the return pipe No.2, and tighten a union bolt.
Tightening Torque:
25 N·m {255 kgf·cm, 18 lbf·ft}

(9) Tighten three nuts to secure three clips.



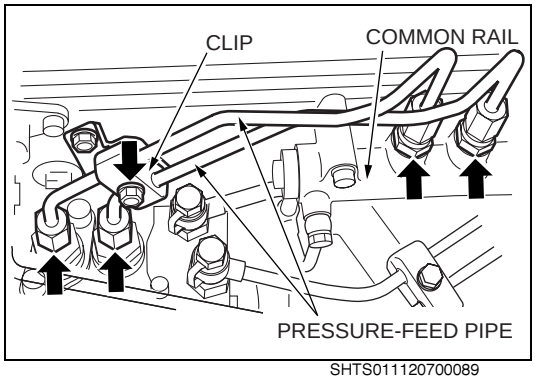
SHTS011120700087

(10) Replace old gaskets with new ones. Connect the return pipe No.2 to the supply pump and the common rail, and tighten two union bolts.
Tightening Torque:
Supply pump side: 27 N·m {275 kgf·cm, 20 lbf·ft}
Common rail side: 12.5 N·m {128 kgf·cm, 9 lbf·ft}



SHTS011120700088

(11) Install the bracket to the cylinder head, and tighten a bolt.



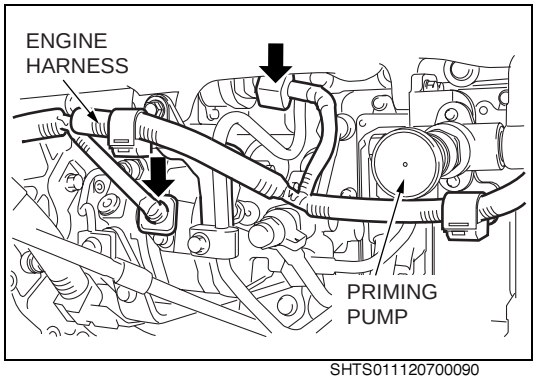
SHTS011120700089

(12) Connect two new pressure-feed pipes.
Tightening Torque:
32 N·m {330 kgf·cm, 24 lbf·ft}

⚠ CAUTION
Note that the pressure-feed pipe must be replaced with a new one. Otherwise fuel might leak out when a high pressure is applied.

(13) Tighten a nut to secure the clip.

NOTICE
After this step, start the engine for tryout to check that no fuel leak is observed form the supply pump.



SHTS011120700090

5. CONNECT THE HARNESS.

(1) Connect the connectors to the engine speed sub sensor and to the supply pump respectively.

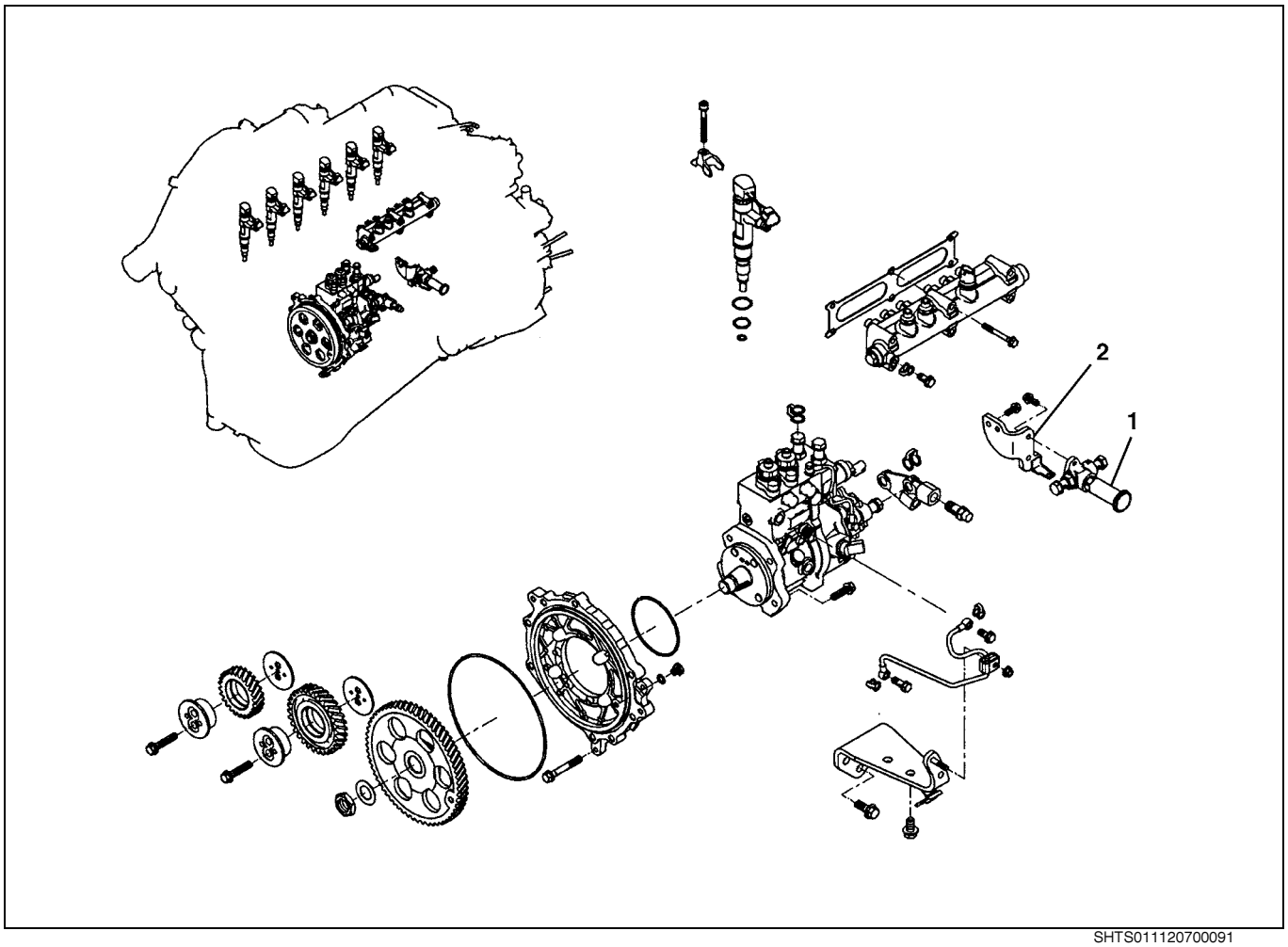
6. BLEED AIR FROM THE FUEL SYSTEM.

(1) Start the priming pump to bleed air from the fuel system. Refer to the section **"FUEL FILTER AND CASE"**.

PRIMING PUMP

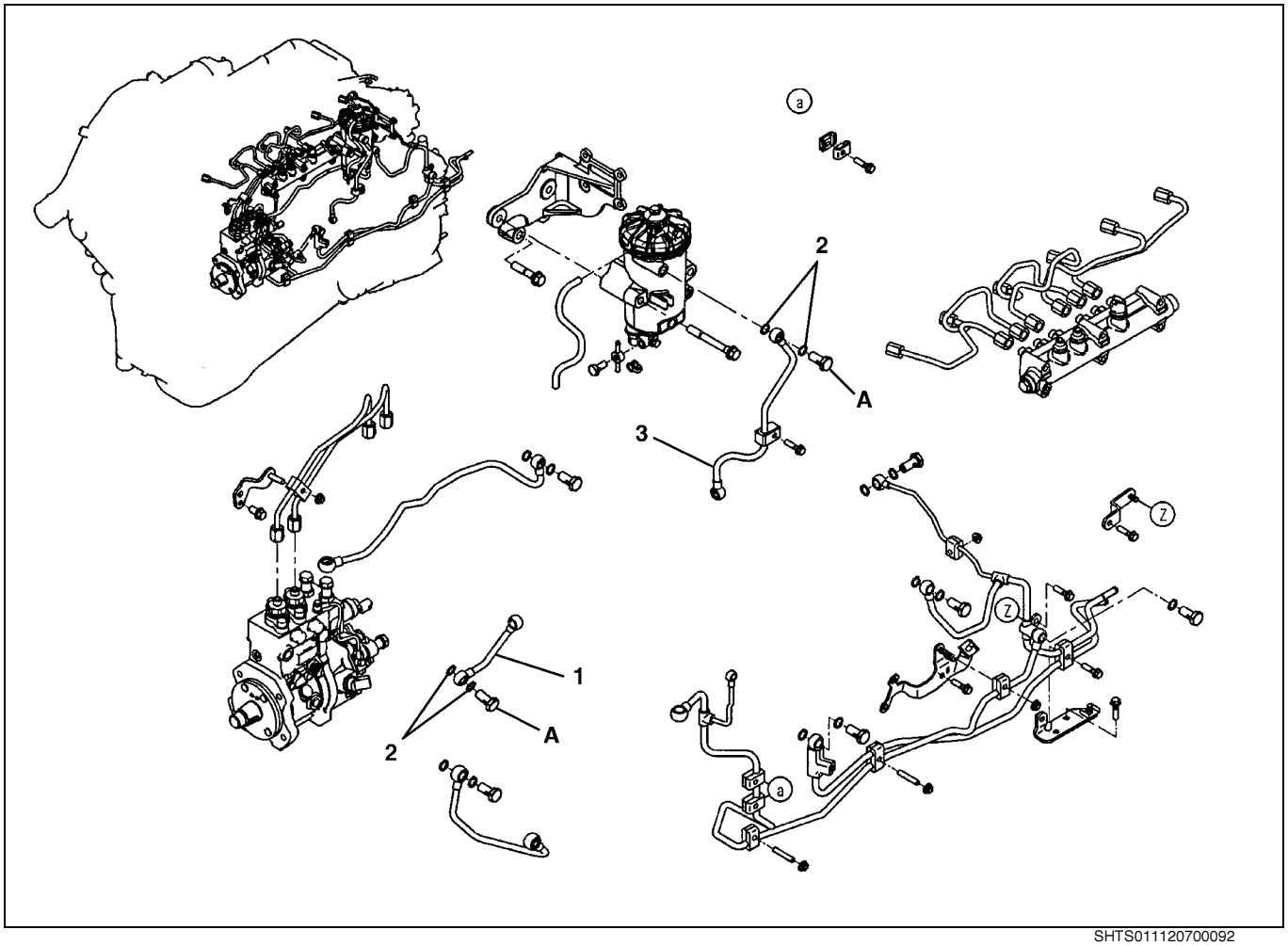
COMPONENT LOCATOR

EN0111207D100007



SHTS011120700091

1	Priming pump	2	Bracket



SHTS011120700092

1	Fuel feed pipe No.2	3	Fuel feed pipe No.4
2	Gasket		

Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

A	27 {275, 20}		

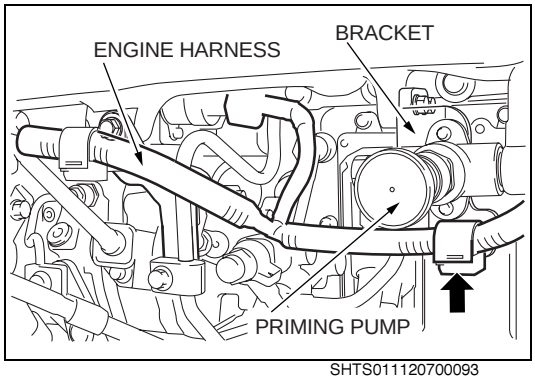
REPLACEMENT

EN0111207H100005

REMOVE THE PRIMING PUMP.

1. DRAIN THE FUEL.

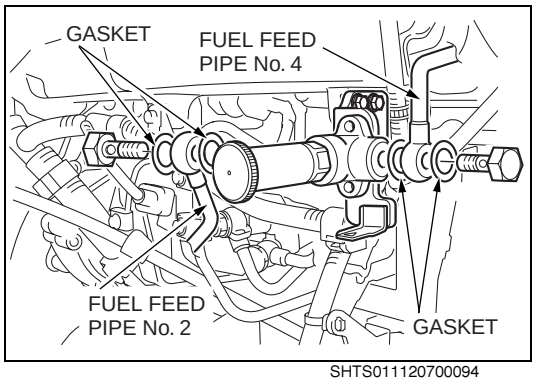
(1) Loosen the drain plug, the bleeder plug and a union bolt on the drain pipe. Drain fuel from the fuel filter case.
Refer to the section **"FUEL FILTER AND CASE"**.



SHTS011120700093

2. DISCONNECT THE FUEL PIPE.

(1) Unlock a clamp to disconnect the engine harness from the bracket on the priming pump.

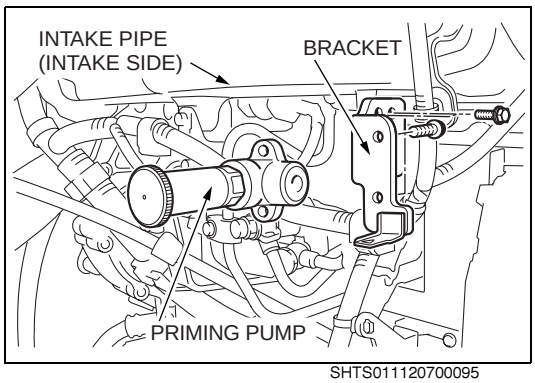


SHTS011120700094

(2) Remove union bolts (one each on the right and left) to remove the gaskets. Disconnect the fuel feed pipes No.2 and No.4 from the priming pump respectively.

HINT

Use a container and a waste as fuel might drip off during disconnection of fuel pipe.

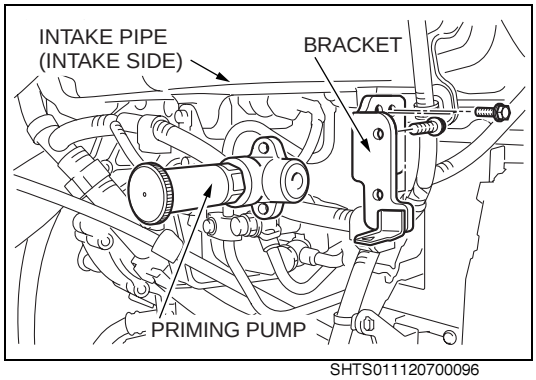


SHTS011120700095

3. REMOVE THE PRIMING PUMP.

(1) Remove two bolts to remove the priming pump together with a bracket from under the intake pipe (intake side).

(2) Remove two bolts to remove the priming pump from the bracket.



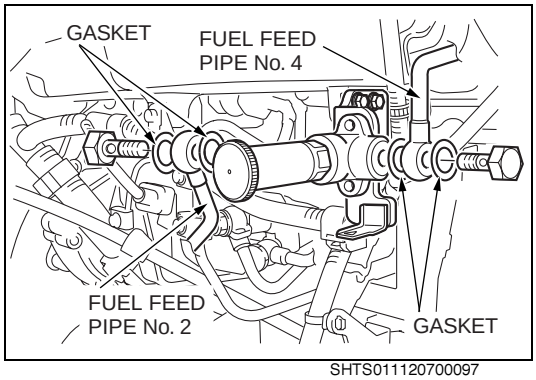
SHTS011120700096

INSTALL THE PRIMING PUMP.

1. INSTALL THE PRIMING PUMP.

(1) Install the priming pump to the bracket, and tighten two bolts.

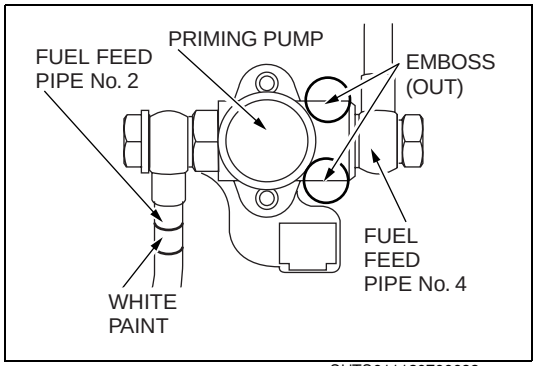
(2) Install the priming pump under the intake pipe (intake side), and tighten two bolts.



SHTS011120700097

2. CONNECT THE FUEL PIPE.

(1) Replace old gaskets with new ones. Connect the fuel feed pipes No.2 and No.4, and tighten two union bolts.
Tightening Torque:
27 N·m {275 kgf·cm, 20 lbf·ft}



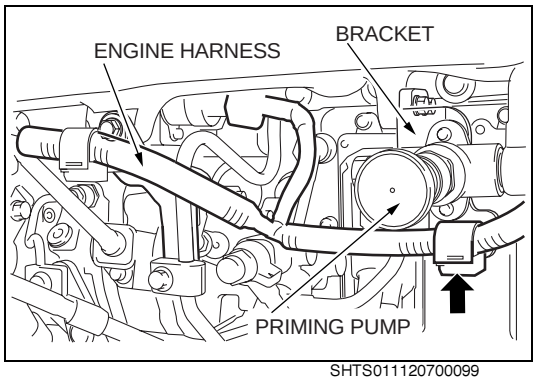
SHTS011120700098

NOTICE

If the fuel pipe fails to be connected, adjust the positioning of a priming pump or a bracket so as to avoid an excessive force from being applied to the fuel pipe.

HINT

- **The emboss "OUT" on the priming pump must be located in the rear direction of the engine.**
- **The white-painted end of the fuel feed pipe No.2 must be connected to the priming pump.**



SHTS011120700099

(2) Fasten a clamp to secure the engine harness onto the bracket on the priming pump.

NOTICE

After this step, start the engine for tryout to check that no fuel leak is observed from the priming pump.

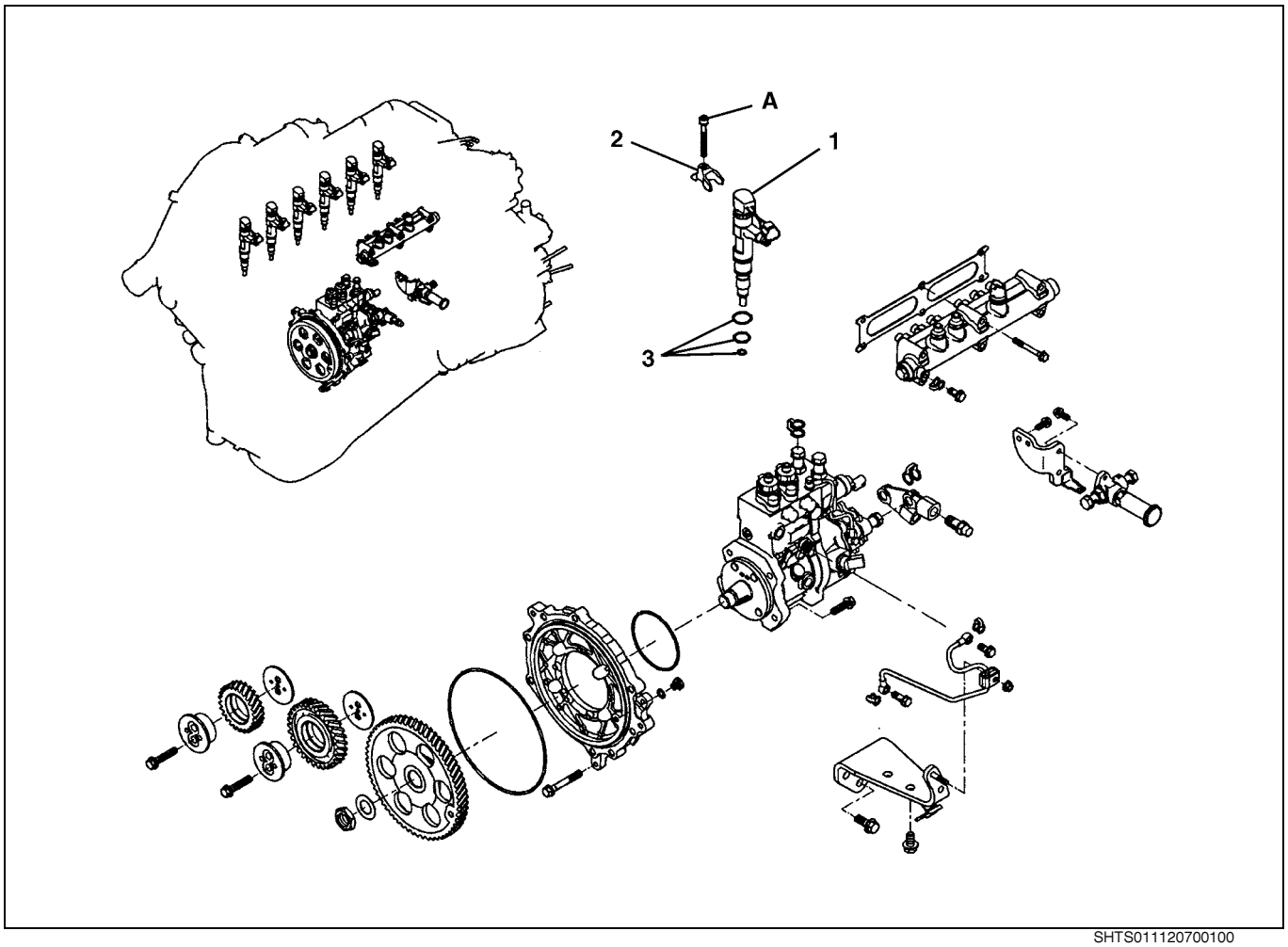
3. BLEED AIR FROM THE FUEL SYSTEM.

(1) Start the priming pump to bleed air from the fuel system.
Refer to the section **"FUEL FILTER AND CASE"**.

INJECTOR

COMPONENT LOCATOR

EN0111207D100008

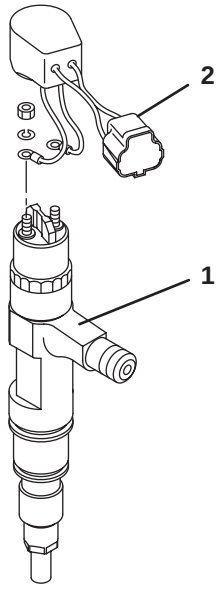


SHTS011120700100

1	Injector	3	O-ring
2	Injector clamp		

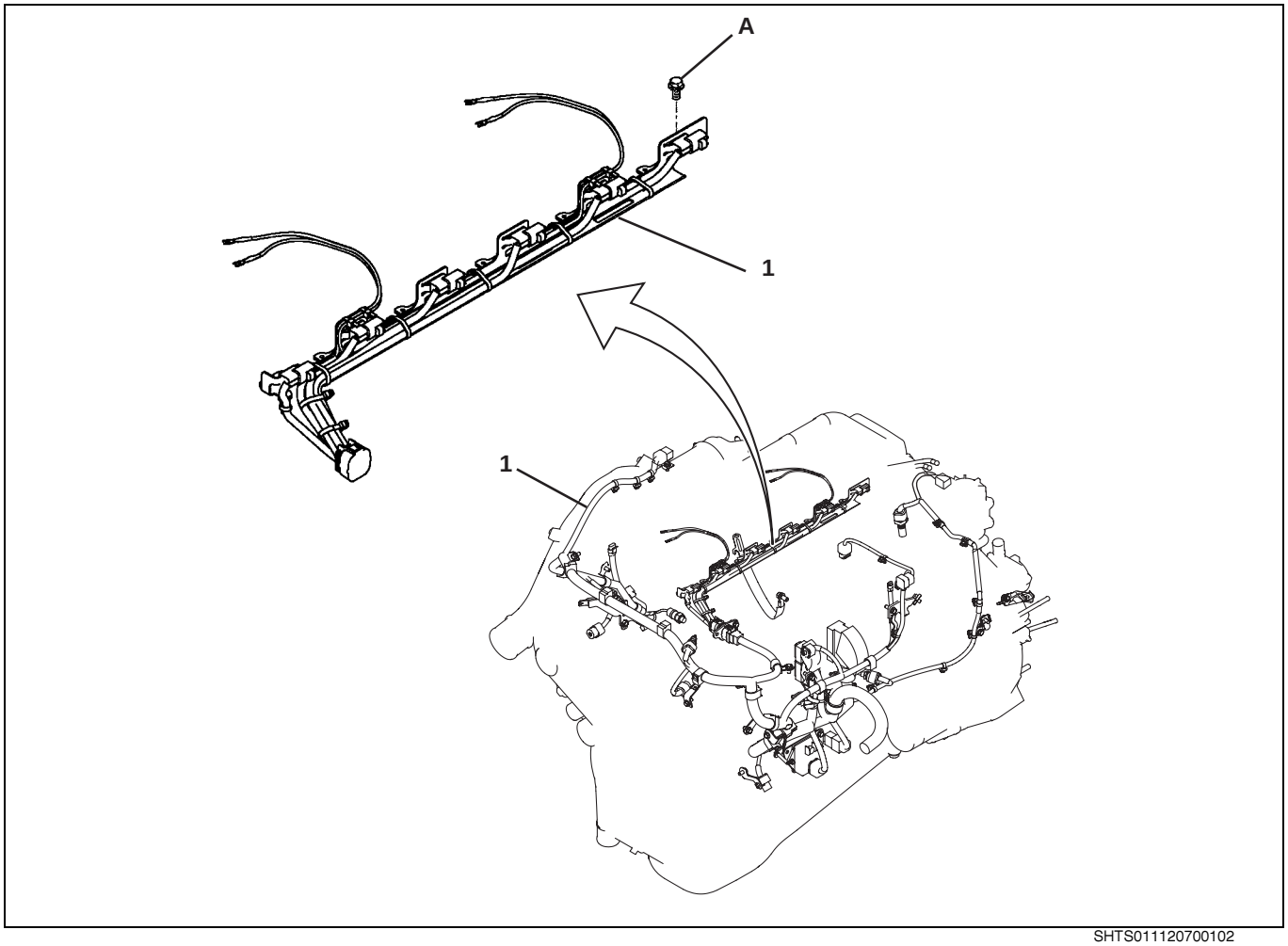
Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

A	34 {345, 25}		



SHTS011120700101

1 Injector	**2 Connector**



SHTS011120700102

1 Injector harness	

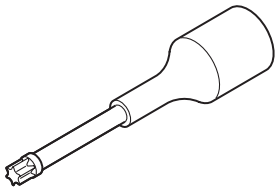
Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

A 28.5 {290, 21}	

SPECIAL TOOL

EN0111207K100002

Prior to starting an engine overhaul, it is necessary to have this special tool.

Illustration	Part number	Tool name	Remarks
	09268-E1010	TORX WRENCH	

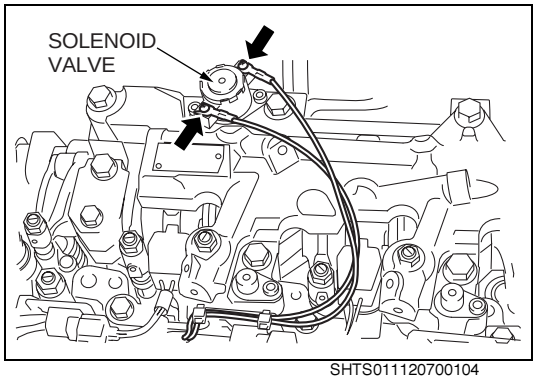
REPLACEMENT

EN0111207H100006

REMOVE THE INJECTOR.

1. REMOVE THE HEAD COVER.

(1) Remove the head cover.
Refer to the section **"HEAD COVER"** in the chapter **"ENGINE MECHANICAL"**.



SHTS011120700104

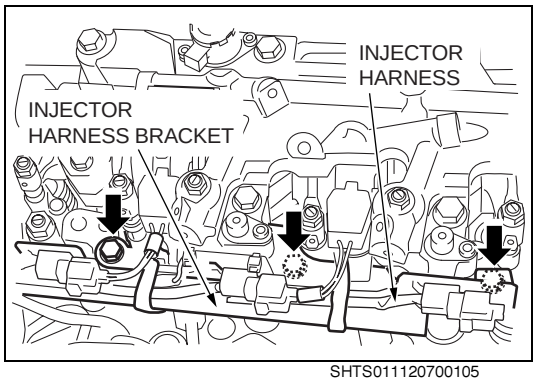
2. DISCONNECT THE INJECTOR HARNESS.

(1) Loosen screws to disconnect the harnesses from the solenoid valve of the engine retarder.

HINT

For easier disconnection, pull the harness off while turning the screw.

(2) Remove a bolt to remove a clip.

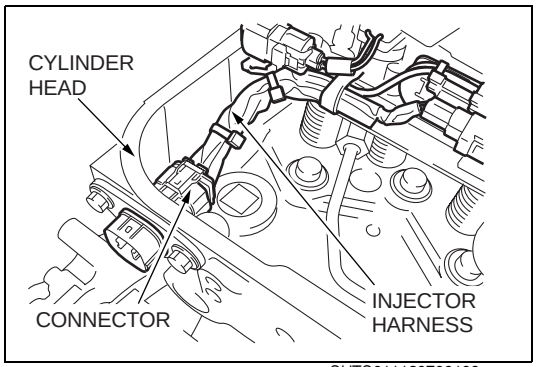


SHTS011120700105

(3) Disconnect each connector from the injector.
(4) Remove six bolts to remove the injector harness together with the injector harness bracket.

NOTICE

Carefully handle this step not to twist the injector harness bracket.



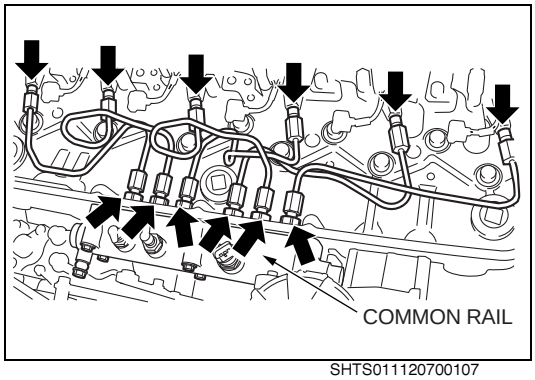
SHTS011120700106

HINT

For easier works in this step, disconnect a connector on the cylinder head after all other disconnections.

3. REMOVE THE ENGINE RETARDER.

(1) Remove the engine retarder.
Refer to the section **"ENGINE RETARDER"** in the chapter **"ENGINE RETARDER"**.



SHTS011120700107

4. DISCONNECT THE INJECTION PIPE.

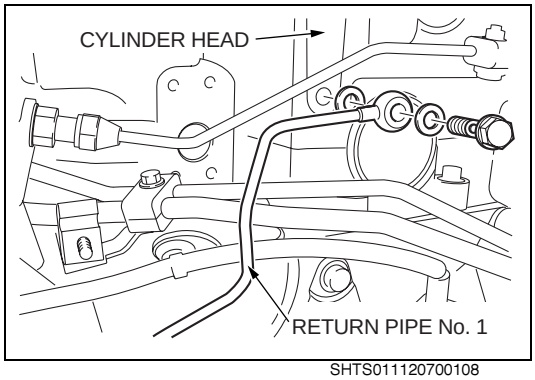
(1) Loosen twelve nuts on the injection pipes to disconnect six injection pipes from the injectors respectively.

⚠ CAUTION

Do not reuse the injection pipes.

HINT

Use a container and a waste as fuel might drip off during disconnection of injection pipes.



SHTS011120700108

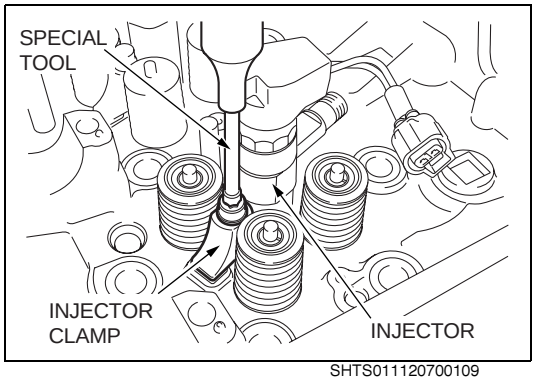
5. REMOVE THE INJECTORS.

(1) Place a container under the return pipe No.1 so as to collect drained fuel.

NOTICE

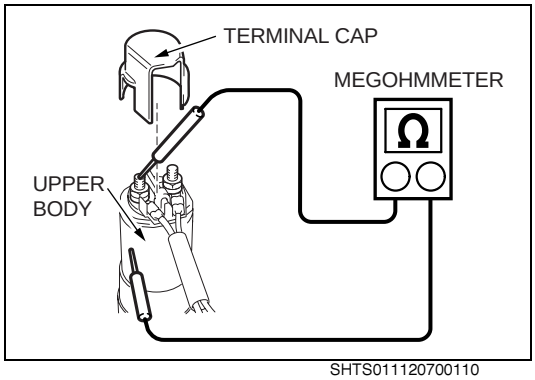
Disposal of fuel must comply with applicable laws and regulations established in each region or country.

(2) Prior to removing of injectors, disconnect the return pipe No.1 on the rear side of the cylinder head and drain the fuel remaining in leakage section.



SHTS011120700109

(3) Use the special tool to remove six torx bolts. Remove six injectors and six injector clamps.
SST: Torx wrench (09268-E1010)



SHTS011120700110

COMPONENT CHECK

1. CHECK A RESISTANCE.

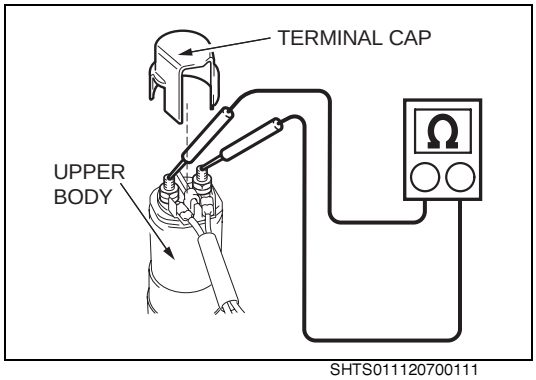
(1) Remove a plastic terminal cap on the injector.

(2) Use a 1,000 V megohmmeter to measure an insulation resistance between the upper body of an injector and either of two terminals (no polarity) to which the injector harness is connected.

⚠ CAUTION

Do not take measurement between terminals. Inobservance of this instruction will damage the injector.

Standard value (ambient temperature): 1,000 Ω or more



SHTS011120700111

(3) Use a circuit tester to measure the resistance between terminals.
Standard value (at 20°C {68°F}): 0.35-0.55 Ω
(4) If measurement readings taken in the steps (2) and (3) above exceed the standard values specified respectively, replace the as-assembled injector.

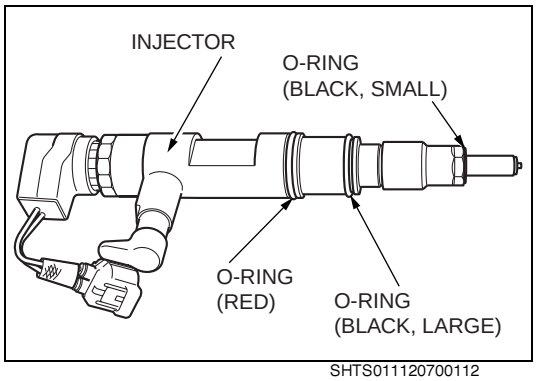
2. CLEAN THE INJECTORS.
(1) Remove sludge, if any, from terminals and peripheral areas.

⚠ CAUTION
- **Do not use cleaning agent but use a waste to wipe sludge off.**
- **Use of cleaning agent will cause a risk of inducing electrical malfunctions due to penetration of cleaning agent.**

INSTALL THE INJECTORS.

1. INSTALL THE INJECTORS.
(1) Attach new O-rings (red and black) to the injector, and insert the injector together with the injector clamp into the cylinder head.

NOTICE
- **Apply engine oil to O-rings, and insert the injector carefully not to allow O-rings to get pinched.**
- **Take this step carefully. Damage in O-rings will cause fuel leakage, resulting in a trouble in engine start.**
- **Do not fix the injector clamp until the injection pipes would be connected.**

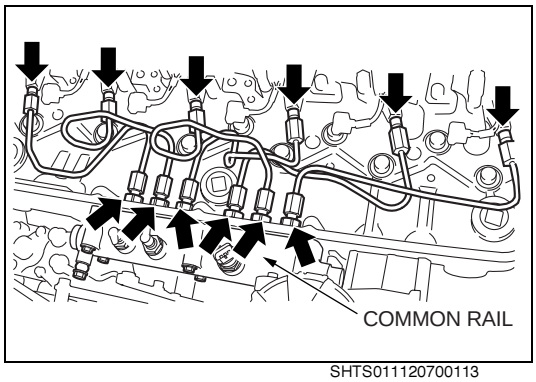


SHTS011120700112

HINT
- **A red O-ring and a black (large) O-ring are used to seal off the leakage section.**
- **A red O-ring is used for oil seal.**

(2) Connect six new injection pipes by using finger torque, to the injector and the common rail.

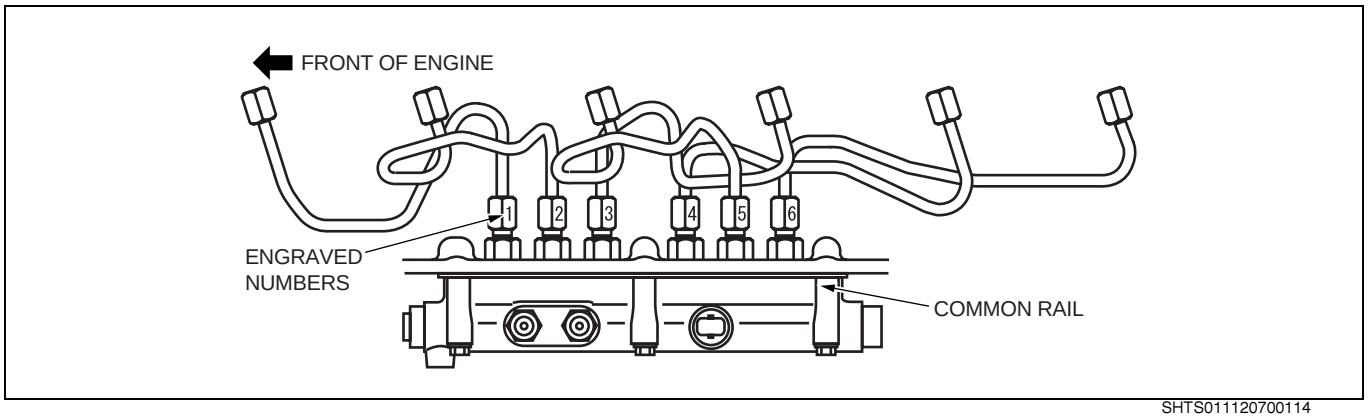
⚠ CAUTION
Note that replacement must be made with new injection pipes. Nonperformance of replacement would cause fuel leakage from connections and damage the engine.



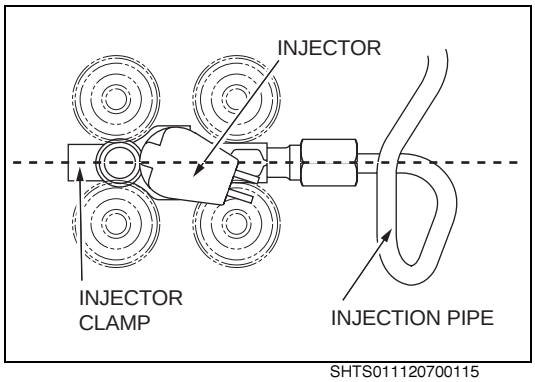
SHTS011120700113

NOTICE

- **Before mounting, place the injection pipes in ascending order of the engraved numbers, starting with the front side of the engine.**

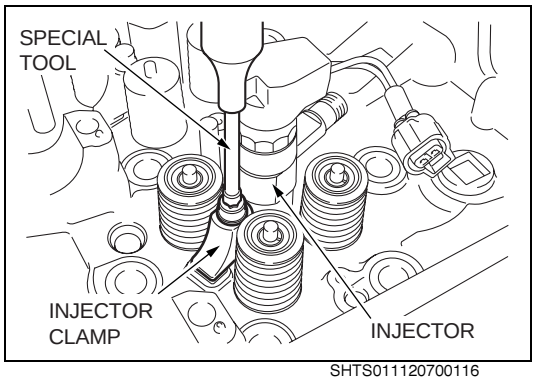


SHTS011120700114



SHTS011120700115

- **During installing, adjust the positions of an injector and all injection pipes in align the mark with each other.**

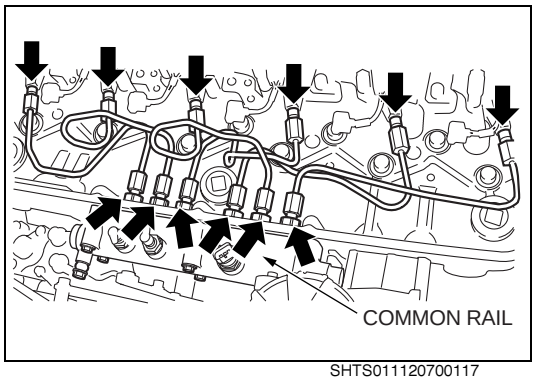


SHTS011120700116

(3) Use the special tool to tighten six torx bolts to secure the injector clamps.
Tightening Torque:
34 N·m {345 kgf·cm, 25 lbf·ft}

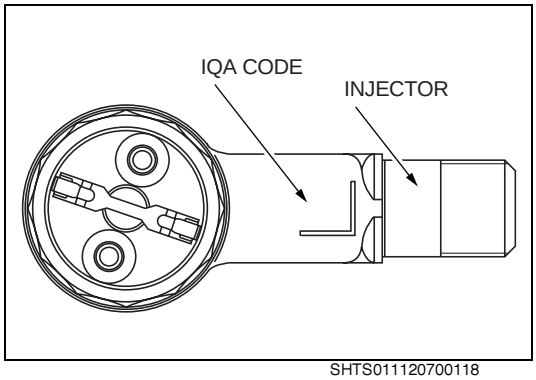
SST: Torx wrench (09268-E1010)

⚠ CAUTION
Insufficient tightening torque will cause gas leakage, resulting in nozzle seizure or other troubles.



SHTS011120700117

(4) Tight the injection pipes at the specified torque.
Tightening Torque:
32 N·m {330 kgf·cm, 24 lbf·ft}



SHTS011120700118

2. UPDATING AN INJECTOR OFFSET IN THE ENGINE ECU (RE-PROGRAMMING)

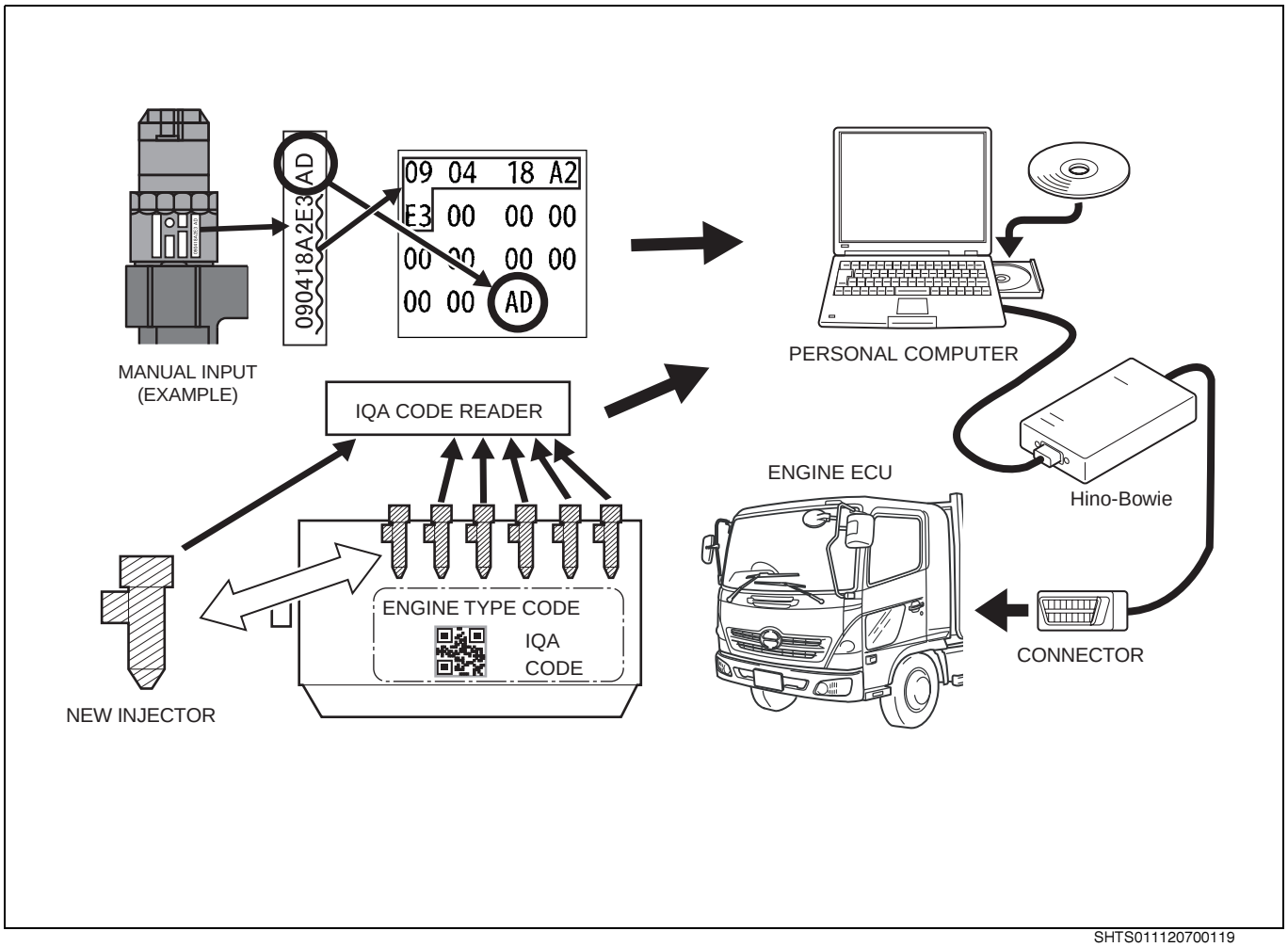
⚠ CAUTION

- **After replacement with a new injector, update the engine ECU with an injector compensation data (IQA code) indicated on a new injector.**
- **Incorrect updating of an offset may cause engine troubles.**

HINT

- **The injector offset can be updated by using both a computer tool and an IQA code reader.**
- **A sequence of work steps are described below.**

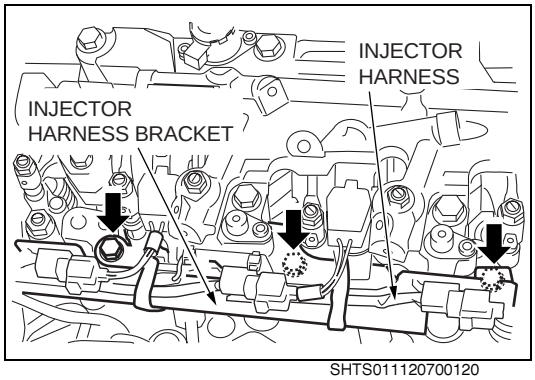
(1) Use the IQA code scanner to read an IQA code of the injector and create an offset data file.
(2) Use a computer to update an injector offset in the engine ECU.



SHTS011120700119

3. INSTALL THE ENGINE RETARDER.

(1) Install the engine retarder.
Refer to the section **"ENGINE RETARDER"** in the chapter **"ENGINE RETARDER"**.

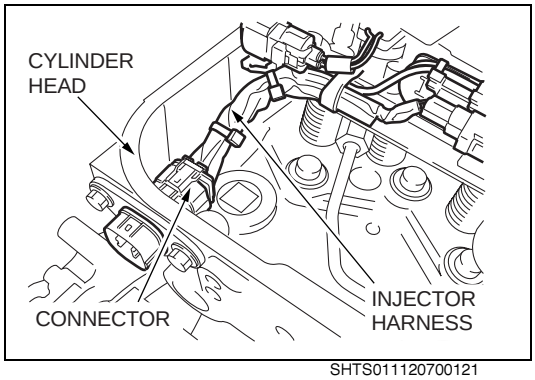


SHTS011120700120

4. CONNECT THE INJECTOR HARNESS.

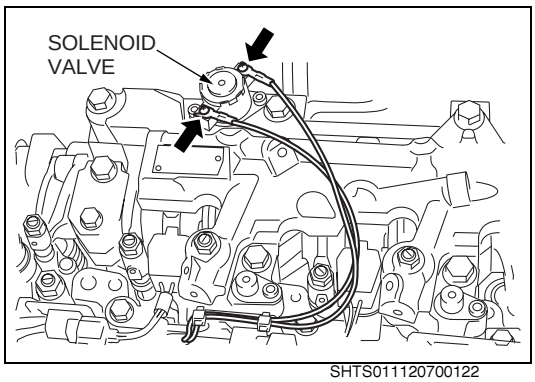
(1) Install the injector harness together with the injector harness bracket, and tighten six bolts.
Tightening Torque:
28.5 N·m {290 kgf·cm, 21 lbf·ft}

(2) Connect individual connectors to the cylinder head and the injectors.



SHTS011120700121

HINT
For easier connection, first connect a connector to the cylinder head.



SHTS011120700122

(3) Connect the harnesses to the solenoid valve of the engine retarder, and tighten screws.
Tightening Torque:
0.8 N·m {8 kgf·cm, 0.6 lbf·ft}

NOTICE
Make sure that harnesses are inserted to the deepest point in the solenoid valve terminal before tightening the screws.

HINT
For easier works in this step, connect the harness while turning the screw.

(4) Install a clip with bolt to secure the harnesses to the solenoid valve.

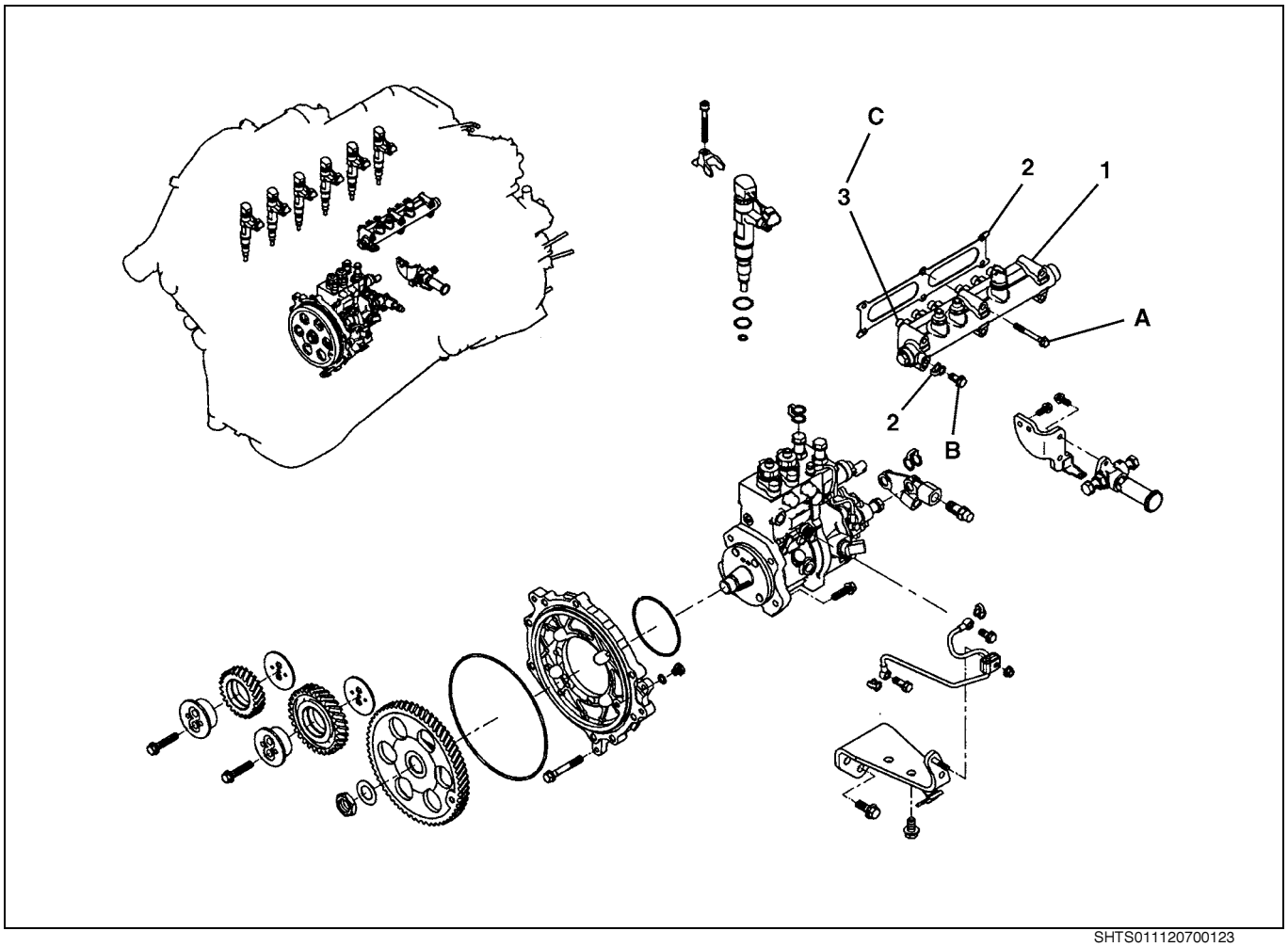
5. INSTALL THE HEAD COVER.

(1) Install the head cover.
Refer to the section **"HEAD COVER"** in the chapter **"ENGINE MECHANICAL"**.

COMMON RAIL

COMPONENT LOCATOR

EN0111207D100009

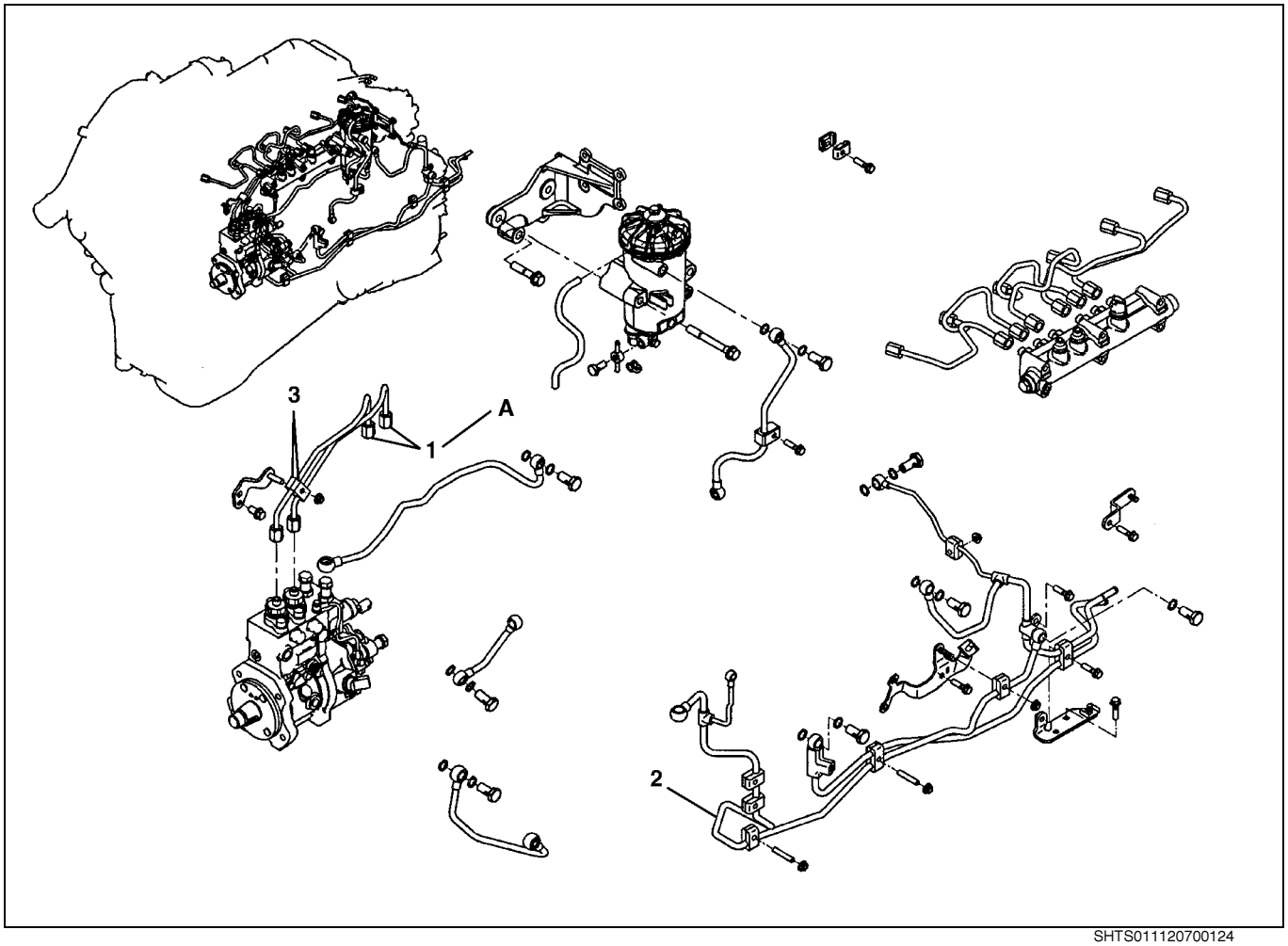


SHTS011120700123

1	Common rail	3	Flow damper
2	Gasket		

Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

A	28.5 {290, 21}	C	100 {1,020, 74}
B	12.5 {128, 9}		

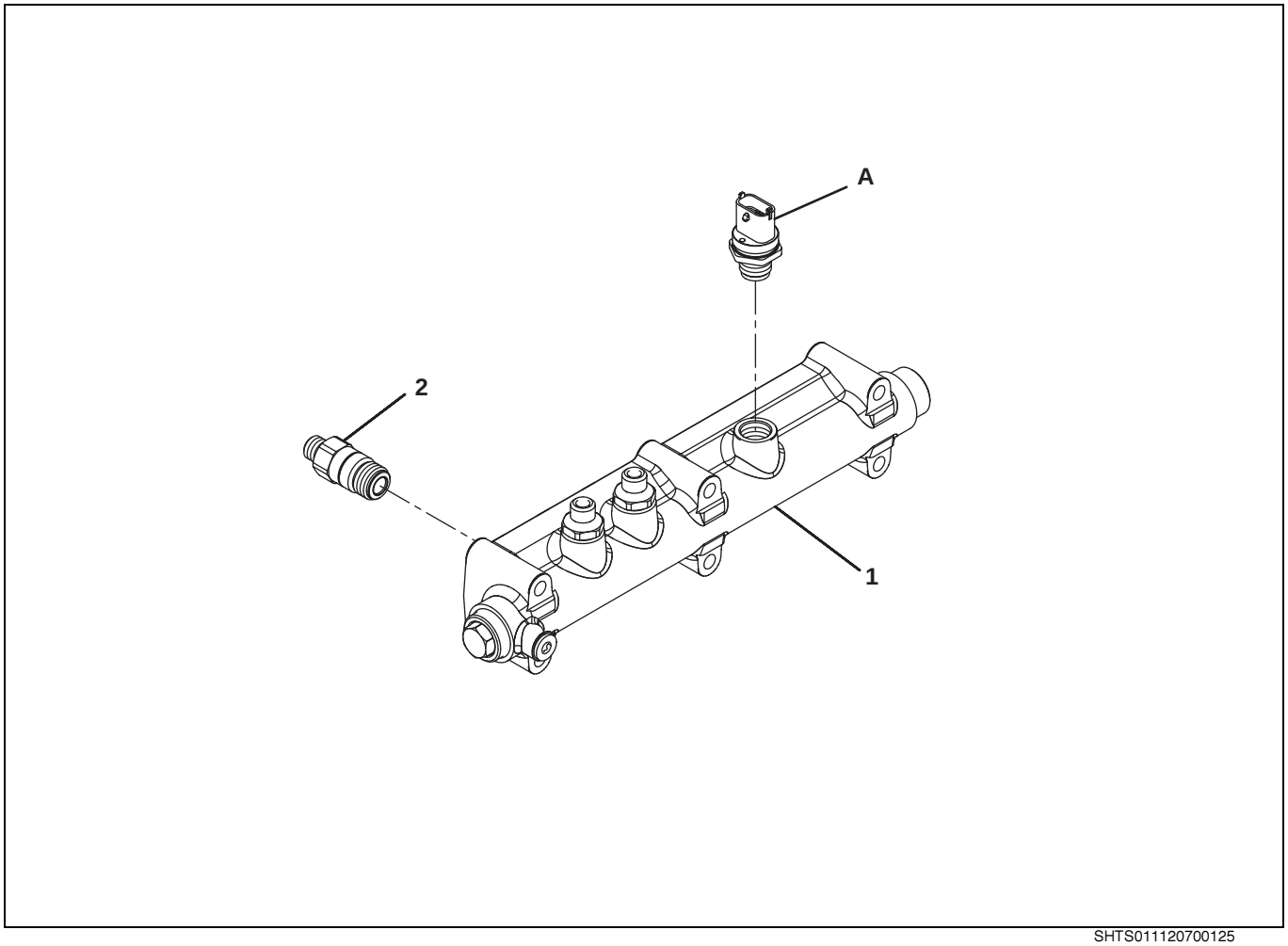


SHTS011120700124

1	Pressure-feed pipe	3	Clip
2	Return pipe No.2		

Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

A	32 {330, 24}		



SHTS011120700125

1 Common rail	2 Flow damper

Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

A 100 {1,020, 74}	

INSPECTION

EN0111207H300001

CHECK THE COMMON RAIL.

1. CHECK THE FLOW DAMPER.

(1) Start and run the engine in a range from idling to full-throttle. Use the Hino-DX to check for the diagnosis code of "flow damper activation".

(2) If the diagnosis code of "flow damper activation" is detected, replace a relevant injector and check again.

(3) If such phenomenon is reproduced after replacement of an injector, replace the flow damper as a common rail assembly.

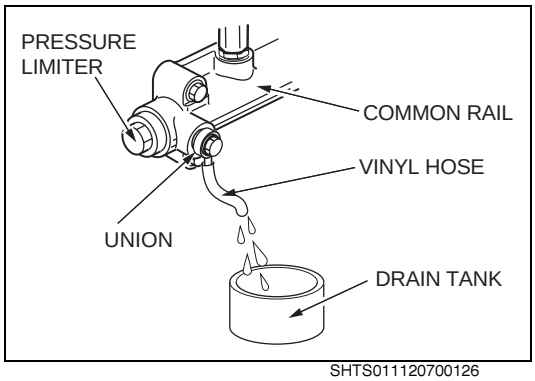
2. CHECK THE PRESSURE LIMITER.

(1) Remove the return pipe No.2.
Refer to the section **"SUPPLY PUMP"**.

(2) Install the union to the pressure limiter.

(3) Set a vinyl hose to the union and set a drain tank.

(4) Start the engine. If the fuel flows continuously, replace the pressure limiter.



SHTS011120700126

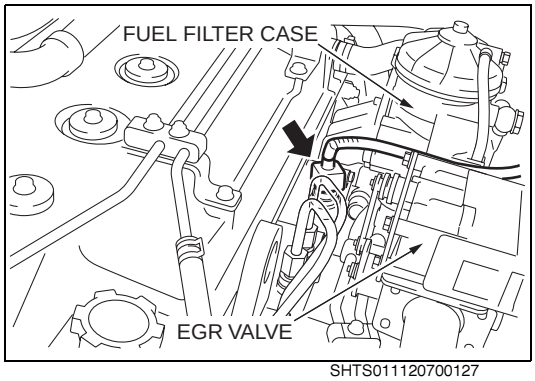
REPLACEMENT

EN0111207H100007

REMOVE THE COMMON RAIL.

1. DISCONNECT THE HARNESS.

(1) Disconnect the connector of the common rail pressure sensor.



SHTS011120700127

2. REMOVE THE HEAD COVER.

(1) Remove the head cover.
Refer to the section **"HEAD COVER"** in the chapter **"ENGINE MECHANICAL"**.

3. REMOVE THE INJECTOR HARNESS.

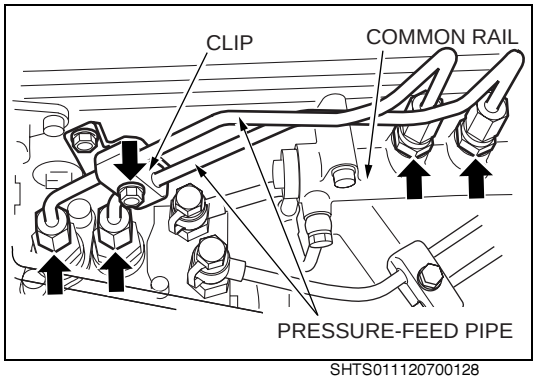
(1) Remove the injector harness together with the bracket.
Refer to the section **"INJECTOR"**.

4. REMOVE THE INJECTION PIPE.

(1) Remove the injection pipe.
Refer to the section **"INJECTOR"**.

5. REMOVE THE EGR VALVE.

(1) Remove the EGR valve.
Refer to the section **"EGR VALVE AND COOLER"** in the chapter **"EMISSION CONTROL"**.



SHTS011120700128

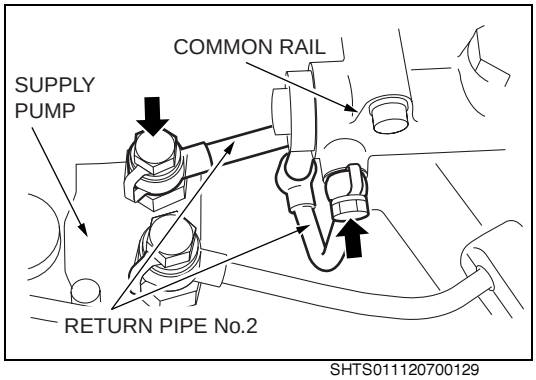
6. DISCONNECT THE PRESSURE-FEED PIPE.

(1) Remove the nut to remove the clip.

(2) Loosen the nut to disconnect two pressure-feed pipes.

HINT

Use a container and a waste as fuel might drip off during disconnection of pressure-feed pipes.

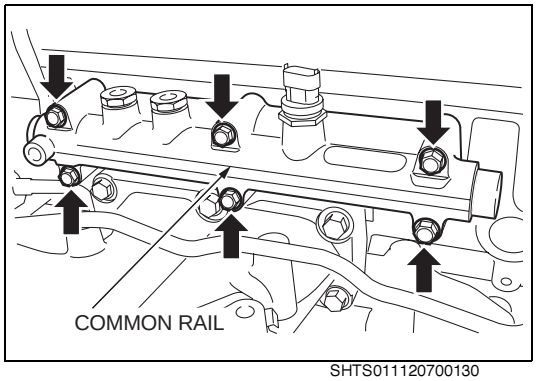


SHTS011120700129

(3) Remove two union bolts to disconnect the return pipe No.2 from the common rail.

HINT

Use a container and a waste as fuel might drip off during disconnection of fuel pipes.



SHTS011120700130

7. REMOVE THE COMMON RAIL.

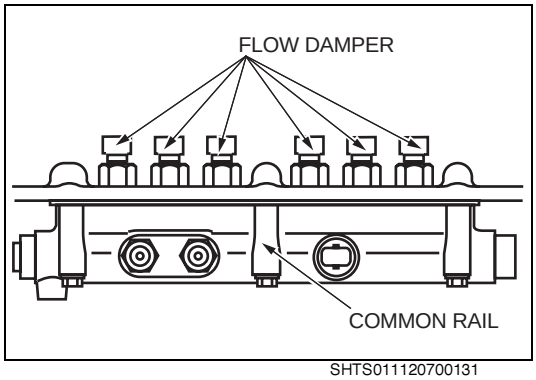
(1) Remove six bolts to remove the common rail and a gasket from the cylinder head.

NOTICE

Use a clean plastic sheet to protect the common rail against incoming dusts.

HINT

Use a container and a waste as fuel might drip off during removal of common rail.



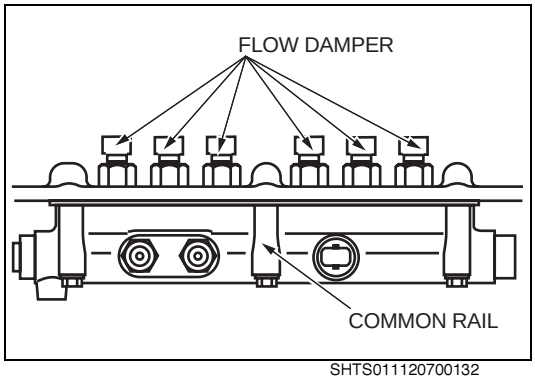
SHTS011120700131

8. REMOVE THE FLOW DAMPER.

(1) Remove six flow damper from the common rail.

HINT

Use a container and a waste as fuel might drip off during removal of flow damper.

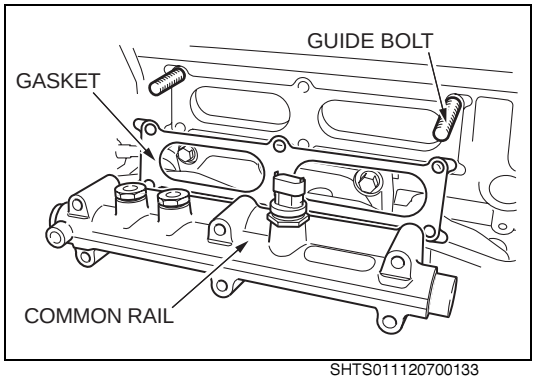


SHTS011120700132

INSTALL THE COMMON RAIL.

1. INSTALL THE FLOW DAMPER.

(1) Install six flow damper to the common rail.
Tightening Torque:
100 N·m {1,020 kgf·cm, 74 lbf·ft}

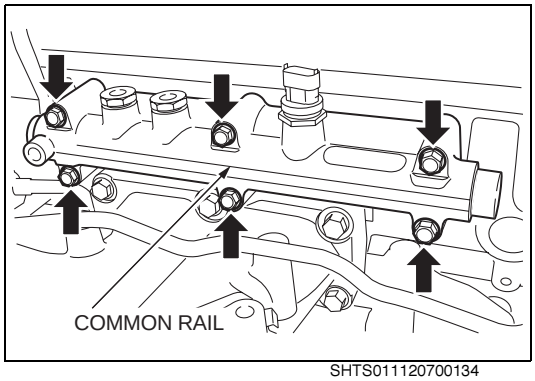


SHTS011120700133

2. INSTALL THE COMMON RAIL.

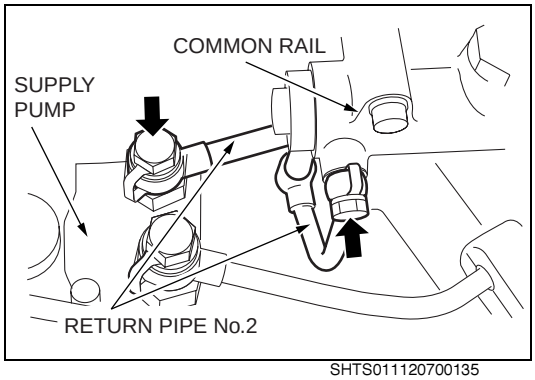
(1) Install two guide bolts horizontally to the cylinder head and set a new gasket to the installation position.

NOTICE
Remove two guide bolts after pre-tightening four mounting bolts for the common rail.



SHTS011120700134

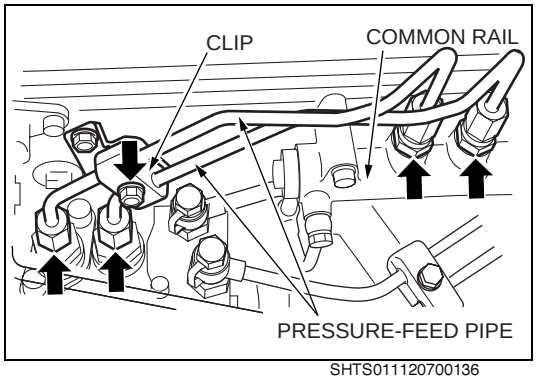
(2) Install the common rail to the cylinder head, and tighten six bolts.
Tightening Torque:
28.5 N·m {290 kgf·cm, 21 lbf·ft}



SHTS011120700135

3. CONNECT THE FUEL PIPE.

(1) Replace the gasket with new one. Connect the return pipe No.2, and tighten two union bolts.
Tightening Torque:
Supply pump side: 27 N·m {275 kgf·cm, 20 lbf·ft}
Common rail side: 12.5 N·m {128 kgf·cm, 9 lbf·ft}



SHTS011120700136

(2) Connect two new pressure-feed pipes.
Tightening Torque:
32 N·m {330 kgf·cm, 24 lbf·ft}

⚠ CAUTION
Replace old pressure-feed pipes with new ones. Otherwise, fuel might leak out when a high pressure is applied.

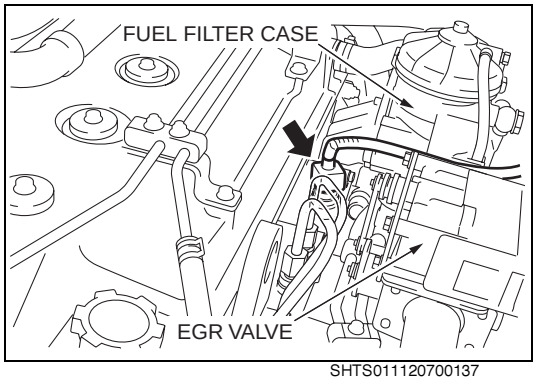
(3) Install the clip with nut.

4. INSTALL THE EGR VALVE.
(1) Install the EGR valve.
Refer to the section **"EGR VALVE AND COOLER"** in the chapter **"EMISSION CONTROL"**.

5. CONNECT THE INJECTION PIPE.
(1) Connect the new injection pipes.
Refer to the section **"INJECTOR"**.

6. INSTALL THE INJECTOR HARNESS.
(1) Install the injector harness assembled with the bracket.
Refer to the section **"INJECTOR"**.

7. INSTALL THE HEAD COVER.
(1) Install the head cover.
Refer to the section **"HEAD COVER"** in the chapter **"ENGINE MECHANICAL"**.



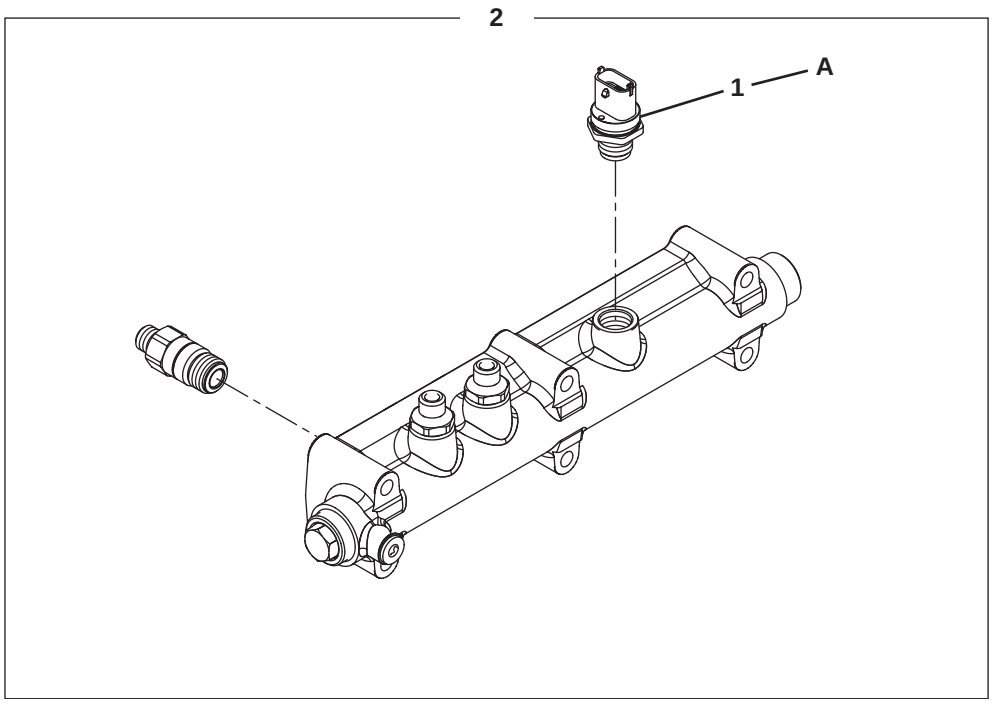
SHTS011120700137

8. CONNECT THE HARNESS.
(1) Connect the connector of the common rail pressure sensor.

COMMON RAIL PRESSURE SENSOR

COMPONENT LOCATOR

EN0111207D100010



SHTS011120700138

1 Common rail pressure sensor	2 Common rail

Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

A 100 {1,020, 74}	

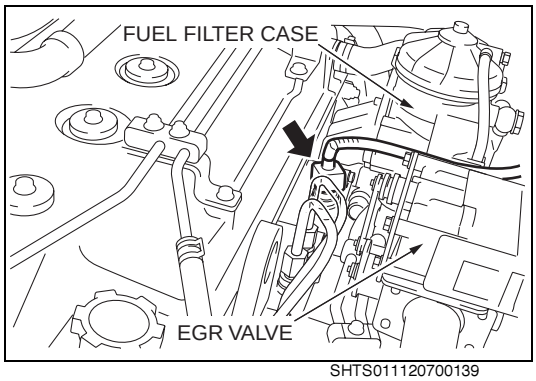
REPLACEMENT

EN0111207H100008

REMOVE THE COMMON RAIL PRESSURE SENSOR.

1. CHECK BEFORE START OF MAINTENANCE WORKS

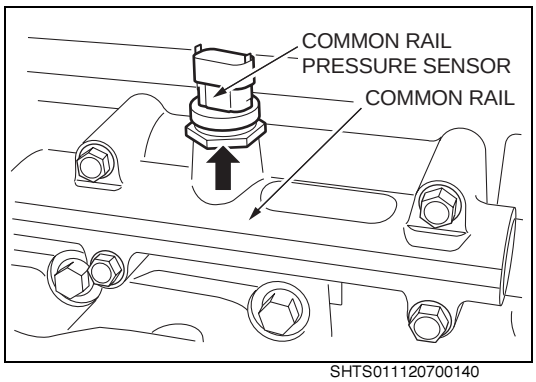
(1) Replace the pressure sensor if the check engine light lights on and the Hino-DX check detects "disconnection of pressure sensor", "short-circuit of pressure sensor", or "no change in pressure sensor output".



SHTS011120700139

2. DISCONNECT THE HARNESS.

(1) Disconnect the connector of the common rail pressure sensor.



SHTS011120700140

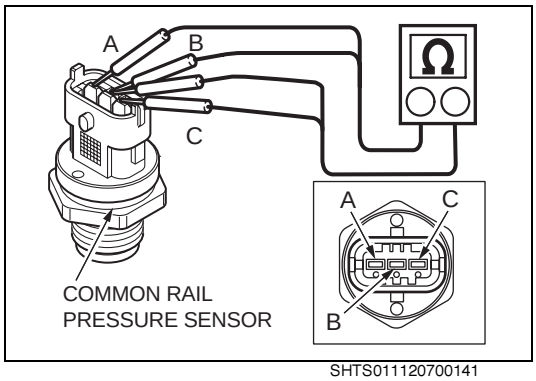
3. REMOVE THE COMMON RAIL PRESSURE SENSOR.

(1) Remove the common rail pressure sensor from the common rail.

⚠ CAUTION

Note that replacement must be made with a new common rail pressure sensor. Do not reuse a once-demounted common rail pressure sensor.

COMPONENT CHECK

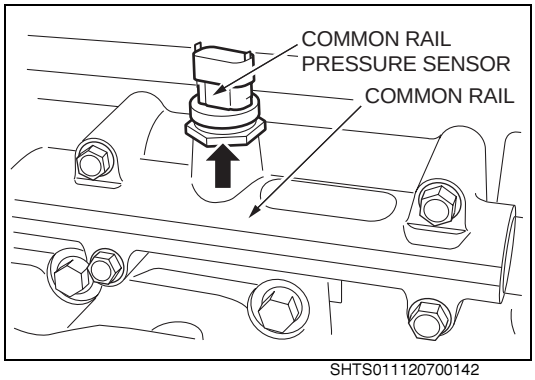


SHTS011120700141

1. CHECK A RESISTANCE.

(1) Use a circuit tester to measure the resistance between terminals. If a measurement reading exceeds the standard value, make replacement as a complete common rail assembly.

Measurement between terminals	Standard value (kΩ) without running the engine
A ↔ B	0.5-3.0
B ↔ C	6.5-18.5

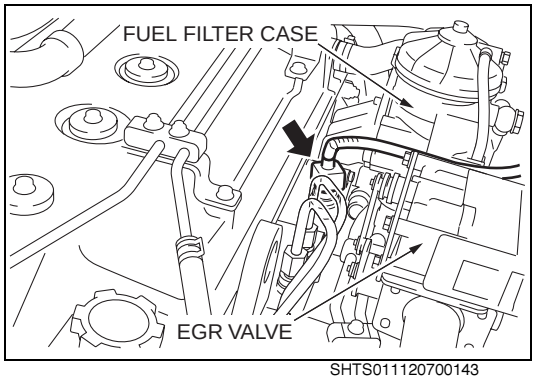


SHTS011120700142

INSTALL THE COMMON RAIL PRESSURE SENSOR.

1. INSTALL THE COMMON RAIL PRESSURE SENSOR.

(1) Install the new common rail pressure sensor to the common rail.
Tightening Torque:
100 N·m {1,020 kgf·cm, 74 lbf·ft}



SHTS011120700143

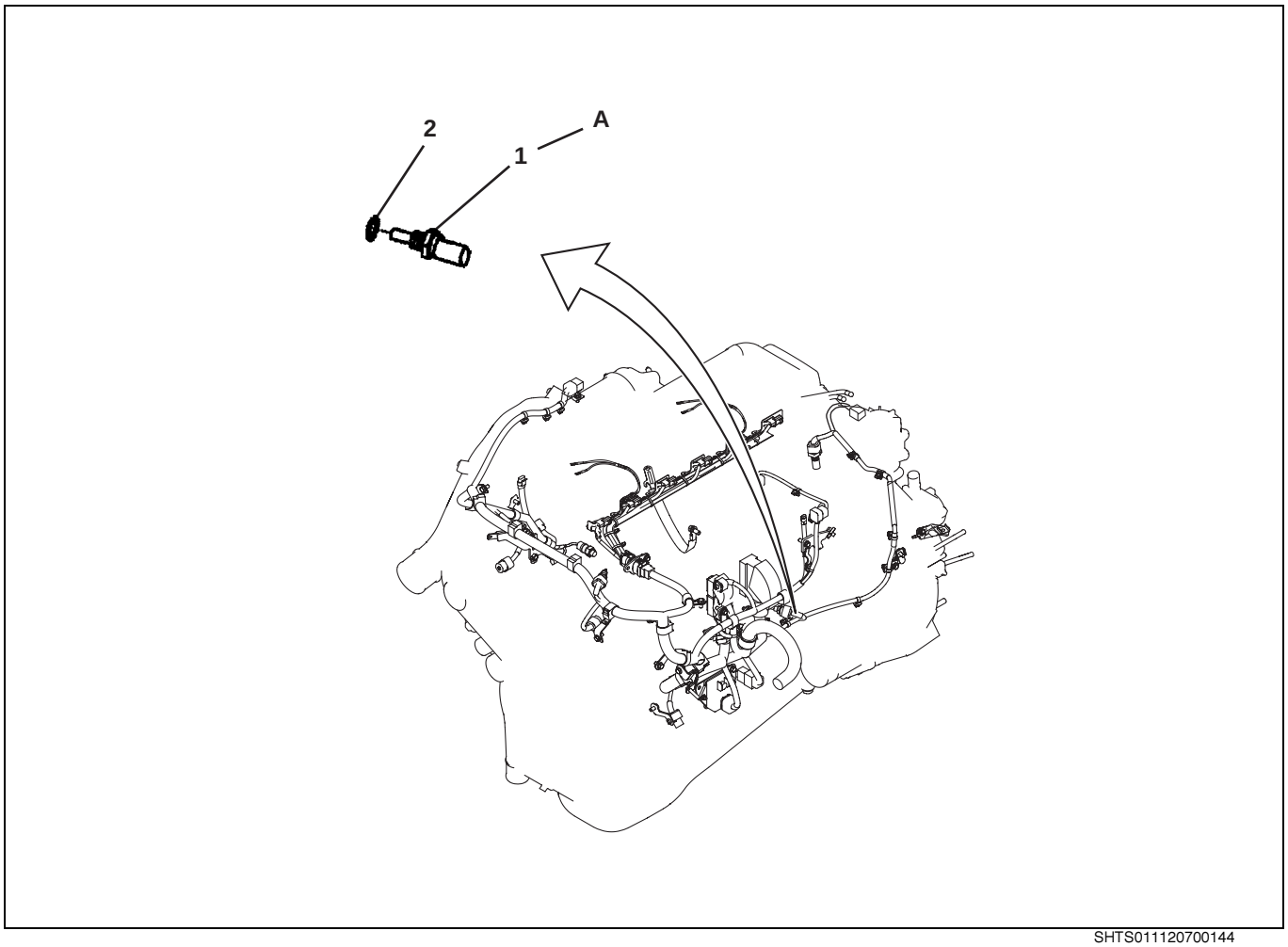
2. CONNECT THE HARNESS.

(1) Connect the connector of the common rail pressure sensor.

FUEL TEMPERATURE SENSOR

COMPONENT LOCATOR

EN0111207D100011



SHTS011120700144

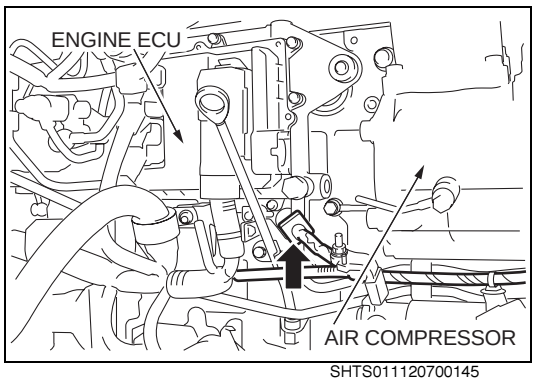
1	Fuel temperature sensor	2	Gasket

Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

A 24.5 {250, 18}	

REPLACEMENT

EN0111207H100009

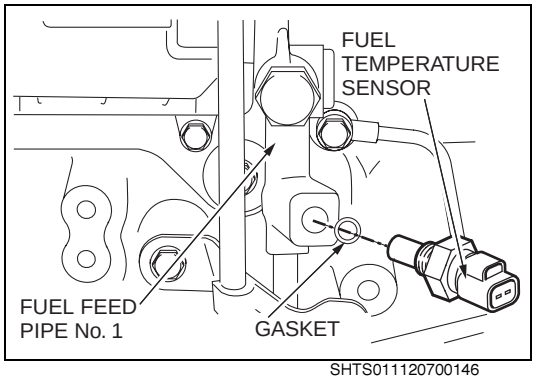


SHTS011120700145

REMOVE THE FUEL TEMPERATURE SENSOR.

1. DISCONNECT THE HARNESS.

(1) Disconnect the connector of the fuel temperature sensor.



SHTS011120700146

2. REMOVE THE FUEL TEMPERATURE SENSOR.

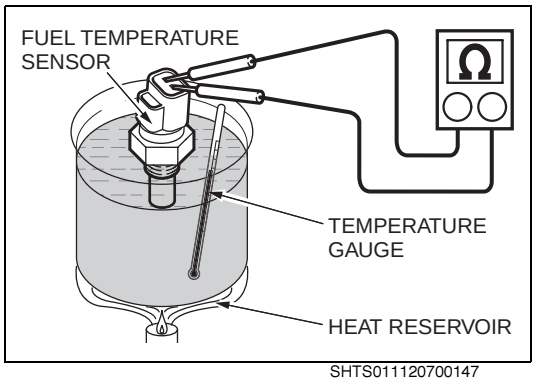
(1) Remove a gasket and the fuel temperature sensor from the fuel feed pipe No.1.

NOTICE

Use a clean plastic sheet to protect the common rail against incoming dusts.

HINT

Use a container and a waste as fuel might drip off during removal of fuel temperature sensor.



SHTS011120700147

COMPONENT CHECK

1. CHECK A RESISTANCE.

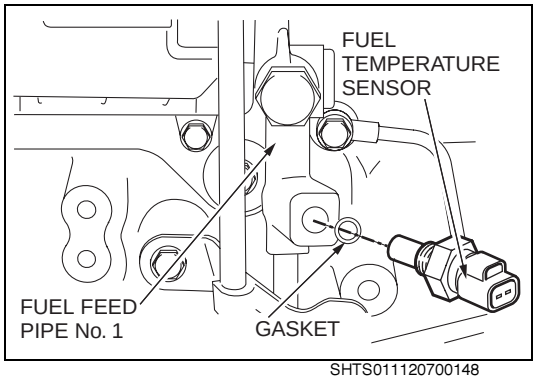
(1) Use water or fuel to heat/cool the fuel temperature sensor.

(2) Use a circuit tester to measure the resistance between terminals. If a measurement reading exceeds the standard value, make replacement.

⚠ CAUTION

If fuel is used in this step, a temperature must not exceed 120°C {248°F}. Otherwise, hazardous gas might be generated.

Temperature (°C {°F})	Standard value (Ω)
-20 {-4}	13.84-16.33
20 {68}	2.32-2.59
80 {176}	0.31-0.326
110 {230}	0.1399-0.1435



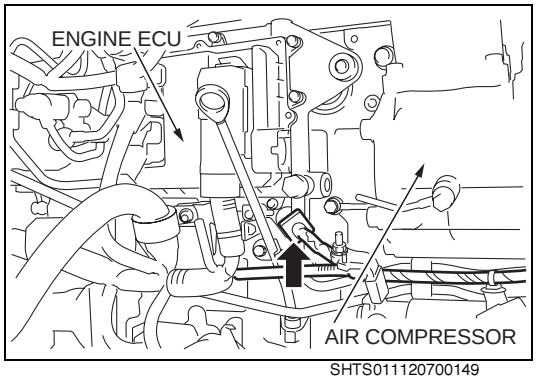
SHTS011120700148

INSTALL THE FUEL TEMPERATURE SENSOR.

1. INSTALL THE FUEL TEMPERATURE SENSOR.

(1) Replace an old gasket with a new one. Install the fuel temperature sensor to the fuel feed pipe No.1.
Tightening Torque:
24.5 N·m {250 kgf·cm, 18 lbf·ft}

NOTICE
After mounting, start the engine for tryout to check that no fuel leak is observed from the fuel temperature sensor.



SHTS011120700149

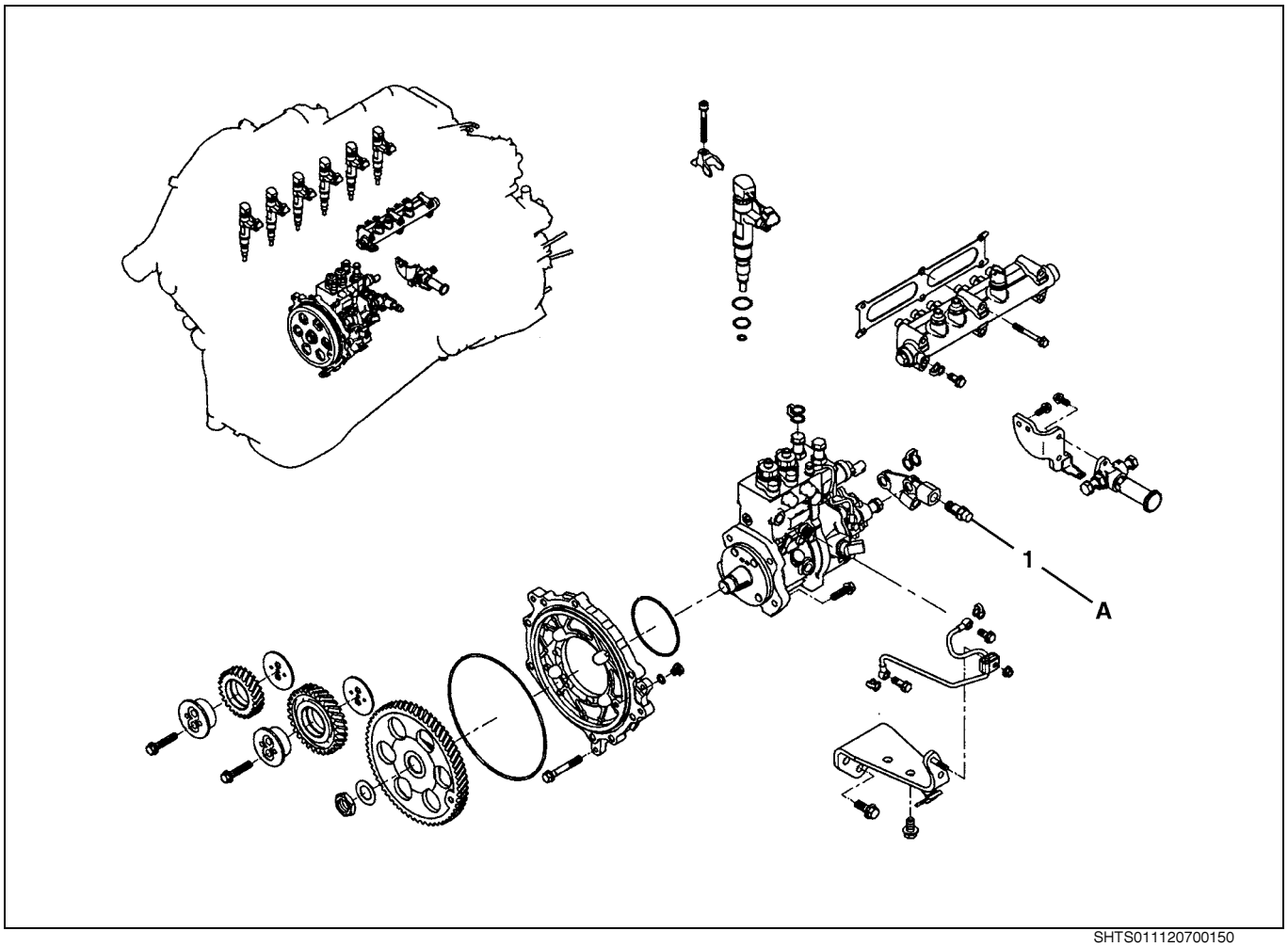
2. CONNECT THE HARNESS.

(1) Connect the connector of the fuel temperature sensor.

FUEL STRAINER

COMPONENT LOCATOR

EN0111207D100012



SHTS011120700150

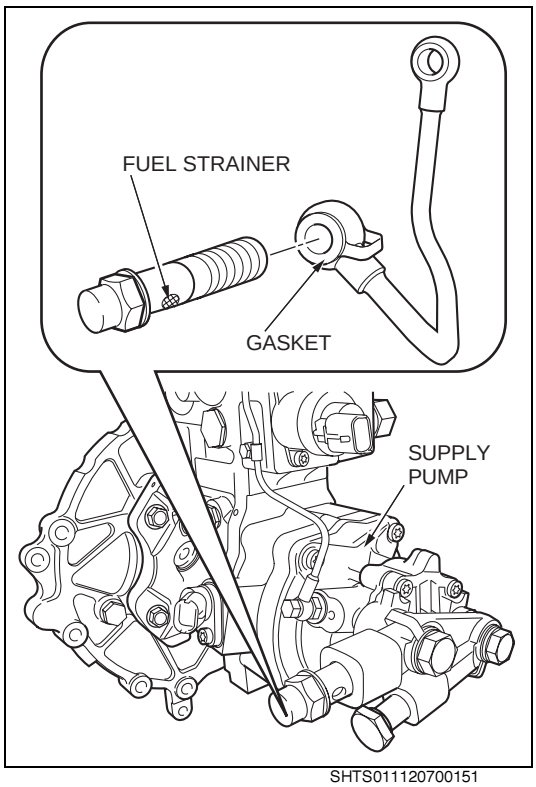
1 Fuel strainer	

Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

A 27 {275, 20}	

REPLACEMENT

EN0111207H100010



SHTS011120700151

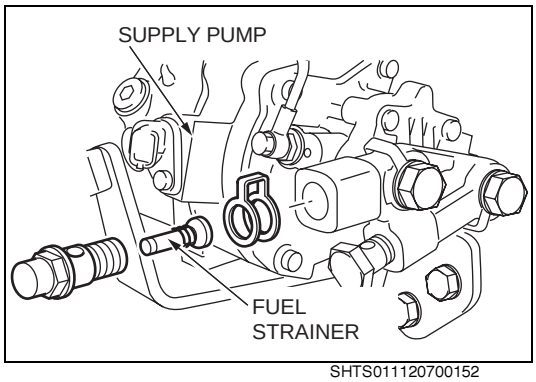
REMOVE THE FUEL STRAINER.

1. REMOVE THE FUEL STRAINER.

(1) Remove the fuel strainer and a gasket from the rear face of the supply pump.

HINT

Use a container and a waste as fuel might drip off during removal of fuel strainer.



SHTS011120700152

COMPONENT CHECK

1. CHECK THE CLOGGING.

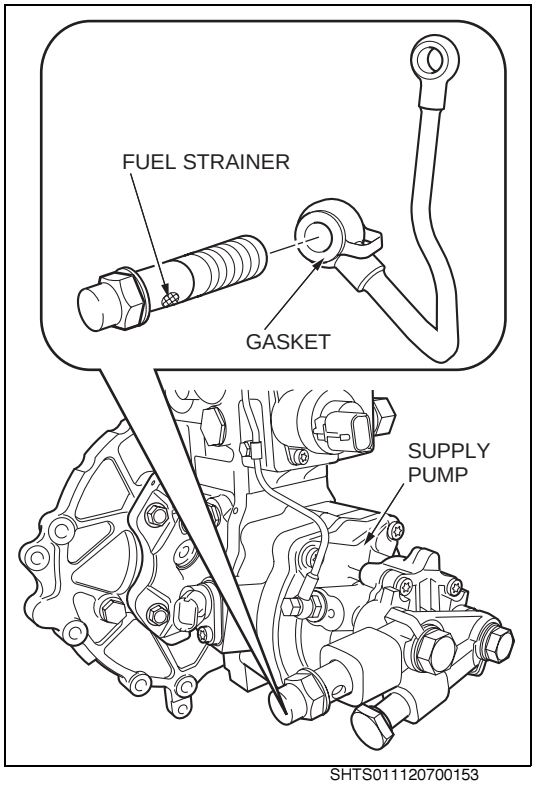
(1) Check the fuel strainer for dirt or clogging. Clean or make replacement if dirt or clogging would be found.

NOTICE

Wipe off fuel spatters on the engine thoroughly if any.

HINT

Use fuel to clean the fuel strainer.



SHTS011120700153

INSTALL THE FUEL STRAINER.

1. INSTALL THE FUEL STRAINER.

(1) Replace an old gasket with a new one. Install the fuel strainer to the rear face of the supply pump.
Tightening Torque:
27 N·m {275 kgf·cm, 20 lbf·ft}

NOTICE
After installing, start the engine for tryout to check that no fuel leak is observed from the fuel strainer.

2. BLEED AIR FROM THE FUEL SYSTEM.

(1) Start the priming pump to bleed air from the fuel system.
Refer to the section **"FUEL FILTER AND CASE"**.

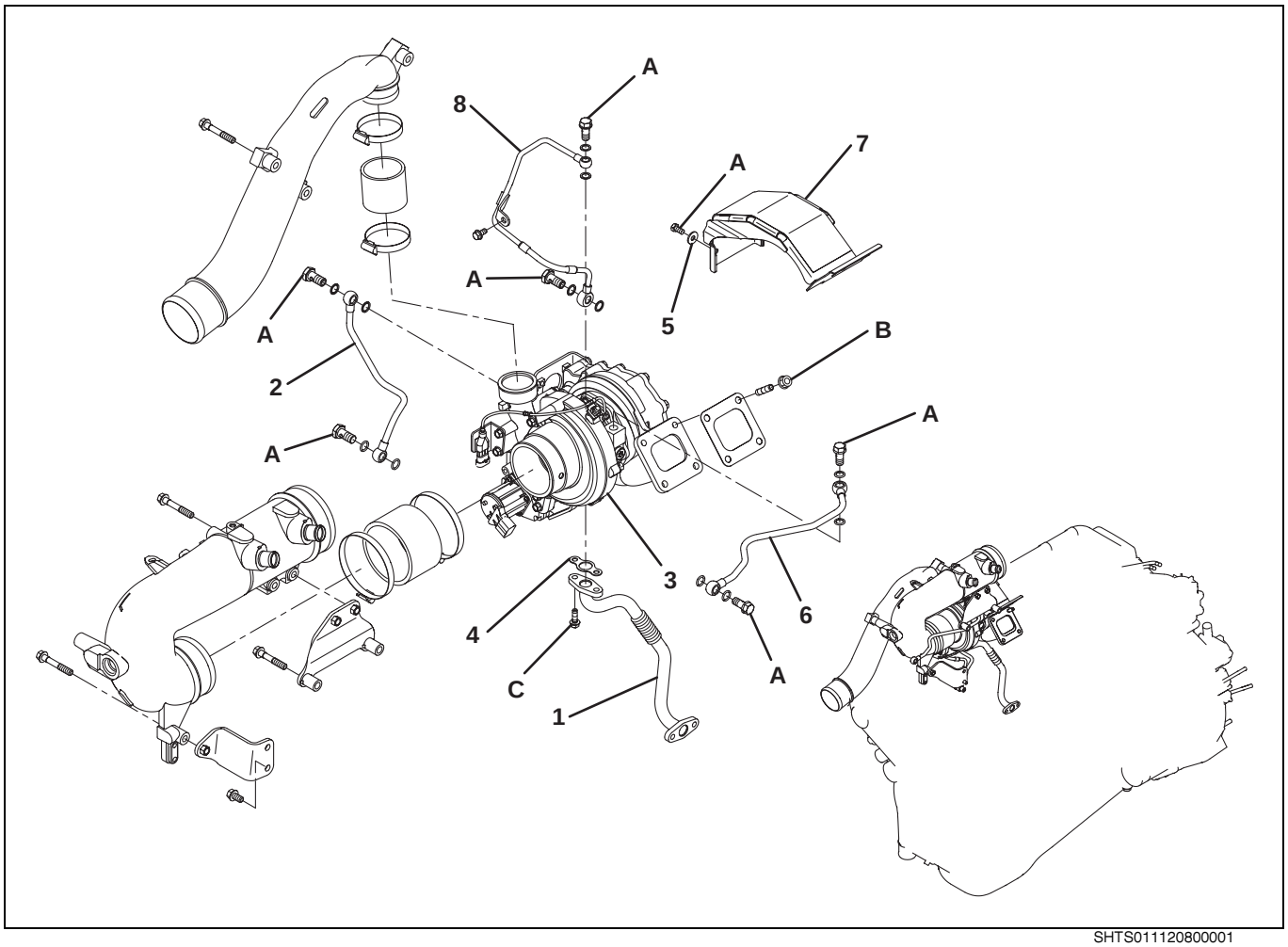
TURBOCHARGER (A09C)

EN08-001

TURBOCHARGER

COMPONENT LOCATOR

EN0111208D100001



SHTS011120800001

1	Oil pipe	5	Washer
2	Coolant pipe	6	Coolant pipe
3	Turbocharger assembly	7	Insulator
4	Gasket	8	Oil pipe

Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

A	25 {255, 18}	C	28.5 {290, 21}
B	74.5 {760, 55}		

TROUBLESHOOTING

EN0111208F300001

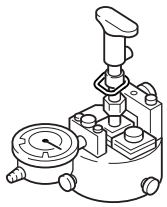
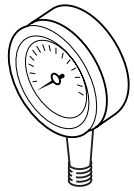
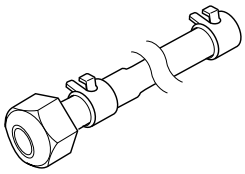
Symptom	Possible cause	Remedy/Prevention
Dense black smoke (Insufficient intake)	Air cleaner is choked with dust, causing greater intake air resistance.	Disassemble and clean or replace the air cleaner element.
	Air inlet is choked	Repair.
	Air is leaking from intake manifold	Repair.
	Blower impeller and turbine shaft not turning freely	Overhaul.
	VG assembly malfunction	Inspect and replace.
Dense black smoke (Turbocharger goes not rotate smoothly.)	Engine oil impurities deposited on rotor, resulting in heavy rotation or sticking.	Overhaul and clean turbocharger and/or repair.
Dense black smoke (Bearing sticking.)	Insufficient lubrication or blockage of lubricating oil lines.	Check lubricating oil system, and/or repair.
	Temperature of lubricating oil too high	Check cooling system.
	Unbalanced rotating parts	Check rotating parts.
	Incomplete warming-up, failure to idle before stopping engine, or jack rabbit starts.	Operate vehicle properly.
Dense black smoke (Loose or damaged turbine rotor or blower impeller.)	Over-rotation	Check and adjust the engine.
	Temperature of exhaust gas too high	Check and adjust the engine.
	Foreign matter present	Remove foreign material. Inspect the air cleaner and air intake manifold. Repair if necessary.
	Worm thrust bearing	Overhaul and repair.
	Incomplete assembly	Reassembly.
High volume exhaust like noise.	Exhaust gas leaking before turbocharger, therefore insufficient revolution.	Check and repair connections.
	Deformed or blocked exhaust gas lines therefore insufficient revolution.	Repair.
White smoke	Choking defects, or deformation of oil return lines so that oil leaks around blower or turbine sides.	Repair and replace the lines.
	Increase in pressure on rear of blower impeller, causing oil to flow into the blower side	Inspect and replace pipes and hoses. Clean or replace air Cleaner element.
	Seal ring may be broken or worn due to abnormal wear of thrust washer.	Replace the thrust washer.
Break into abatement engine oil	Increase in pressure on rear of blower impeller, causing oil to flow into the blower side	Inspect and replace pipes and hoses. Clean or replace air Cleaner element.
	Exhaust gas before turbocharger, get mixed engine oil	Repair.
Loss of power	Gas leakage from exhaust system	Repair.
	Air leakage from air manifold	Repair.
	Clogged air cleaner element	Clean or replace.
	Turbocharger dirty or damaged	Repair or replace.
	VG assembly malfunction	Inspect and replace.

Symptom	Possible cause	Remedy/Prevention
Poor response of turbocharger	Carbon accumulation on the turbine side seal ring and heavy rotation	Change engine oil, clean turbocharger.
	Air or gas leaking from parts of the intake or exhaust system	Inspect and repair the problem area.
	Poor combustion	Check fuel system and improve combustion.
	VG assembly malfunction	Inspect and replace.
High pitched noise and vibration (Noise)	So called "surging" Surging sometimes occurs when the gas passage at the nozzle of the turbine housing is choked or when compressed air does not flow in proper responses to acceleration.	Overhaul and clean turbocharger.
	Loosen rotating parts	Overhaul or replace.
	VG assembly malfunction	Inspect and repair.
	Air of gas leaking from parts of the intake or exhaust system	Inspect and repair the problem area.
High pitched noise and vibration (Vibration)	Joints loose between turbocharger and intake, exhaust manifold or oil lines	Check the mounting and repair.
	Damaged bearing, loose rotating parts, imbalanced rotating parts, etc.	Repair.
	Unbalanced rotating parts	Repair or replace.

SPECIAL TOOL

EN0111208K100001

Prior to starting a turbocharger overhaul, it is necessary to have these special tools.

Illustration	Part number	Tool name	Remarks
	09290-E1010	TOOL ASSEMBLY	Attachment for measuring turbine shaft play
	S0944-41250	GAUGE	
	09258-E1010	HOSE	

INSPECTION

EN0111208H300001

INSPECTION USING HINO-DX

1. OPERATION CHECK

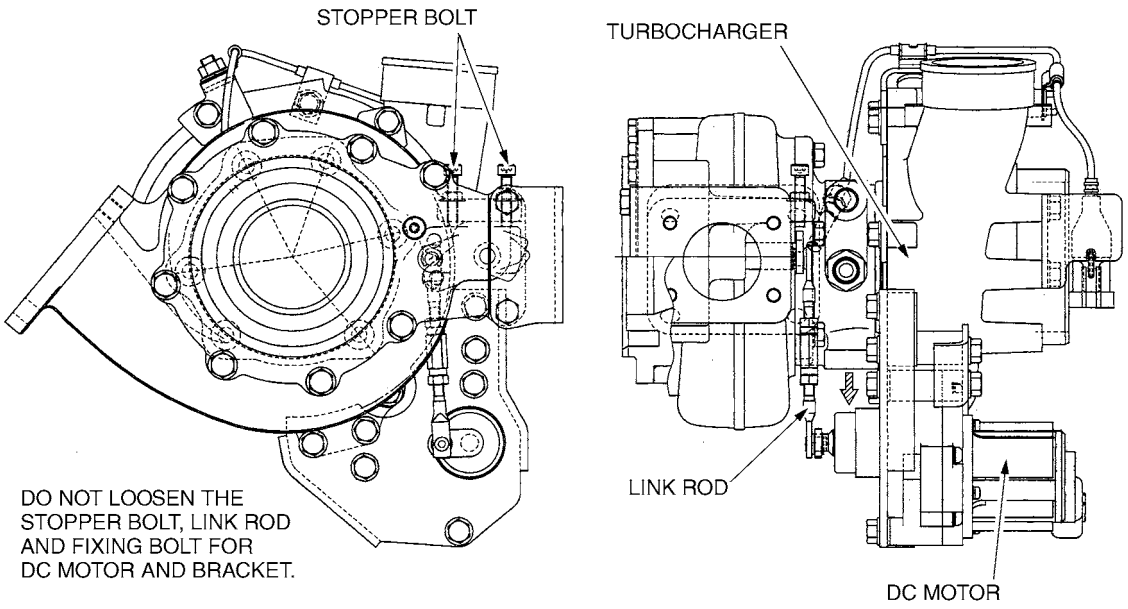
(1) Using Hino-DX, check the turbocharger operating condition.

2. INSPECTION OF THE DC MOTOR

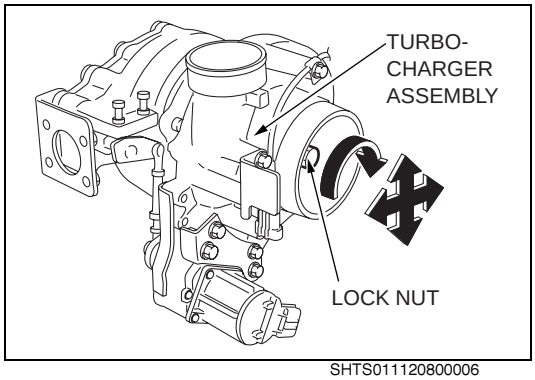
(1) Use the Hino-DX to actuate the DC motor. Check that the link rod operates smoothly, and take measurement to examine that the predetermined lift is met.

NOTICE

Do not loosen the link rod and the stopper bolts designed for adjusting the VG full-open/full-close as these parts have been already adjusted.



SHTS011120800005



SHTS011120800006

INSPECTION OF THE TURBINE SHAFT

1. INSPECTION

(1) Hold the lock nut at the end of the blower impeller, and manually turn the turbine shaft lightly to check the rotations.

(2) Hold the lock nut at the end of the blower impeller, and manually check the turbine shaft for radial play.

HINT

Use a metal wear boundary sample of the turbocharger assembly to compare the degree of play.

Part No.	Part Name	Permissible limit
S2410-02360	Turbocharger assembly	Boundary sample for detecting axial play in the turbine by hand

(3) Replace the turbocharger assembly if the turbine shaft would not rotate, would rotate but not smooth, or would have large radial play or if the blower impeller contacts with the blower case.

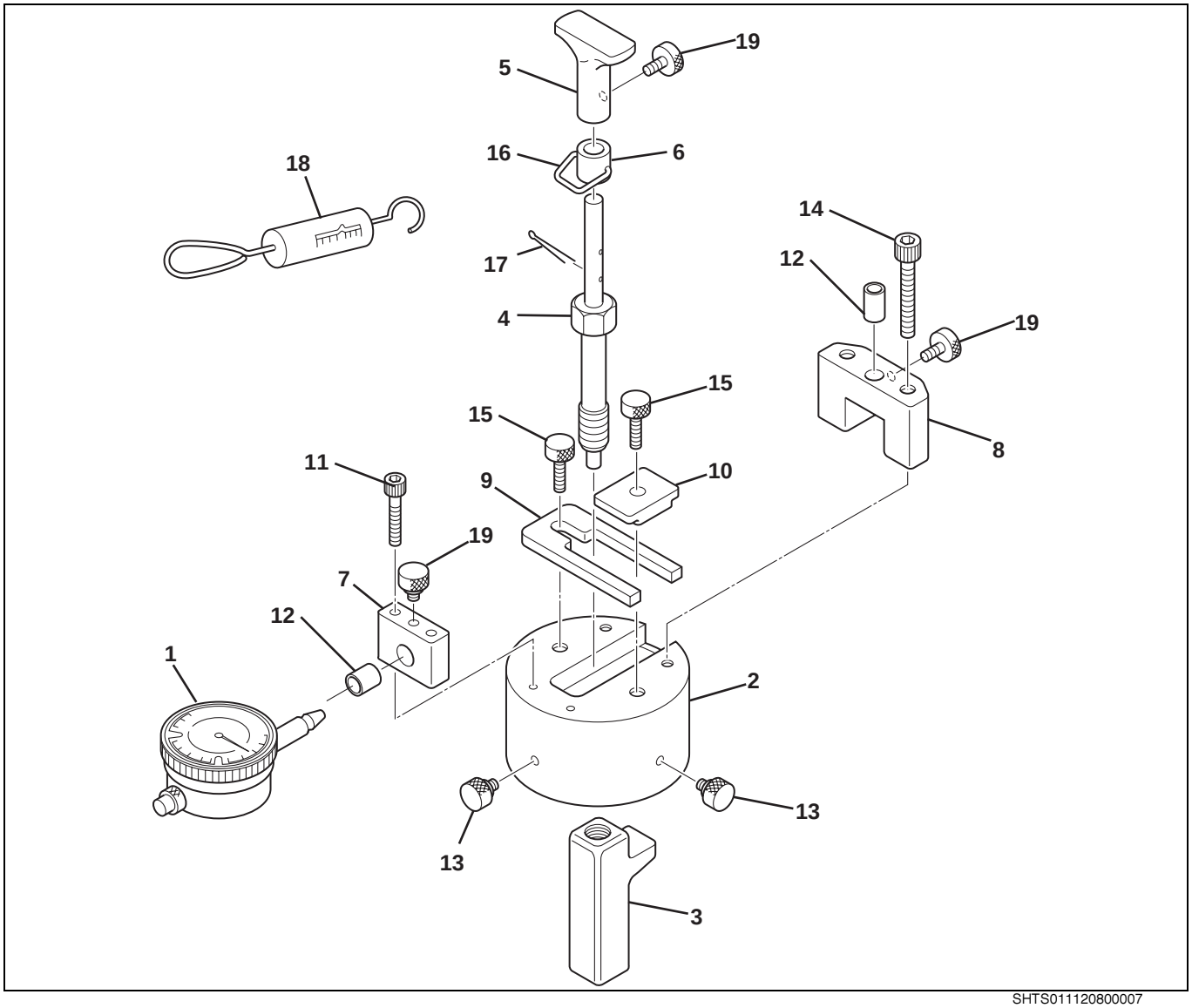
(4) If it is difficult to determine the degree of play, use a special tool referred above to check for play and determine whether the turbocharger assembly needs to be replaced.

HINT

If the turbocharger assembly would be replaced, omit the procedures described in the section "INSPECTION USING THE SPECIAL TOOL".

2. INSPECTION USING THE SPECIAL TOOL

(1) Exploded diagram of tool assembly



SHTS011120800007

Key No.	Part Name	Part No.	Key No.	Part Name	Part No.
Assy	Tool assembly	09290-E1010	1	Gauge (Dial gauge)	S0944-41510
2	Guide	S0948-11270	3	Stopper	S0945-11170
4	Bar	S0947-21900	5	Puller	S0942-11210
6	Sleeve	S0942-31240	7	Plate	S0942-41600
8	Plate	S0942-41480	9	Guide	S0948-11190
10	Stopper	S0948-11200	11	Bolt	S0959-11030
12	Sleeve	S0942-31250	13	Bolt	SZ910-24165
14	Bolt	SZ910-24166	15	Bolt	SZ910-24167
16	Hook	S0942-21330	17	Snap ring (Locking device)	SM381-01615
18	Bar (Spring)	S0947-21910	19	Bolt	SZ910-24171

(2) Illustration of check for axial/radial play in the turbine shaft with a special tool

(EXAMPLE)

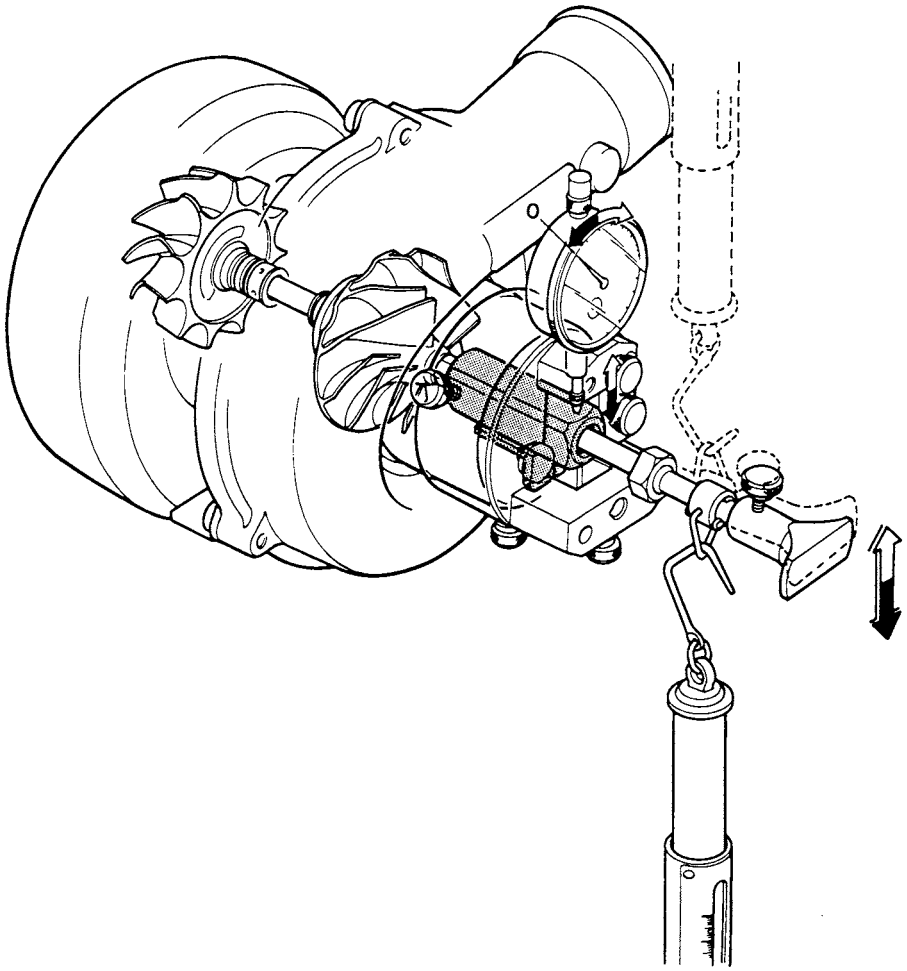


ILLUSTRATION OF MEASUREMENT FOR RADIAL PLAY IN THE TURBINE SHAFT

SHTS011120800008

(EXAMPLE)

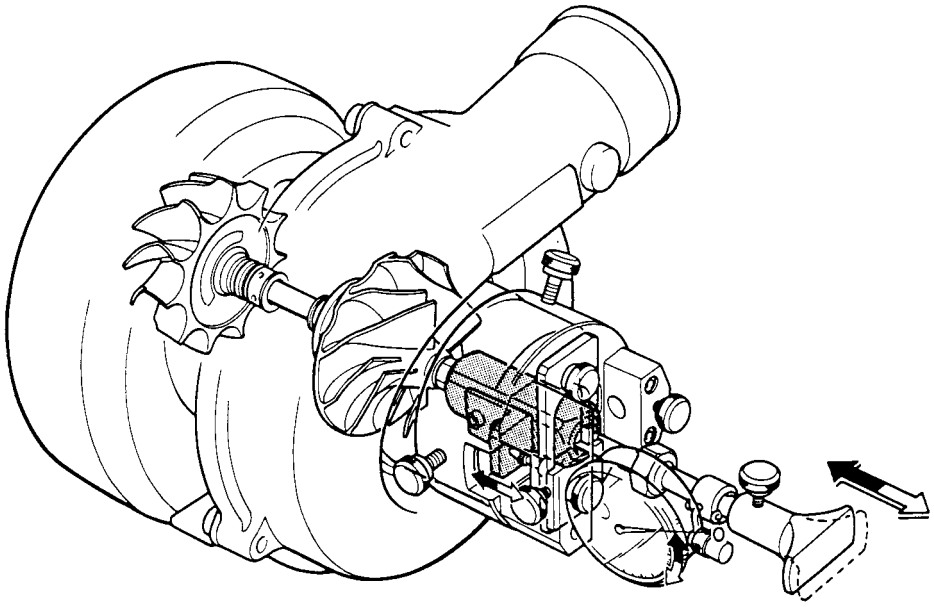
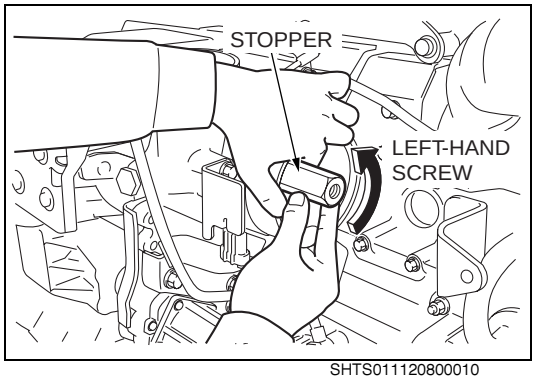


ILLUSTRATION OF MEASUREMENT FOR AXIAL PLAY IN THE TURBINE SHAFT

SHTS011120800009



SHTS011120800010

3. CHECK FOR RADIAL PLAY.

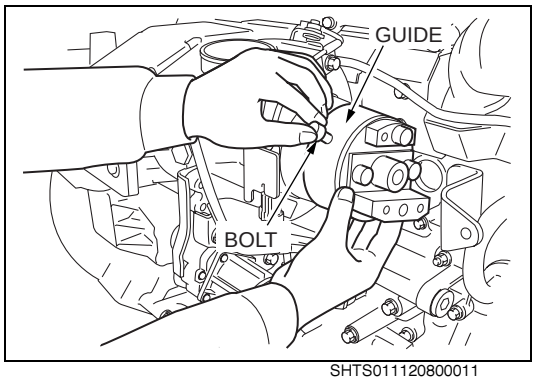
NOTICE

For the key numbers referred in the text, see an exploded diagram of tool assembly.

(1) Screw a stopper (key No.3) on the thread protruding on the lock nut at the end of the blower impeller.

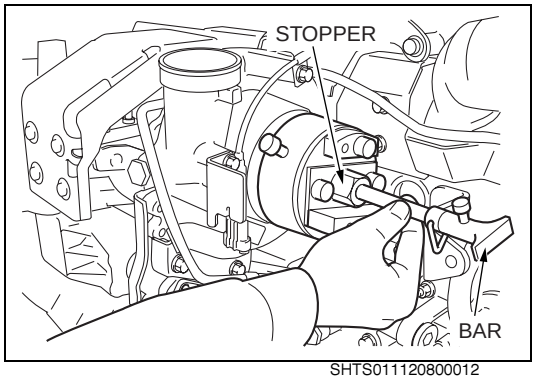
NOTICE

This stopper is left-hand-threaded.



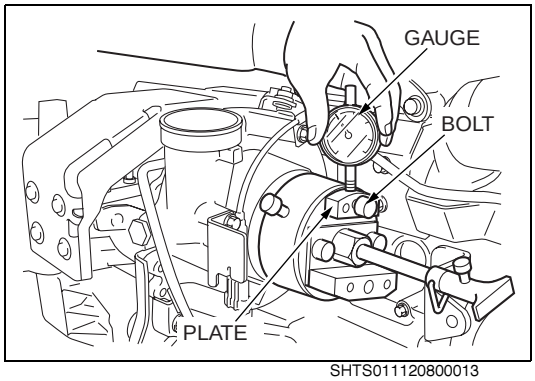
SHTS011120800011

(2) Insert a guide (key No.2) in the blower case on the air intake side. Tighten and secure a bolt (key No.13).



SHTS011120800012

(3) Screw a bar (key No.4) in the stopper (key No.3) and lock it.

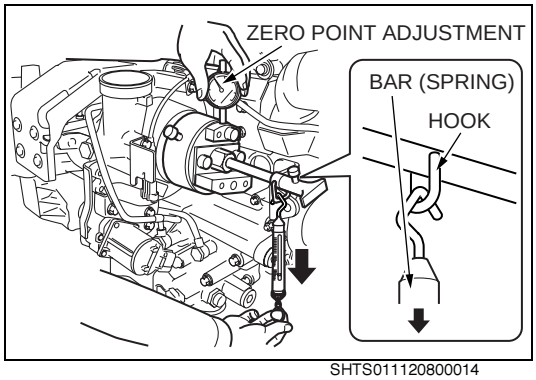


SHTS011120800013

(4) Insert a sleeve (key No.12) and a gauge (key No.1) in the plate (key No.7) in this sequential order. Secure a bolt (key No.19).

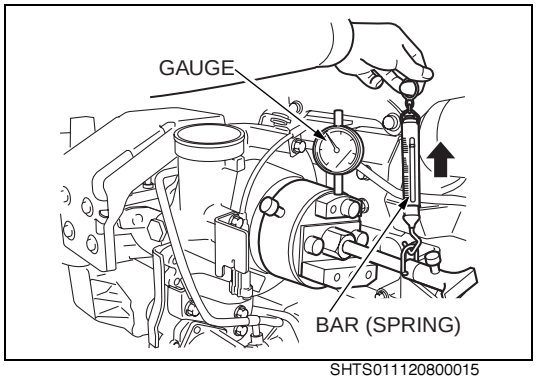
NOTICE

Keep inserting until the gauge end contacts with the stopper (key No.3), and secure a bolt.



SHTS011120800014

(5) Hang a bar [spring (key No.18)] on the hook (key No.16) at the end of the bar (key No.4), and pull it down with a force of 4.9 to 5.9 N {0.5 to 0.6 kgf, 1.2 to 1.3 lbf}. While keeping this pulling force, set a gauge reading to zero.



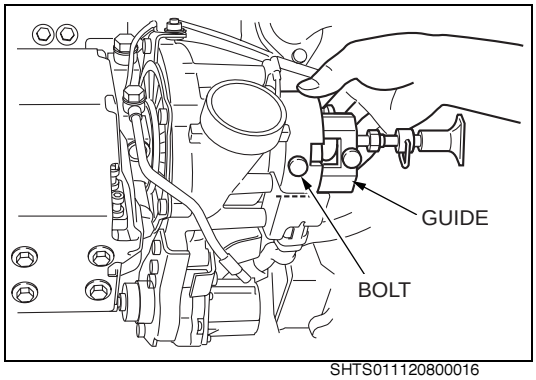
SHTS011120800015

(6) While pulling a bar [spring (key No.18)] upward with a force of 4.9 to 5.9 N {0.5 to 0.6 kgf, 1.2 to 1.3 lbf}, measure radial play with a gauge.

(7) Take three measurements and calculate an average. If an average exceeds the permissible limit, replace it with a new part.
RADIAL PLAY

Limit	1.0 mm {0.039 in.}

HINT
If the turbocharger assembly is replaced, other checking works hereafter will not be required.

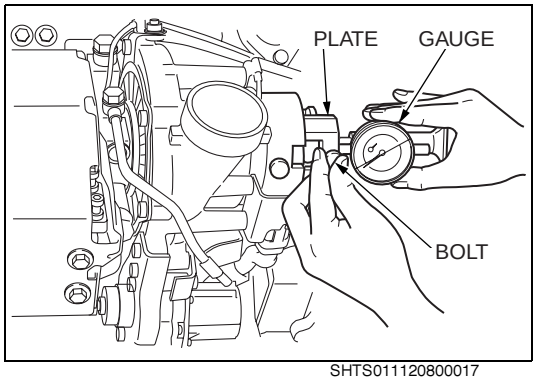


SHTS011120800016

4. CHECK FOR THRUST PLAY.

NOTICE
For the key numbers referred in the text, see an exploded diagram of tool assembly.

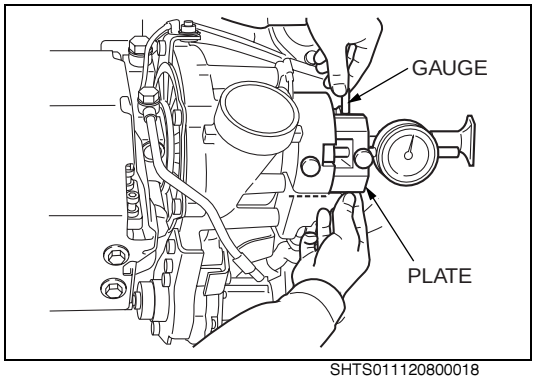
(1) Remove a gauge (key No.1), a sleeve (key No.12) and a plate (key No.7). Loose a bolt (key No.13) on the guide (key No.2) and turn the guide (key No.2) by 90° to fix it.



SHTS011120800017

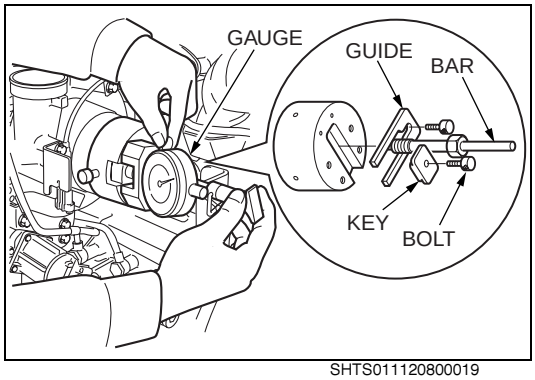
(2) Use a bolt (key No.14) to attach a plate (key No.8) to be checked for thrust play. Insert a gauge, and tighten and secure a bolt (key No.19).

NOTICE
Keep inserting until the gauge end contacts with the stopper (key No.3), and secure a bolt.



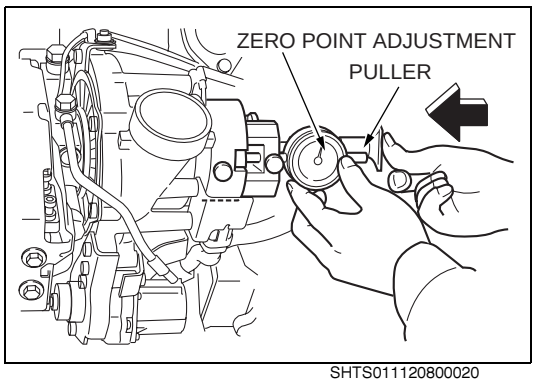
SHTS011120800018

(3) Attach a guide (key No.9) for the purpose of preventing lateral displacement of a measuring instrument.



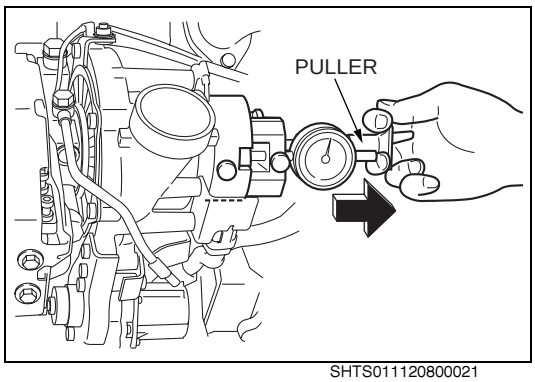
SHTS011120800019

(4) When fixating a guide (key No.9), move a bar (key No.4) up and down and adjust a guide (key No.9) to ensure that a gauge pointer reads a middle range. Then secure a stopper (key No.10).



SHTS011120800020

(5) While holding a puller (key No.5) against the turbine side in the axial direction, set a gauge reading to zero.



SHTS011120800021

(6) Next, pull it in the opposite direction and measure thrust play.

(7) Take three measurements and calculate an average. If an average exceeds the permissible limit, replace it with a new part.
THRUST PLAY

Limit	0.1 mm {0.003 in.}

REPLACEMENT

EN0111208H100001

REMOVE THE TURBOCHARGER REVOLUTION SENSOR.

1. CHECK BEFORE START OF MAINTENANCE WORKS

(1) Use the Hino-DX to conduct a check. If a trouble is found, make replacement as a complete turbocharger assembly.

2. DISCONNECT THE HARNESS.

(1) Disconnect the connector of the turbocharger revolution sensor.
Refer to **"REMOVE THE TURBOCHARGER ASSEMBLY"**.

3. REMOVE THE TURBOCHARGER.

(1) Remove the turbocharger assembly.
Refer to **"REMOVE THE TURBOCHARGER ASSEMBLY"**.

INSTALL THE TURBOCHARGER REVOLUTION SENSOR.

1. INSTALL THE TURBOCHARGER.

(1) Install the turbocharger assembly.
Refer to **"INSTALL THE TURBOCHARGER ASSEMBLY"**.

2. CONNECT THE HARNESS.

(1) Connect the connector of the turbocharger revolution sensor.
Refer to **"INSTALL THE TURBOCHARGER ASSEMBLY"**.

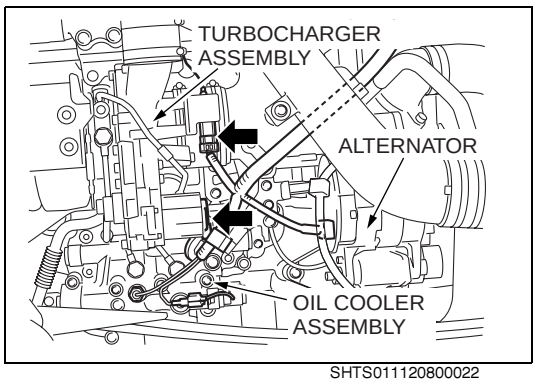
REMOVE THE TURBOCHARGER ASSEMBLY.

1. DRAIN THE COOLANT.

(1) Drain the coolant.
Refer to the section **"RADIATOR"** in the chapter **"COOLING SYSTEM"**.

2. DISCONNECT THE HARNESS.

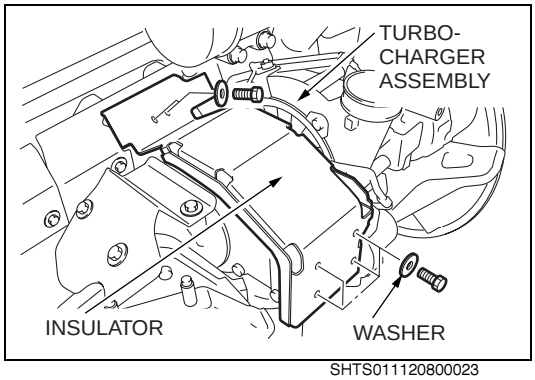
(1) Disconnect the connectors of the DC motor and the turbocharger revolution sensor.



SHTS011120800022

3. REMOVE THE INTAKE PIPE (EXHAUST SIDE).

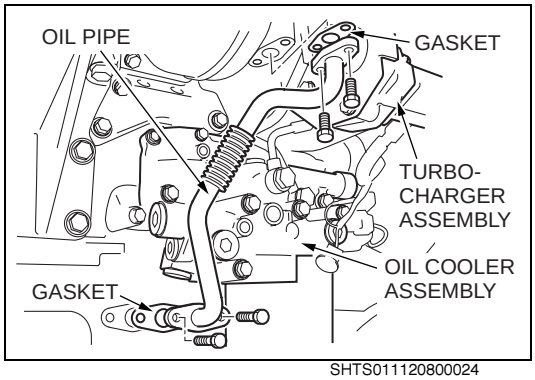
(1) Remove the U-turn pipe and the boost pipe.
Refer to the section **"INTAKE PIPE (EXHAUST SIDE)"** in the chapter **"AIR INTAKE SYSTEM"**.



SHTS011120800023

4. REMOVE THE INSULATOR.

(1) Remove six bolts and washer to remove the insulator from the turbocharger assembly.



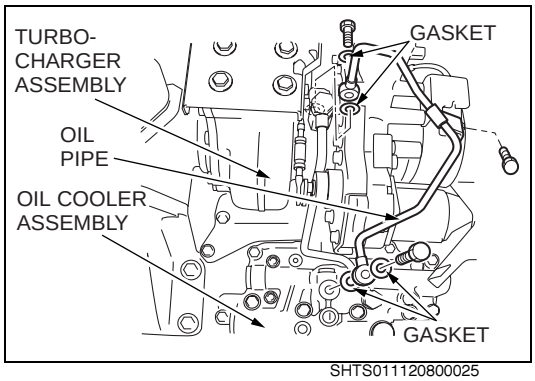
SHTS011120800024

5. REMOVE THE TURBOCHARGER ASSEMBLY.

(1) Remove four bolts to remove the oil pipe and gasket from the turbocharger assembly.

HINT

Use a container and a waste as engine oil might drip off during removal of oil pipe.

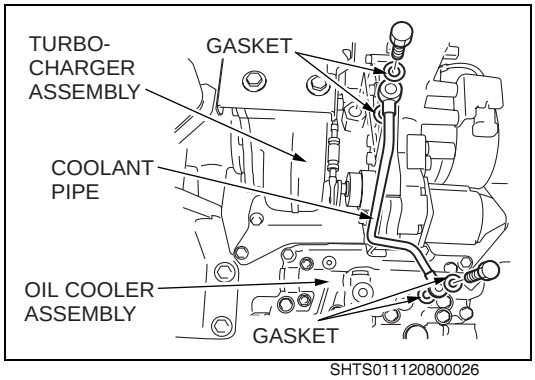


SHTS011120800025

(2) Remove the bolt and union bolts to remove the oil pipe and gasket from the turbocharger assembly.

HINT

Use a container and a waste as engine oil might drip off during removal of oil pipe.

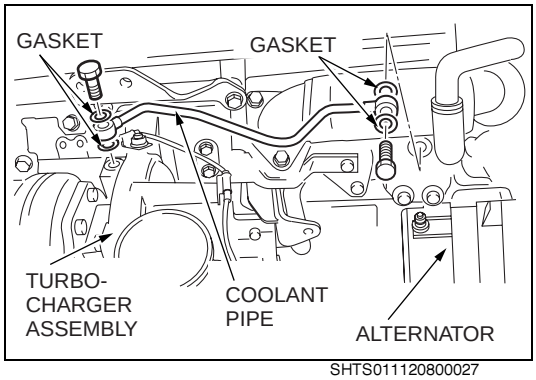


SHTS011120800026

(3) Remove two union bolts to remove the coolant pipe and gasket from the turbocharger assembly.

HINT

Use a container and a waste as coolant might drip off during removal of coolant pipe.



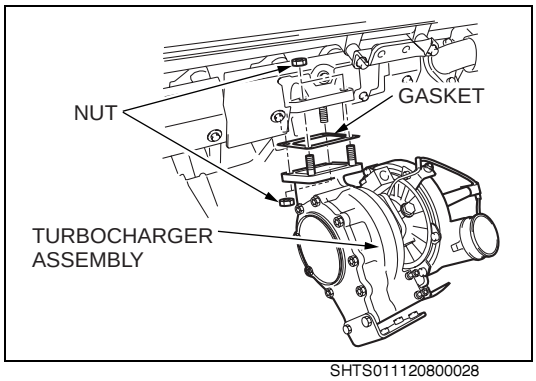
SHTS011120800027

(4) Remove two union bolts to remove the coolant pipe and gasket from the turbocharger assembly.

HINT
Use a container and a waste as coolant might drip off during removal of coolant pipe.

(5) To prevent contamination, cover individual oil holes and water holes in the turbocharger assembly.

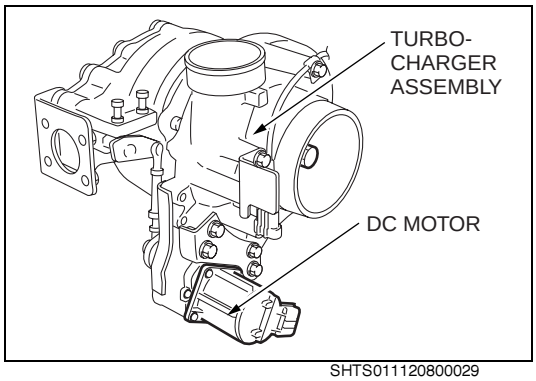
⚠ CAUTION
Take a meticulous care to prevent contaminants from coming into the turbocharger assembly.



SHTS011120800028

(6) Remove four nuts to remove the turbocharger assembly and gasket from the exhaust manifold.

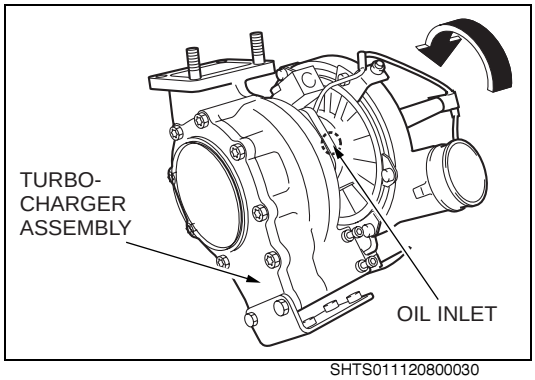
⚠ CAUTION
- **The DC motor link rod has been already adjusted. Do not remove it.**
- **Removal of the DC motor will ruin adjustment, which will degrade the turbocharger functionality.**



SHTS011120800029

- **Place the turbocharger assembly in its proper posture during storage after removal, in order to prevent damages in the DC motor (plastic).**

(7) To prevent contamination, cover an opening in the exhaust manifold.



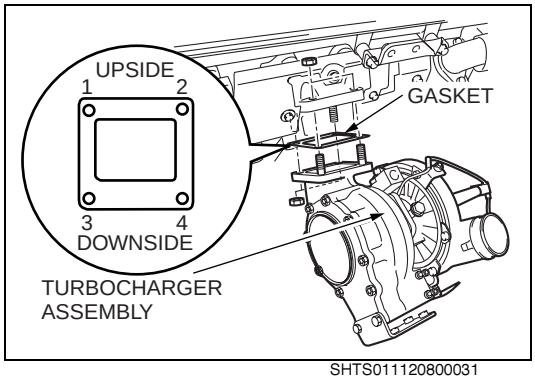
SHTS011120800030

INSTALL THE TURBOCHARGER ASSEMBLY.

1. INSTALL THE TURBOCHARGER ASSEMBLY.

(1) Before mounting, pour engine oil through the oil inlet and manually rotate the turbocharger assembly to lubricate the journal bearings and thrust bearings.

(2) Check that no dusts or contaminants are seen in the exhaust piping.



SHTS011120800031

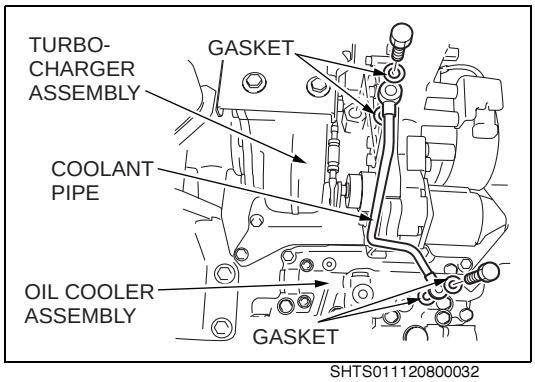
(3) Replace the gasket with a new one and install the turbocharger assembly to the exhaust manifold with four nuts in the order shown in the figure.

Tightening Torque:
74.5 N·m {760 kgf·cm, 55 lbf·ft}

(4) Tighten the nuts in the same order as in (3).
Tightening Torque:
74.5 N·m {760 kgf·cm, 55 lbf·ft}

NOTICE

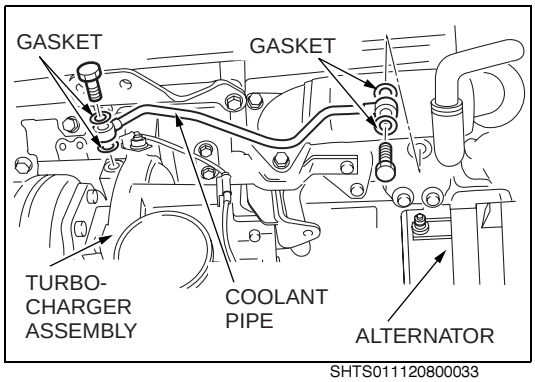
- **Make sure to tighten twice.**
- **If the stud bolts are stuck in the exhaust flange, use a commercially available stud bolt remover and replace stuck stud bolts.**



SHTS011120800032

(5) Replace the gasket with a new one and install the coolant pipe to the turbocharger, and tighten two bolts.
Tightening Torque:
25 N·m {255 kgf·cm, 18 lbf·ft}

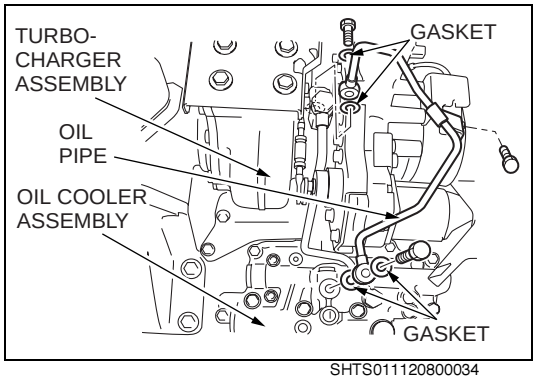
NOTICE
After cleaning the coolant pipe, check that no crush, dust or contaminants are seen in the pipe.



SHTS011120800033

(6) Replace the gasket with a new one. Install the coolant pipe to the turbocharger assembly, and tighten four bolts.
Tightening Torque:
25 N·m {255 kgf·cm, 18 lbf·ft}

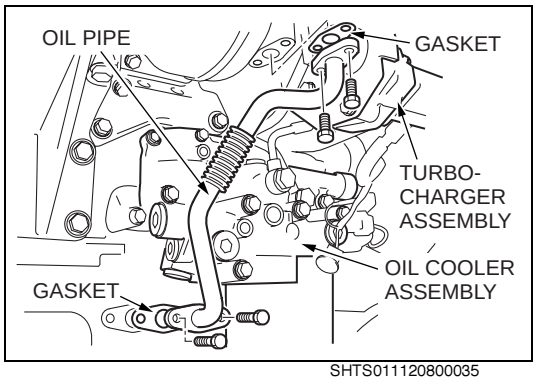
NOTICE
After cleaning the coolant pipe, check that no crush, dust or contaminants are seen in the pipe.



SHTS011120800034

(7) Replace the gasket a with new a one. Install the oil pipe to the turbocharger assembly, and tighten four bolts.
Tightening Torque:
25 N·m {255 kgf·cm, 18 lbf·ft}

NOTICE
After cleaning the oil pipe, check that no crush, dust or contaminants are seen in the pipe.

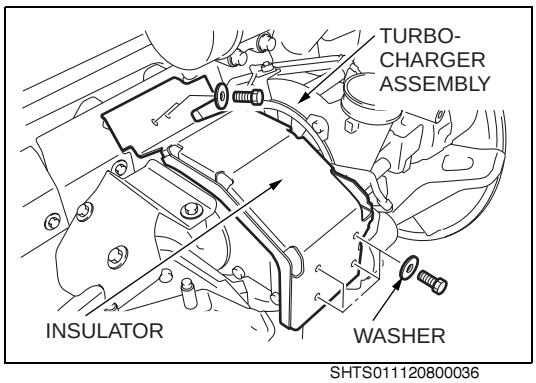


SHTS011120800035

(8) Replace the gasket with a new one. Install the oil pipe to the turbocharger assembly, and tighten four bolts.
Tightening Torque:
28.5 N·m {290 kgf·cm, 21lbf·ft}

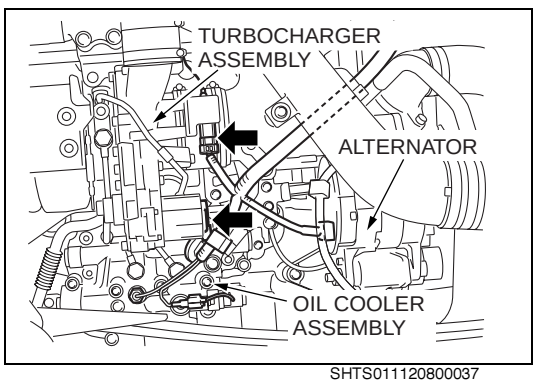
NOTICE
After cleaning the oil pipe, check that no crush, dust or contaminants are seen in the pipe.

2. INSTALL THE INTAKE PIPE (EXHAUST SIDE).
(1) Install the U-turn pipe and boost pipe.
Refer to the section **"INTAKE PIPE (EXHAUST SIDE)"** in the chapter **"AIR INTAKE SYSTEM"**.



SHTS011120800036

3. INSTALL THE INSULATOR.
(1) Replace the gasket with a new one. Install the insulator to the turbocharger assembly, and tighten six bolts.
Tightening Torque:
25 N·m {255 kgf·cm, 18 lbf·ft}



SHTS011120800037

4. INSTALL THE HARNESS.
(1) Connect the connectors of the DC motor and the turbocharger revolution sensor.

5. FILL ENGINE OIL.

(1) Check the engine oil level, and refill the coolant, if the coolant level is low.
Refer to the section **"DISMOUNTING AND MOUNTING"** in the chapter **"ENGINE INTRODUCTION"**.

6. FILL THE COOLANT.

(1) Fill the coolant.
Refer to the section **"RADIATOR"** in the chapter **"COOLING SYSTEM"**.

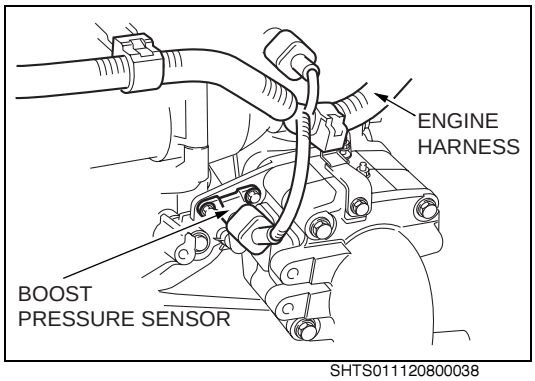
CHECK AFTER THE INSTALLATION

1. OPERATING PROCEDURES

(1) After mounting the turbocharger to the engine body, start the engine and check each portion for leakage of engine oil, coolant and exhaust gas.

⚠ CAUTION

- **Do not racing or run the engine at a high rpm immediately after starting the engine. Actuation of the turbocharger with insufficient oiling at initial start will cause various troubles such as bearing seizure.**
- **Keep idling for approximately 5 min. before stopping the engine.**
- **If the engine is suddenly stopped, rotations will keep running with no turbocharger oil pressure. This will use up oil film, resulting in wear in the bearing.**



SHTS011120800038

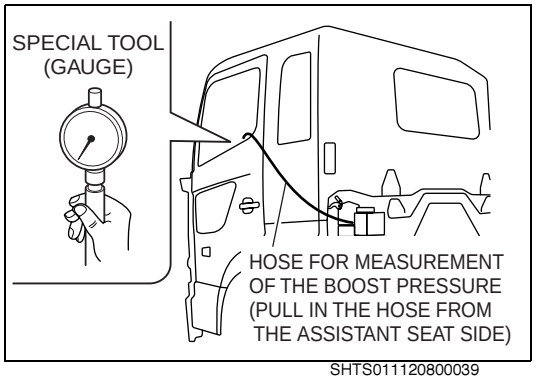
2. CHECK THE BOOST PRESSURE.

(1) Use the Hino-DX to check a boost pressure.
Standard value (max speed at no load):
4.9 kPa {0.05 kgf/cm^2, 0.7 lbf/in.^{2}} or more

NOTICE

When using the Hino-DX, the display will indicate a total pressure of an atmospheric pressure and a boost pressure (check a pressure when the engine is stopped).

(2) Remove the boost pressure sensor from the intake pipe and connect special tools.
SST:
Gauge (S0944-41250)
Boost pressure measuring hose (09258-E1010)



SHTS011120800039

(3) Next, take a gauge (special tool) into a cab as shown in the figure.

(4) After fully warming the engine, depress the clutch pedal to disengage the clutch.

(5) Depress the accelerator pedal to the deepest point and measure a boost pressure at the max rpm at no load with a special tool (gauge).

NOTICE

Keep a special tool (gauge) positioned vertically, or a gauge pointer will be instable and cannot take an accurate reading.

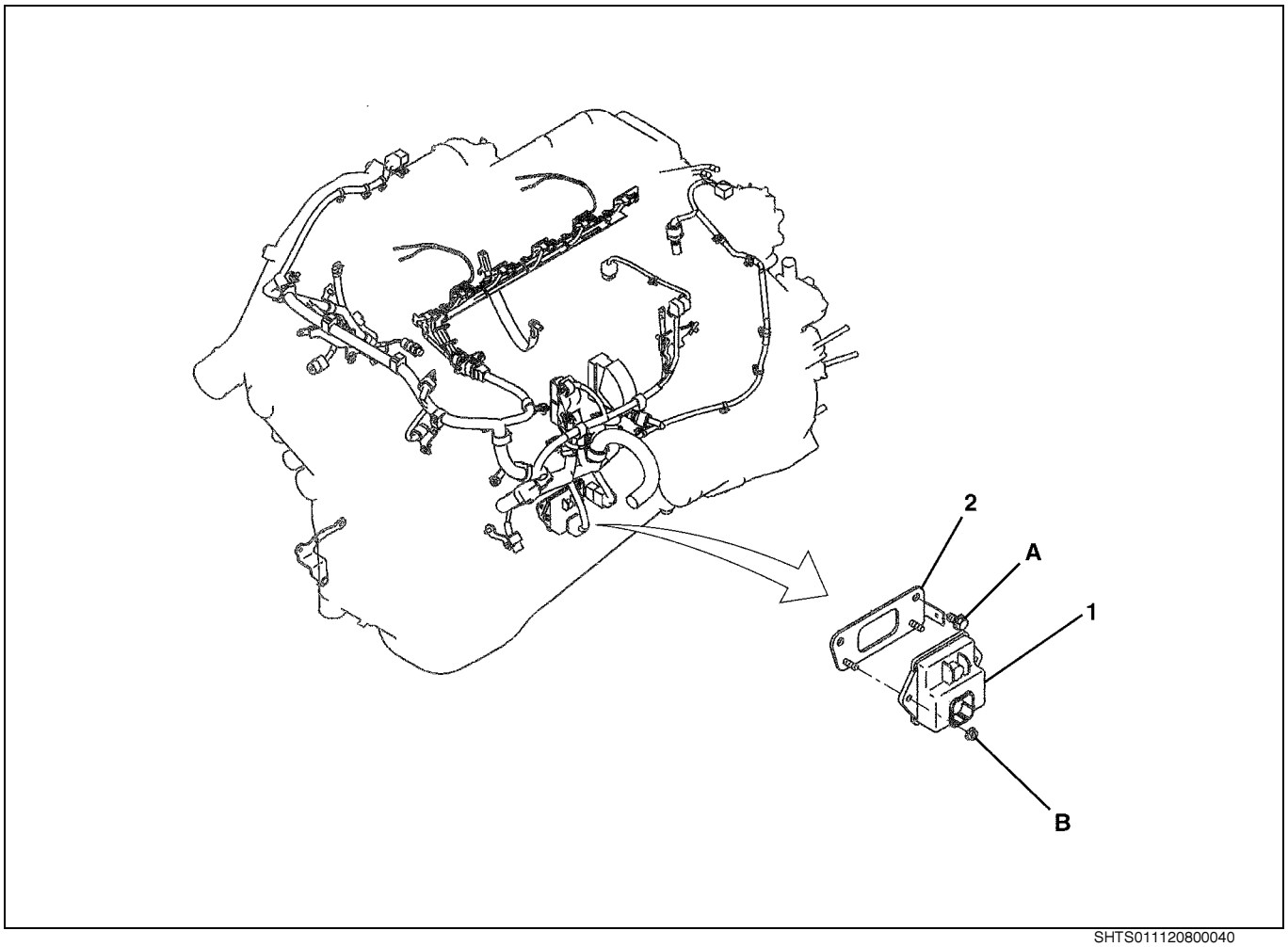
(6) If a measurement value does not reach the standard boost pressure, check whether air is leaking from the air seal in the intake system, whether the air cleaner or the intercooler is clogged, and whether the VG mechanism incurs failures.

(7) After measurement, replace an old gasket with a new one and set the boost pressure take-up portion back to its original state.

DC MOTOR CONTROLLER

COMPONENT LOCATOR

EN0111208D100002



SHTS011120800040

1	DC motor controller	2	Bracket

Tightening torque Unit: N·m {kgf·cm, lbf·ft}

A	28.5 {290, 21}	B	6 {60, 4.4}

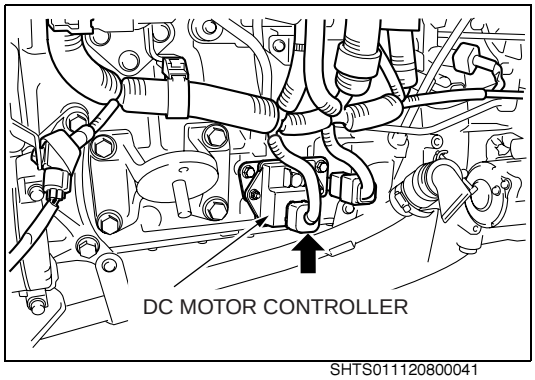
REPLACEMENT

EN0111208H100002

REMOVE THE DC MOTOR CONTROLLER.

1. CHECK BEFORE START OF MAINTENANCE WORKS

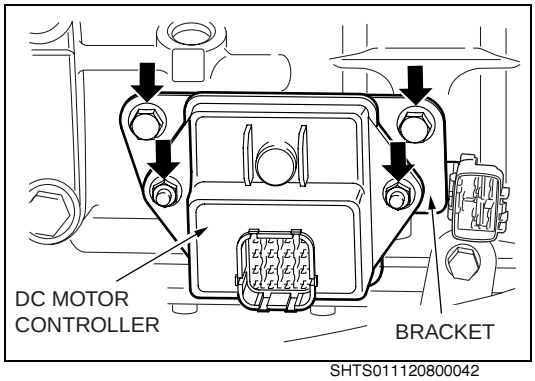
(1) Use the Hino-DX to conduct a check. If a trouble is found, make replacement as a complete turbocharger assembly.



SHTS011120800041

2. DISCONNECT THE HARNESS.

(1) Disconnect the connector of the DC motor controller.



SHTS011120800042

3. REMOVE THE DC MOTOR CONTROLLER.

(1) Remove two nuts to remove the DC motor controller from the bracket.

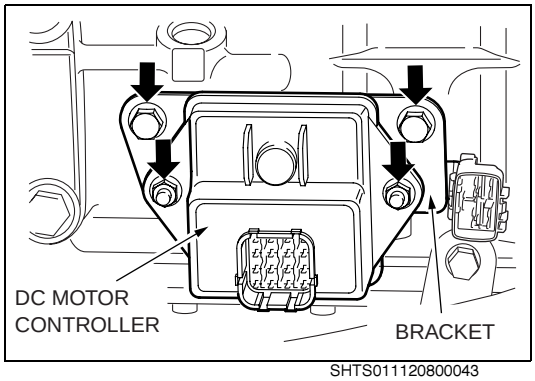
(2) Remove two bolts to remove the bracket from the cylinder block.

INSTALL THE DC MOTOR CONTROLLER.

1. INSTALL THE DC MOTOR CONTROLLER.

(1) Install the bracket to the cylinder block, and tighten two bolts.
Tightening Torque:
28.5 N·m {290 kgf·cm, 21 lbf·ft}

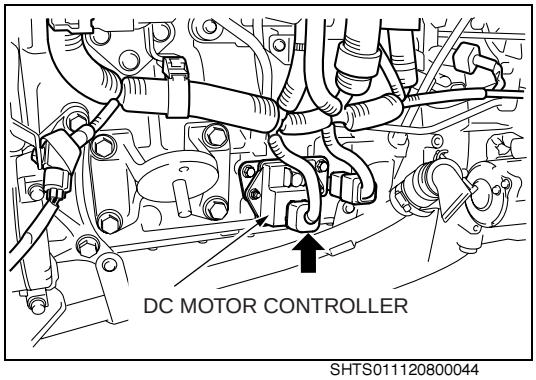
(2) Install the DC motor controller to the bracket, and tighten two nuts.
Tightening Torque:
6 N·m {60 kgf·cm, 4.4 lbf·ft}



SHTS011120800043

NOTICE

Make sure that a connector on the DC motor controller is positioned at the bottom.



SHTS011120800044

2. CONNECT THE HARNESS.

(1) Connect the connector of the DC motor controller.

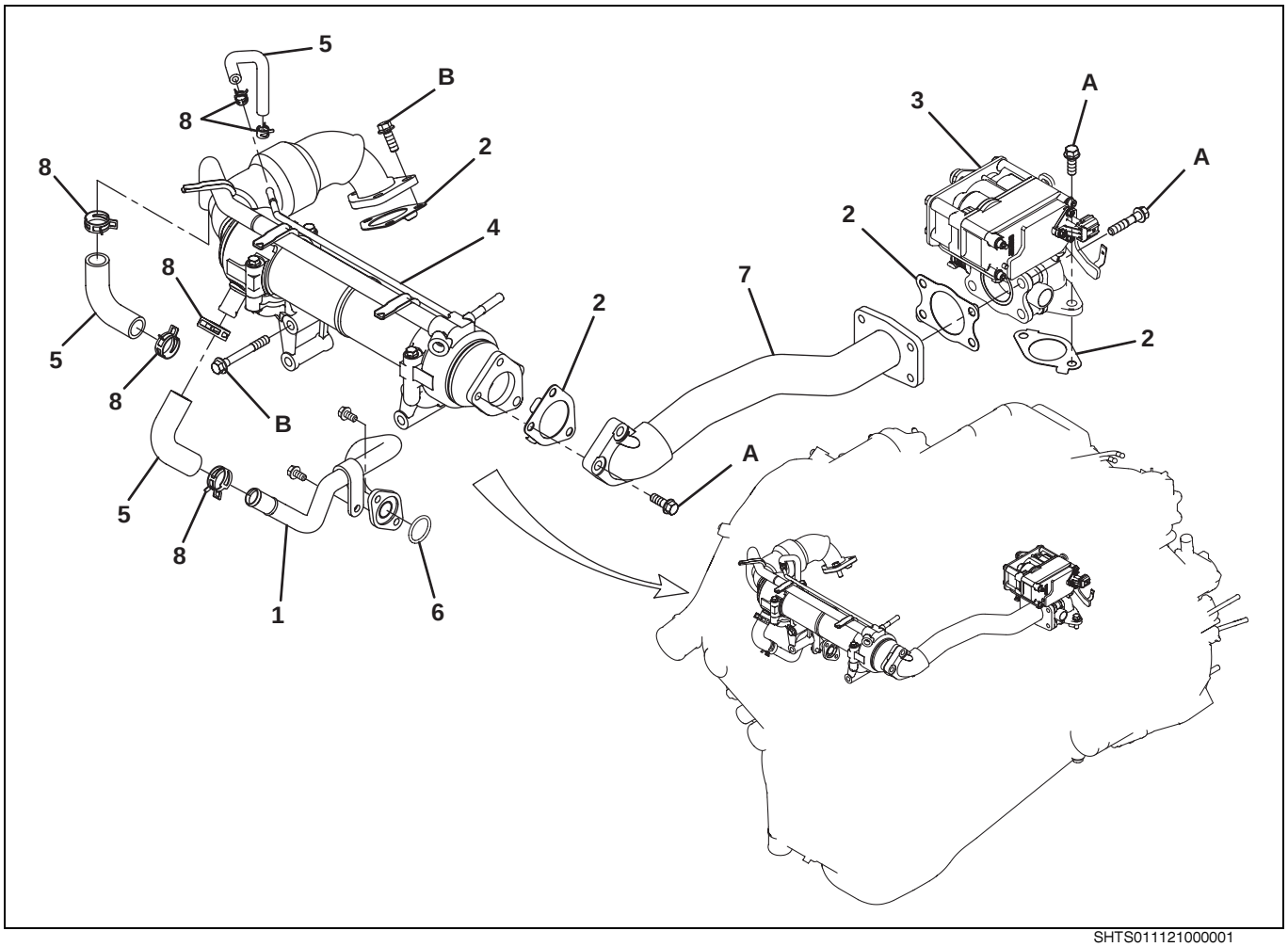
EMISSION CONTROL (A09C)

EN10-001

EGR VALVE AND COOLER

COMPONENT LOCATOR

EN0111210D100001



SHTS011121000001

1	Coolant pipe	5	Coolant hose
2	Gasket	6	O-ring
3	EGR valve	7	EGR pipe
4	EGR cooler	8	Clamp

Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

A	55 {560, 41}	B	68.5 {700, 51}

REPLACEMENT

EN0111210H100001

REMOVE THE EGR VALVE AND COOLER.

1. CHECK BEFORE START OF MAINTENANCE WORKS.

(1) Use the Hino-DX to check the air flow sensor.
Refer to the section **"AIR FLOW SENSOR"** in the chapter **"AIR INTAKE SYSTEM"**.

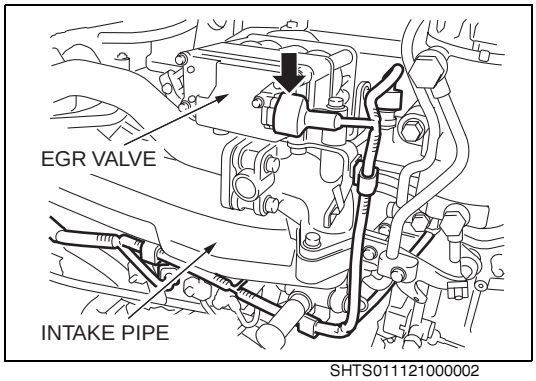
(2) Use the Hino-DX to check operations of the onboard EGR valve.

2. DRAIN THE COOLANT.

(1) Drain the coolant.
Refer to the section **"RADIATOR"** in the chapter **"COOLING SYSTEM"**.

3. DISCONNECT THE HARNESS.

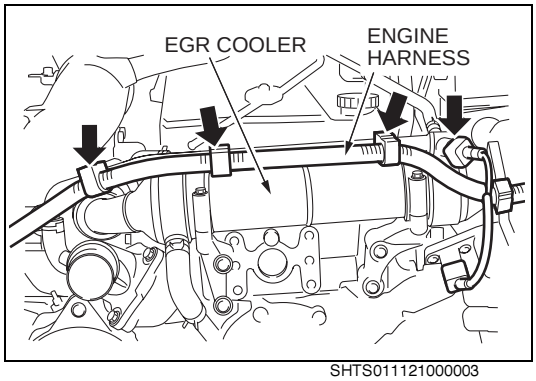
(1) Disconnect a connector of the EGR valve.



SHTS011121000002

(2) Disconnect a connector from the EGR cooler outlet coolant temperature sensor.

(3) Unlock three clamps and disconnect the engine harness from the EGR cooler.



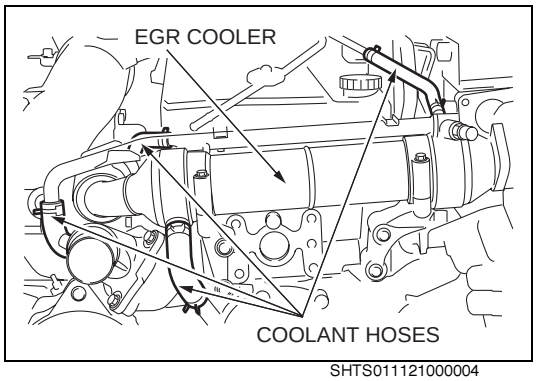
SHTS011121000003

4. DISCONNECT THE COOLANT HOSES.

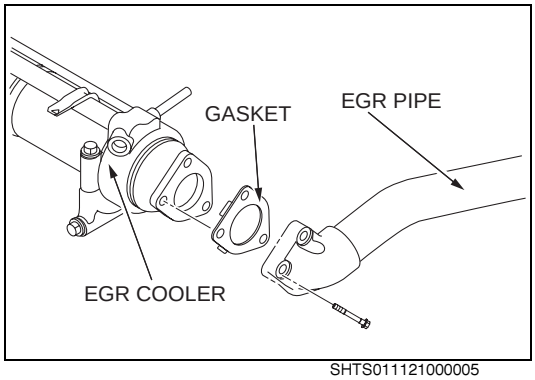
(1) Remove eight clips to disconnect four coolant hoses from the EGR cooler.

⚠ CAUTION
Proceed with all replacement works only after all related components/parts cool down. Otherwise hot components/parts will cause burn injury. (Set the starter switch to the "LOCK" position and leave it for at least 30 min.)

HINT
Use a container and a waste as coolant might drip off during disconnection of coolant hoses.



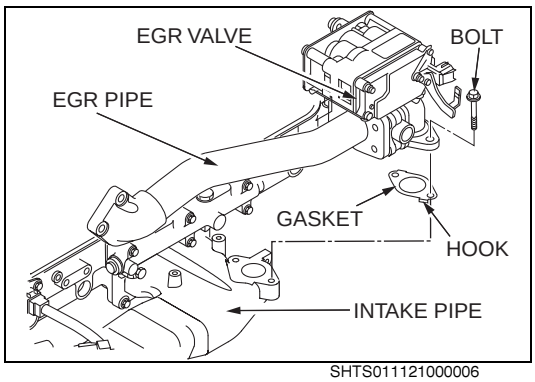
SHTS011121000004



SHTS011121000005

5. REMOVE THE EGR VALVE.

(1) Remove three bolts to disconnect the EGR pipe and remove a gasket from the EGR cooler.

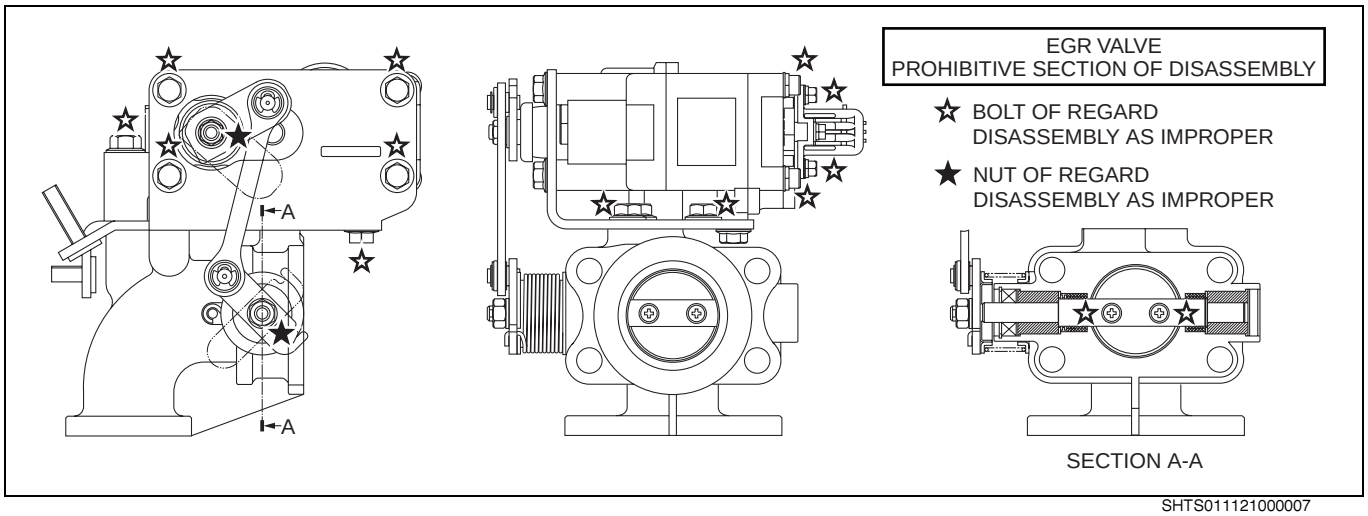


SHTS011121000006

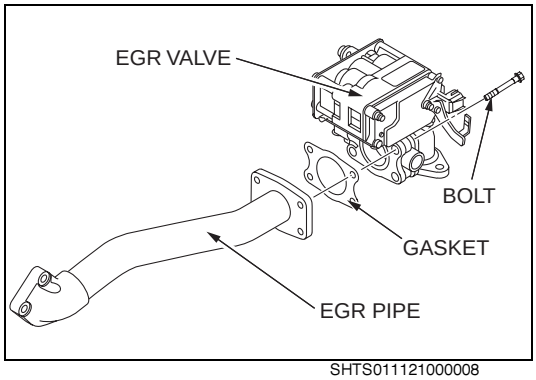
(2) Remove two bolts to remove the EGR valve, the EGR pipe and a gasket from the intake pipe.

⚠ CAUTION

- **During engine maintenance works, do not step on the EGR valve.**
- **Removal/loosening of bolts and nuts on the EGR valve components will cause performance failure.**
- **If bolts and nuts are unfastened to disassemble the EGR valve, make replacement with a new EGR valve. Do not attempt to reassemble a once-disassembled EGR valve.**



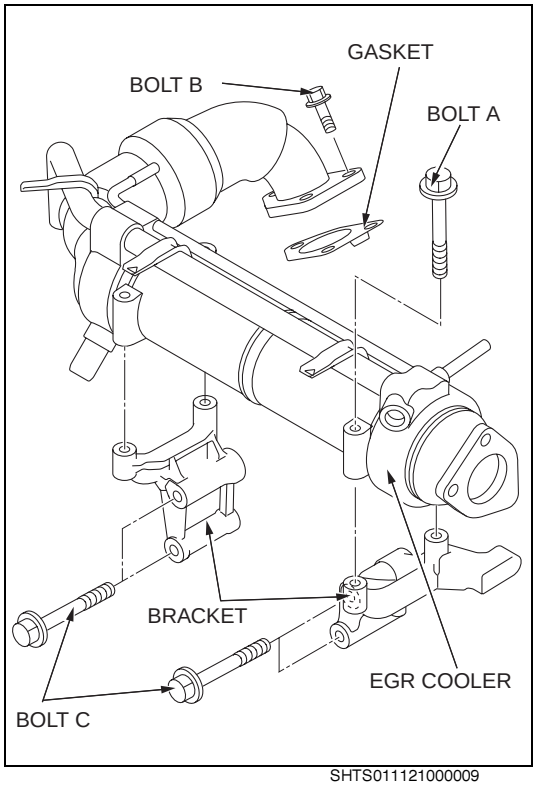
SHTS011121000007



SHTS011121000008

6. DISCONNECT THE EGR PIPE.

(1) Remove four bolts to disconnect the EGR pipe and remove a gasket from the EGR valve.



SHTS011121000009

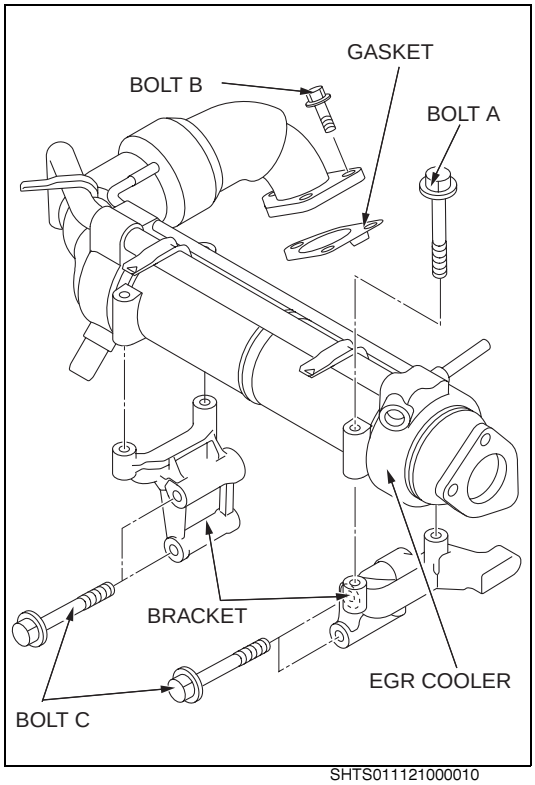
7. REMOVE THE EGR COOLER.

(1) Remove four A bolts, three B bolts and a gasket. Remove the EGR cooler from the brackets.

(2) Remove four C bolts to remove the right/left brackets from the cylinder head.

HINT

If no troubles or failures are found, do not remove these components.



SHTS011121000010

INSTALL THE EGR VALVE AND COOLER.

1. INSTALL THE EGR COOLER.

(1) Pretighten four C bolts to preinstall the right/left brackets to the cylinder head.

HINT

Omit this step if brackets have not been removed.

(2) Pretighten four A bolts to preinstall the EGR cooler to the right/left brackets.

(3) Attach a new gasket between the EGR cooler and the exhaust manifold, and pretighten three B bolts.

(4) Use a specified torque to fully tighten four C bolts that have been pretightened to preinstall the right/left brackets to the cylinder head.
Tightening Torque:
68.5 N·m {700 kgf·cm, 51 lbf·ft}

NOTICE

Make correct positioning before tightening at a specified torque so that no excessive force will be applied to the EGR cooler or brackets.

HINT

Omit this step if brackets have not been removed.

(5) Use a specified torque to fully tighten four A bolts that have been pretightened to preinstall the EGR cooler to the right/left brackets.
Tightening Torque:
28.5 N·m {290 kgf·cm, 21 lbf·ft}

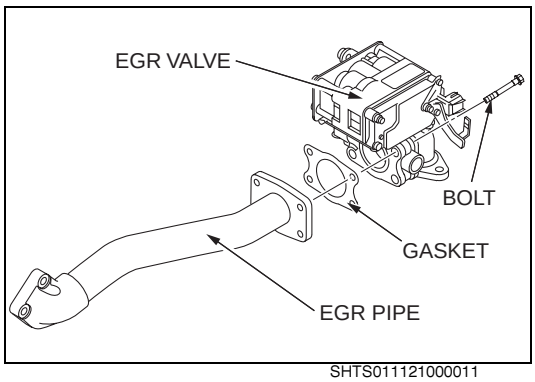
NOTICE

Make correct positioning before tightening at a specified torque so that no excessive force will be applied to the EGR cooler or brackets.

(6) Use a specified torque to fully tighten three B bolts that have been pretightened to preinstall the EGR cooler (on the exhaust manifold side).
Tightening Torque:
68.5 N·m {700 kgf·cm, 51 lbf·ft}

NOTICE

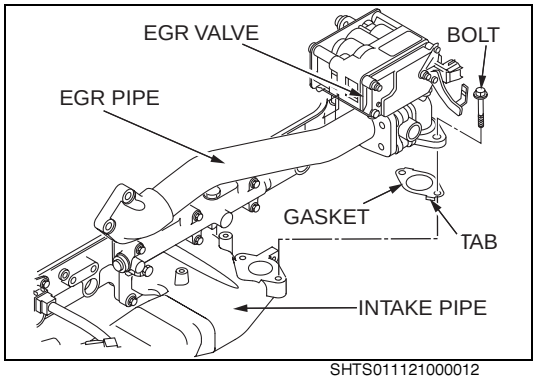
Make correct positioning before tightening at a specified torque so that no excessive force will be applied to the EGR cooler or brackets.



SHTS011121000011

2. CONNECT THE EGR PIPE.

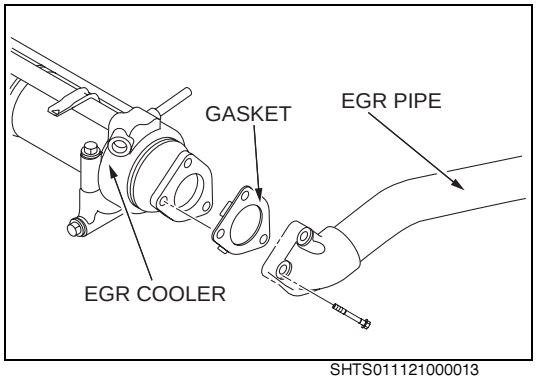
(1) Attach a new gasket between the EGR pipe and the EGR valve, and tighten four bolts.
Tightening Torque:
55 N·m {560 kgf·cm, 41 lbf·ft}



SHTS011121000012

3. INSTALL THE EGR VALVE.

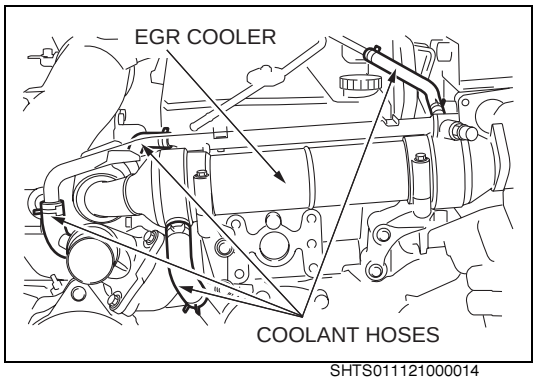
(1) Set the positioning tab of a new gasket in the downward direction, and attach the gasket between the EGR valve and the intake pipe. Pretighten two bolts.



SHTS011121000013

(2) Attach a new gasket between the EGR pipe and the EGR cooler, and fasten three bolts.

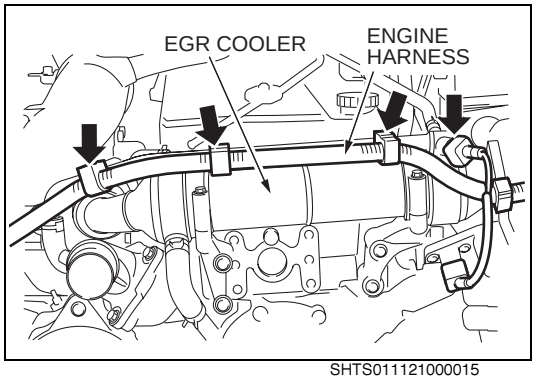
(3) Use a specified torque to fully tighten five bolts that have been pretightened on the intake pipe and the EGR cooler.
Tightening Torque:
55 N·m {560 kgf·cm, 41 lbf·ft}



SHTS011121000014

4. CONNECT THE COOLANT HOSES.

(1) Insert four coolant hoses into the EGR cooler, and fasten eight clips.

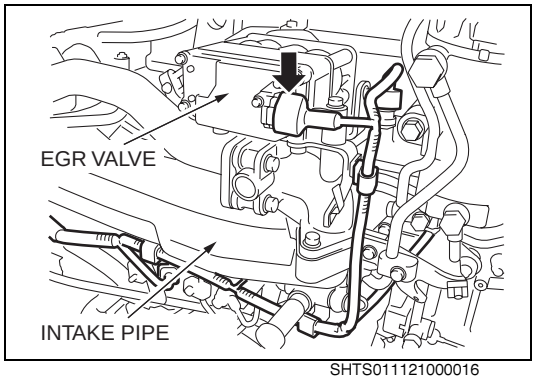


SHTS011121000015

5. CONNECT THE HARNESS.

(1) Connect the engine harness to the EGR cooler, and fasten three clamps.

(2) Connect a connector to the EGR cooler outlet coolant temperature sensor.



SHTS011121000016

(3) Connect the connector of the EGR valve.

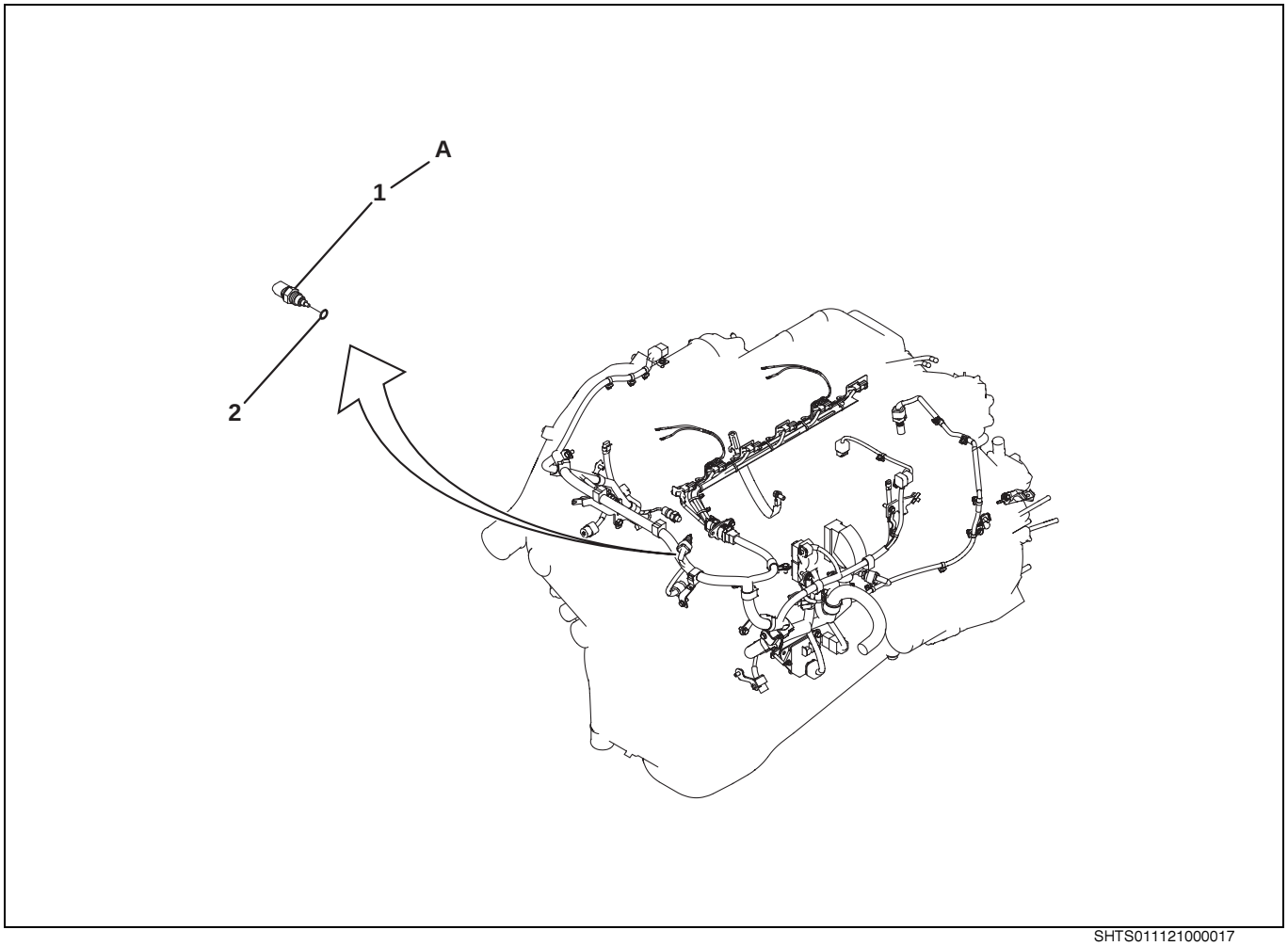
6. FILL COOLANT.

(1) Fill coolant.
Refer to the section **"RADIATOR"** in the chapter **"COOLING SYSTEM"**.

EGR COOLER OUTLET COOLANT TEMPERATURE SENSOR

COMPONENT LOCATOR

EN0111210D100002



SHTS011121000017

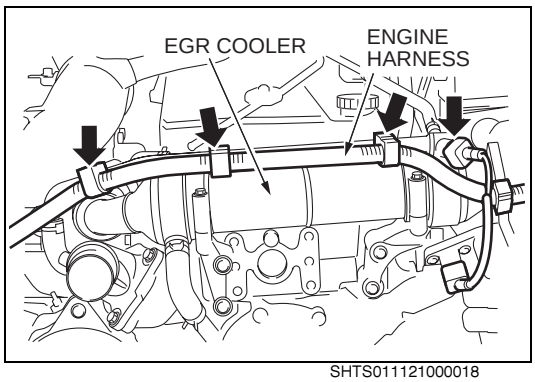
1	EGR cooler outlet coolant temperature sensor	2	Gasket

Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

A	26.95-31.85 {275-325, 20-23}		

REPLACEMENT

EN0111210H100002

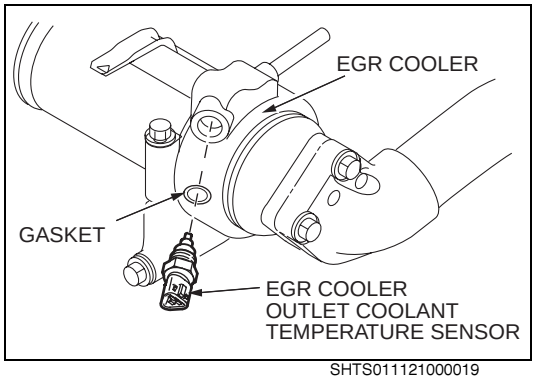


SHTS011121000018

REMOVE THE EGR COOLER OUTLET COOLANT TEMPERATURE SENSOR.

1. DISCONNECT THE HARNESS.

(1) Disconnect a connector of the EGR cooler outlet coolant temperature sensor.



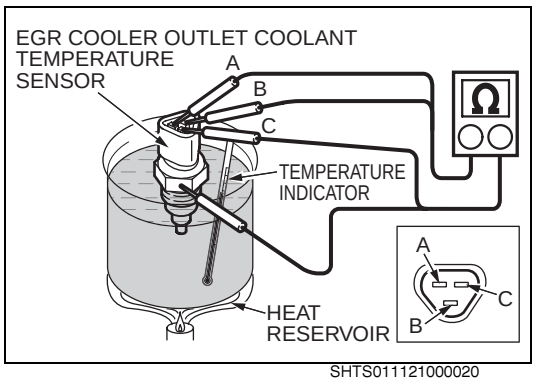
SHTS011121000019

2. REMOVE THE EGR COOLER OUTLET COOLANT TEMPERATURE SENSOR.

(1) Remove the EGR cooler outlet coolant temperature sensor and a gasket from the EGR cooler.

HINT

Use a container and a waste as coolant might drip off during removal of EGR cooler outlet coolant temperature sensor.



SHTS011121000020

COMPONENT CHECK

1. CHECK A RESISTANCE.

(1) Use water or engine oil to heat/cool the coolant temperature sensor.

⚠ CAUTION

If engine oil is used in this step, a temperature must not exceed 120°C {248°F}. Otherwise, hazardous gas might be generated.

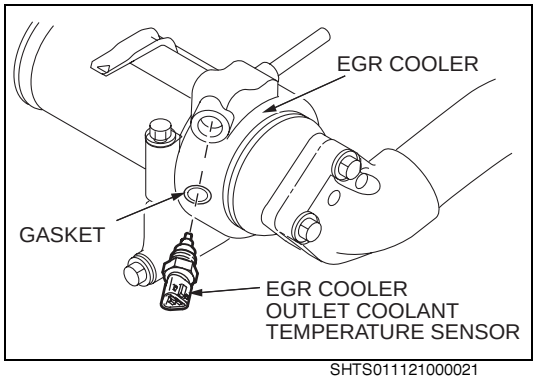
(2) Use a circuit tester to measure the resistance between terminals. If a measurement reading exceeds the standard value, make replacement.

Between A and C terminals

Temperature (°C {°F})	Standard value (Ω)
-20 {-4}	13.84-16.33
20 {68}	2.32-2.59
80 {176}	0.31-0.326
110 {230}	0.1399-0.1435

Between B terminal and body

Temperature (°C {°F})	Standard value (Ω)
75 {167}	79-92
100 {212}	35.5-42.5



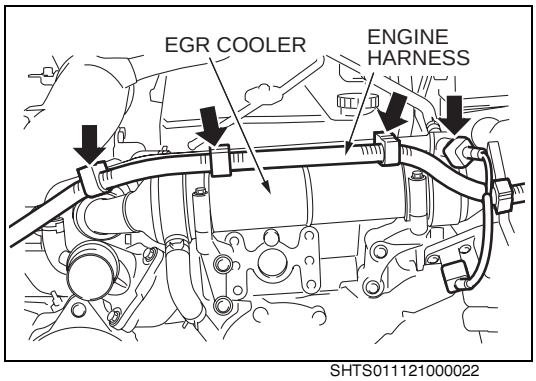
SHTS011121000021

INSTALL THE EGR COOLER OUTLET COOLANT TEMPERATURE SENSOR.

1. INSTALL THE EGR COOLER OUTLET COOLANT TEMPERATURE SENSOR.

(1) Replace an old gasket with a new one, and install the EGR cooler outlet coolant temperature sensor to the EGR cooler.

Tightening Torque:
26.95-31.85 N·m {275-325 kgf·cm, 20-23 lbf·ft}



SHTS011121000022

2. CONNECT THE HARNESS.

(1) Connect a connector of the EGR cooler outlet coolant temperature sensor.

3. FILL THE COOLANT.

(1) Check the coolant level, and refill the coolant if the coolant level is low.
Refer to the section **"RADIATOR"** in the chapter **"COOLING SYSTEM"**.

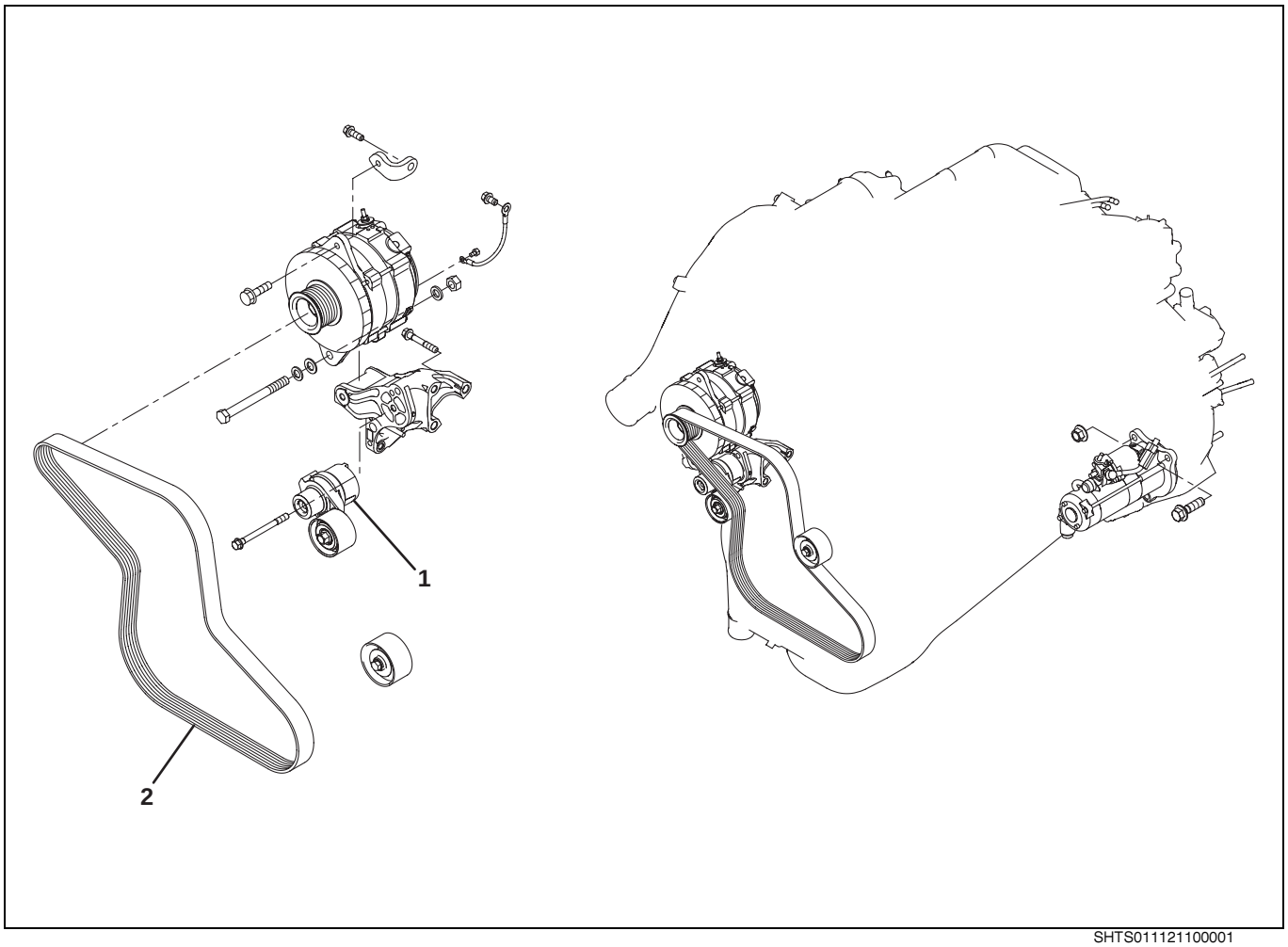
ALTERNATOR (A09C)

EN11-001

V-RIBBED BELT

COMPONENT LOCATOR

EN0111211D100001

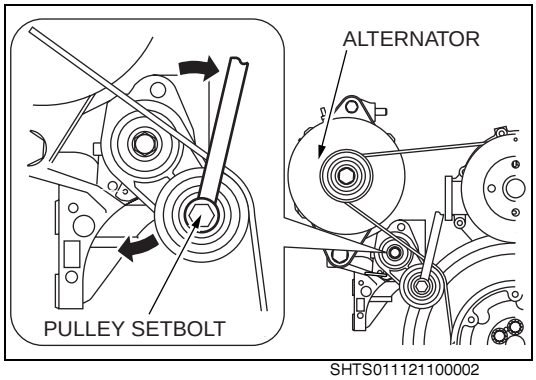


SHTS011121100001

1	Auto tensioner	2	V-ribbed belt

REPLACEMENT

EN0111211H100001



SHTS011121100002

REMOVE THE V-RIBBED BELT.

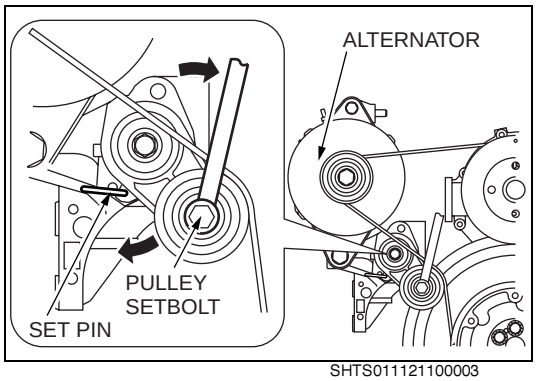
1. REMOVE THE V-RIBBED BELT.

(1) Using a box wrench, move the auto tensioner pulley setbolt slowly to arrow marked direction and loosen the V-ribbed belt.

(2) Remove the V-ribbed belt and bring back the auto tensioner slowly.

NOTICE

Remove and check an indicator if unsmoothness is found when the auto tensioner is activated.



SHTS011121100003

INSTALL THE V-RIBBED BELT.

1. INSTALL THE V-RIBBED BELT.
(IF A SET PIN IS INSTALLED.)

HINT

The set pin is installed when the auto tensioner is replaced.

(1) Preassemble the V-ribbed belt to the pulley other than the auto tensioner pulley. Hold the V-ribbed belt in the location near the auto tension pulley with one of your hands.

(2) With your other hand, gradually turn the pulley setbolt with a box wrench in the direction shown with an arrow in the figure, and pull off the set pin.

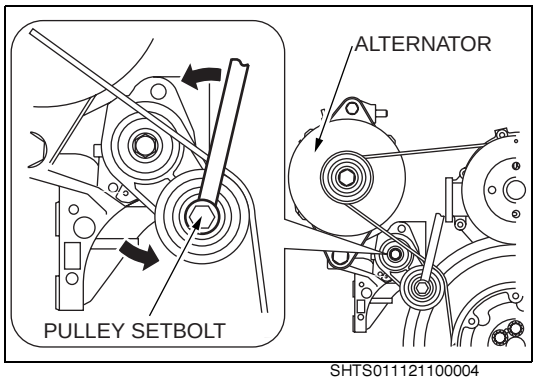
(3) Gradually turn the pulley setbolt back to tension the V-ribbed belt.

NOTICE

Make sure that the V-ribbed belt does not come off from a groove in each pulley.

HINT

The auto tensioner is installed and does not require belt tension adjustments.



SHTS011121100004

2. INSTALL THE V-RIBBED BELT.
(IF A SET PIN IS NOT INSTALLED.)

(1) Preassemble the V-ribbed belt to the pulley other than the auto tensioner pulley. Hold the V-ribbed belt in the location near the auto tensioner pulley with one of your hands.

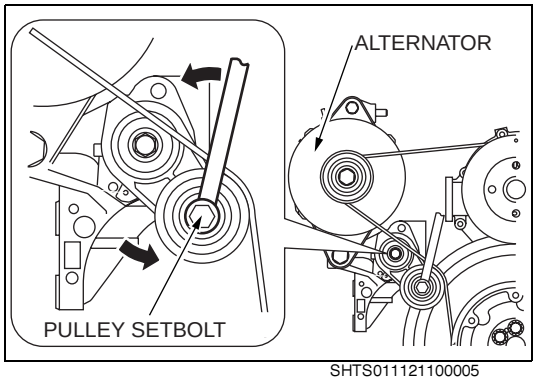
(2) Gradually turn the pulley setbolt back to tension the V-ribbed belt.

NOTICE

Make sure that the V-ribbed belt does not come off from a groove in each pulley.

HINT

The auto tensioner is installed and does not require belt tension adjustments.



SHTS011121100005

AUTO TENSIONER

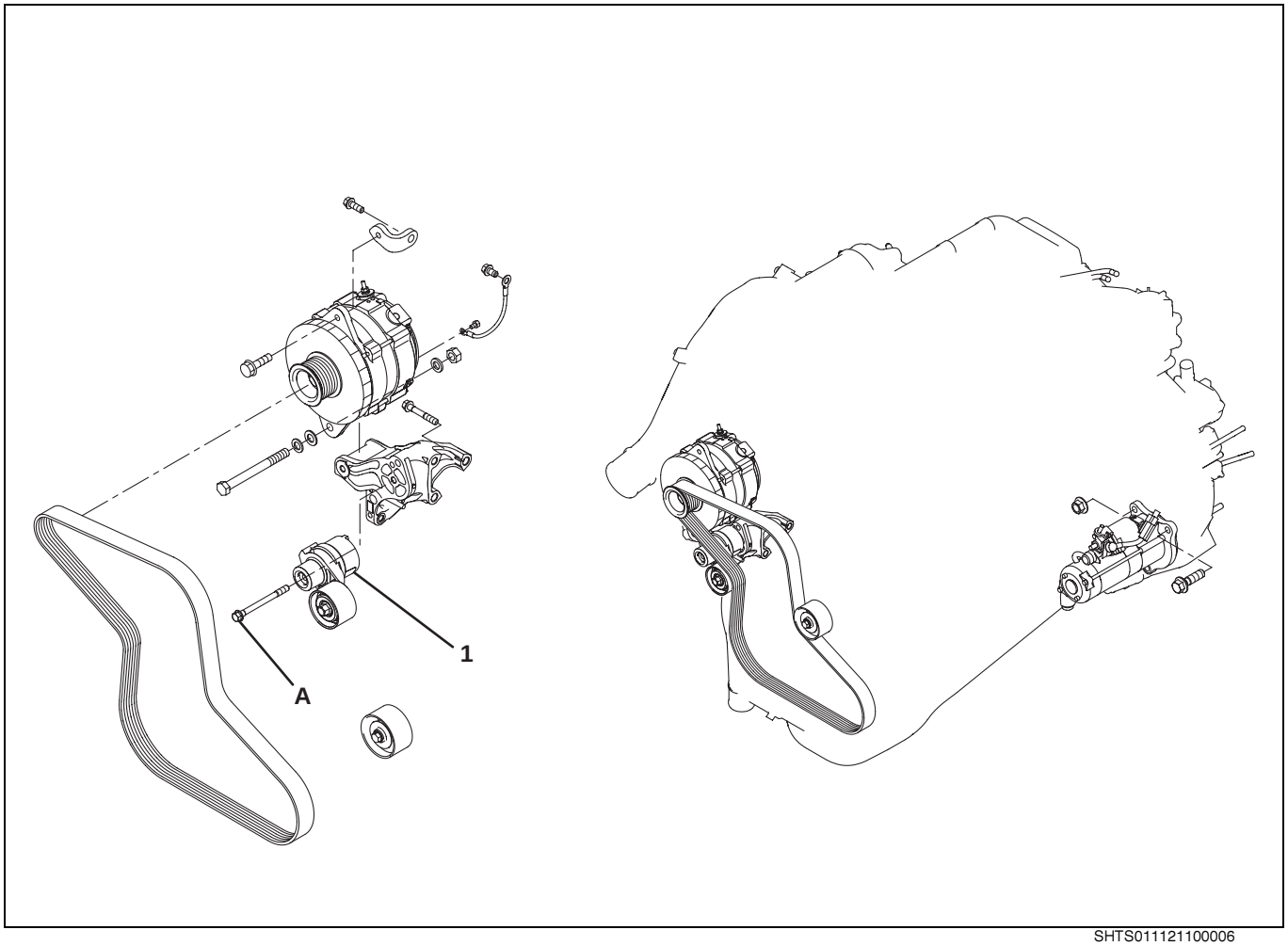
TROUBLESHOOTING

EN0111211F300001

Symptom	Possible cause	Remedy/Prevention
Charging current does not flow (Light does not light)	I.C. regulator faulty	Replace I.C. regulator.
	Stator coil faulty (Disconnecting or rare short)	Replace stator coil.
	Field coil faulty (Disconnecting or rare short)	Replace field coil.
	Diode faulty (Open or short circuit)	Replace rectifier holder.
	Lead wiring disconnected or loose (Plate, support etc.)	Repair or replace.
	Wiring disconnection (Including fuse)	Replace.
Voltmeter indicates 29V or more (Light does not light)	I.C. regulator installation faulty (EX: Installation support)	Repair or replace.
Charging current is always insufficient (Battery goes dead) (Light does light)	Stator coil faulty	Replace stator coil.
	Diode faulty (open or short circuit)	Replace rectifier holder.
	Lead wiring disconnecting or loose (Plate or support etc.)	Repair or replace.
Charging current is always insufficient (Battery goes dead) (Light remains dark)	Volume of using load is too high (Volume of using load is imbalance)	Decrease the load.
Charging current is always too great (Battery does dry in short amount of time) (Light remains dark)	I.C. regulator installation faulty (EX: Installation of support)	Replace rectifier holder.
	Battery nearly over its life period	Repair or replace.
Abnormal noise	Stator coil faulty (Rare short, earth)	Repair or replace.
	Bumping inside (Bearing inside and bracket abrasion)	Repair or replace.
	Tension of belt faulty (Belt slip)	Repair.

COMPONENT LOCATOR

EN0111211D100002



SHTS011121100006

1 Auto tensioner	

Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

A 55 {560, 41}	

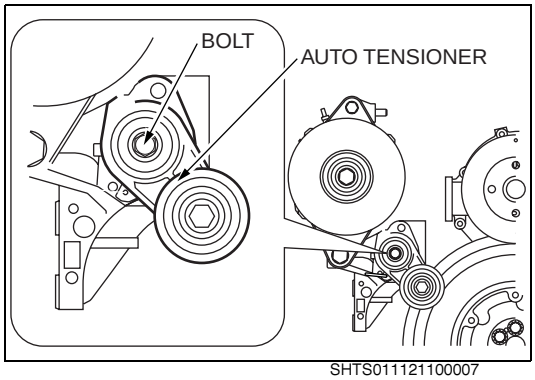
REPLACEMENT

EN0111211H100002

REMOVE THE AUTO TENSIONER.

1. REMOVE THE V-RIBBED BELT.

(1) Remove the V-ribbed belt.
Refer to the section **"V-RIBBED BELT"**.



SHTS011121100007

2. REMOVE THE AUTO TENSIONER.

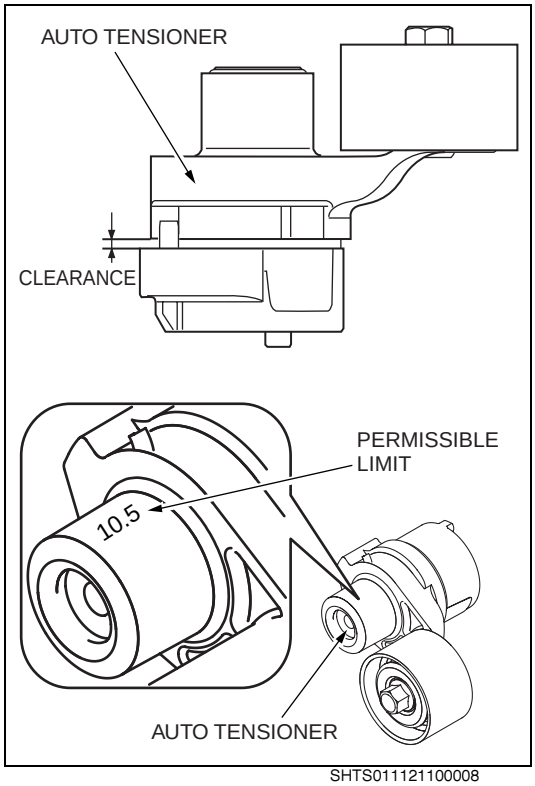
(1) Remove a bolt to remove the auto tensioner from the alternator bracket.

INSTALL THE AUTO TENSIONER.

1. INSTALL THE V-RIBBED BELT.

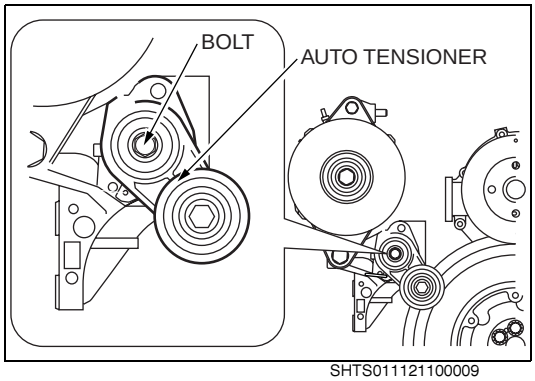
(1) With the auto tensioner having been removed, measure a clearance as shown in the figure. If a measurement reading exceeds the permissible limit, make replacement.

Standard value	Permissible limit
9.0 mm {0.354 in.}	10.5 mm {0.413 in.}



SHTS011121100008

(2) Install the auto tensioner to the alternator bracket, and tighten a bolt.
Tightening Torque:
55 N·m {560 kgf·cm, 41 lbf·ft}



SHTS011121100009

(3) Gradually turn back the pulley setbolt on the auto tensioner to install the V-ribbed belt.
Refer to the section **"V-RIBBED BELT"**.

ALTERNATOR (24V-60A)

DATA AND SPECIFICATIONS

EN0111211I200001

Nominal voltage	**24V**
Nominal output	**24V-60A**
Max. output	**60A at 28V, 5,000 r/min.**
Initial output starting speed	**950 r/min. at 27V**
Max. rotating	**8,400 r/min.**
Rotating direction	**Right (seen from pulley side)**
Regulator	**Mount-on**

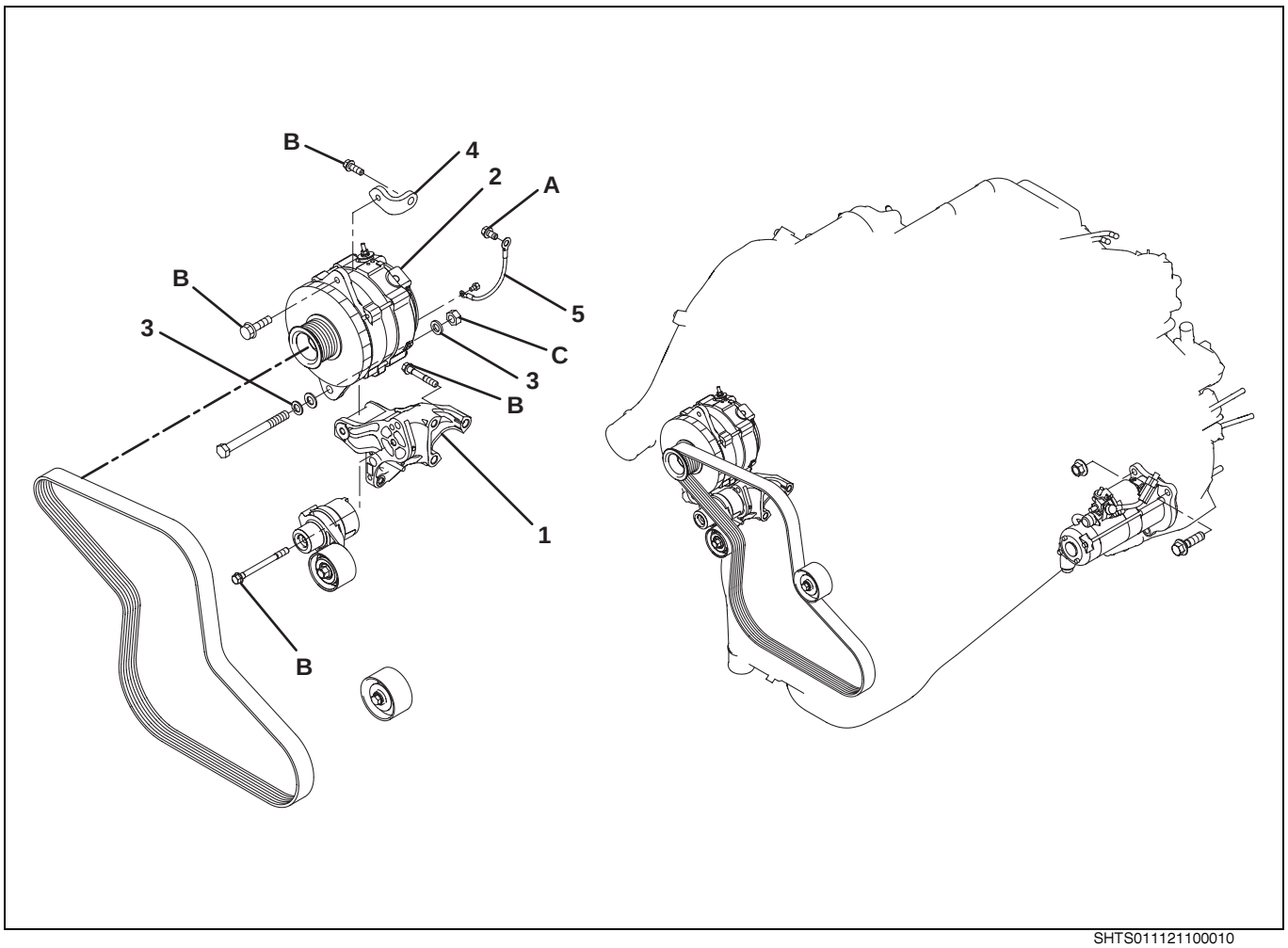
TROUBLESHOOTING

EN0111211F300002

Symptom	Possible cause	Remedy/Prevention
Charging current does not flow (Light does not turn on)	I.C. regulator faulty	Replace I.C. regulator.
	Stator coil faulty (Disconnecting or rare short)	Replace stator coil.
	Field coil faulty (Disconnecting or rare short)	Replace field coil.
	Diode faulty (Open or short circuit)	Replace rectifier holder.
	Lead wiring disconnected or loose (Plate, support etc.)	Repair or replace.
	Wiring disconnection (Including fuse)	Replace.
Voltmeter indicates 29V or more (Light does not turn on)	I.C. regulator faulty	Replace I.C. regulator.
	I.C. regulator installation faulty (EX: Installation support)	Repair or replace.
Charging current flows normally (Light does not turn on)	I.C. regulator faulty	Replace I.C. regulator.
Charging current is always insufficient (Battery goes dead) (Light remains dark)	Stator coil faulty	Replace stator coil.
	Diode faulty (open or short circuit)	Replace rectifier holder.
	Lead wiring disconnecting or loose (Plate or support)	Repair or replace.
	Volume of using load is too high (Volume of using load is imbalance)	Decrease the load.
Charging current is always too great (Battery does dry in short amount of time) (Light remains dark)	I.C. regulator faulty	Replace stator coil.
	I.C. regulator installation faulty (EX: Installation of support)	Replace rectifier holder.
	Battery nearly over its life period	Repair it.
Abnormal noise	Stator coil faulty (Rare short, earth)	Replace stator coil.
	Bumping inside (Bearing inside and bracket abrasion)	Repair or replace.
	Tension of belt faulty (Belt slip)	Repair.

COMPONENT LOCATOR

EN0111211D100003

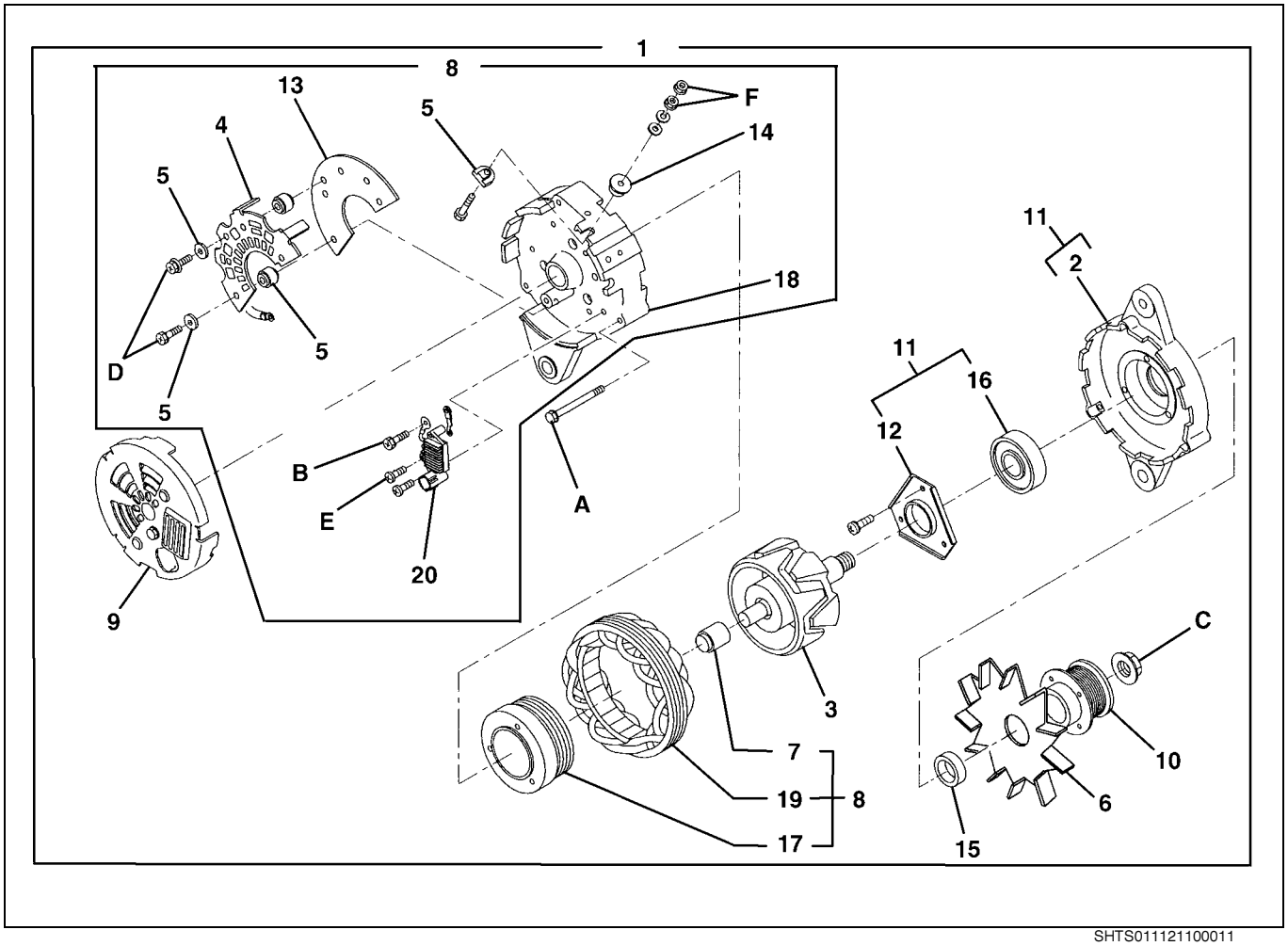


SHTS011121100010

1	Alternator bracket	4	Brace
2	Alternator	5	Alternator earth
3	Washer		

Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

A	4 {40, 2.9}	C	132 {1,350, 97}
B	55 {560, 41}		



SHTS011121100011

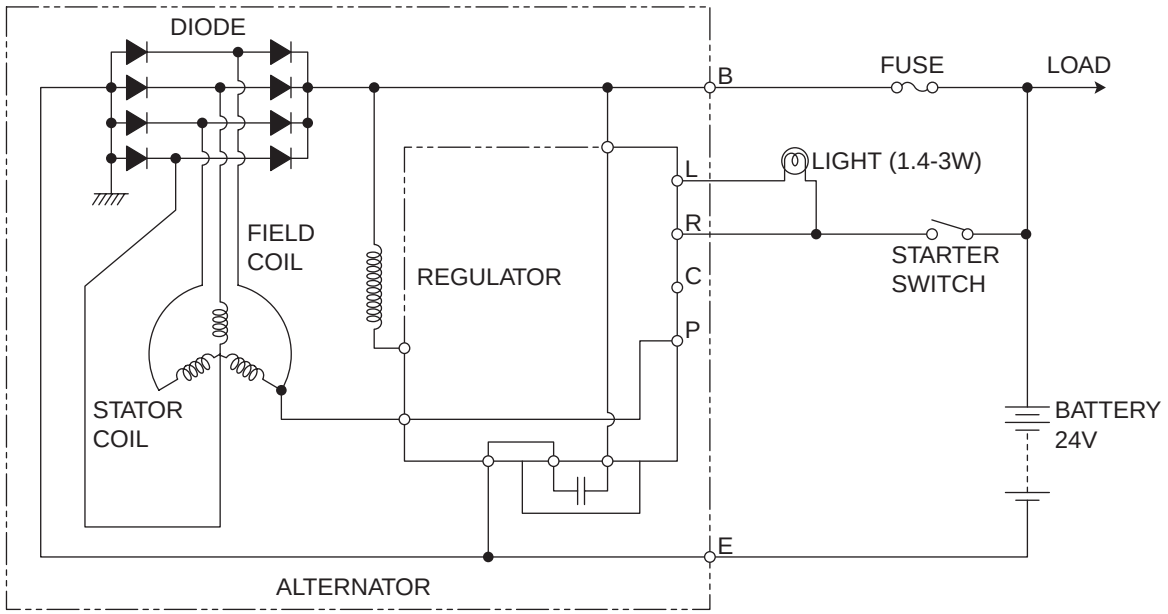
1	Alternator	11	Drive end frame assembly
2	Drive end frame	12	Bearing cover
3	Rotor assembly	13	Rectifier minus
4	Rectifier end frame	14	B terminal
5	Insulator	15	Collar
6	Fan	16	Front bearing
7	Rear bearing	17	Field coil
8	End frame assembly	18	End frame
9	Cover	19	Stator coil
10	Pulley	20	Regulator

Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

A	5.9-8.8 {60-90, 4.4-6.4}	D	1.9-2.5 {20-25, 1.5-1.8}
B	2.9-3.9 {30-39, 2.2-2.8}	E	1.6-2.3 {16-23, 1.2-1.6}
C	127-157 {1,300-1,600, 94-115}	F	4.9-5.9 {50-60, 3.7-4.3} (Inner nut)

DIAGRAM

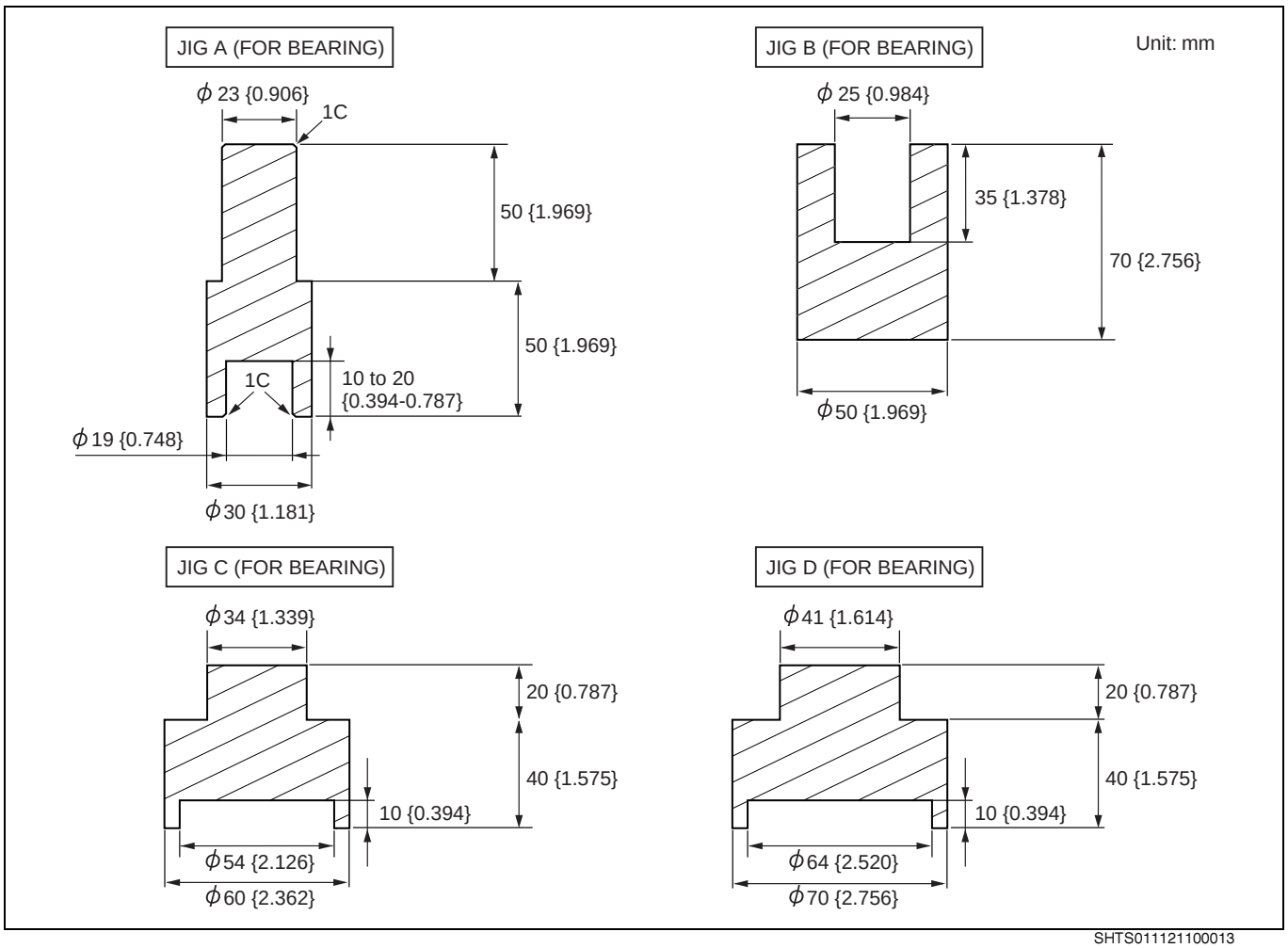
EN0111211J100001



SHTS011121100012

PROPOSAL TOOL

EN0111211K100001



SHTS011121100013

REPLACEMENT

EN0111211H100003

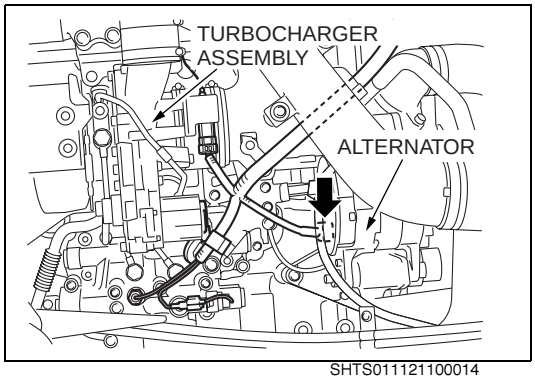
REMOVE THE ALTERNATOR.

1. DISCONNECT THE BATTERY CABLE.

(1) Disconnect the battery earth cable from the battery minus terminal.

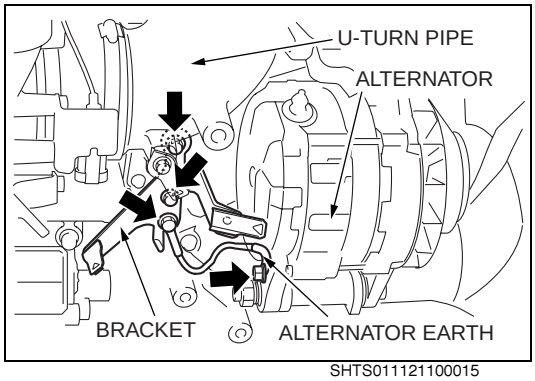
2. DISCONNECT THE HARNESS.

(1) Disconnect the connector of the alternator.



SHTS011121100014

(2) Remove four bolts to remove the alternator earth and bracket.



SHTS011121100015

3. DISCONNECT THE INTAKE PIPE (EXHAUST SIDE).

(1) Disconnect the U-turn pipe and the boost pipe.
Refer to the section **"INTAKE PIPE (EXHAUST SIDE)"** in the chapter **"AIR INTAKE SYSTEM"**.

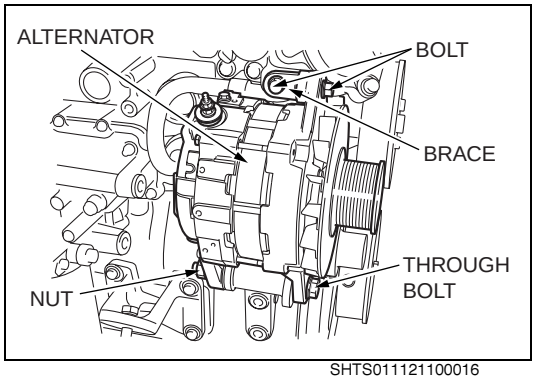
4. REMOVE THE V-RIBBED BELT.

(1) Remove the V-ribbed belt.
Refer to the section **"V-RIBBED BELT"**.

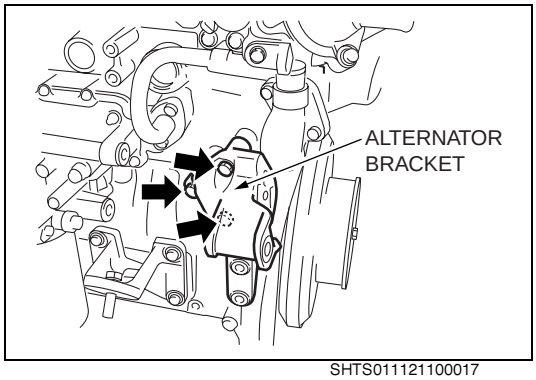
5. REMOVE THE ALTERNATOR.

(1) Remove two bolts to remove the brace.

(2) Remove the nut and through bolt to remove the alternator and washer.



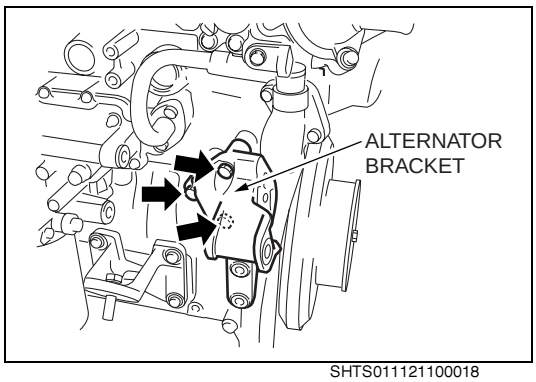
SHTS011121100016



SHTS011121100017

(3) Remove three bolts to remove the alternator bracket from the cylinder block.

HINT
Remove the alternator bracket only if it has some problems.



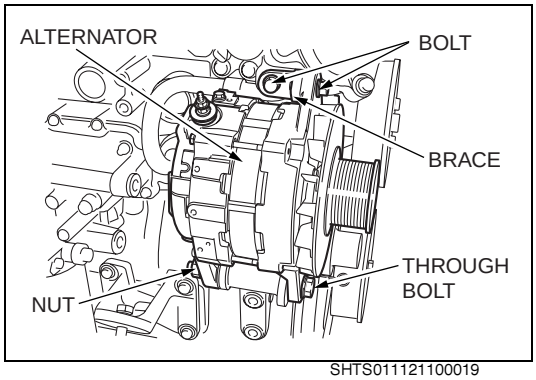
SHTS011121100018

INSTALL THE ALTERNATOR.

1. INSTALL THE ALTERNATOR.

(1) Install the alternator bracket, and tighten three bolts.
Tightening Torque:
55 N·m {560 kgf·cm, 41 lbf·ft}

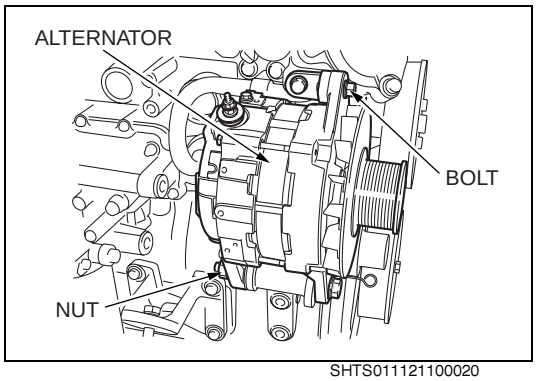
HINT
Omit this work step if the alternator bracket has not been removed.



SHTS011121100019

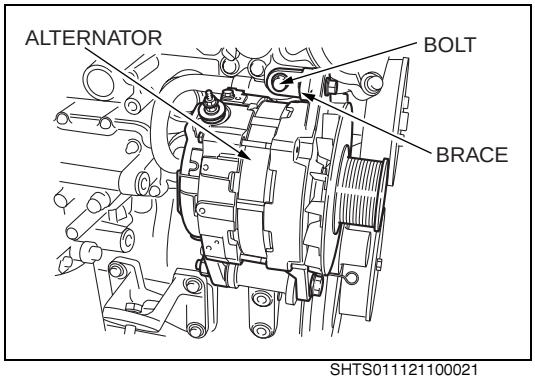
(2) Replace the washer with new one and preinstall the alternator and the brace with two bolts, nut and through bolt.

NOTICE
Adjust the positions of an alternator and a brace carefully so that no excessive force will be applied to the brace.



SHTS011121100020

(3) Use a specified torque to fully tighten a bolt and nut that have been pretighten to preinstall the alternator.
Tightening Torque:
Nut: 132 N·m {1,350 kgf·cm, 97 lbf·ft}
Bolt: 55 N·m {560 kgf·cm, 41 lbf·ft}

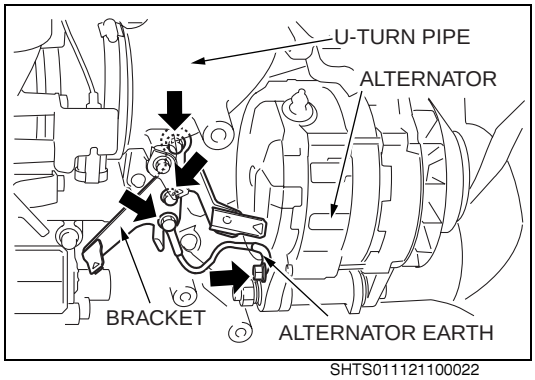


SHTS011121100021

(4) Use a specified torque to fully tighten a bolt that have been pre-tighten to preinstall the brace.
Tightening Torque:
55 N·m {560 kgf·cm, 41 lbf·ft}

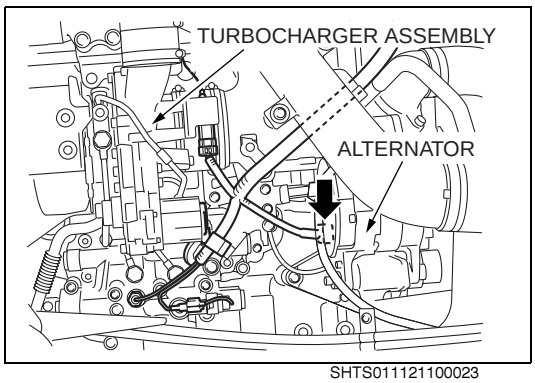
2. INSTALL THE V-RIBBED BELT.
(1) Install the V-ribbed belt.
Refer to the section **"V-RIBBED BELT"**.

3. CONNECT THE INTAKE PIPE (EXHAUST SIDE).
(1) Connect the U-turn pipe and the boost pipe.
Refer to the section **"INTAKE PIPE (EXHAUST SIDE)"** in the chapter **"AIR INTAKE SYSTEM"**.



SHTS011121100022

4. CONNECT THE HARNESS.
(1) Install the alternator earth and bracket, and tighten four bolts.
Tightening Torque:
Alternator earth: 4 N·m {40 kgf·cm, 2.9 lbf·ft}
Bracket: 28.5 N·m {290 kgf·cm, 21 lbf·ft}



SHTS011121100023

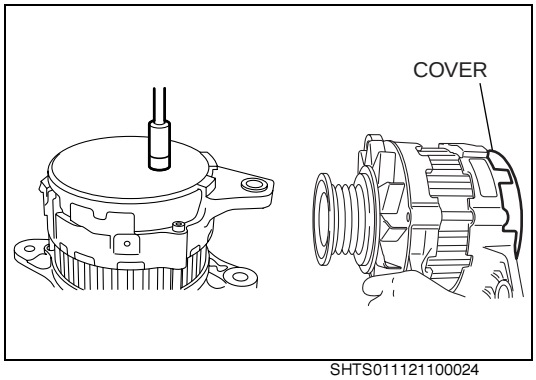
(2) Connect the connector of the alternator.

5. CONNECT THE BATTERY CABLE.
(1) Connect the battery earth cable to the battery minus terminal.

6. CHECK AFTER REINSTALLING THE ALTERNATOR.
(1) Check that the engine harness does not interfere with the alternator.
(2) Ensure that a connector is properly connected.
(3) Check the alternator rotations and charging.

OVERHAUL

EN0111211H200001



SHTS011121100024

DISASSEMBLE THE ALTERNATOR.

1. DISASSEMBLE THE END FRAME AND DRIVE END FRAME.

NOTICE

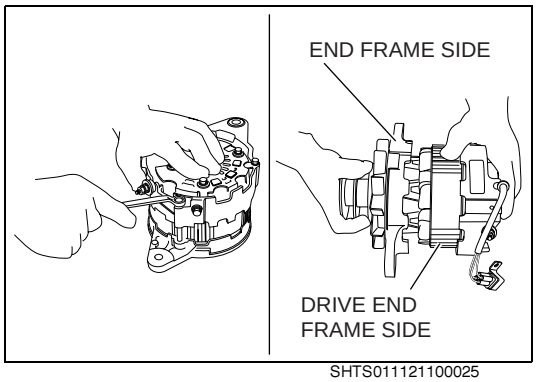
The work should be done on such thing as rubber mat and the like.

(1) Remove the setbolt to remove the cover.

NOTICE

- **To avoid cracks, take care not to apply an excessive force in pressing a tab on the cover.**
- **Do not use a screwdriver to press a tab.**

(2) Remove the through bolts, disassemble the end frame and drive end frame.



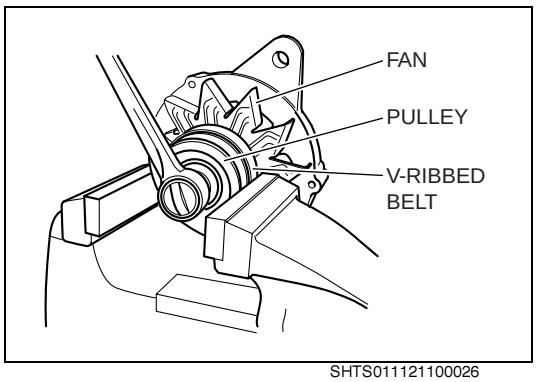
SHTS011121100025

2. DISASSEMBLE THE DRIVE END FRAME SIDE.

(1) Remove the pulley lock nut, remove the pulley, the fan and the collar.1

NOTICE

- **Fit a generally available V-ribbed belt in a groove in the pulley. Use a vise to fixate the pulley.**
- **Do not reuse a pulley if its ridge is damaged.**

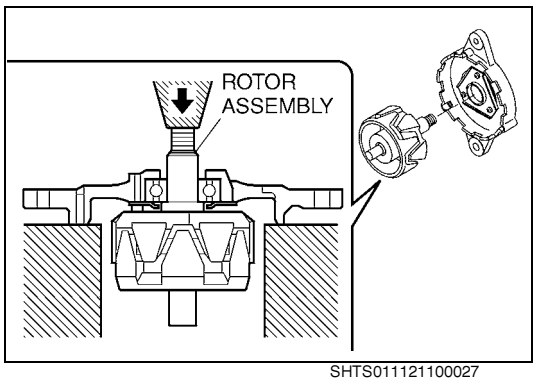


SHTS011121100026

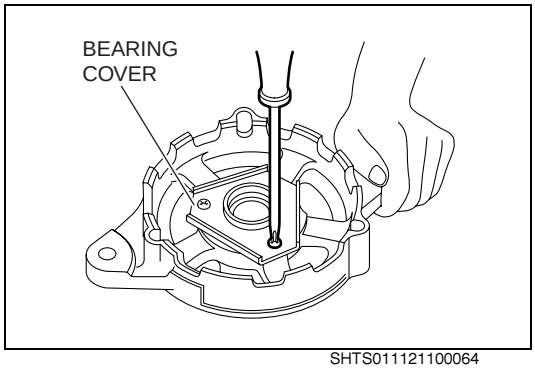
(2) Remove the rotor assembly from drive end frame, using a press.

NOTICE

- **Do not damage to the screw tip.**
- **Hold rotor by hand so that it will not fall off.**

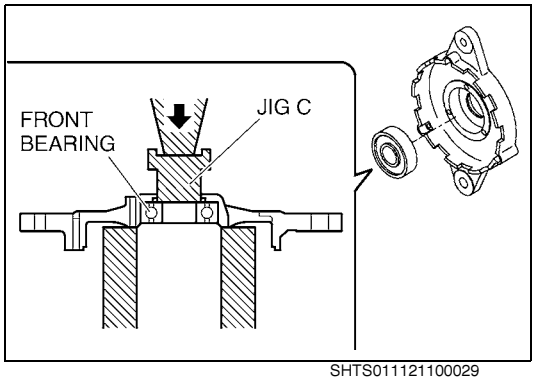


SHTS011121100027



SHTS011121100064

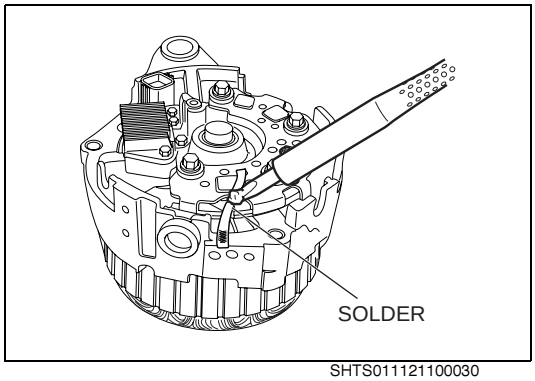
(3) Remove the bolt using a screwdriver to remove the bearing cover.



SHTS011121100029

(4) Using a press and jig C, remove the front bearing from the drive end frame.

NOTICE
Attach the jig C to inner race of the ball bearing.

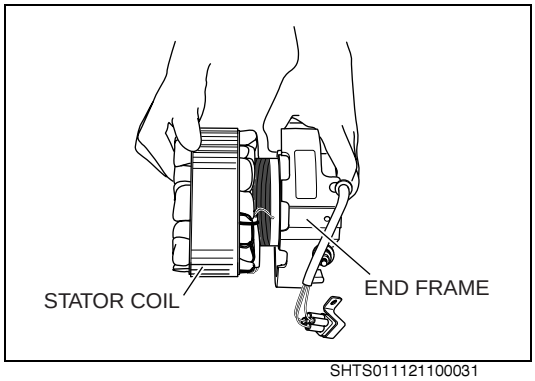


SHTS011121100030

3. DISASSEMBLE THE END FRAME SIDE.
(1) Unsolder the lead wire between starter coil and diode and remove it by pulling gently.

NOTICE

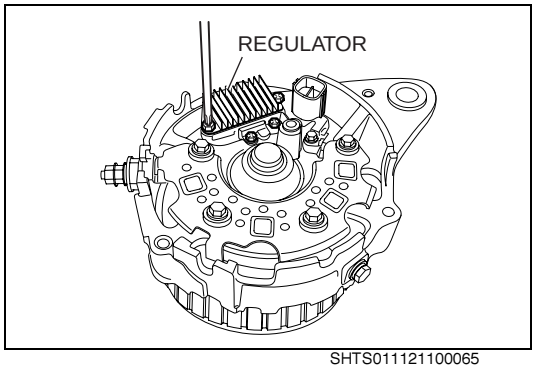
- **Unsolder the wiring connections at the stator and diode and take off excess solder spread claws part at the connections and disconnect stator lead wires.**
- **In case that diode is distorted, do not reuse the diode.**
- **Unsoldering work should be done for short moment (Within 5 sec.).**



SHTS011121100031

(2) Remove the stator from the end frame.

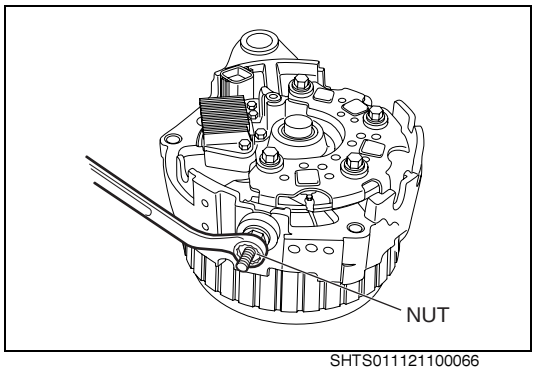
⚠ CAUTION
Be careful not to damage the stator coil.



SHTS011121100065

(3) Remove three regulator connecting bolts and two regulator setbolts, and remove the regulator.

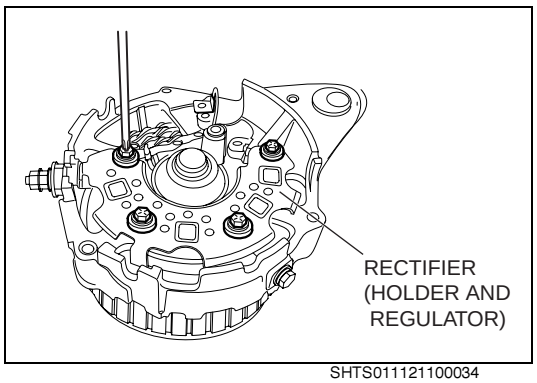
⚠ CAUTION
Regulator setbolt is used not to be unscrewed easily. So, be careful not to damage the groove on bolt head.



SHTS011121100066

(4) Loosen the "B" terminal nut.

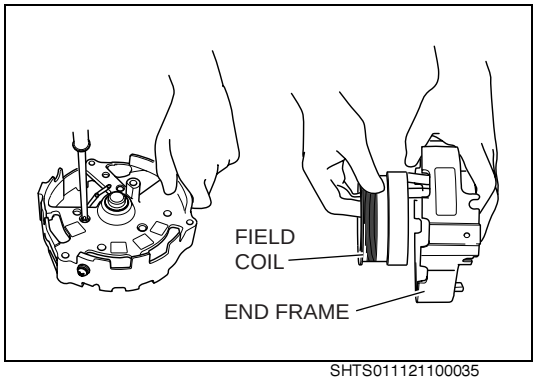
NOTICE
Loosen the nut to some extent and do not remove from terminal B.



SHTS011121100034

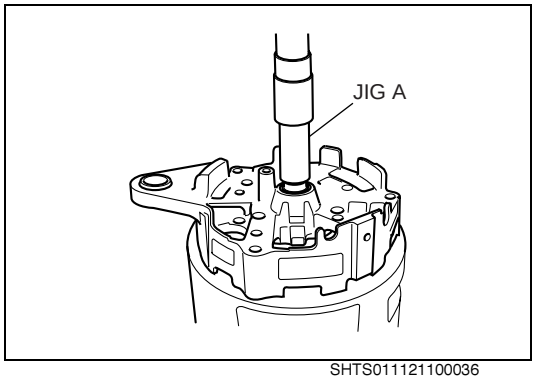
(5) Using a screwdriver, remove four bolts to remove the rectifier holder and regulator.

⚠ CAUTION
Lock agent is used not to be unscrewed easily. So, be careful not to damage the groove on bolt head.



SHTS011121100035

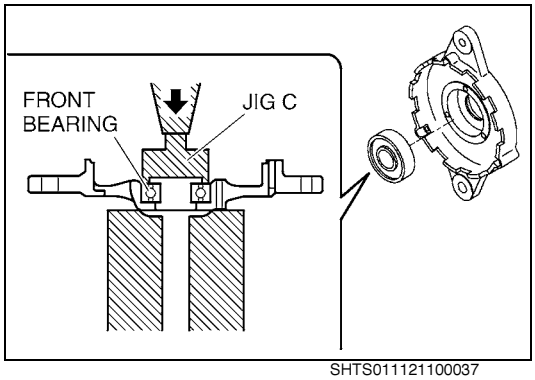
(6) Using a screwdriver, remove three bolts to remove the field coil from the end frame.



SHTS011121100036

(7) Attach the jig A to inner race of the rear bearing and remove rear bearing from the end frame, using a press.

⚠ CAUTION
A removed bearing should not be reused. Replace it with a new one.



SHTS011121100037

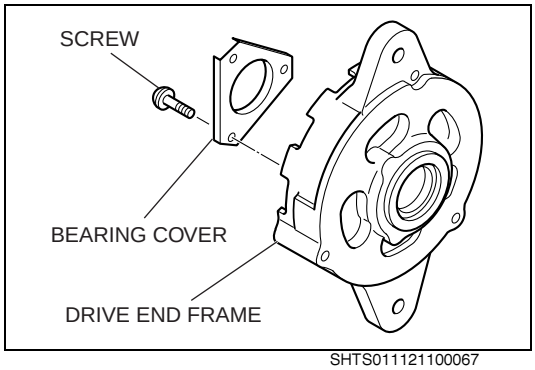
ASSEMBLE THE ALTERNATOR.

1. ASSEMBLE THE DRIVE END FRAME SIDE.

NOTICE
The work should be done on such thing as rubber mat and the like.

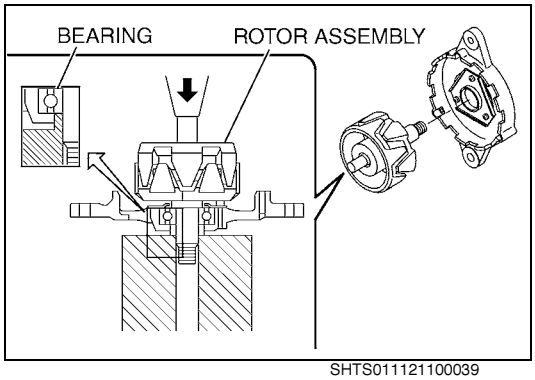
(1) Using a press and a jig C, install new front bearing into the drive end frame.

NOTICE
Attach the jig C on the outer race of the front bearing.



SHTS011121100067

(2) Install the bearing cover to the drive end frame, and tighten a screw.
Tightening Torque:
1.9-2.5 N·m {20-25 kgf·cm, 1.5-1.8 lbf·ft}

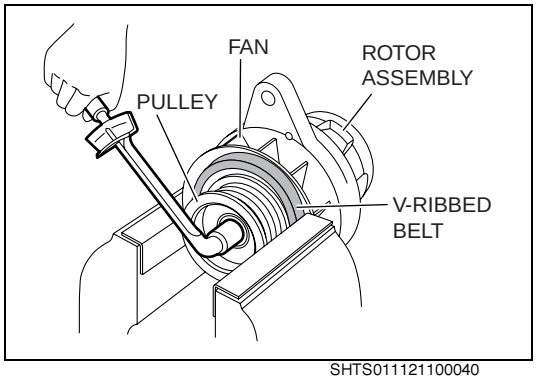


SHTS011121100039

(3) Using a press, install the rotor assembly.

NOTICE

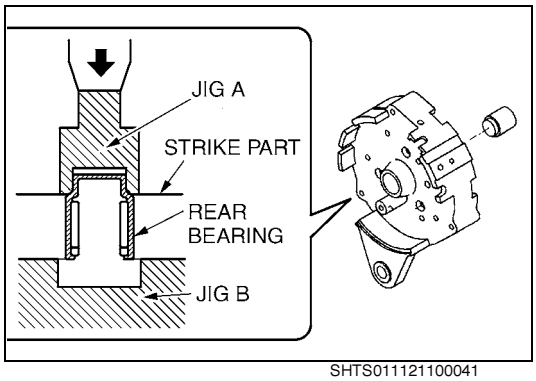
- **When pressing in rotor, it should be supported by the inner lace of bearing.**
- **Take care not to damage the rotor shaft.**



SHTS011121100040

(4) Fit a generally available V-ribbed belt in a groove in the pulley. Use a vise to fixate the pulley.
(5) Install the collar, fan and pulley to the shaft of the rotor assembly.
Tightening Torque:
127-157 N·m {1,300-1,600 kgf·cm, 94-115 lbf·ft}

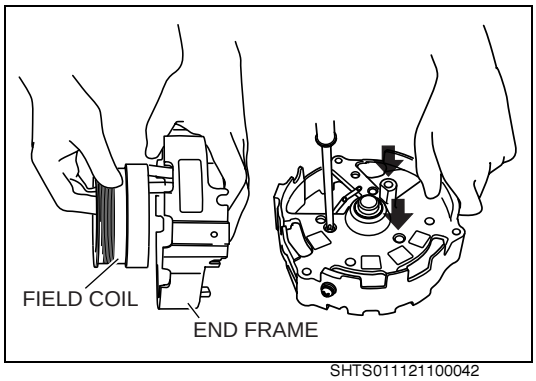
⚠ CAUTION
Do no reuse a pulley if its ridge is damaged.



SHTS011121100041

2. ASSEMBLE THE END FRAME SIDE.
(1) Using a press, jig A and jig B, install new rear bearing into the end frame.

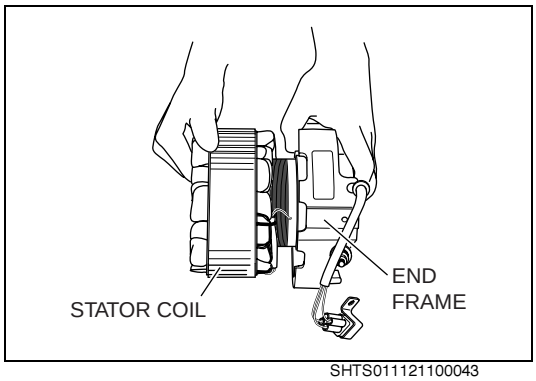
NOTICE
- **Press fit until jig A hits to the end frame.**
- **If the bearing case is deformed or damaged during press-fitting, do not reuse it.**



SHTS011121100042

(2) Install the field coil to the end frame.
Tightening Torque:
2.9-3.9 N·m {30-39 kgf·cm, 2.2-2.8 lbf·ft}

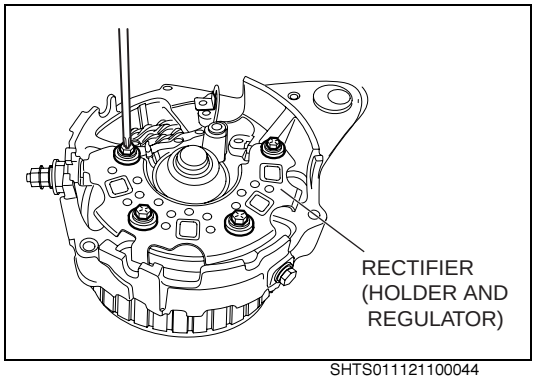
NOTICE
Tighten bolts evenly after pretightening.



SHTS011121100043

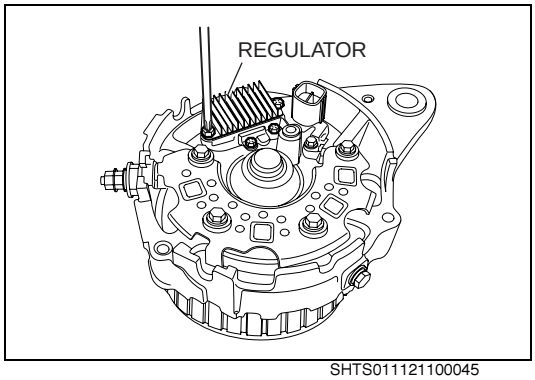
(3) Preinstall the stator coil to the end frame.

⚠ CAUTION
Be careful not to damage the stator coil.



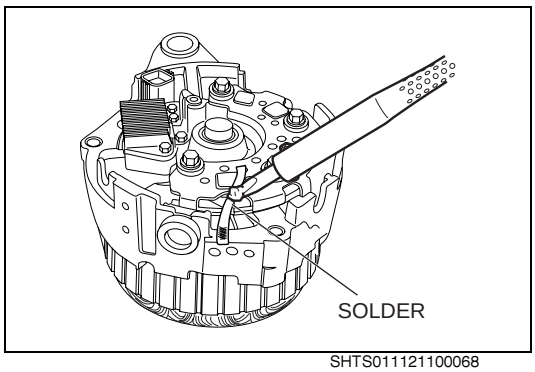
SHTS011121100044

(4) Apply lock agent (ThreeBond TB1344) to the tip of mounting bolts for rectifier. Install the rectifier to the end frame, and tighten the bolts.
Tightening Torque:
1.9-2.5 N·m {20-25 kgf·cm, 1.5-1.8 lbf·ft}



SHTS011121100045

(5) Apply lock agent (ThreeBond TB1344) to the tip of setbolts for regulator. Install the regulator to the end frame, and tighten the bolts.
Tightening Torque:
Regulator: 1.6-2.3 N·m {16-23 kgf·cm, 1.2-1.6 lbf·ft}
Coil lead: 1.0-1.4 N·m {10-14 kgf·cm, 0.8-1.0 lbf·ft}
Heat sink: 1.0-1.4 N·m {10-14 kgf·cm, 0.8-1.0 lbf·ft}

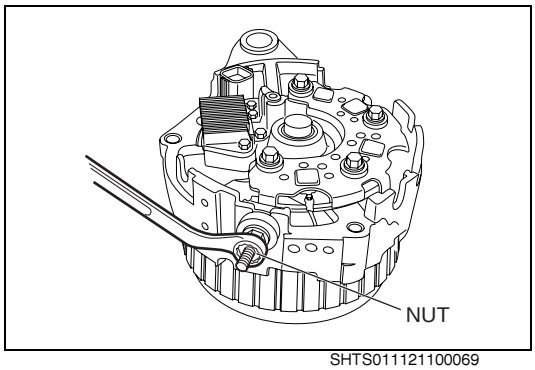


SHTS011121100068

(6) Using a solder ring iron, solder the lead wire connecting the regulator and field coil as well as the stator coil and diode.

NOTICE

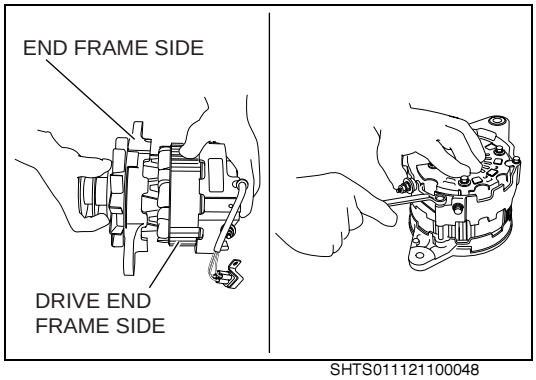
- **Soldering work should be done just after tightening the bolt.**
- **Solder lead wire after bending and fixing the terminal of regulator.**
- **Solder field coil after caulking the tip of diode.**
- **Soldering work should be done for short moment (Within 5 sec.).**



SHTS011121100069

(7) Tighten the inner nut of the B terminal.
Tightening Torque:
4.9-5.9 N·m {50-60 kgf·cm, 3.7-4.3 lbf·ft}

HINT
Outer nut should be tightened after installing alternator and connecting its wiring.

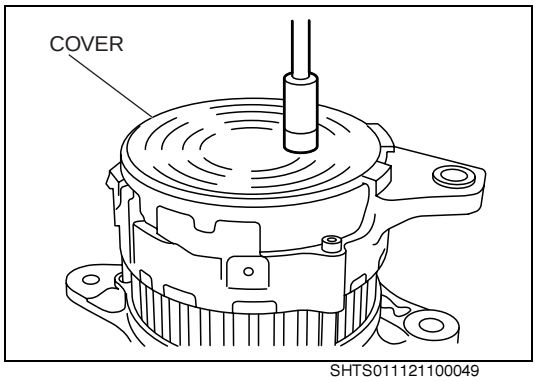


SHTS011121100048

3. ASSEMBLE THE END FRAME AND DRIVE END FRAME.

(1) Assemble the end frame and drive end frame with the through bolts.
Tightening Torque:
7.8-9.8 N·m {80-100 kgf·cm, 5.8-7.2 lbf·ft}

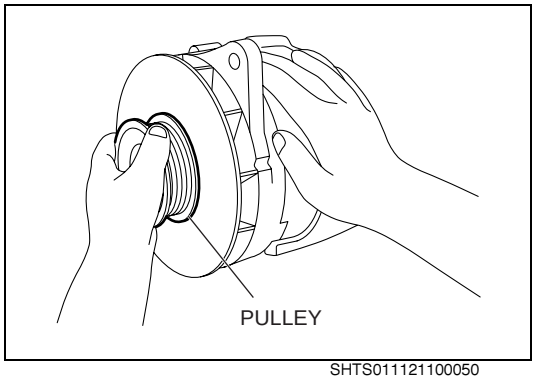
NOTICE
Tighten the through bolt evenly.



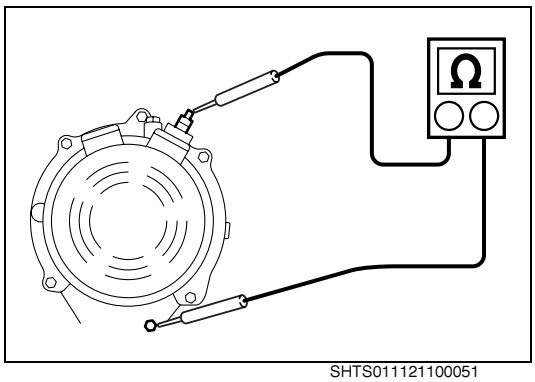
SHTS011121100049

(2) Attach a cover with its tab positioned in place, and tighten bolts.
Tightening Torque:
3.2-4.4 N·m {33-44 kgf·cm, 2.4-3.2 lbf·ft}

⚠ CAUTION
Do not hit the cover, it might cause tab damage.



SHTS011121100050



SHTS011121100051

CHECK THE ALTERNATOR.

1. CHECK THE ALTERNATOR FOR PROPER ROTATION.

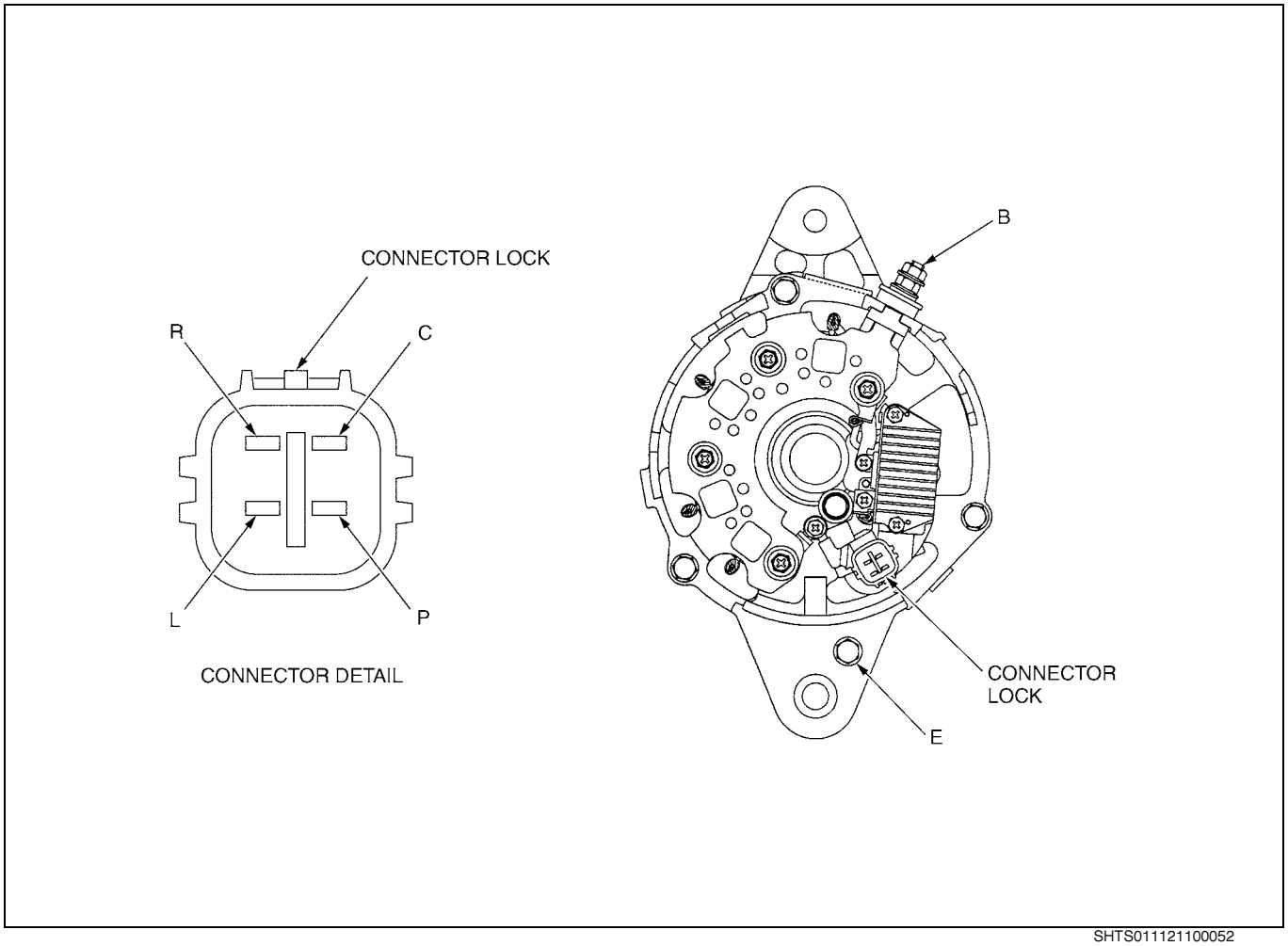
NOTICE

The work should be done on such thing as rubber mat and the like.

(1) Turn the pulley by hand and make sure that there is no noise, catching or rough movement in the shaft direction and that it rotates smoothly.

(2) Measure the resistance between terminals. If the resistance is not specified value, reassemble the alternator.

Test lead		Standard
(+)	(–)	
B	E	APPROX. 20 Ω
E	B	∞ Ω
P	E	APPROX. 7 Ω
E	P	∞ Ω

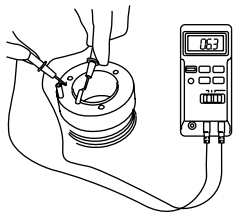
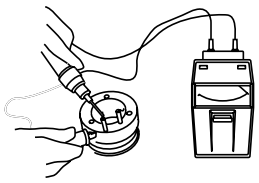
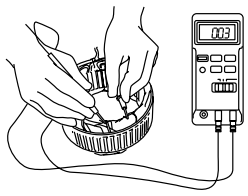
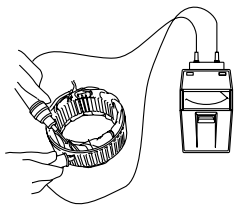
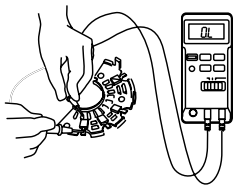
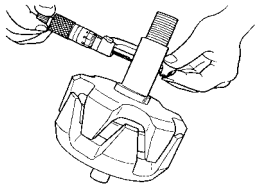
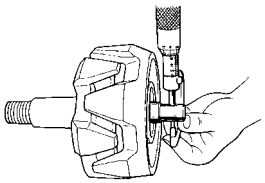


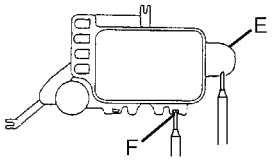
SHTS011121100052

INSPECTION AND REPAIR

EN0111211H300001

Unit: mm {in.}

Inspection item	Standard	Limit	Remedy	Inspection procedure
Resistance of field coil [at 20°C (68°F)]	**6.2-6.8 Ω**	**—**	**Replace.**	**Measure** 
Insulation resistance of field coil	**1 MΩ or more**	**—**	**Replace.**	**Measure** 
Resistance of stator coil [at 20°C (68°F)]	**0.15-0.17 Ω**	**—**	**Replace.**	**Measure** 
Insulation resistance of stator	**1 MΩ or more**	**—**	**Replace.**	**Measure** 
Resistance of diode	**Normal direction APPROX. 10 Ω Reverse direction ∞ Ω**	**—**	**Replace.**	**Measure** 
Rotor shaft outside diameter (Front bearing portion)	**25 {0.984}**	**24.98 {0.9835}**	**Replace.**	**Measure** 
Rotor shaft outside diameter (Rear bearing portion)	**17 {0.669}**	**16.98 {0.6685}**	**Replace.**	**Measure** 

Inspection item	Standard	Limit	Remedy	Inspection procedure
Resistance of regulator	**Normal direction APPROX. 10 Ω Reverse direction** ∞ Ω	**—**	**Replace.**	**Measure** 

ALTERNATOR (24V-90A)

DATA AND SPECIFICATIONS

EN0111211I200002

Nominal voltage	**24V**
Nominal output	**24V-90A**
Max. output	**90A at 28V, 5,000 r/min.**
Initial output starting speed	**1,000 r/min. at 27V**
Max. rotating	**8,400 r/min.**
Rotating direction	**Right (seen from pulley side)**
Regulator	**Mount-on**

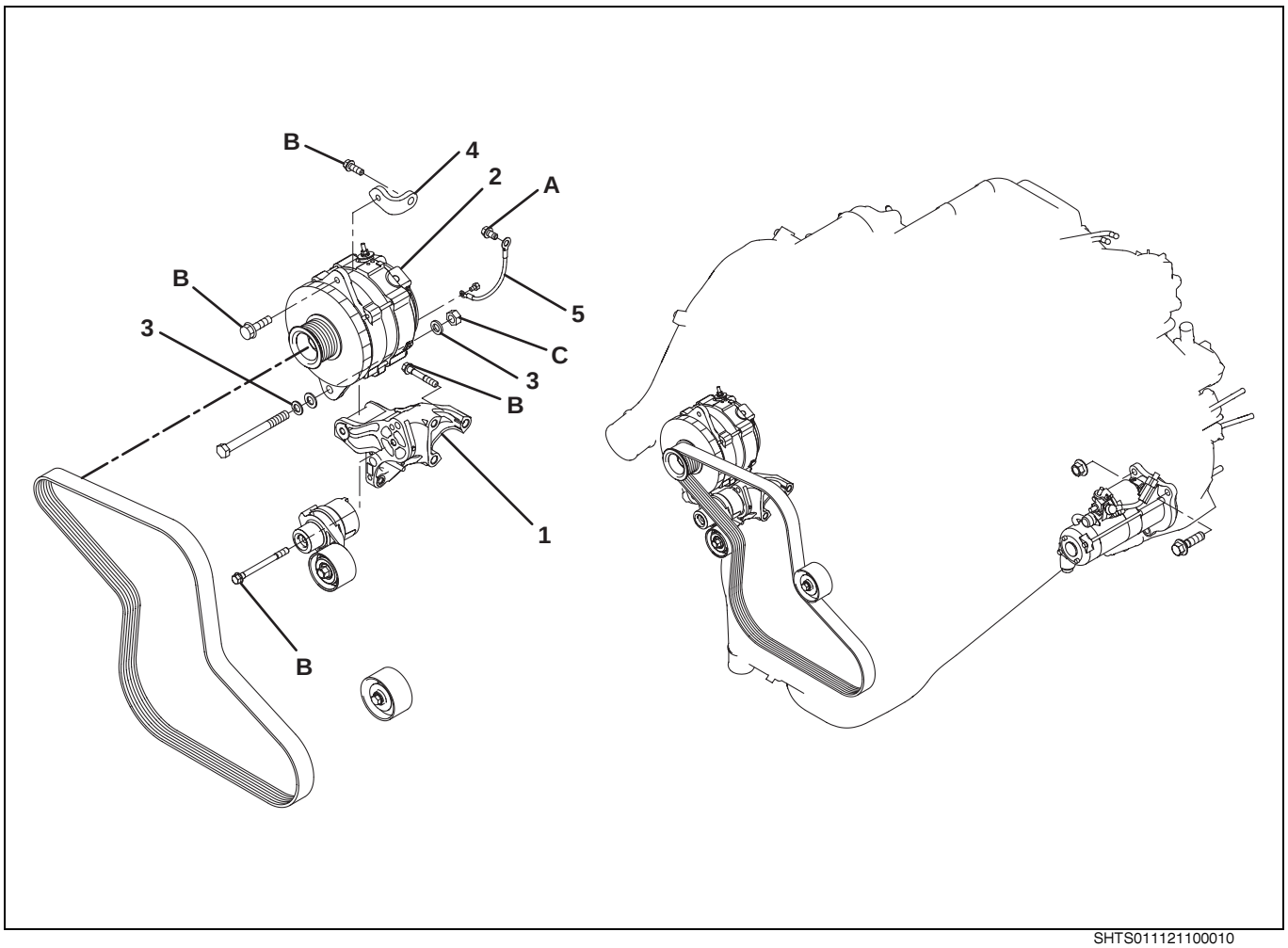
TROUBLESHOOTING

EN0111211F300003

Symptom	Possible cause	Remedy/Prevention
Charging current does not flow (Light does not turn on)	I.C. regulator faulty	Replace I.C. regulator.
	Stator coil faulty (Disconnecting or rare short)	Replace stator coil.
	Field coil faulty (Disconnecting or rare short)	Replace field coil.
	Diode faulty (Open or short circuit)	Replace rectifier holder.
	Lead wiring disconnected or loose (Plate, support etc.)	Repair or replace.
	Wiring disconnection (Including fuse)	Replace.
Voltmeter indicates 29V or more (Light does not turn on)	I.C. regulator faulty	Replace I.C. regulator.
	I.C. regulator installation faulty (EX: Installation support)	Repair or replace.
Charging current flows normally (Light does not turn on)	I.C. regulator faulty	Replace I.C. regulator.
Charging current is always insufficient (Battery goes dead) (Light remains dark)	Stator coil faulty	Replace stator coil.
	Diode faulty (open or short circuit)	Replace rectifier holder.
	Lead wiring disconnecting or loose (Plate or support)	Repair or replace.
	Volume of using load is too high (Volume of using load is imbalance)	Decrease the load.
Charging current is always too great (Battery does dry in short amount of time) (Light remains dark)	I.C. regulator faulty	Replace stator coil.
	I.C. regulator installation faulty (EX: Installation of support)	Replace rectifier holder.
	Battery nearly over its life period	Repair it.
Abnormal noise	Stator coil faulty (Rare short, earth)	Replace stator coil.
	Bumping inside (Bearing inside and bracket abrasion)	Repair or replace.
	Tension of belt faulty (Belt slip)	Repair.

COMPONENT LOCATOR

EN0111211D100004

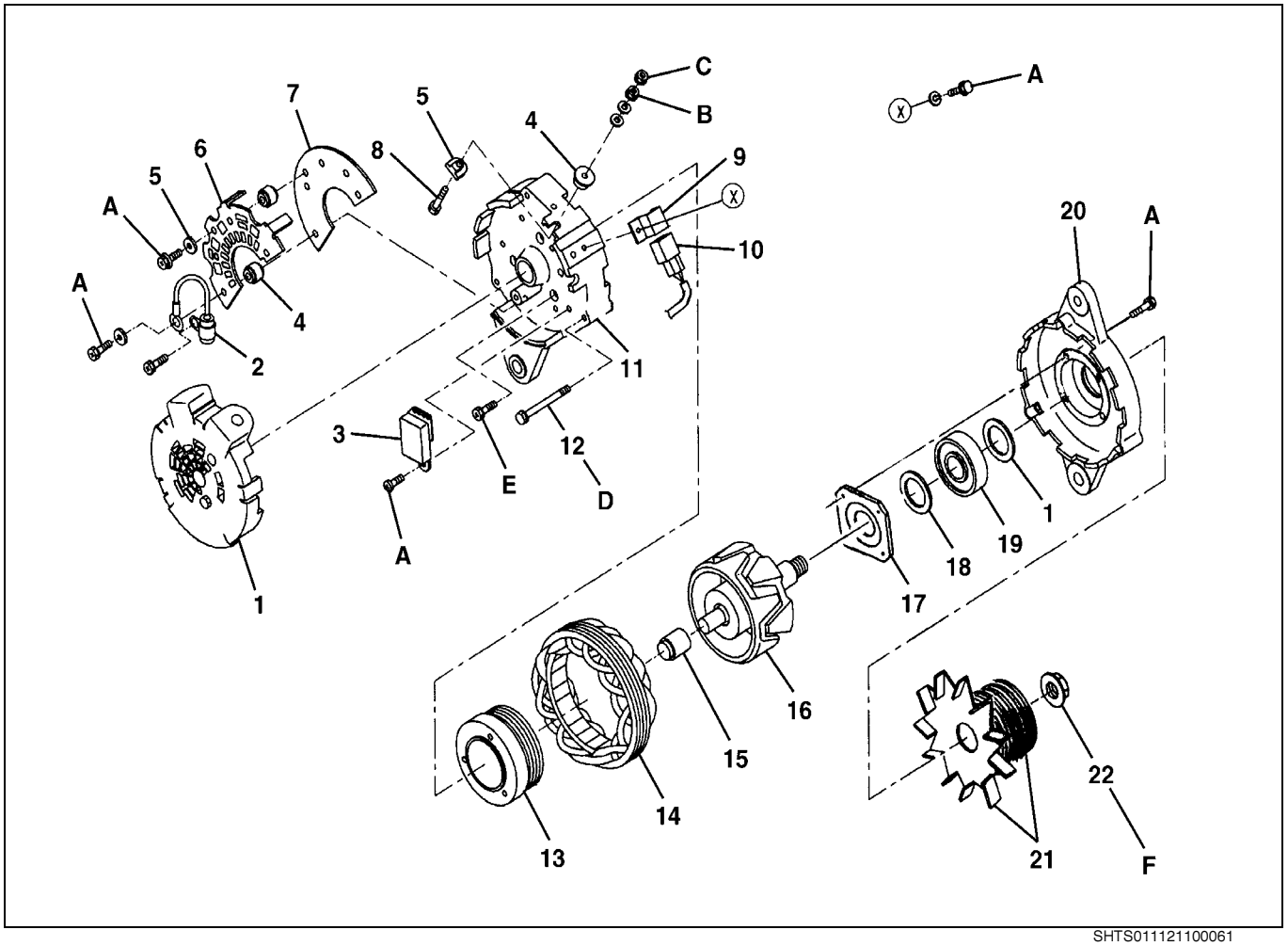


SHTS011121100010

1	Alternator bracket	4	Brace
2	Alternator	5	Alternator earth
3	Washer		

Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

A	4 {40, 2.9}	C	132 {1,350, 97}
B	55 {560, 41}		



SHTS011121100061

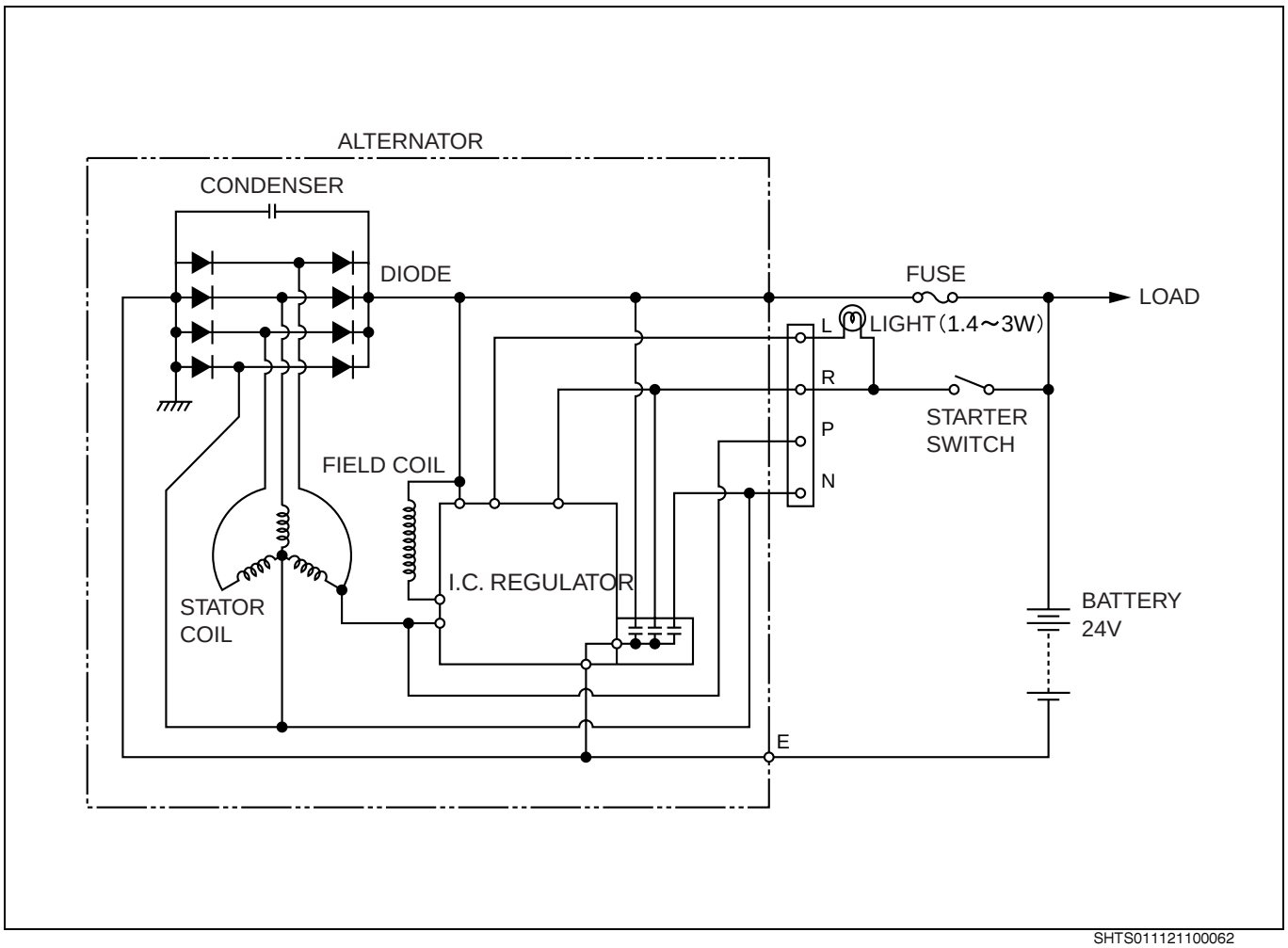
1	Cover	12	Through bolt
2	Condenser	13	Field coil
3	Regulator	14	Stator assembly
4	Terminal insulator	15	Roller bearing
5	Terminal insulator	16	Rotor assembly
6	Rectifier holder	17	Retainer plate
7	Holder	18	Shim
8	Terminal bolt	19	Ball bearing
9	Clamp	20	Drive end frame
10	Lead wire connector	21	Fan and pulley
11	Rectifier end frame	22	Lock nut

Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

A	1.9-2.5 {20-25, 1.5-1.8}	D	2.9-3.9 {30-39, 2.2-2.8}
B	4.9-5.9 {50-60, 3.7-4.3}	E	5.9-8.8 {60-90, 4.4-6.4}
C	3-5 {31-50, 2.3-3.6}	F	127-157 {1,300-1,600, 94-115}

DIAGRAM

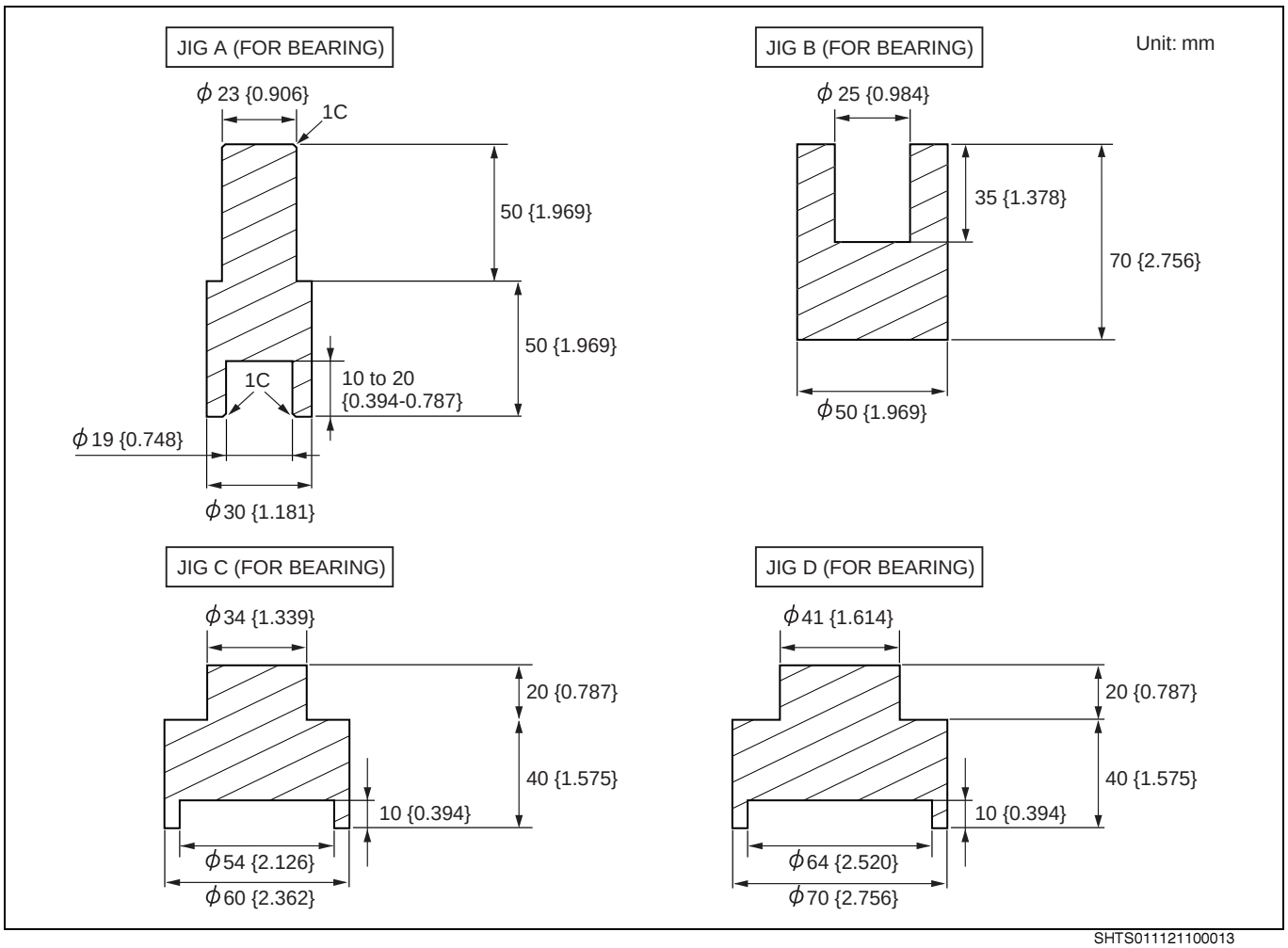
EN0111211J100002



SHTS011121100062

PROPOSAL TOOL

EN0111211K100002



SHTS011121100013

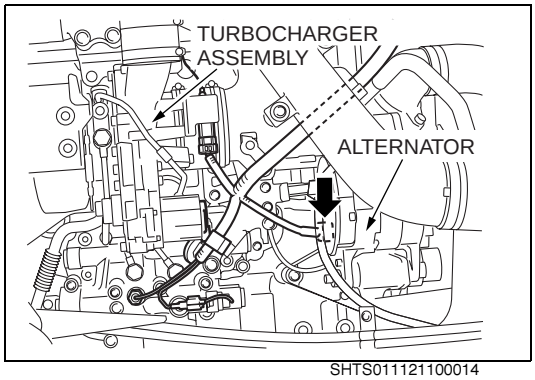
REPLACEMENT

EN0111211H100004

REMOVE THE ALTERNATOR.

1. DISCONNECT THE BATTERY CABLE.

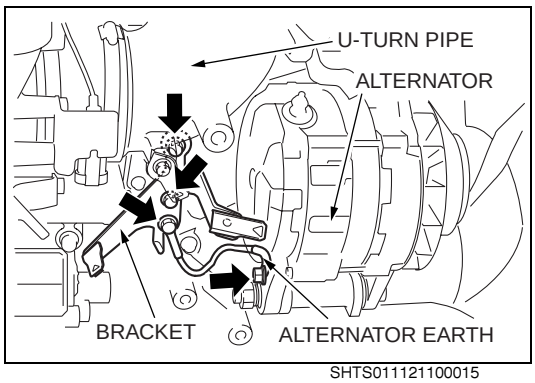
(1) Disconnect the battery earth cable from the battery minus terminal.



SHTS011121100014

2. DISCONNECT THE HARNESS.

(1) Disconnect the connector of the alternator.



SHTS011121100015

(2) Remove four bolts to remove the alternator earth and bracket.

3. DISCONNECT THE INTAKE PIPE (EXHAUST SIDE).

(1) Disconnect the U-turn pipe and the boost pipe.
Refer to the section **"INTAKE PIPE (EXHAUST SIDE)"** in the chapter **"AIR INTAKE SYSTEM"**.

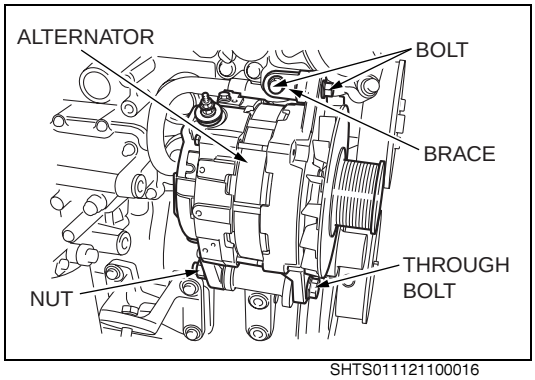
4. REMOVE THE V-RIBBED BELT.

(1) Remove the V-ribbed belt.
Refer to the section **"V-RIBBED BELT"**.

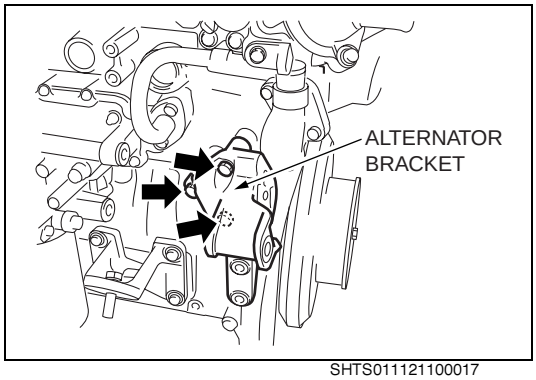
5. REMOVE THE ALTERNATOR.

(1) Remove two bolts to remove the brace.

(2) Remove the nut and through bolt to remove the alternator and washer.



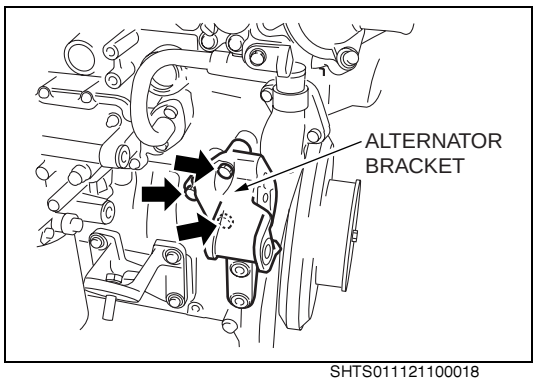
SHTS011121100016



SHTS011121100017

(3) Remove three bolts to remove the alternator bracket from the cylinder block.

HINT
Remove the alternator bracket only if it has some problems.



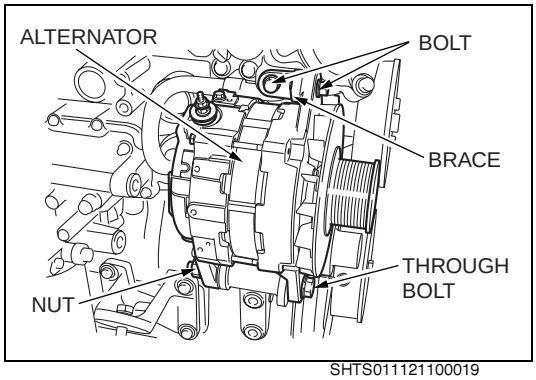
SHTS011121100018

INSTALL THE ALTERNATOR.

1. INSTALL THE ALTERNATOR.

(1) Install the alternator bracket, and tighten three bolts.
Tightening Torque:
55 N·m {560 kgf·cm, 41 lbf·ft}

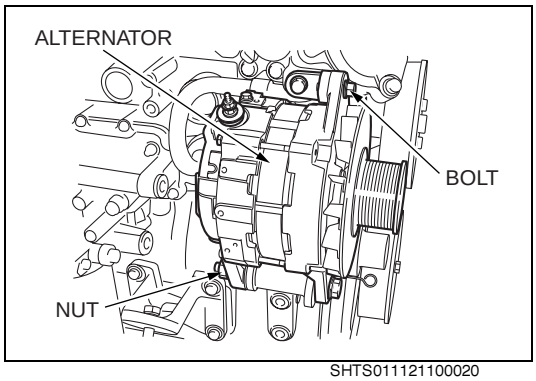
HINT
Omit this work step if the alternator bracket has not been removed.



SHTS011121100019

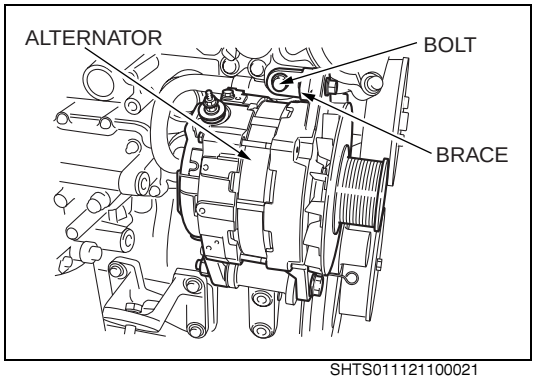
(2) Replace the washer with new one and preinstall the alternator and the brace with two bolts, nut and through bolt.

NOTICE
Adjust the positions of an alternator and a brace carefully so that no excessive force will be applied to the brace.



SHTS011121100020

(3) Use a specified torque to fully tighten a bolt and nut that have been pretighten to preinstall the alternator.
Tightening Torque:
Nut: 132 N·m {1,350 kgf·cm, 97 lbf·ft}
Bolt: 55 N·m {560 kgf·cm, 41 lbf·ft}

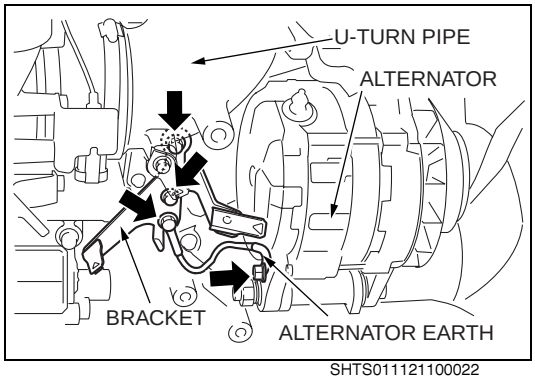


SHTS011121100021

(4) Use a specified torque to fully tighten a bolt that have been pre-tighten to preinstall the brace.
Tightening Torque:
55 N·m {560 kgf·cm, 41 lbf·ft}

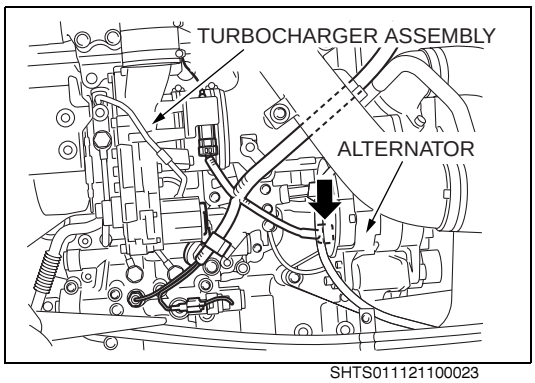
2. INSTALL THE V-RIBBED BELT.
(1) Install the V-ribbed belt.
Refer to the section **"V-RIBBED BELT"**.

3. CONNECT THE INTAKE PIPE (EXHAUST SIDE).
(1) Connect the U-turn pipe and the boost pipe.
Refer to the section **"INTAKE PIPE (EXHAUST SIDE)"** in the chapter **"AIR INTAKE SYSTEM"**.



SHTS011121100022

4. CONNECT THE HARNESS.
(1) Install the alternator earth and bracket, and tighten four bolts.
Tightening Torque:
Alternator earth: 4 N·m {40 kgf·cm, 2.9 lbf·ft}
Bracket: 28.5 N·m {290 kgf·cm, 21 lbf·ft}



SHTS011121100023

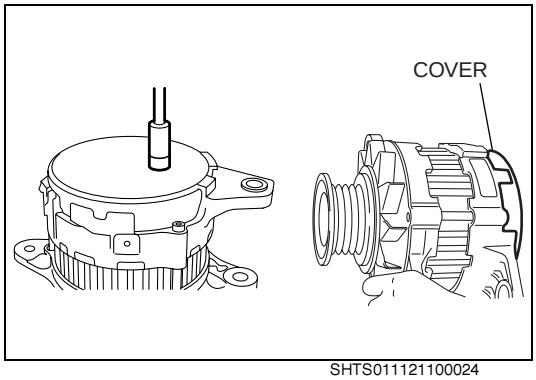
(2) Connect the connector of the alternator.

5. CONNECT THE BATTERY CABLE.
(1) Connect the battery earth cable to the battery minus terminal.

6. CHECK AFTER REINSTALLING THE ALTERNATOR.
(1) Check that the engine harness does not interfere with the alternator.
(2) Ensure that a connector is properly connected.
(3) Check the alternator rotations and charging.

OVERHAUL

EN0111211H200002



SHTS011121100024

DISASSEMBLE THE ALTERNATOR.

1. DISASSEMBLE THE END FRAME AND DRIVE END FRAME.

NOTICE

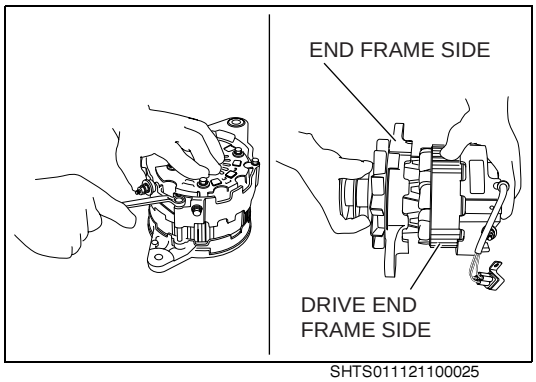
The work should be done on such thing as rubber mat and the like.

(1) Remove the setbolt to remove the cover.

NOTICE

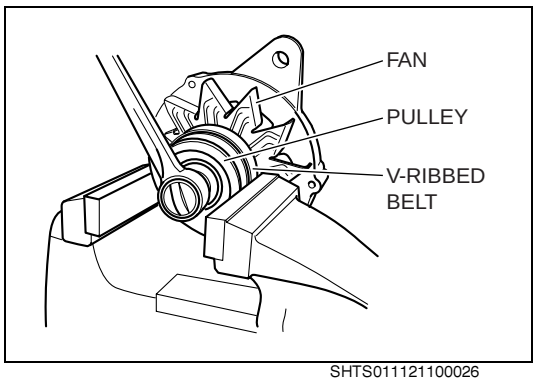
- **To avoid cracks, take care not to apply an excessive force in pressing a tab on the cover.**
- **Do not use a screwdriver to press a tab.**

(2) Remove the through bolts, disassemble the end frame and drive end frame.



SHTS011121100025

2. DISASSEMBLE THE DRIVE END FRAME SIDE.

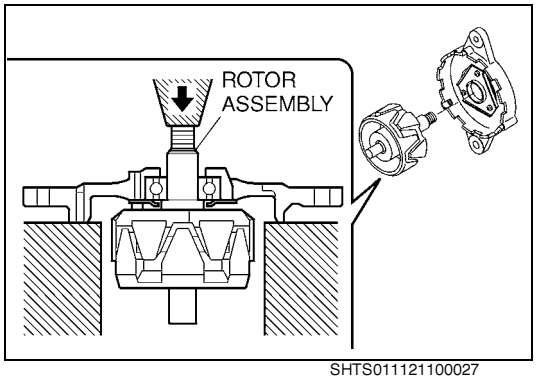


SHTS011121100026

(1) Remove the pulley lock nut, remove the pulley, the fan and the collar.

NOTICE

- **Fit a generally available V-ribbed belt in a groove in the pulley. Use a vise to fixate the pulley.**
- **Do not reuse a pulley if its ridge is damaged.**

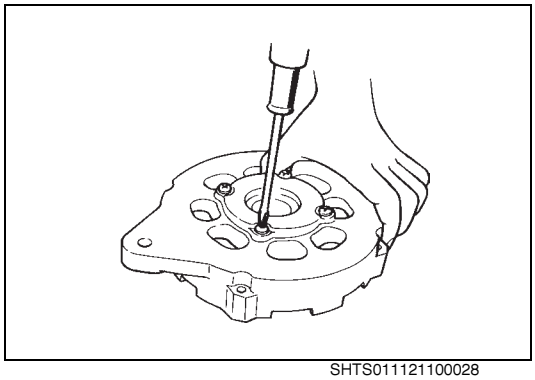


SHTS011121100027

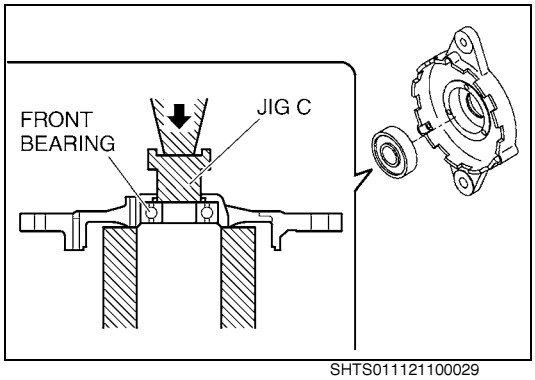
(2) Remove the rotor assembly from drive end frame, using a press.

NOTICE

- **Do not damage to the screw tip.**
- **Hold rotor by hand so that it will not fall off.**


SHTS011121100028

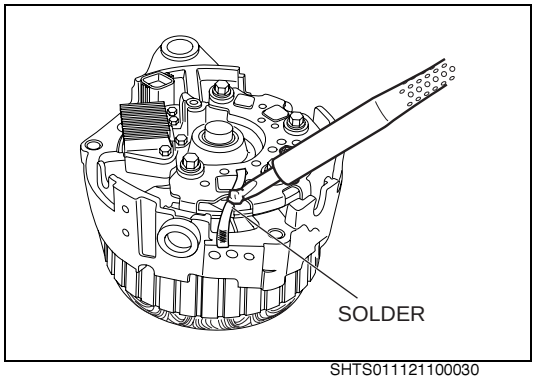
(3) Remove the bolt using a screwdriver to remove the bearing cover.



SHTS011121100029

(4) Using a press and jig C, remove the front bearing from the drive end frame.

NOTICE
Attach the jig C to inner race of the ball bearing.



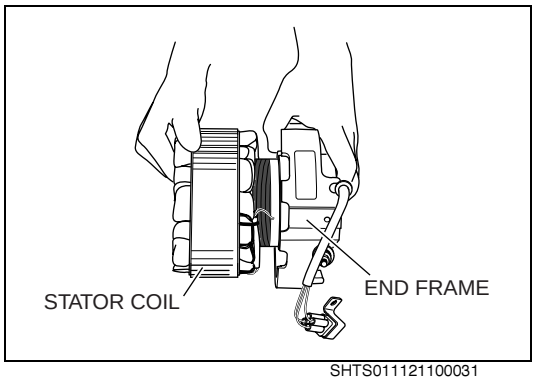
SHTS011121100030

3. DISASSEMBLE THE END FRAME SIDE.

(1) Unsolder the lead wire between starter coil and diode and remove it by pulling gently.

NOTICE

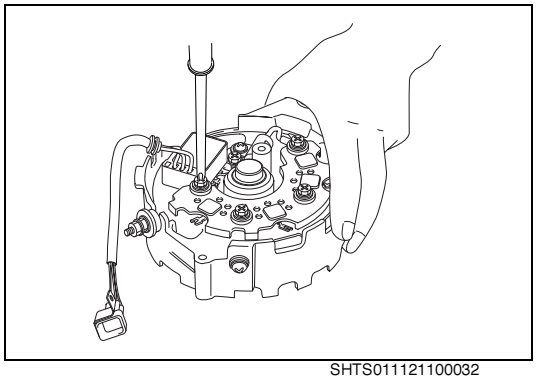
- **Unsolder the wiring connections at the stator and diode and take off excess solder spread claws part at the connections and disconnect stator lead wires.**
- **In case that diode is distorted, do not reuse the diode.**
- **Unsoldering work should be done for short moment (Within 5 sec.).**



SHTS011121100031

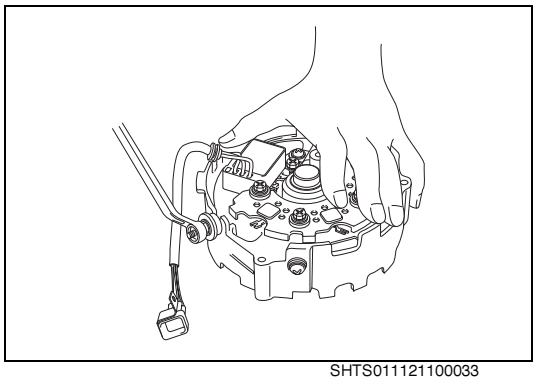
(2) Remove the stator from the end frame.

⚠ CAUTION
Be careful not to damage the stator coil.


SHTS011121100032

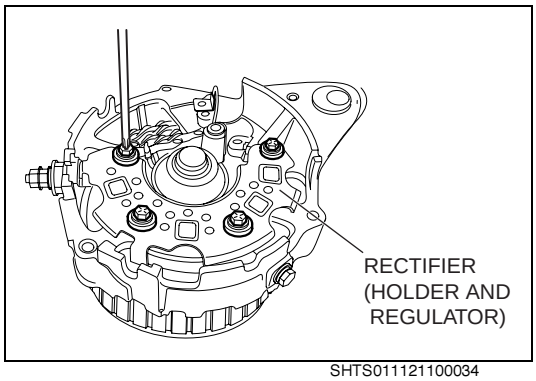
(3) Remove three regulator connecting bolts and two regulator setbolts, and remove the regulator.

⚠ CAUTION
Regulator setbolt is used not to be unscrewed easily. So, be careful not to damage the groove on bolt head.


SHTS011121100033

(4) Loosen the "B" terminal nut.

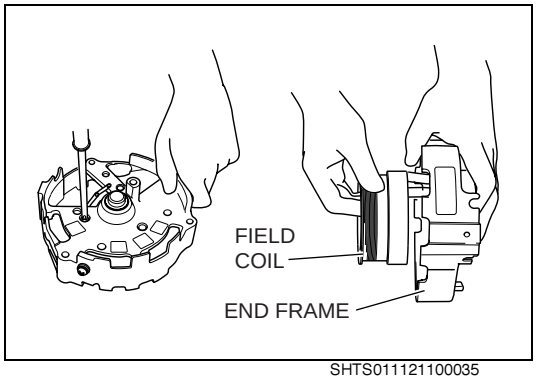
NOTICE
Loosen the nut to some extent and do not remove from terminal B.



SHTS011121100034

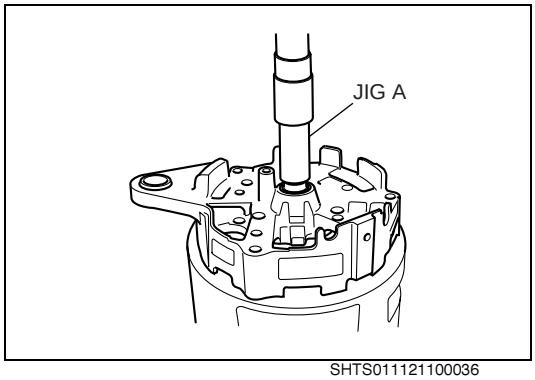
(5) Using a screwdriver, remove four bolts to remove the rectifier holder and regulator.

⚠ CAUTION
Lock agent is used not to be unscrewed easily. So, be careful not to damage the groove on bolt head.



SHTS011121100035

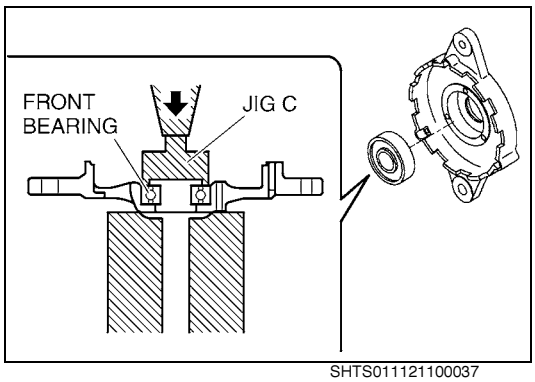
(6) Using a screwdriver, remove three bolts to remove the field coil from the end frame.



SHTS011121100036

(7) Attach the jig A to inner race of the rear bearing and remove rear bearing from the end frame, using a press.

⚠ CAUTION
A removed bearing should not be reused. Replace it with a new one.



SHTS011121100037

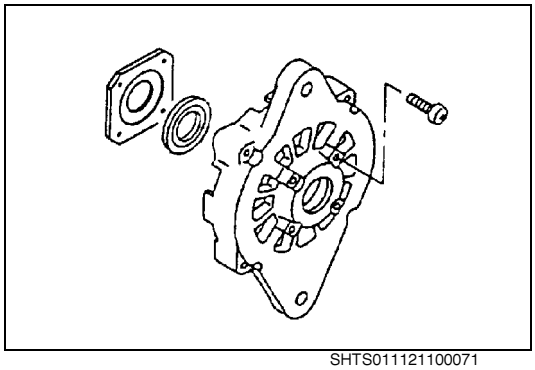
ASSEMBLE THE ALTERNATOR.

1. ASSEMBLE THE DRIVE END FRAME SIDE.

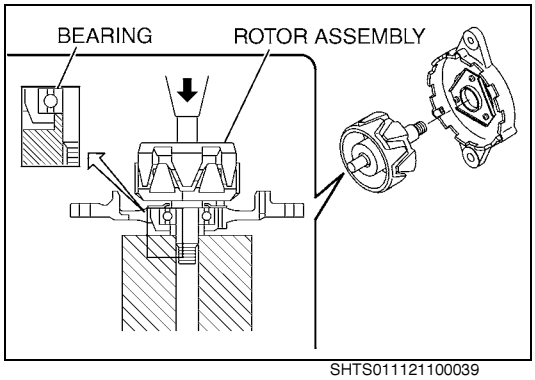
NOTICE
The work should be done on such thing as rubber mat and the like.

(1) Using a press and a jig C, install new front bearing into the drive end frame.

NOTICE
Attach the jig C on the outer race of the front bearing.


SHTS011121100071

(2) Install the bearing cover to the drive end frame, and tighten a screw.
Tightening Torque:
1.9-2.5 N·m {20-25 kgf·cm, 1.5-1.8 lbf·ft}

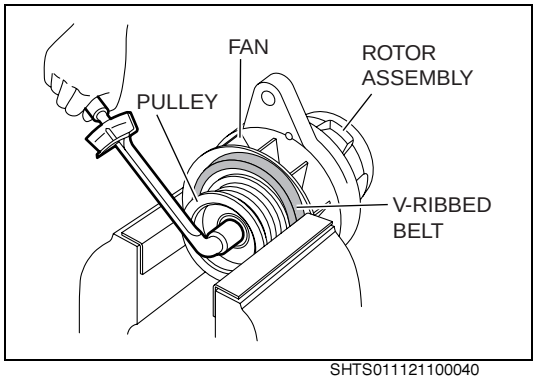


SHTS011121100039

(3) Using a press, install the rotor assembly.

NOTICE

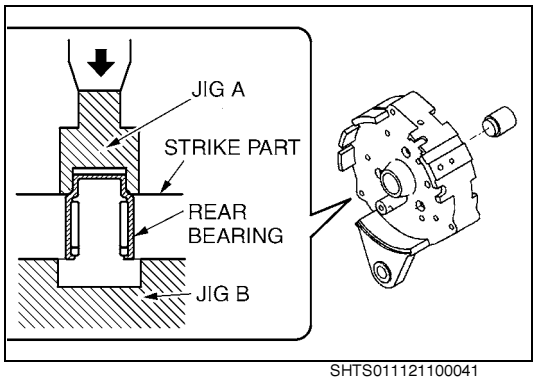
- **When pressing in rotor, it should be supported by the inner lace of bearing.**
- **Take care not to damage the rotor shaft.**



SHTS011121100040

(4) Fit a generally available V-ribbed belt in a groove in the pulley. Use a vise to fixate the pulley.
(5) Install the collar, fan and pulley to the shaft of the rotor assembly.
Tightening Torque:
127-157 N·m {1,300-1,600 kgf·cm, 94-115 lbf·ft}

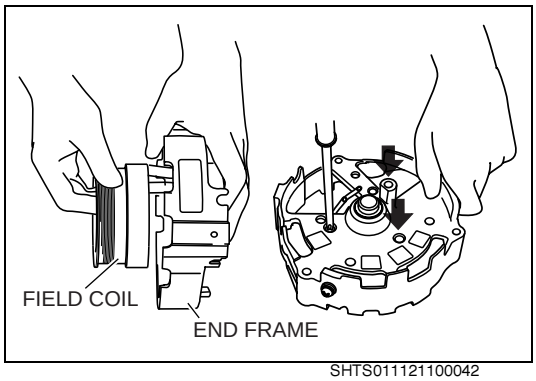
⚠ CAUTION
Do no reuse a pulley if its ridge is damaged.



SHTS011121100041

2. ASSEMBLE THE END FRAME SIDE.
(1) Using a press, jig A and jig B, install new rear bearing into the end frame.

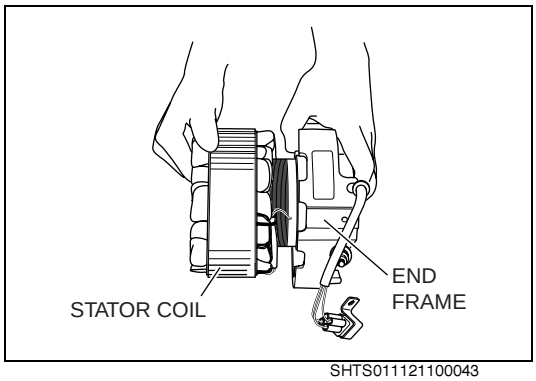
NOTICE
- **Press fit until jig A hits to the end frame.**
- **If the bearing case is deformed or damaged during press-fitting, do not reuse it.**



SHTS011121100042

(2) Install the field coil to the end frame.
Tightening Torque:
2.9-3.9 N·m {30-39 kgf·cm, 2.2-2.8 lbf·ft}

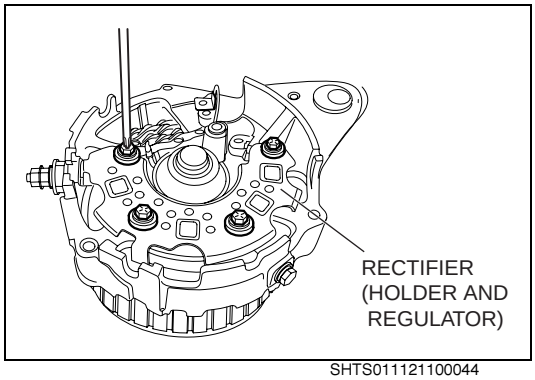
NOTICE
Tighten bolts evenly after pretightening.



SHTS011121100043

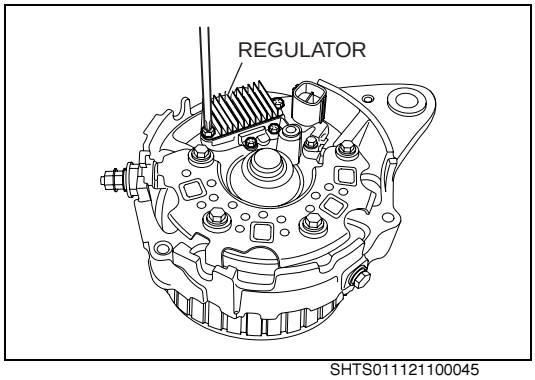
(3) Preinstall the stator coil to the end frame.

⚠ CAUTION
Be careful not to damage the stator coil.



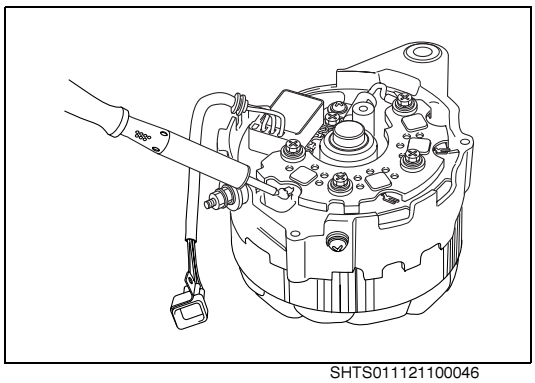
SHTS011121100044

(4) Apply lock agent (ThreeBond TB1344) to the tip of mounting bolts for rectifier. Install the rectifier to the end frame, and tighten the bolts.
Tightening Torque:
1.9-2.5 N·m {20-25 kgf·cm, 1.5-1.8 lbf·ft}



SHTS011121100045

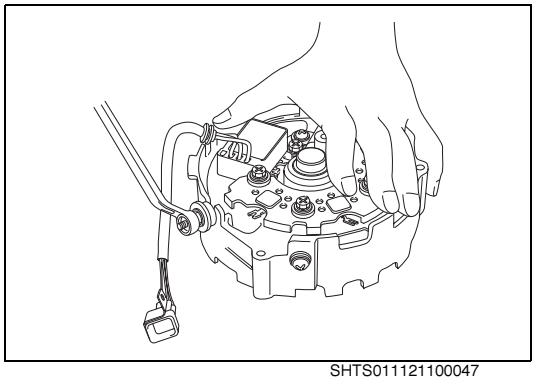
(5) Apply lock agent (ThreeBond TB1344) to the tip of setbolts for regulator. Install the regulator to the end frame, and tighten the bolts.
Tightening Torque:
Regulator: 1.6-2.3 N·m {16-23 kgf·cm, 1.2-1.6 lbf·ft}
Coil lead: 1.0-1.4 N·m {10-14 kgf·cm, 0.8-1.0 lbf·ft}
Heat sink: 1.0-1.4 N·m {10-14 kgf·cm, 0.8-1.0 lbf·ft}


SHTS011121100046

(6) Using a solder ring iron, solder the lead wire connecting the regulator and field coil as well as the stator coil and diode.

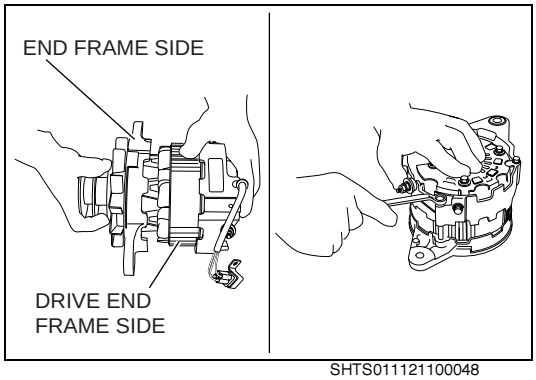
NOTICE

- **Soldering work should be done just after tightening the bolt.**
- **Solder lead wire after bending and fixing the terminal of regulator.**
- **Solder field coil after caulking the tip of diode.**
- **Soldering work should be done for short moment (Within 5 sec.).**


SHTS011121100047

(7) Tighten the inner nut of the B terminal.
Tightening Torque:
4.9-5.9 N·m {50-60 kgf·cm, 3.7-4.3 lbf·ft}

HINT
Outer nut should be tightened after installing alternator and connecting its wiring.

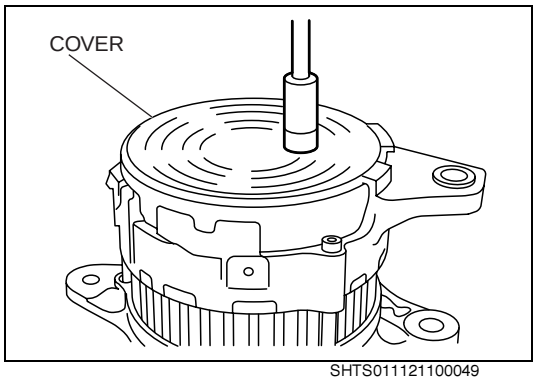


SHTS011121100048

3. ASSEMBLE THE END FRAME AND DRIVE END FRAME.

(1) Assemble the end frame and drive end frame with the through bolts.
Tightening Torque:
7.8-9.8 N·m {80-100 kgf·cm, 5.8-7.2 lbf·ft}

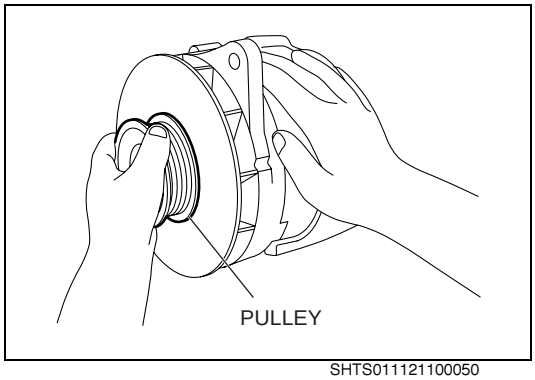
NOTICE
Tighten the through bolt evenly.



SHTS011121100049

(2) Attach a cover with its tab positioned in place, and tighten bolts.
Tightening Torque:
3.2-4.4 N·m {33-44 kgf·cm, 2.4-3.2 lbf·ft}

⚠ CAUTION
Do not hit the cover, it might cause tab damage.



SHTS011121100050

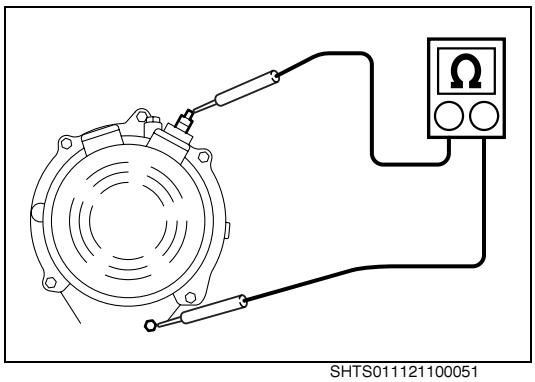
CHECK THE ALTERNATOR.

1. CHECK THE ALTERNATOR FOR PROPER ROTATION.

NOTICE

The work should be done on such thing as rubber mat and the like.

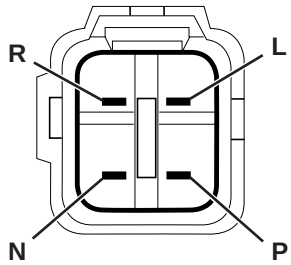
(1) Turn the pulley by hand and make sure that there is no noise, catching or rough movement in the shaft direction and that it rotates smoothly.



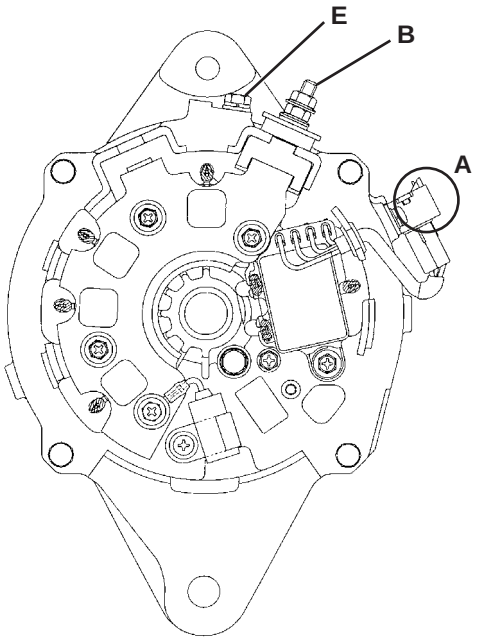
SHTS011121100051

(2) Measure the resistance between terminals. If the resistance is not specified value, reassemble the alternator.

Test lead		Standard
(+)	(–)	
B	E	APPROX. 20 Ω
E	B	∞ Ω
P	E	APPROX. 7 Ω
E	P	∞ Ω



DETAIL OF A

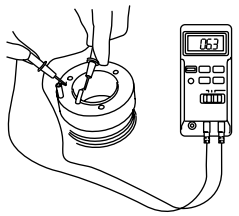
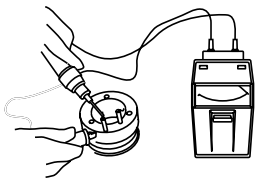
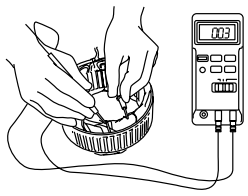
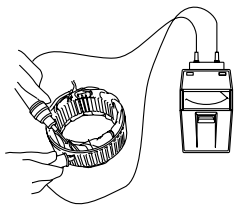
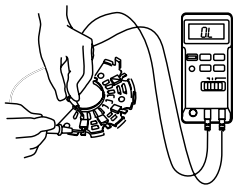
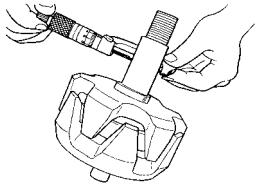
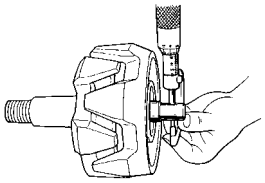


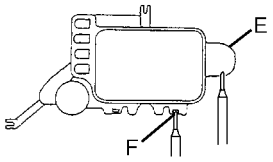
SHTS011121100063

INSPECTION AND REPAIR

EN0111211H300002

Unit: mm {in.}

Inspection item	Standard	Limit	Remedy	Inspection procedure
Resistance of field coil [at 20°C (68°F)]	**6.6-7.2 Ω**	**—**	**Replace.**	**Measure** 
Insulation resistance of field coil	**1 MΩ or more**	**0.5MΩ or less**	**Replace.**	**Measure** 
Resistance of stator coil [at 20°C (68°F)]	**0.11-0.12 Ω**	**—**	**Replace.**	**Measure** 
Insulation resistance of stator	**1 MΩ or more**	**0.5MΩ or less**	**Replace.**	**Measure** 
Resistance of diode	**Normal direction APPROX. 10 Ω Reverse direction ∞ Ω**	**—**	**Replace.**	**Measure** 
Rotor shaft outside diameter (Front bearing portion)	**30 {1.181}**	**29.98 {1.1803}**	**Replace.**	**Measure** 
Rotor shaft outside diameter (Rear bearing portion)	**17 {0.669}**	**16.98 {0.6685}**	**Replace.**	**Measure** 

Inspection item	Standard	Limit	Remedy	Inspection procedure
Resistance of regulator	**Normal direction APPROX. 10 Ω Reverse direction** ∞ Ω	**—**	**Replace.**	**Measure** 

STARTER (A09C)

EN12-001

STARTER

DATA AND SPECIFICATIONS

EN0111212I200001

Type	**Reduction gear (planetary gear) type**
Rated output	**24V, 6kW**
Number of teeth of pinion	**11**
Module	**3.5**
Rotating direction	**Clockwise (Seen from pinion side)**

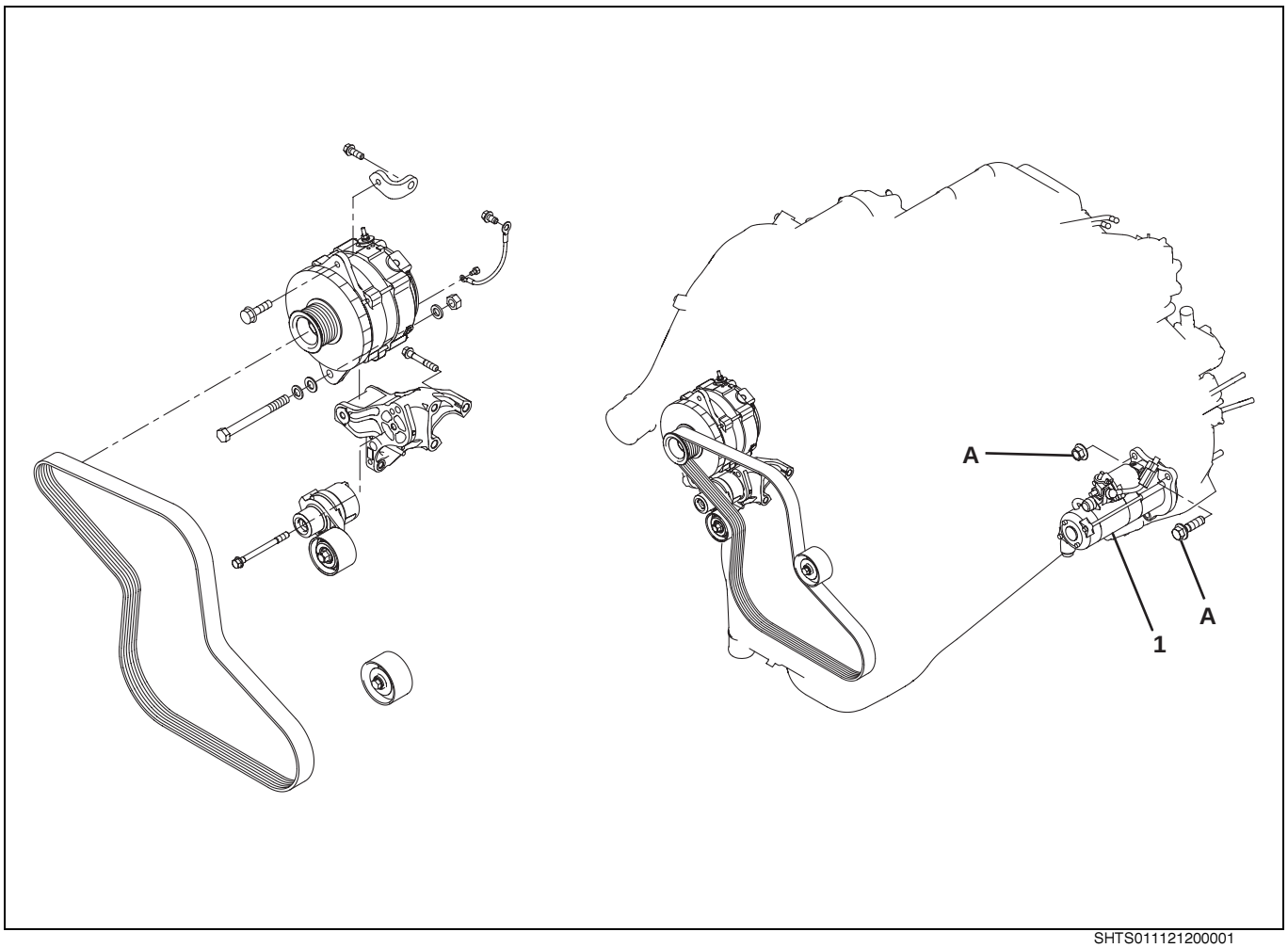
TROUBLESHOOTING

EN0111212F300001

Symptom	Possible cause	Remedy/Prevention
Engine does not crank, or cranks slowly. (Ignition switch)	Poor contact	Repair or replace.
Engine does not crank, or cranks slowly. (Battery)	Discharged battery	Charge.
	Poor contact at battery terminal	Clean or retighten.
	Poor contact at earth cable	Absolutely assemble.
Engine does not crank, or cranks slowly. (Engine oil)	Improper viscosity oil	Change oil.
Engine does not crank, or cranks slowly. (Magnetic switch)	Poor contact	Repair or replace.
Engine does not crank, or cranks slowly. (Starter relay)	Defective or poor contact	Repair or replace.
Engine does not crank, or cranks slowly. (Starter)	Brush worn out	Replace.
	Commutator burnt out	Replace.
	Commutator worn out	Correct by undercutting.
	Armature winding shorted or grounded	Replace armature.
	Insufficient brush spring tension	Replace brush spring.
	Out of commission clutch inside starter	Clean or replace.

COMPONENT LOCATOR

EN0111212D100001

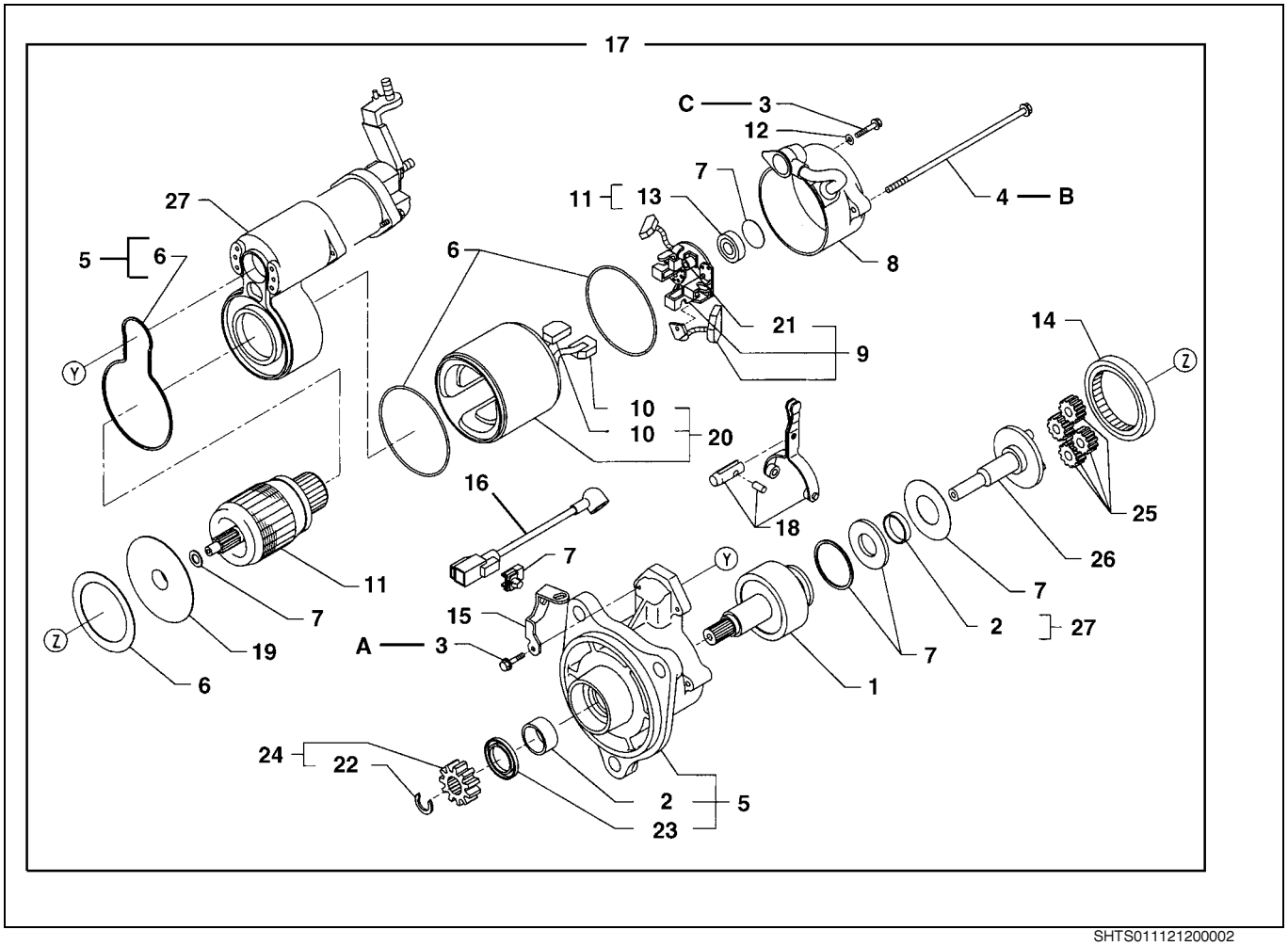


SHTS011121200001

1 Starter	

Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

A 127 {1,295, 94}	



SHTS011121200002

1	Clutch sub assembly	15	Bracket
2	Bushing	16	Lead wire
3	Set bolt	17	Starter
4	Through bolt	18	Lever
5	Start drive housing	19	Cover
6	Packing	20	Yoke assembly
7	Plate	21	Spring
8	Commutator end frame	22	Retainer ring
9	Brush holder assembly	23	Dust protector
10	Brush	24	Pinion
11	Armature assembly	25	Planetary gear
12	O-ring	26	Shaft assembly
13	Bearing	27	Start magnet switch
14	Internal gear		

Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

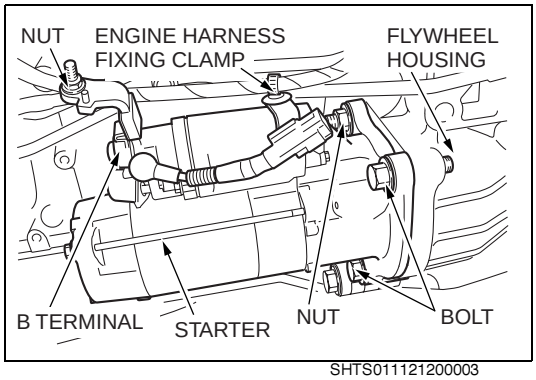
A	14-16 {140-160, 10.4-11.7}	C	3.6-4.9 {37-49, 2.7-3.6}
B	15.7-17.6 {160-179, 11.6-12.9}		

REPLACEMENT

EN0111212H100001

REMOVE THE STARTER.

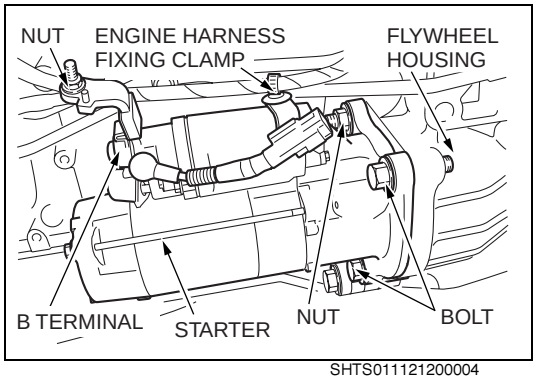
1. DISCONNECT THE BATTERY CABLE.
(1) Disconnect the battery earth cable from the battery minus terminal.



SHTS011121200003

2. REMOVE THE STARTER.
(1) Disconnect the connector of the starter.
(2) Remove the nut and disconnect the starter cable from the B terminal.
(3) Remove the engine harness fixing clamp.
(4) Remove two bolts and a nut to remove the starter from the flywheel housing.

INSTALL THE STARTER.



SHTS011121200004

1. INSTALL THE STARTER.
(1) Install the starter to the flywheel housing with two bolts and a nut.
Tightening Torque:
127 N·m {1,295 kgf·cm, 94 lbf·ft}

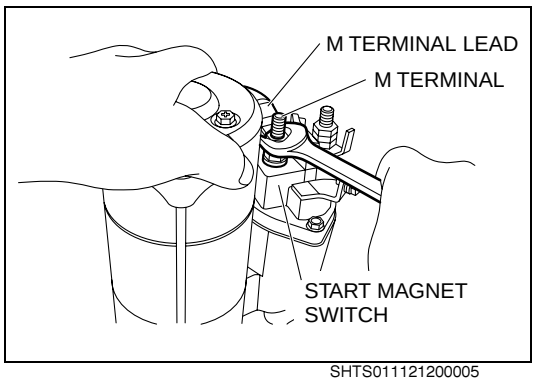
(2) Install the engine harness fixing clamp.
(3) Connect the starter cable to the B terminal with the nut.
Tightening Torque:
12.3-15.2 N·m {125-155 kgf·cm, 9.1-11.2 lbf·ft}

(4) Connect the connector of the starter.

2. CONNECT THE BATTERY CABLE.
(1) Connect the battery earth cable to the battery minus terminal.

OVERHAUL

EN0111212H200001



SHTS011121200005

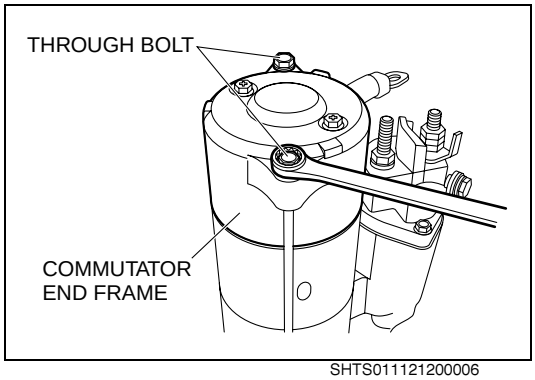
DISASSEMBLE THE STARTER.

1. REMOVE THE M TERMINAL LEAD.

HINT

For easier works, secure the starter on a work bench.

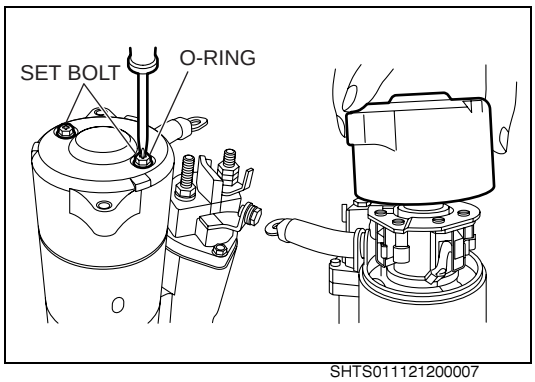
(1) Remove the M terminal cap from the start magnet switch.
(2) Remove the nut, and remove the M terminal lead from the start magnet switch.



SHTS011121200006

2. REMOVE THE COMMUTATOR END FRAME.

(1) Remove the through bolt from the commutator end frame.

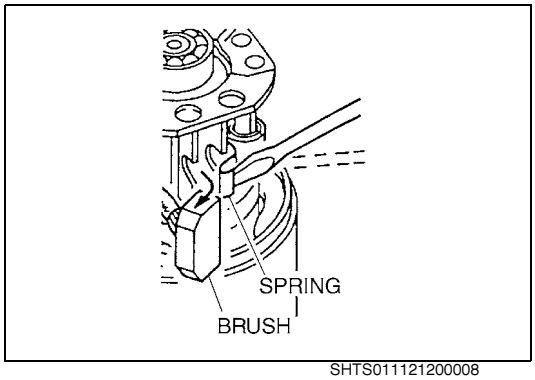


SHTS011121200007

(2) Remove set bolts and O-rings to remove the commutator end frame.

NOTICE

While holding down the M terminal lead, slightly lift the commutator end frame for removal.



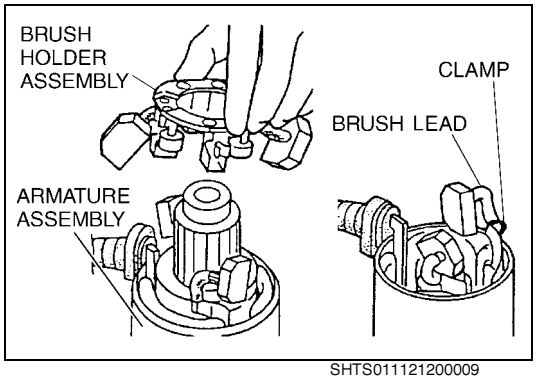
SHTS011121200008

3. REMOVE THE BRUSH HOLDER ASSEMBLY.

(1) Using a flat head screwdriver, needle-nose plier or plier, remove the brush from the brush holder assembly.

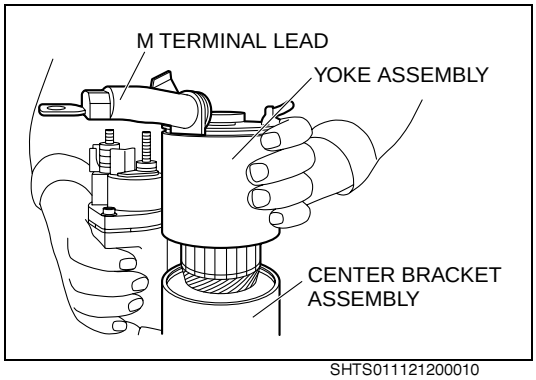
NOTICE

Do not cut the fixed clamp of brush lead.



SHTS011121200009

(2) Remove the brush holder assembly from the armature assembly.



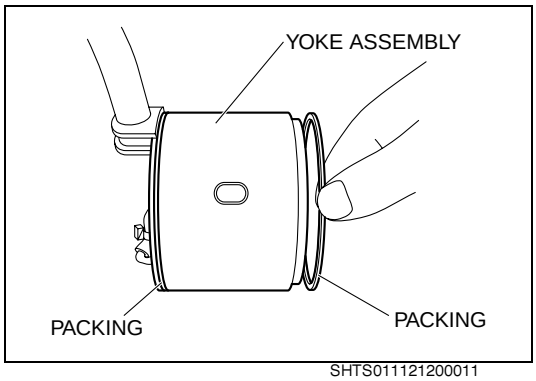
SHTS011121200010

4. REMOVE THE YOKE ASSEMBLY.

(1) Remove the yoke assembly from the center bracket assembly.

NOTICE

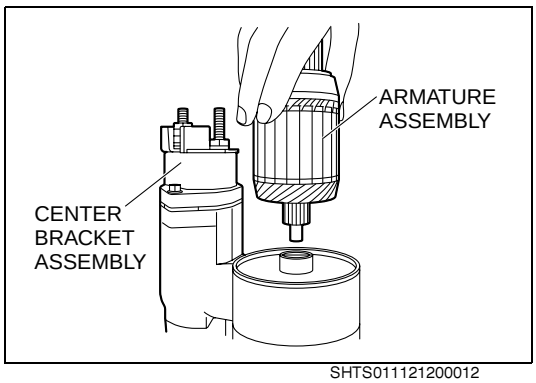
Do not grasp the M terminal lead. Grasp the yoke assembly outer diameter.



SHTS011121200011

5. REMOVE THE PACKING.

(1) Remove the packing from both ends of the yoke assembly.



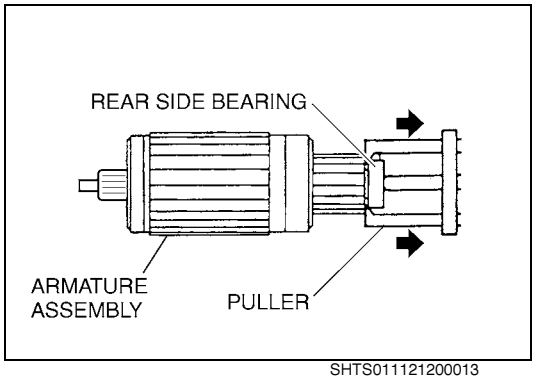
SHTS011121200012

6. REMOVE THE ARMATURE ASSEMBLY.

(1) Remove the armature assembly from the center bracket assembly.

NOTICE

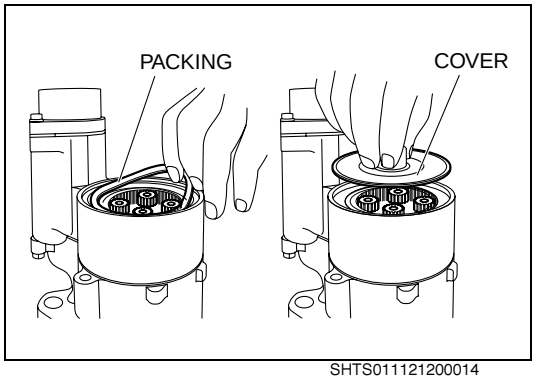
Note that a plate at the end of the gear might drop off and get lost when removing the armature assembly.



SHTS011121200013

7. REMOVE THE REAR SIDE BEARING.

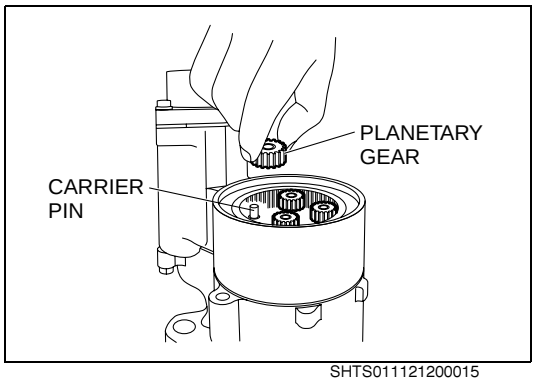
(1) Remove the bearing of the armature assembly using a puller or a press.



SHTS011121200014

8. REMOVE THE COVER.

(1) Remove the cover and packing from the center bracket assembly.

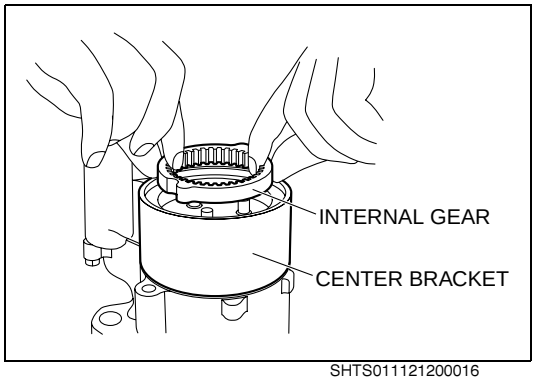


SHTS011121200015

9. REMOVE THE PLANETARY GEAR.

(1) Remove the planetary gear from the carrier pin.

NOTICE
Make sure that the gear is not damaged.

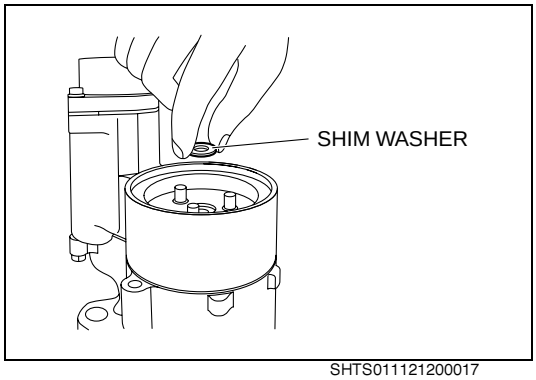


SHTS011121200016

10. REMOVE THE INTERNAL GEAR.

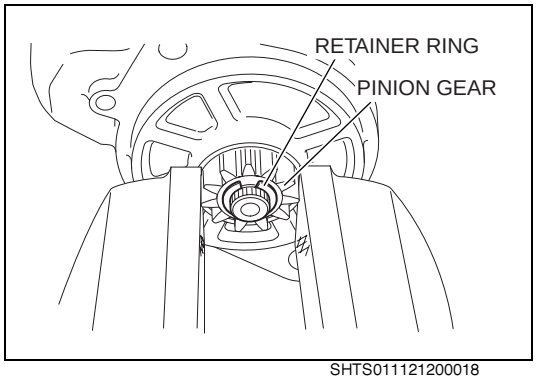
(1) Remove the internal gear from the center bracket.

NOTICE
Make sure that the gear is not damaged.



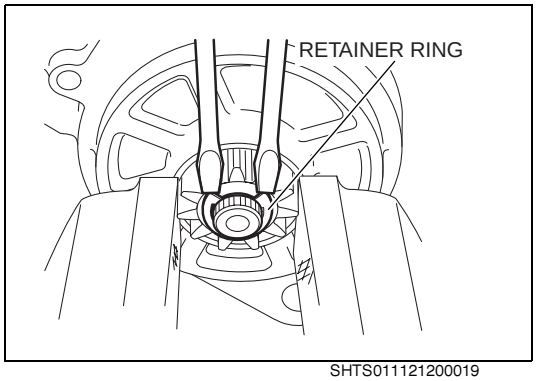
SHTS011121200017

11. REMOVE THE SHIM WASHER.
(1) Remove the shim washer from the shaft assembly.



SHTS011121200018

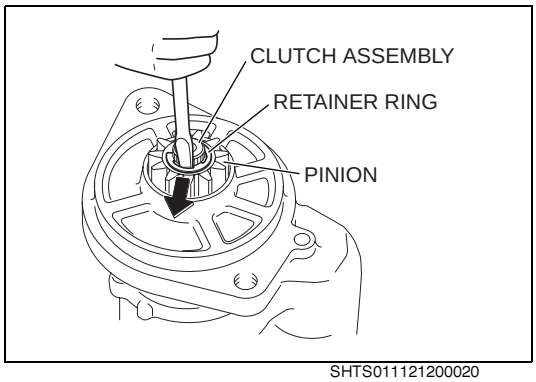
12. REMOVE THE PINION.
(1) Put the retainer ring orifice directly above. Using a vise, support the pinion gear to avoid turing the pinion gear.



SHTS011121200019

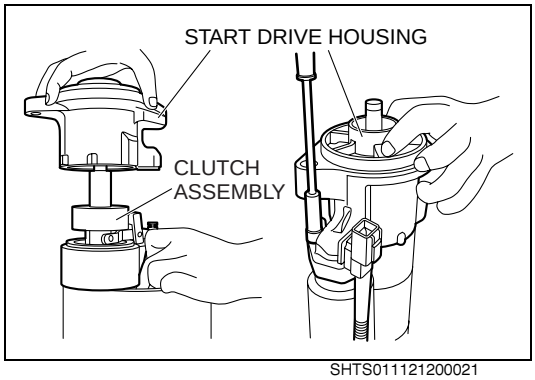
(2) Apply two flat head screwdrivers to both ends of the retainer ring orifice. Strike a screwdriver with a hammer to stagger the retainer ring.

⚠ CAUTION
Wear a pair of safety goggles, because the retainer ring may spring out the groove at the time of removal.



SHTS011121200020

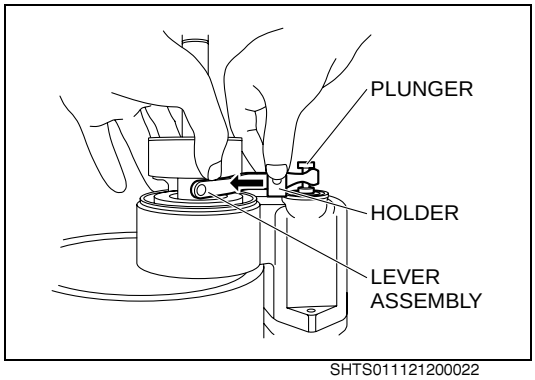
(3) Remove the pinion stopper using a flat head screwdriver.
(4) Remove the pinion from the clutch assembly.



SHTS011121200021

13. REMOVE THE START DRIVE HOUSING.

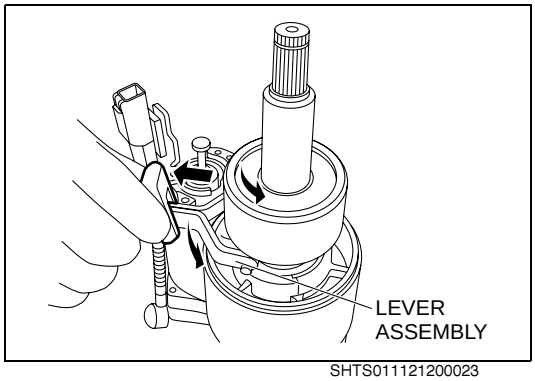
(1) Using a box screwdriver or a box wrench, remove two set bolts from the switch. Remove the start drive housing.



SHTS011121200022

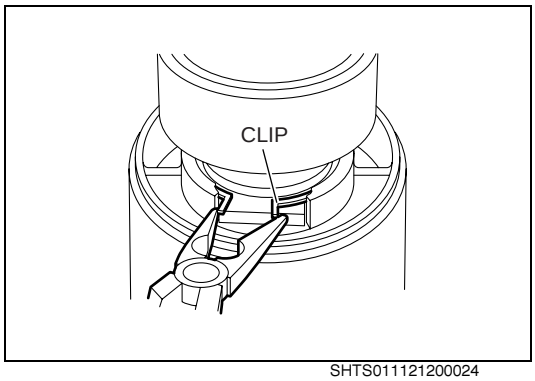
14. REMOVE THE LEVER ASSEMBLY.

(1) Pushing the lever toward clutch to disconnect the lever assembly from the plunger.



SHTS011121200023

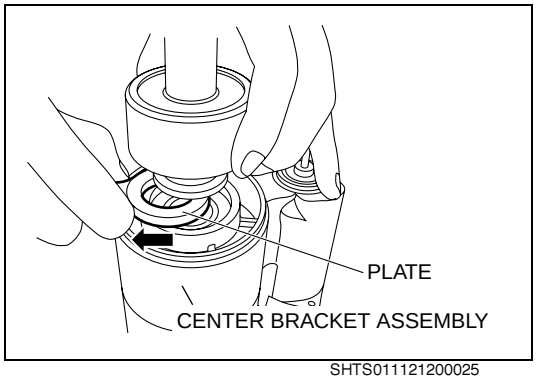
(2) Turn the lever and remove the lever.



SHTS011121200024

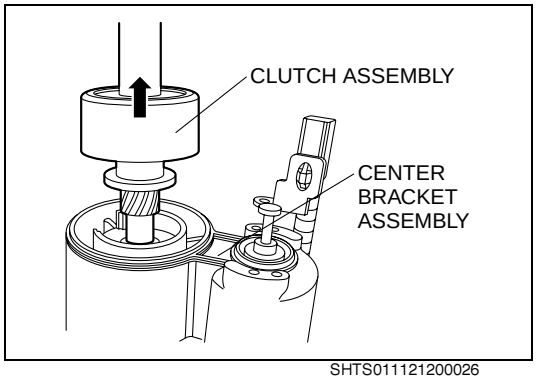
15. REMOVE THE BRAKE PLATE.

(1) Holding the outer diameter of the clutch case and sliding the clutch assembly to upper side, remove it, pinching the clip of fixing the brake plate with a needle-nose pliers.



SHTS011121200025

(2) Remove the plate from the center bracket assembly.

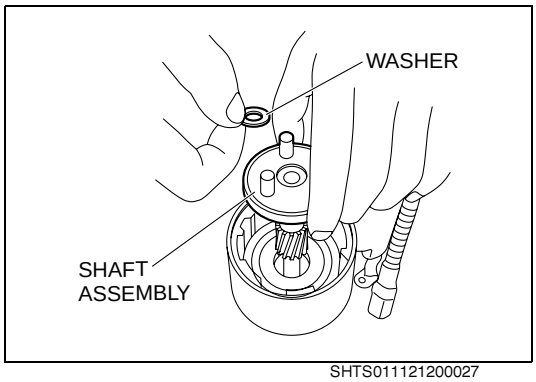


SHTS011121200026

16. REMOVE THE CLUTCH ASSEMBLY.

(1) Pushing the clutch assembly toward center bracket assembly, shift a bit by a tooth the phase of helical spline.

(2) Pulling out to upper direction from its shifted location, remove the clutch assembly.



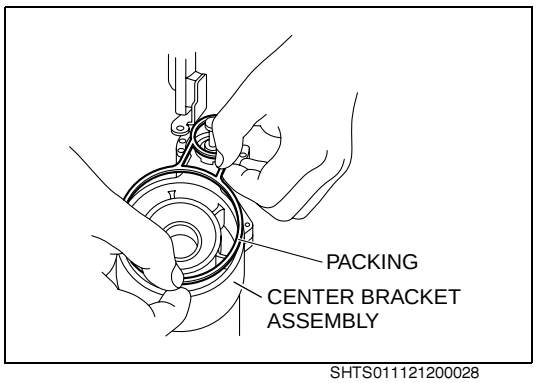
SHTS011121200027

17. REMOVE THE SHAFT ASSEMBLY.

(1) Turning the center bracket assembly upside-down, pull out the shaft assembly, holding the carrier plate.

NOTICE

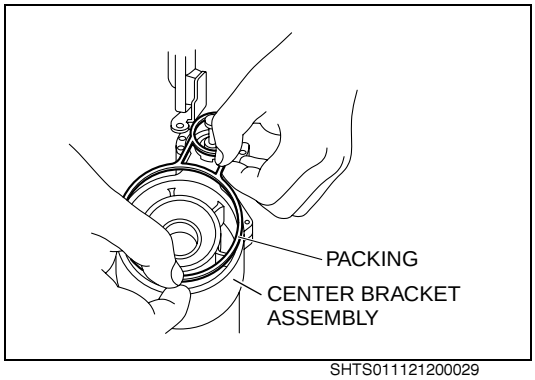
Be careful not to lose the washers of upper and lower sides of the carrier plate.



SHTS011121200028

18. REMOVE THE PACKING.

(1) Turning the center bracket assembly upside-down again, remove the packing reversed.

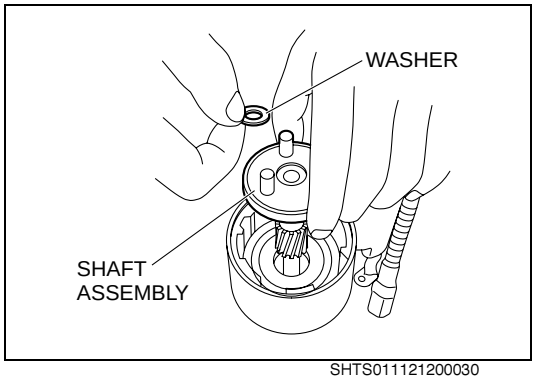


SHTS011121200029

ASSEMBLE THE STARTER.

1. INSTALL THE PACKING.

(1) Install the new packing to the center bracket assembly.



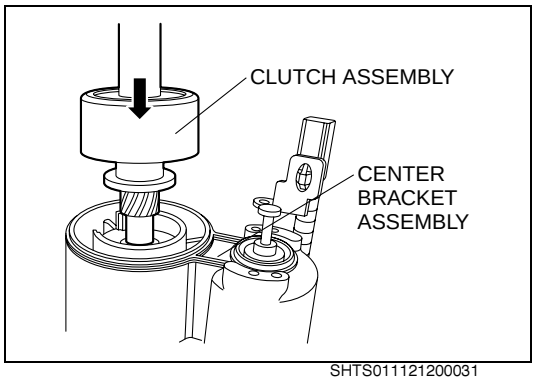
SHTS011121200030

2. INSTALL THE SHAFT ASSEMBLY.

(1) Turning the center bracket assembly upside-down. Holding the carrier plate, grease each portion (Refer to **"LUBRICATION"**) and install the shaft assembly.

NOTICE

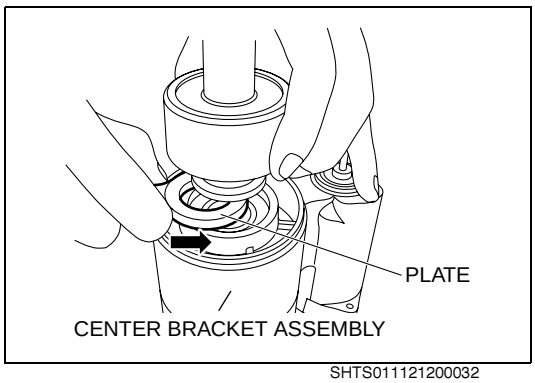
Be careful not to lose the washers of upper and lower sides of the carrier plate.



SHTS011121200031

3. INSTALL THE CLUTCH ASSEMBLY.

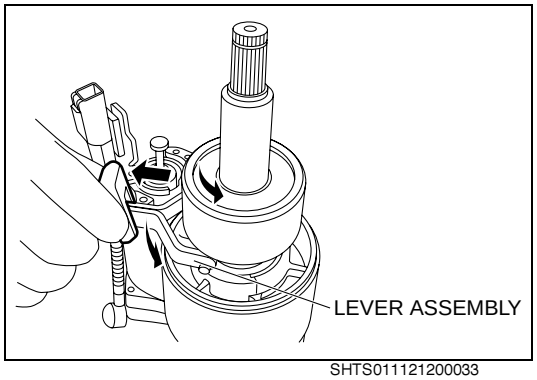
(1) Apply the grease to each portion (Refer to **"LUBRICATION"**) and insert the clutch assembly into the center bracket assembly.



SHTS011121200032

4. INSTALL THE PLATE.

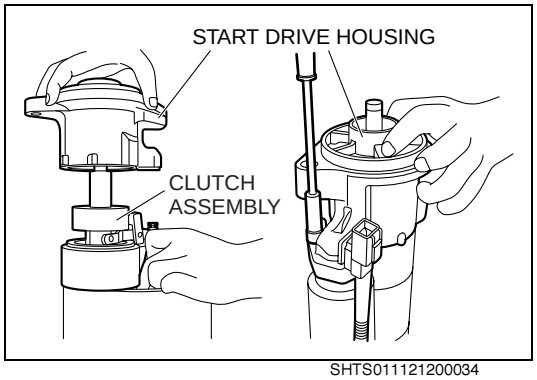
(1) Apply the grease to each portion (Refer to **"LUBRICATION"**) and install the plate to the center bracket assembly.



SHTS011121200033

5. INSTALL THE LEVER ASSEMBLY.

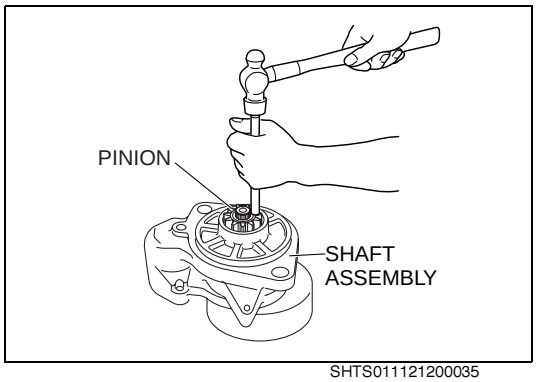
(1) Apply the grease to each portion (Refer to **"LUBRICATION"**). Turn the lever and install the lever.



SHTS011121200034

6. INSTALL THE START DRIVE HOUSING.

(1) Install two set bolts to the switch using a box screwdriver or a box wrench.
Tightening Torque:
14-16 N·m {140-160 kgf·cm, 10.4-11.7 lbf·ft}

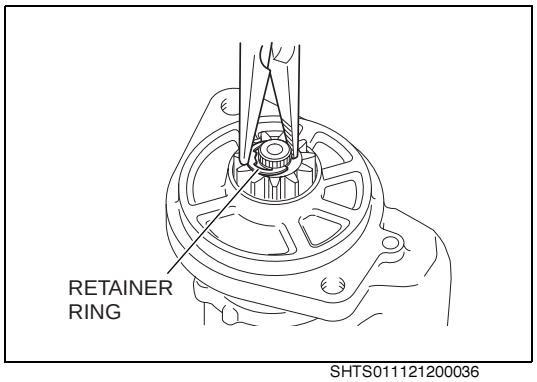


SHTS011121200035

7. INSTALL THE PINION.

(1) Set the shaft assembly on a work stand and install the pinion. If it is difficult to install the pinion gear, tap the pinion evenly using a brass bar and hammer and install it to the shaft assembly.

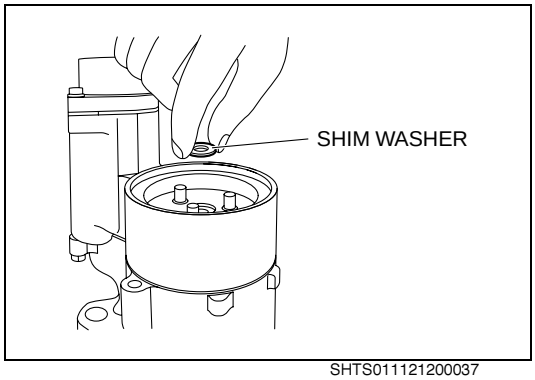
NOTICE
When installing the pinion, set the chamfered side of the gear to outside.



SHTS011121200036

(2) Using a long nose plier, install a new retainer ring.

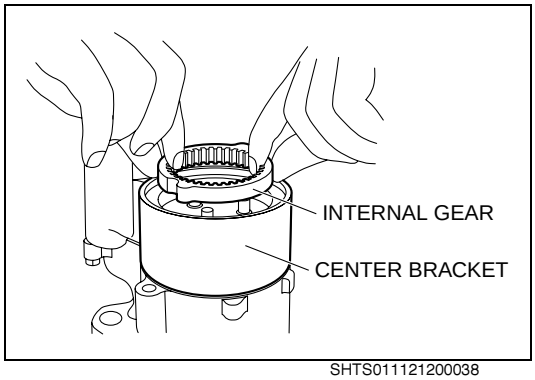
⚠ CAUTION
Wear a safety goggle, because the retainer ring may spring out the groove at the time of installation.



SHTS011121200037

8. INSTALL THE SHIM WASHER.

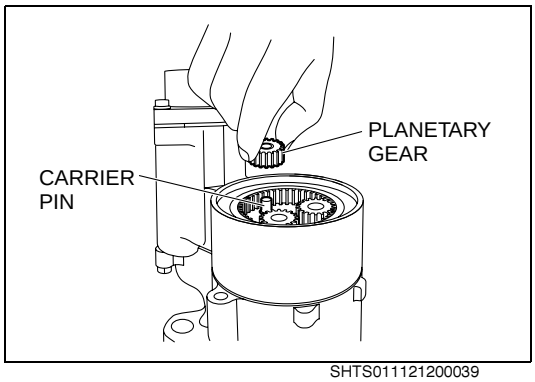
(1) Apply the grease to each portion (Refer to **"LUBRICATION"**) and install the shim washer to the center bracket.



SHTS011121200038

9. INSTALL THE INTERNAL GEAR.

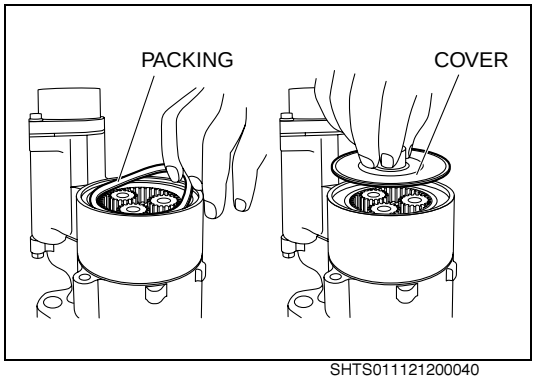
(1) Apply the grease to each portion (Refer to **"LUBRICATION"**) and internal gear to the center bracket.



SHTS011121200039

10. INSTALL THE PLANETARY GEAR.

(1) Apply the grease to each portion (Refer to **"LUBRICATION"**) and planetary gear to the carrier pin.



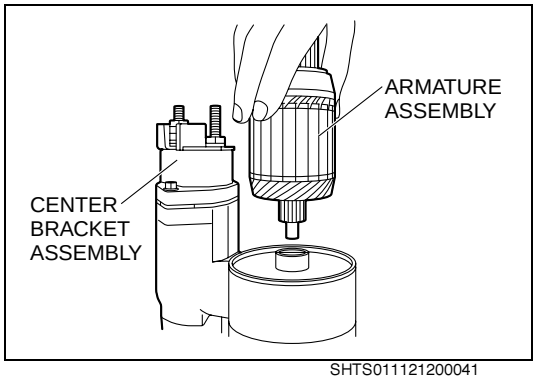
SHTS011121200040

11. INSTALL THE COVER.

(1) Replace the packing with a new one and install the cover to the center bracket assembly.

12. INSTALL THE REAR SIDE BEARING.

(1) Using a press, install the new bearing to the armature assembly.



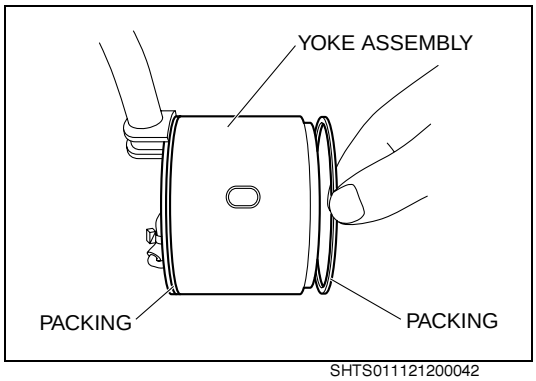
SHTS011121200041

13. INSTALL THE ARMATURE ASSEMBLY.

(1) Install the armature assembly to the center bracket assembly.

NOTICE

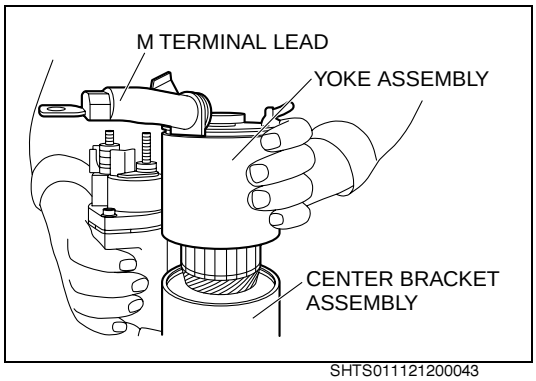
Note that a plate at the end of the gear might drop off and get lost when installing the armature assembly.



SHTS011121200042

14. INSTALL THE PACKING.

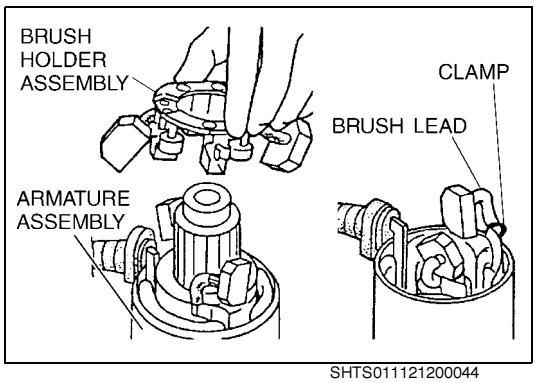
(1) Install the new packing to both ends of the yoke assembly.



SHTS011121200043

15. INSTALL THE YOKE ASSEMBLY.

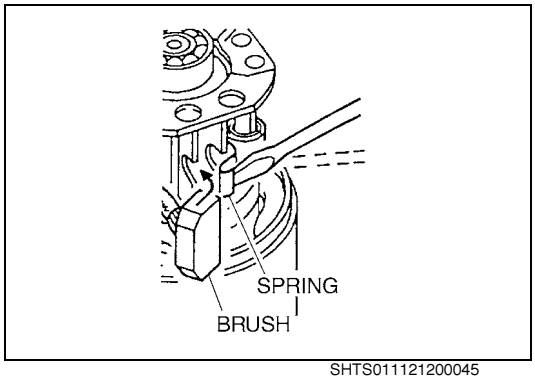
(1) Install the yoke assembly to the center bracket assembly.



SHTS011121200044

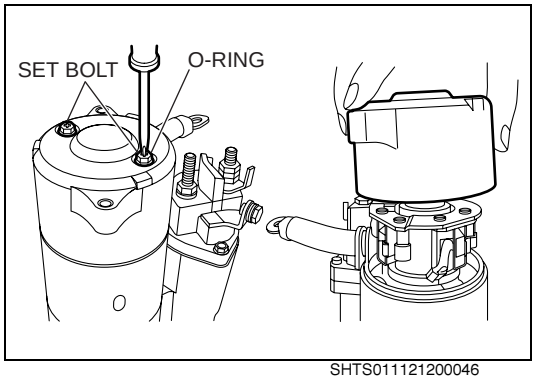
16. INSTALL THE BRUSH HOLDER ASSEMBLY.

(1) Install the brush holder assembly to the armature assembly.



SHTS011121200045

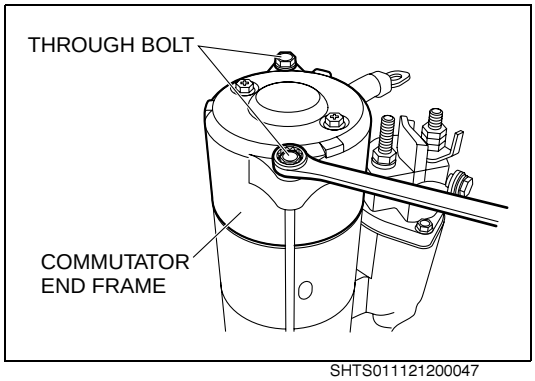
(2) Install the brush to the brush holder assembly using a flat head screwdriver, needle-nose plier or a plier.



SHTS011121200046

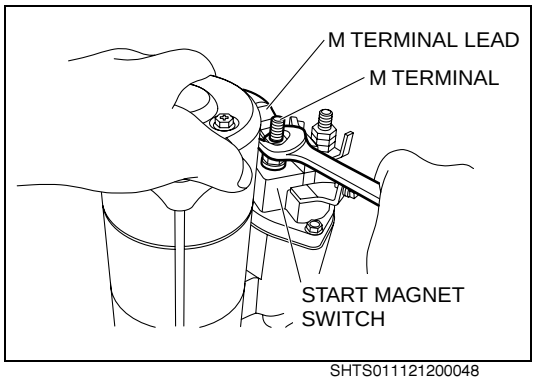
17. INSTALL THE COMMUTATER END FRAME.

(1) Insert the commutator end frame into the yoke assembly. Replace the O-ring with new one, screw through bolt lightly and tighten two set bolts.
Tightening Torque:
3.6-4.9 N·m {37-49 kgf·cm, 2.7-3.6 lbf·ft}



SHTS011121200047

(2) Tighten the through bolts.
Tightening Torque:
15.7-17.6 N·m {160-179 kgf·cm, 11.6-12.9 lbf·ft}



SHTS011121200048

18. INSTALL THE M TERMINAL LEAD.

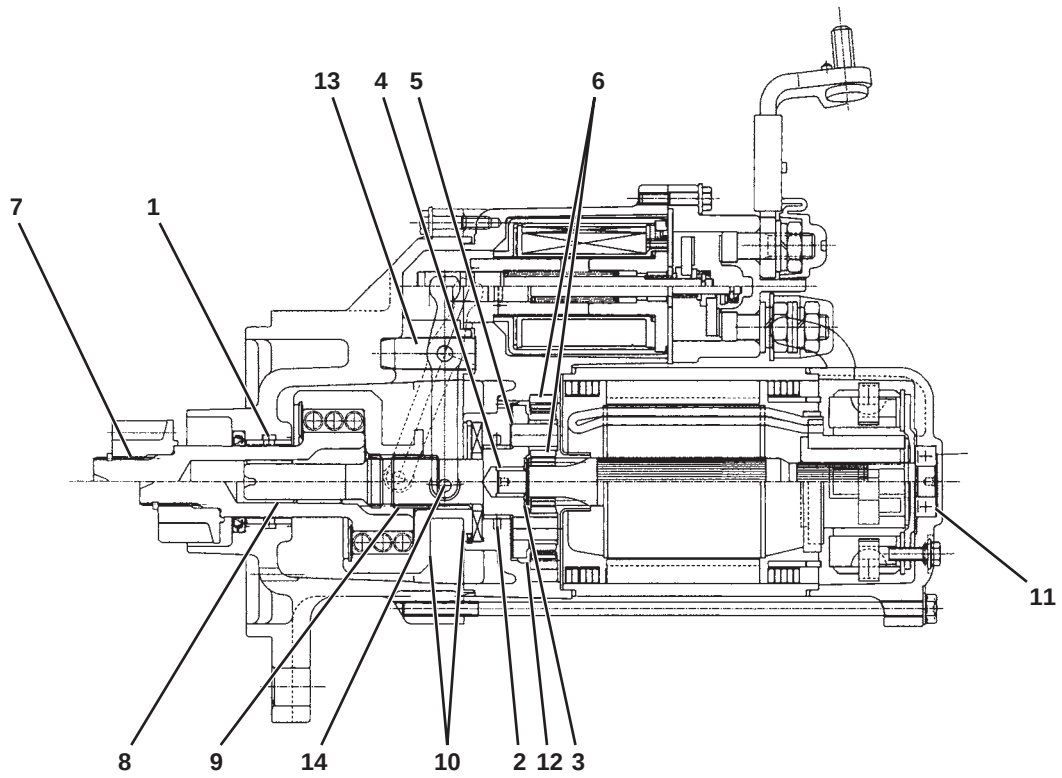
(1) Install the M terminal lead to the start magnet switch with nut.
(2) Install the M terminal cap to the start magnet switch.

19. LUBRICATION

(1) Apply the grease to the portion as shown in the figure.

NOTICE

Grease should be adhered on commutator surface, brash nor other connecting points.



SHTS011121200049

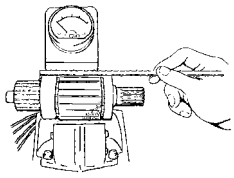
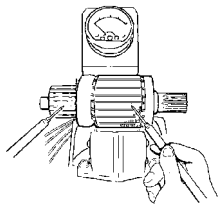
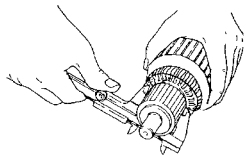
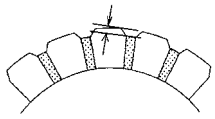
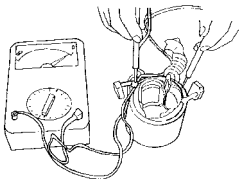
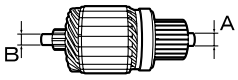
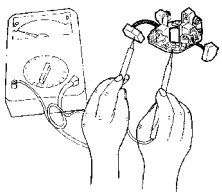
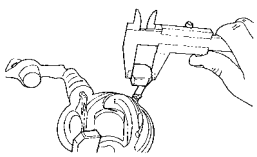
LIST OF LUBRICATION

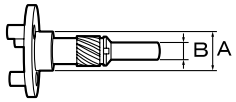
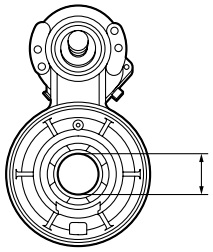
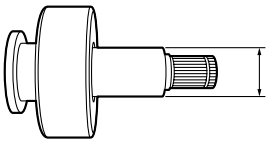
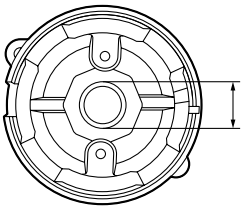
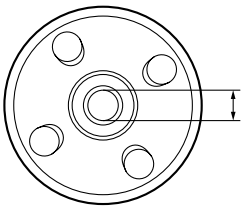
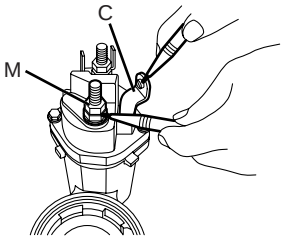
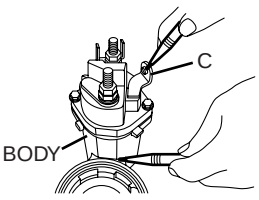
No.	Part of lubrication	Grease	Quantity (g)	Remarks
1	Pinion case bushing and grease joint	Multemp AC-N	0.8-1.5	
2	Bracket center bushing and grease joint	Multemp AC-N	0.8-1.5	
3	Shim washer	Multemp AC-N	0.2-0.5	Washer (both sides)
4	Armature front bushing	Multemp AC-N	0.5-1.0	
5	Shim washer	Multemp AC-N	0.2-0.5	Washer (both sides)
6	Internal gear	Multemp AC-N	7-11	
	Armature gear			
	Planetary gear			
7	Pinion straight spline	Multemp AC-N	0.5-1.0	
8	Inner sleeve bushing	Multemp AC-N	0.3-0.6	
9	Helical spline	Multemp AC-N	0.5-1.0	
10	Clutch case lever shifter unit	Pyronoc No.2	1-2	
11	Bracket rear bearing housing	Pyronoc No.2	0.2-0.5	
12	Planetary gear housing	Multemp AC-N	1-2	
13	Lever holder unit	Multemp AC-N	0.4-0.8	
14	Lever roller rod unit	Pyronoc No.2	0.2-0.5	

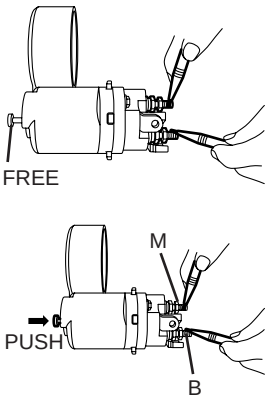
INSPECTION AND REPAIR

EN0111212H300001

Unit: mm {in.}

Inspection item	Standard	Limit	Remedy	Inspection procedure
Armature short circuit test (Using a growler tester)	If the iron rod does not vibrated, the armature is good.	—	Replace.	Measure 
Armature insulation	More than 1 MΩ	Less than 1 kΩ	Replace.	Measure 
Outside diameter of the commutator	36 {1.417}	Less than 34 {1.339}	Replace.	Measure 
Depth between the mica and the commutator (Under cut depth)	0.5-0.8 {0.0197-0.0314}	Less than 0.2 {0.0078}	Replace or repair.	Measure 
Insulation between the brush and the yoke body	—	Less than 1 kΩ	Replace.	Measure 
Outside diameter of the armature assembly	A: 12 {0.472} B: 9 {0.354}	A: 11.98 {0.4717} B: 8.98 {0.3535}	Replace.	Measure 
Insulation between the brush and brush holder	More than 1 MΩ	Less than 1 kΩ	Replace.	Measure 
Brush length	18 {0.709}	13 {0.5112}	Replace.	Measure 

Inspection item	Standard	Limit	Remedy	Inspection procedure
Outside diameter of the drive shaft assembly	A: 26.0 {1.024} B: 14.1 {0.555}	A: 25.90 {1.0197} B: 14.04 {0.5528}	Replace.	Measure 
Inside diameter of the center bracket	26.0 {1.024}	More than 26.2 {1.031}	Replace the metal.	Measure 
Outside diameter of the clutch assembly inner sleeve	28 {1.102}	27.90 {1.0984}	Replace.	Measure 
Inside diameter of commutator end frame	28 {1.102}	28.1 {1.1063}	Replace.	Measure 
Inside diameter of shaft assembly bushing	9 {0.3543}	More than 9.2 {0.3622}	Replace.	Measure 
Resistance between the C terminal and M terminal (Pulling Coil)	0.12-0.14 Ω	—	Replace.	Measure 
Resistance between the C terminal and the body (Holding Coil)	1.13-1.25 Ω	—	Replace.	Measure 

Inspection item	Standard	Limit	Remedy	Inspection procedure
Continuity between the M terminal and B terminal	**Free: No continuity Push: Continuity**	**—**	**Replace.**	

AIR COMPRESSOR (A09C)

EN13-001

AIR COMPRESSOR

DATA AND SPECIFICATIONS

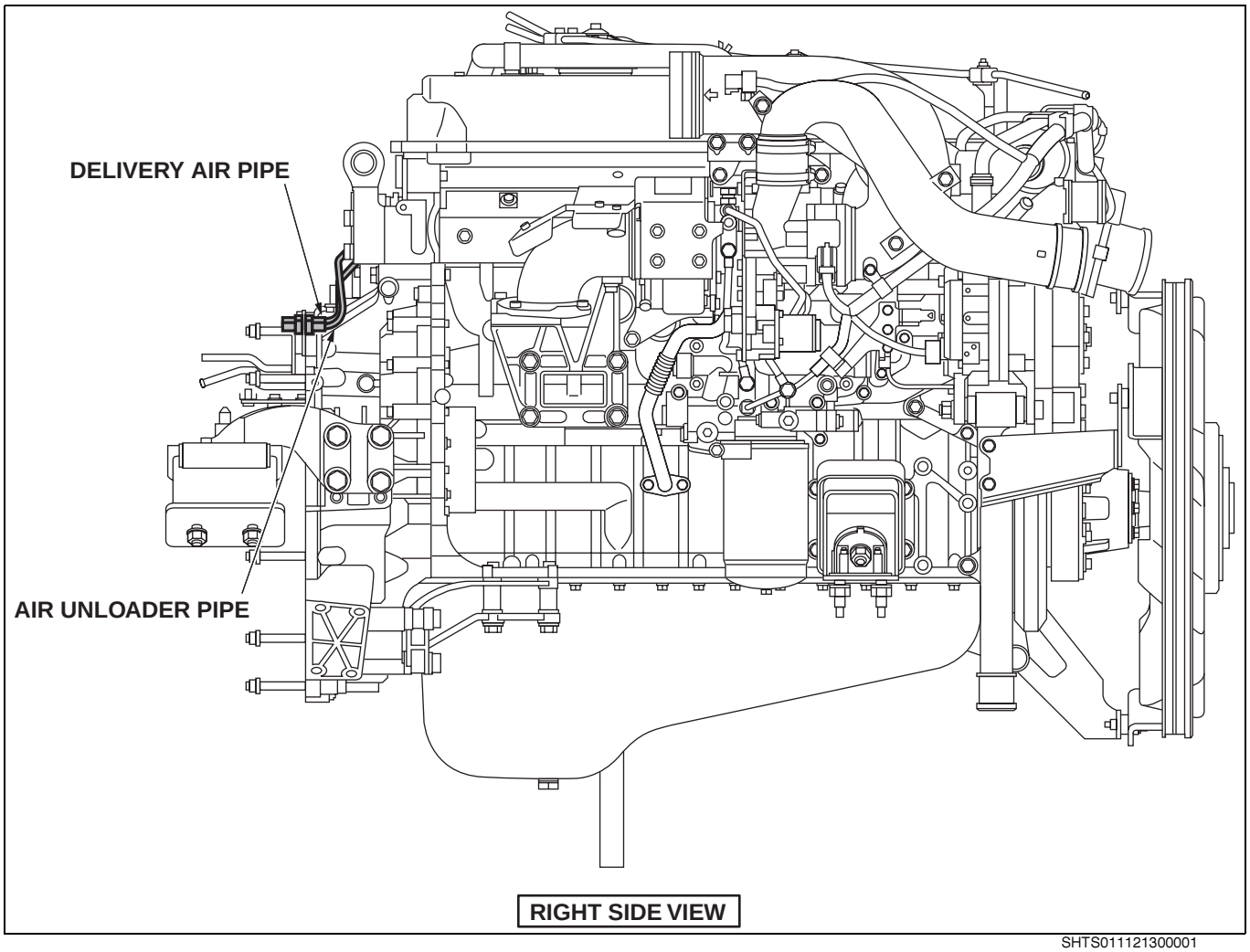
EN0111213I200001

Type	**Reciprocating, single cylinder**
Discharge amount	**340 cm^3 {20.7 cu.in.}**
Bore x stroke	**85 mm x 60 mm {3.35 in. x 2.36 in.}**
Lubrication system	**Forced feed lubrication**
Cooling system	**Forced water-circulated**

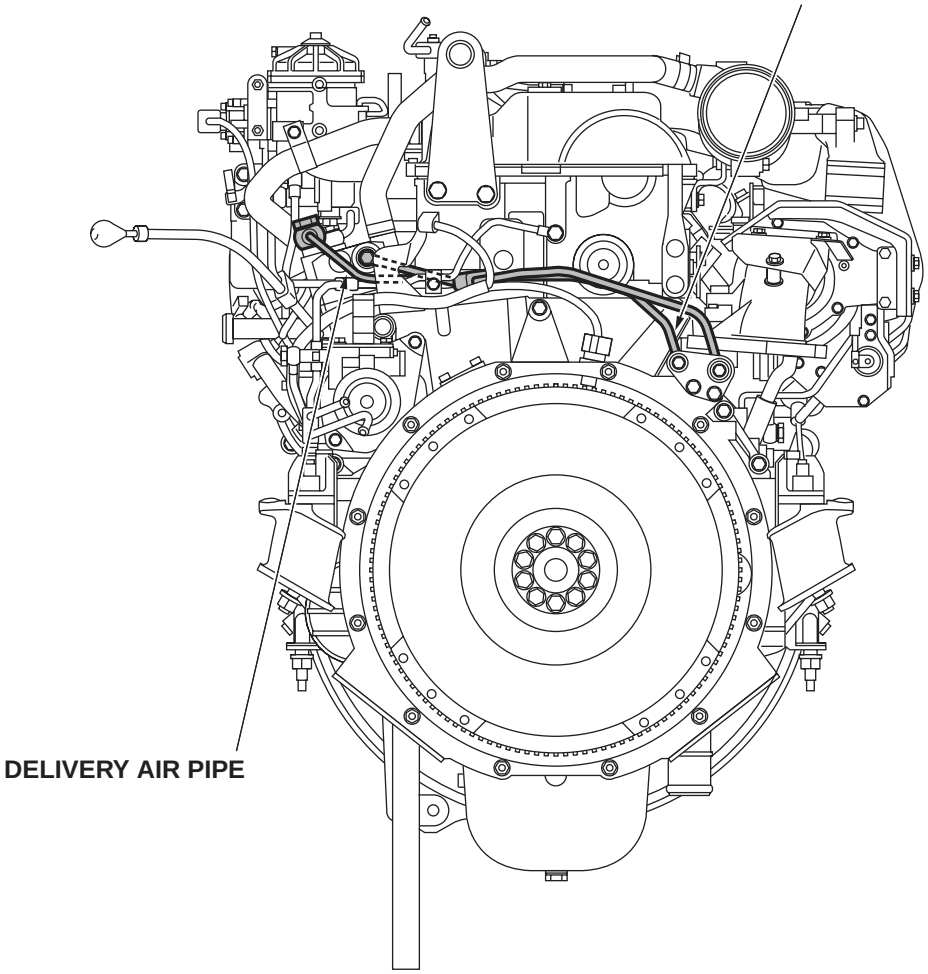
DESCRIPTION

EN0111213C100001

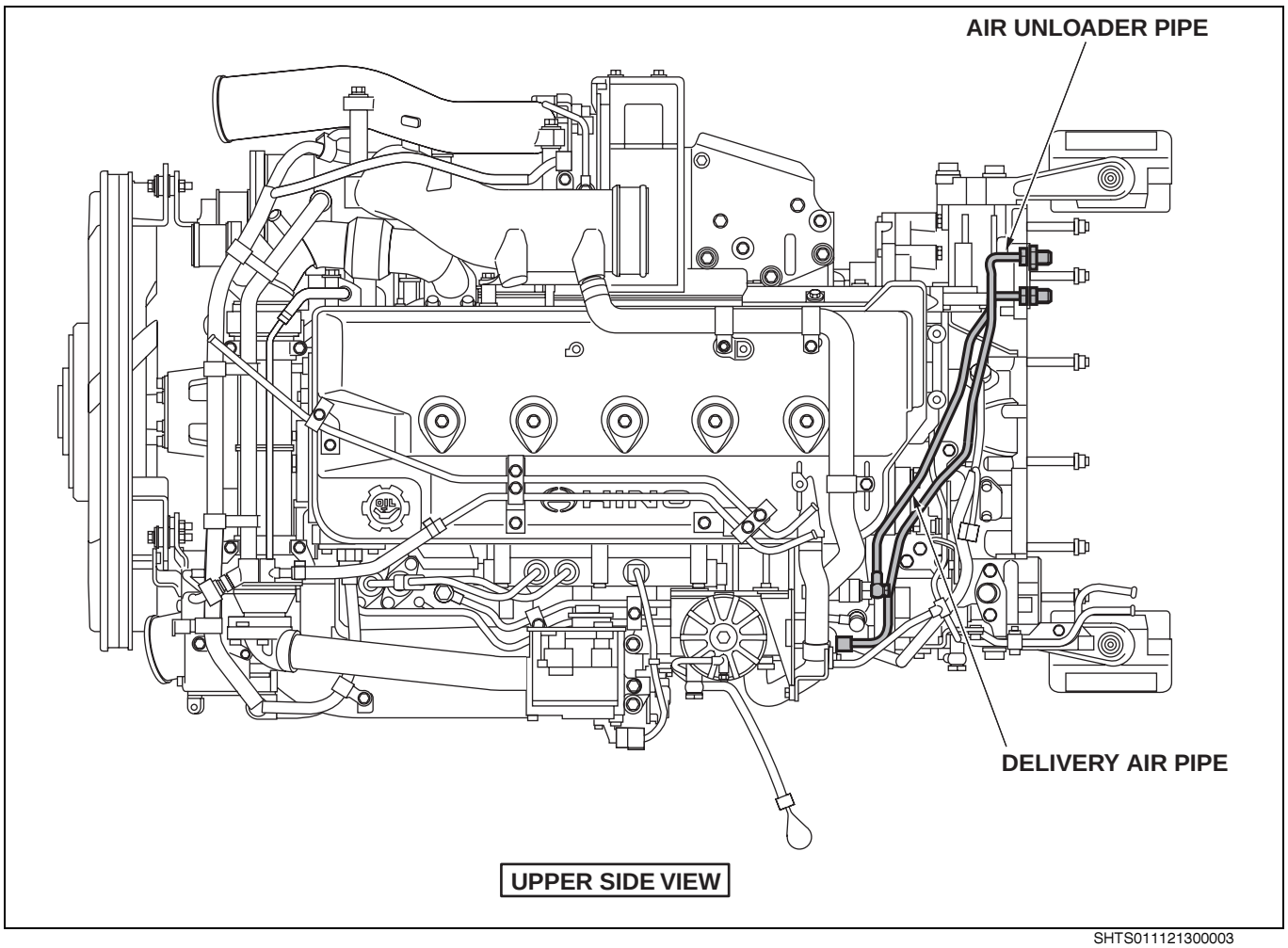
AIR PIPING



SHTS011121300001



SHTS011121300002



SHTS011121300003

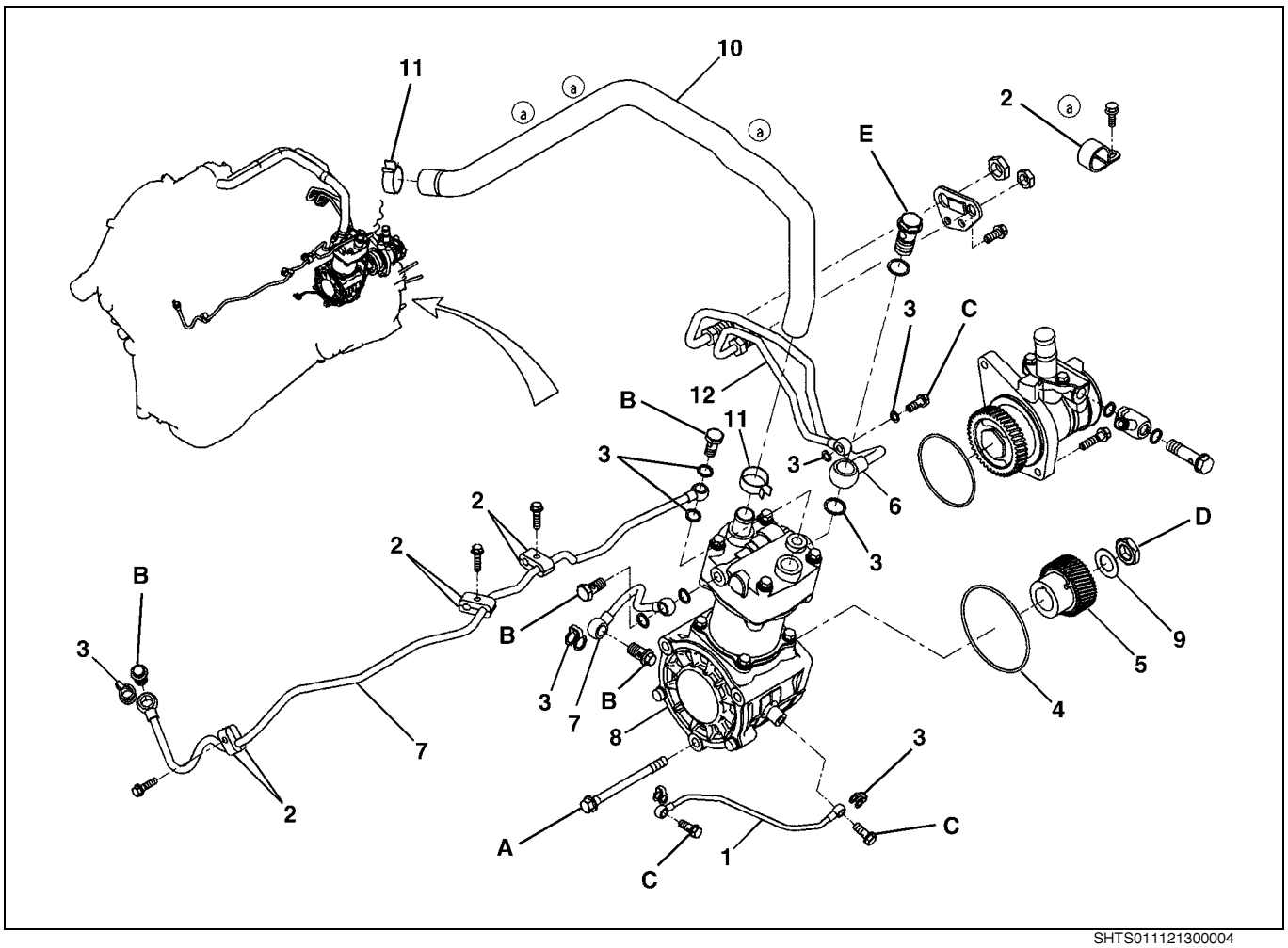
TROUBLESHOOTING

EN0111213F300001

Symptom	Possible cause	Remedy/Prevention
Charging efficiency dropped (Valve)	Abnormal wear, damage, or poor contact	Replace.
Charging efficiency dropped (Piston, cylinder liner and piston rings)	Worn piston and cylinder liner	Replace.
	Seized piston	Replace (piston, piston rings and cylinder liner).
	Worn or broken piston ring	Replace.
Charging efficiency dropped (Air pipe and joints)	Leakage of high-pressure air	Replace or tighten pipe joint.
	Clogged air pipe	Inspect and clean.
Charging efficiency dropped (Air cleaner)	Clogged element	Clean or replace element.
Noisy operation (Piston)	Wear of piston pin boss or piston pin	Replace.
	Seized, damaged or worn connecting rod small end	Overhaul.
	Worn piston or cylinder liner	Replace.
	Damaged or seized piston	Replace.
	Foreign particles on the top surface of piston	Clean or replace.
Noisy operation (Bearing)	Damaged, or worn ball bearing and/or connecting rod bearing	Replace.
Out of commission (Unloader valve)	Tenesmus of unloader valve	Clean or replace.
	Air leakage	Repair or tighten.
	Out of commission (Pressure regulator)	Adjustment or replace.
Excessive carbon or oil in the compressor cylinder head or discharge line (Piston ring)	Worn, sticking or broken piston rings	Replace piston rings and/or cylinder liner.
	Insufficient piston ring tension	Replace piston rings and/or cylinder liner.
	Malposition of piston rings (Upside down)	Reposition piston rings.

COMPONENT LOCATOR

EN0111213D100001

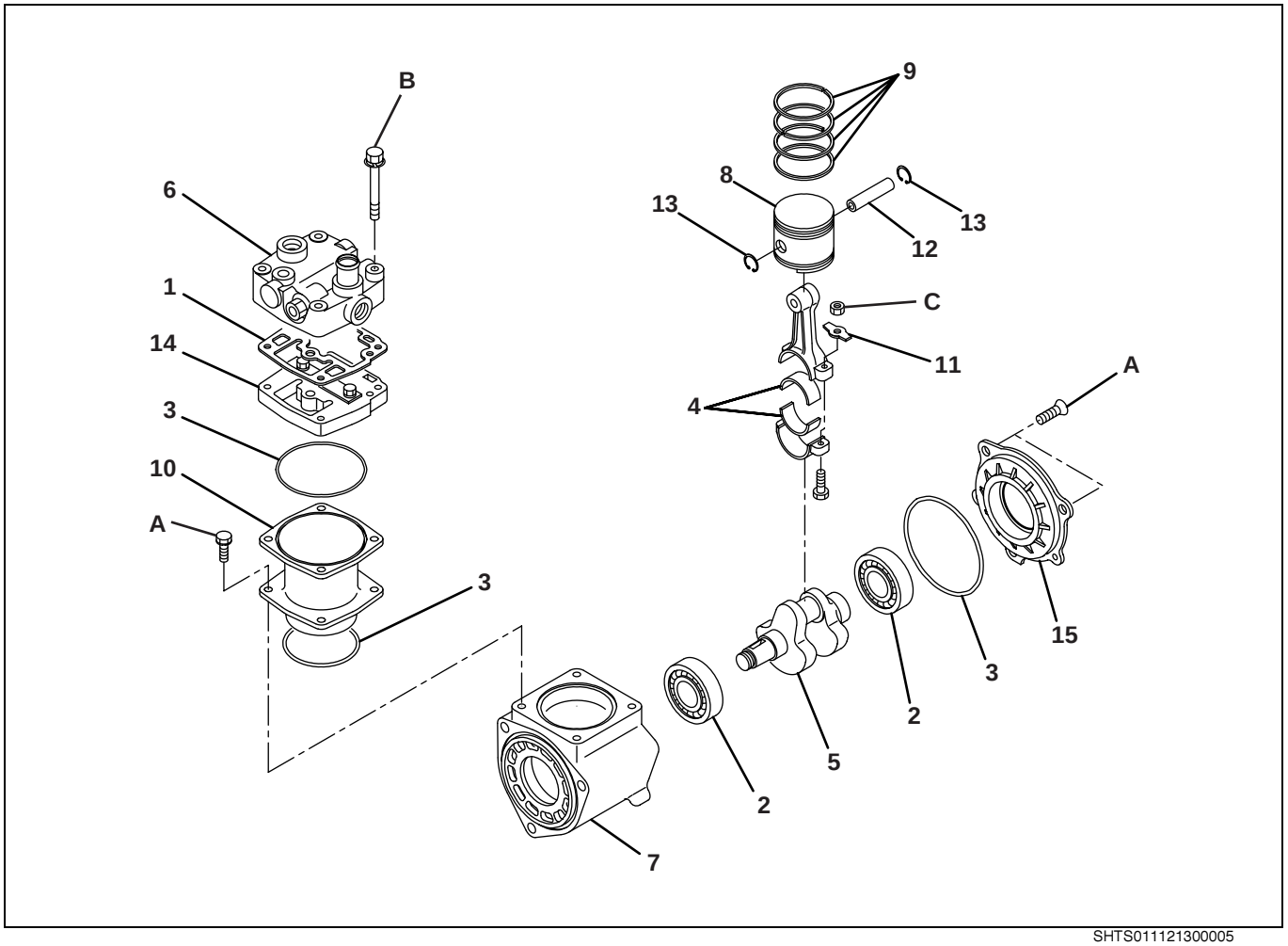


SHTS011121300004

1	Oil pipe	7	Coolant pipe
2	Clip	8	Air compressor
3	Gasket	9	Plate
4	O-ring	10	Air compressor suction hose
5	Air compressor drive gear	11	Clamp
6	Delivery air pipe	12	Air unloader pipe

Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

A	97 {990, 72}	D	142 {1,450, 105}
B	25 {255, 18}	E	68.5 {700, 51}
C	19.6 {200, 14}		



SHTS011121300005

1	Gasket	9	Piston ring
2	Main bearing	10	Cylinder liner
3	O-ring	11	Lock plate
4	Bearing	12	Piston pin
5	Crankshaft	13	Retainer ring
6	Cylinder head	14	Valve seat
7	Crank case	15	Bearing holder
8	Piston		

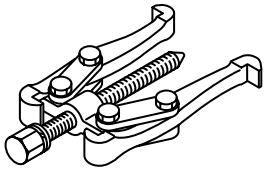
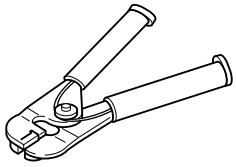
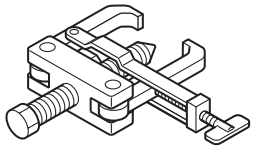
Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

A	25-29 {250-300, 19-21}	C	23-26 {230-260, 17-19}
B	29-34 {300-350, 22-25}		

SPECIAL TOOL

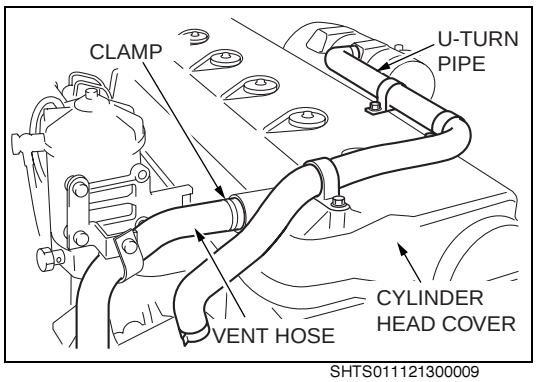
EN0111213K100001

Prior to starting an air compressor overhaul, it is necessary to have these special tools.

Illustration	Part number	Tool name	Remarks
	S0965-01101	PULLER ASSEMBLY	
	S0944-21011	PISTON RING EXPANDER	
	S0965-01101	BEARING PULLER	

REPLACEMENT

EN0111213H100001

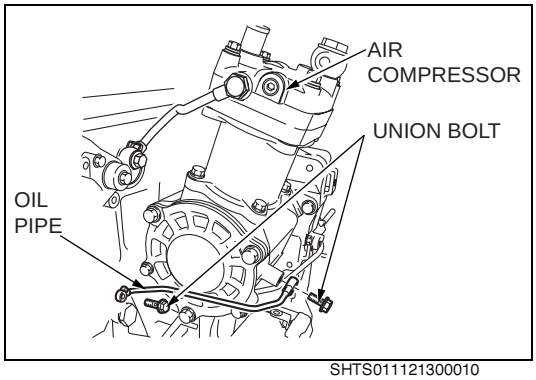


SHTS011121300009

REMOVE THE AIR COMPRESSOR.

1. REMOVE THE AIR COMPRESSOR SUCTION HOSE.

(1) Remove two clamps, three bolts and three clips to remove the air compressor suction hose.



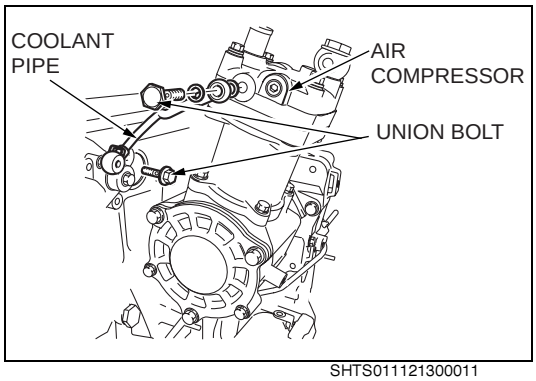
SHTS011121300010

2. REMOVE THE OIL PIPE.

(1) Remove two union bolts to remove the oil pipe and gasket from the air compressor.

HINT

Use a container and a waste as engine oil might drip off during removal of oil pipe.



SHTS011121300011

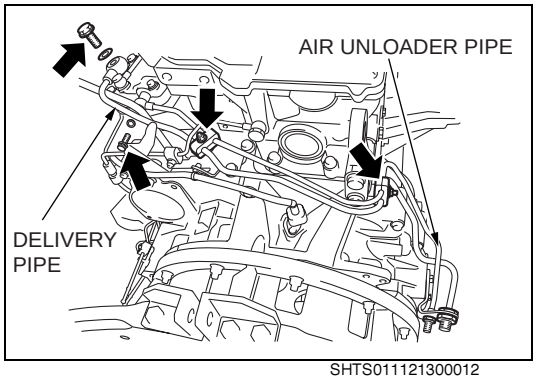
3. REMOVE THE COOLANT PIPE.

(1) Remove the union bolt to remove the coolant pipe from the air compressor.
Refer to the section **"COOLANT PUMP"** in the chapter **"COOLING SYSTEM"**.

(2) Remove two union bolts to remove the coolant pipe and gasket from the air compressor.

HINT

Use a container and a waste as coolant might drip off during removal of coolant pipe.



SHTS011121300012

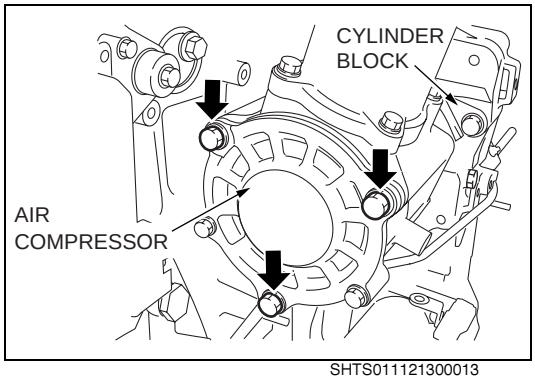
4. REMOVE THE AIR PIPE.

(1) Remove two nuts and two clips.

(2) Remove two nuts to remove the air unloader pipe, the delivery pipe and the gasket.

5. REMOVE THE BRACKET (ON THE REAR SIDE OF THE INTAKE PIPE).

(1) Remove the bracket (on the rear side of the intake pipe).
Refer to the section **"INTAKE PIPE (INTAKE SIDE)"** in the chapter **"AIR INTAKE SYSTEM"**.



SHTS011121300013

6. REMOVE THE AIR COMPRESSOR.

(1) Remove three bolts to remove the air compressor and O-ring from the cylinder block.

NOTICE

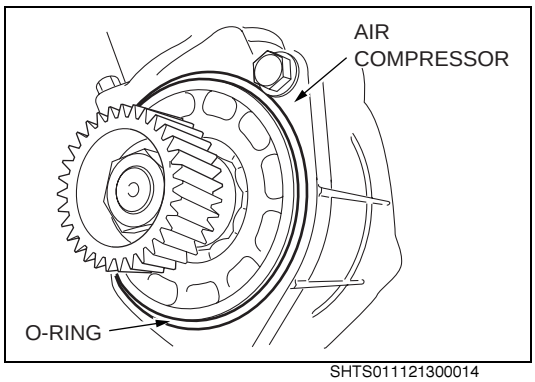
- **If the flywheel housing is not removed, indicate an alignment mark on the air compressor drive gear and on the air compressor idle gear respectively.**
- **When removing/installing the air compressor, take care to avoid contact with the fuel temperature sensor.**

INSTALL THE AIR COMPRESSOR.

1. INSTALL THE AIR COMPRESSOR.

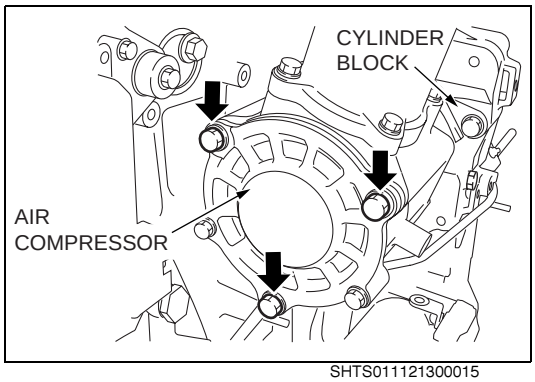
(1) Set the No.1 cylinder to the top dead center of the compression stroke.
Refer to the section **"SUPPLY PUMP"** in the chapter **"FUEL SYSTEM"**.

(2) Set the new O-ring on the O-ring groove of the air compressor.

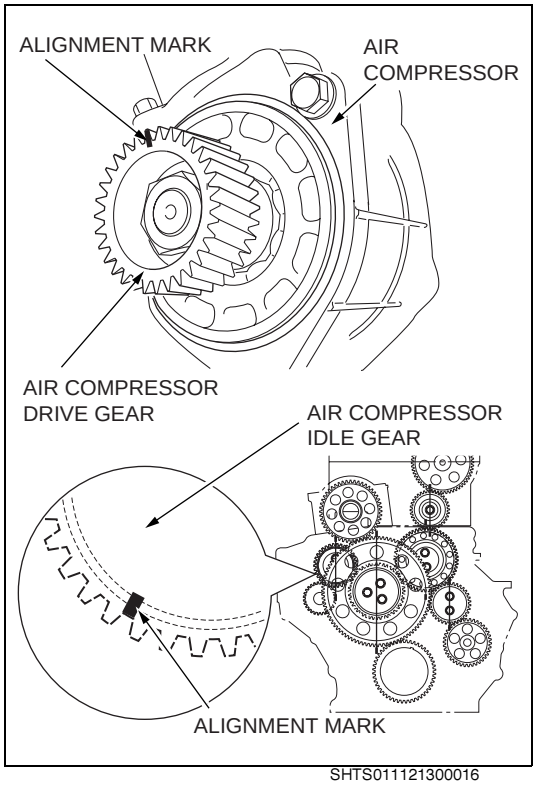


SHTS011121300014

(3) At first, insert three bolts in the air compressor and assemble the air compressor to the cylinder block. Then pretighten three bolts.



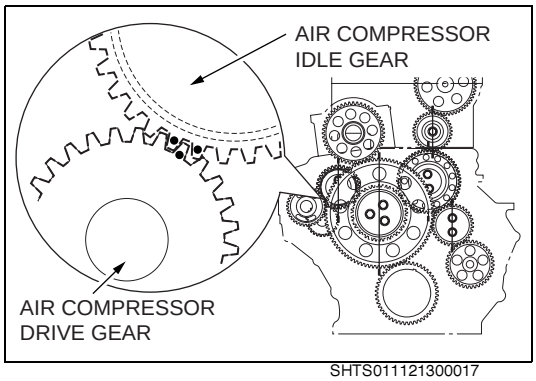
SHTS011121300015



SHTS011121300016

NOTICE

- **If the flywheel housing is not removed, make sure that alignment marks indicated prior to removal of the air compressor are flush with each other when installing the air compressor.**

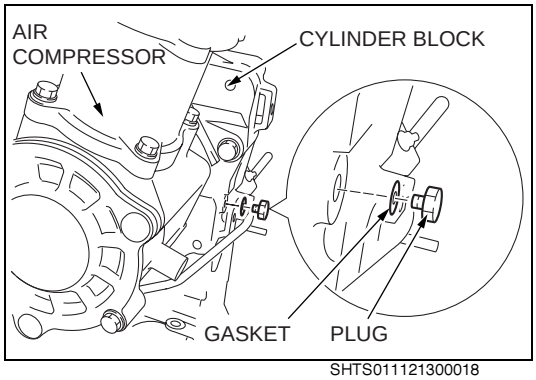


SHTS011121300017

- **If the flywheel housing has been removed, install the air compressor after making sure that a punched mark (white paint at the tooth top) on the air compressor drive gear is aligned with punched marks on the air compressor idle gear as shown in the figure.**
- **Do not rotate the gear and the air compressor body in the rotational direction until gear engagement is ensured.**
- **When removing/installing the air compressor, take care to avoid contact with the fuel temperature sensor.**

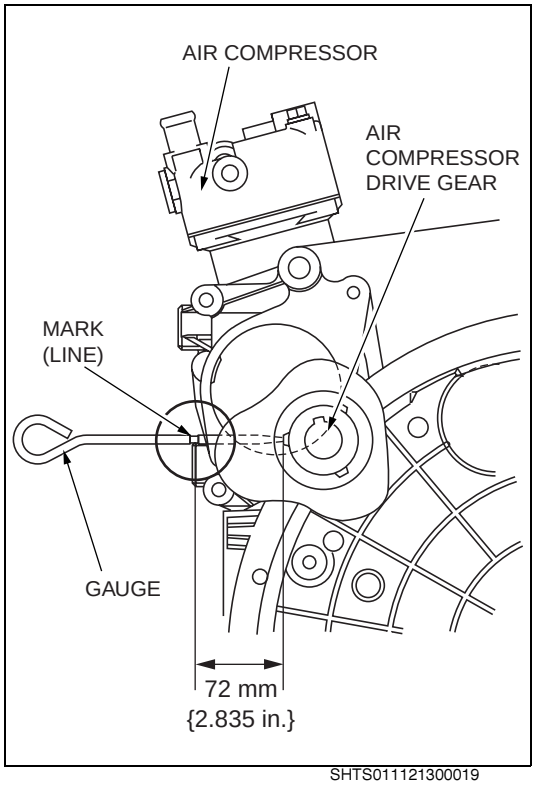
HINT

When mounting the air compressor, make sure to first insert bolts in the air compressor. Otherwise, the air compressor cannot be mounted due to interference with the engine ECU cooler.



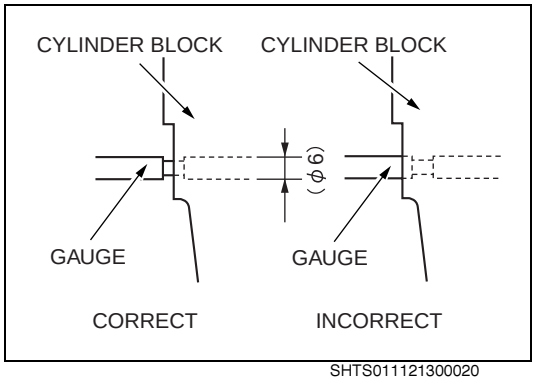
SHTS011121300018

(4) Remove a plug and a gasket from the orientation check hole in the cylinder block.



SHTS011121300019

(5) Insert a gauge (ϕ6) having a mark (line) at a point of 72 mm {2.835 in.} from its tip, into the orientation check hole in the cylinder block until it contacts with the gear. Check whether the air compressor drive gear is assembled in its correct orientation.

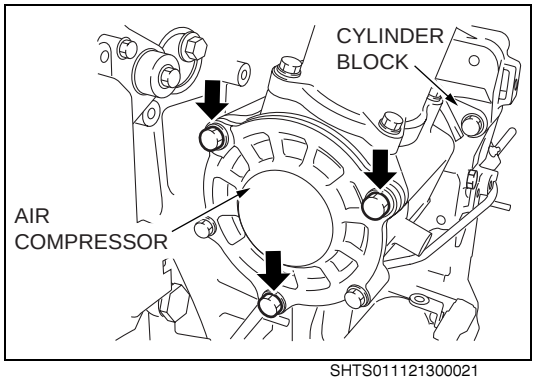


SHTS011121300020

(6) When a tip of the gauge contacts with the gear, a mark (line) must be out of the cylinder block as shown in the figure.

NOTICE
If a groove in the gauge goes into the cylinder block, restart the remounting procedures again and correct the gear orientation.

(7) Replace the gasket with new one. Install the plug into the orientation check hole in the cylinder block.
Tightening Torque:
13 N·m {130 kgf·cm, 10 lbf·ft}

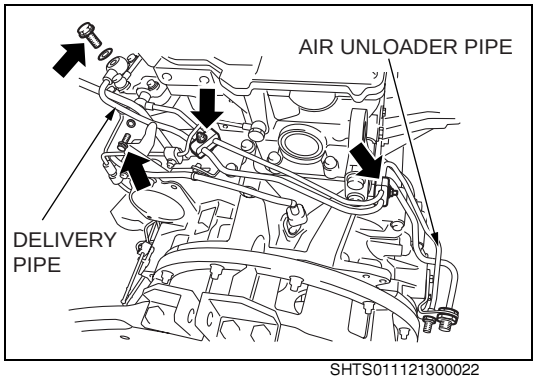


SHTS011121300021

(8) Tighten three bolts to the specified torque.
Tightening Torque:
97 N·m {990 kgf·cm, 72 lbf·ft}

2. INSTALL THE BRACKET (ON THE REAR SIDE OF THE INTAKE PIPE).

(1) Install the bracket (on the rear side of the intake pipe).
Refer to the section **"INTAKE PIPE (INTAKE SIDE)"** in the chapter **"AIR INTAKE SYSTEM"**.

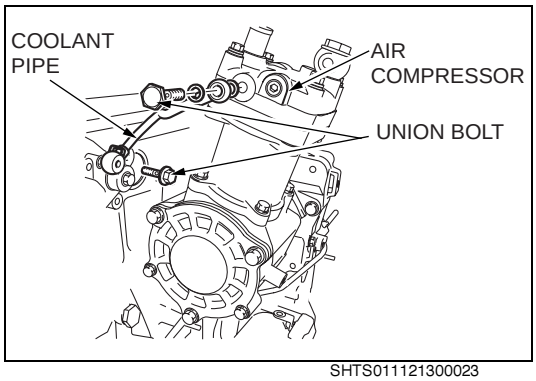


SHTS011121300022

3. INSTALL THE AIR PIPE.

(1) Replace the gasket with new one and install the air unloader pipe and two delivery air pipes, and tighten two union bolts.
Tightening Torque:
Delivery air pipe: 68.5 N·m {700 kgf·cm, 51 lbf·ft}
Air unloader pipe: 19.6 N·m {200 kgf·cm, 14 lbf·ft}

(2) Install two clips with two nuts.

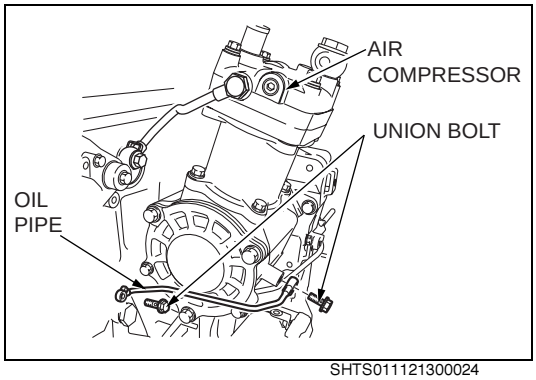


SHTS011121300023

4. INSTALL THE COOLANT PIPE.

(1) Replace the gasket with new one. Install the coolant pipe, and tighten two union bolts.
Tightening Torque:
25 N·m {255 kgf·cm, 18 lbf·ft}

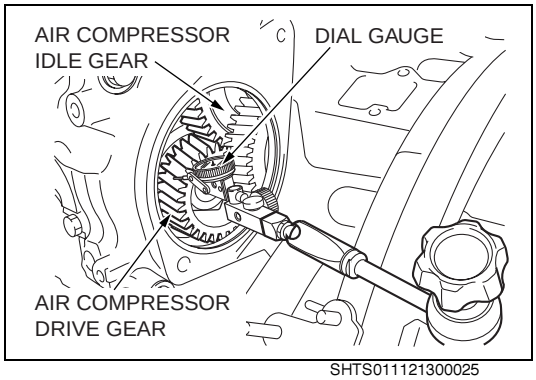
(2) Install the coolant pipe between the coolant pump and the air compressor.
Refer to the section **"COOLANT PUMP"** in the chapter **"COOLING SYSTEM"**.



SHTS011121300024

5. INSTALL THE OIL PIPE.

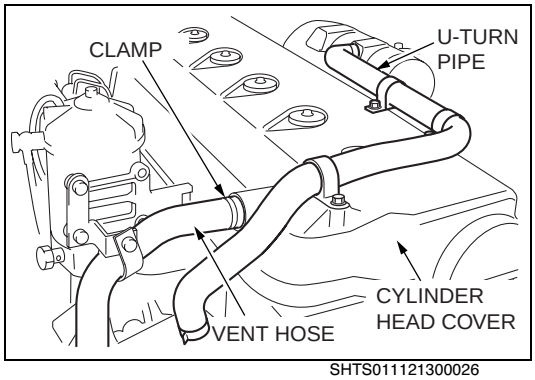
(1) Install the gasket with new one. Install the oil pipe, and tighten two union bolts.
Tightening Torque:
19.6 N·m {200 kgf·cm, 14 lbf·ft}



SHTS011121300025

6. INSPECT THE BACKLASH.

(1) Using a dial gauge, measure the backlash between air compressor idle gear and air compressor drive gear.
Standard value: 0.020-0.133 mm {0.0007-0.0052 in.}



SHTS011121300026

7. INSTALL THE AIR COMPRESSOR SUCTION HOSE.

(1) Install the air compressor suction hose with two clamps, three bolts and three P-clips.

⚠ CAUTION

- **Avoid distorting the suction hose.**
- **Keep the head cover from coming in contact with the suction hose.**

8. FILL ENGINE OIL.

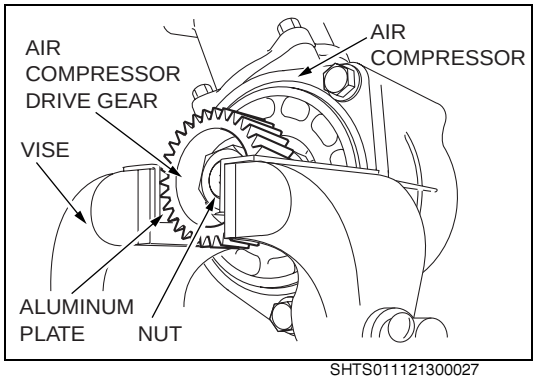
(1) Check the engine oil level, and refill the engine oil, if the engine oil level is low.
Refer to the section **"DISMOUNTING AND MOUNTING"** in the chapter **"ENGINE INTRODUCTION"**.

9. FILL THE COOLANT.

(1) Check the coolant level, and refill the coolant, if the coolant level is low.
Refer to the section **"RADIATOR"** in the chapter **"COOLING SYSTEM"**.

OVERHAUL

EN0111213H200001



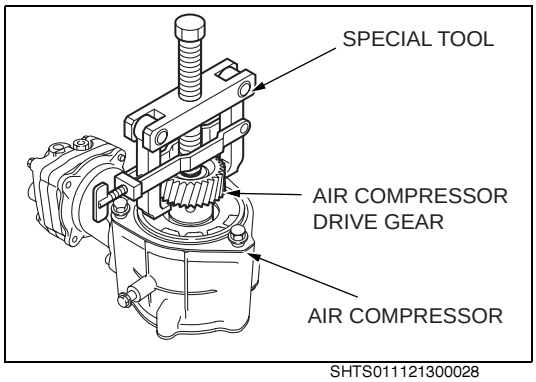
SHTS011121300027

DISASSEMBLE THE AIR COMPRESSOR.

1. REMOVE THE AIR COMPRESSOR DRIVE GEAR.

(1) Set an aluminum sheet in a vise. Use this vise to fixate the air compressor drive gear. Remove a nut and a plate.

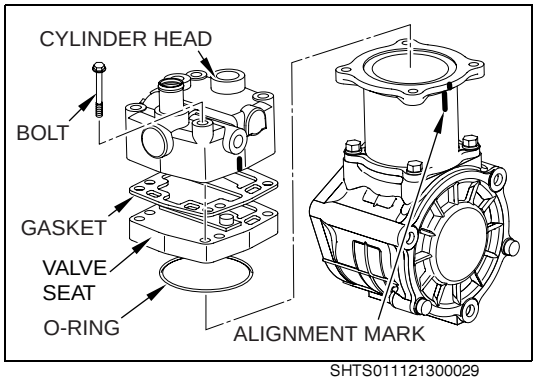
⚠ CAUTION
Take care not to deform or scratch the air compressor drive gear.



SHTS011121300028

(2) Using the special tool, remove the air compressor drive gear from the air compressor.
SST: Bearing puller (S0965-01101)

HINT
For easier removal of the air compressor drive gear, use a hammer to apply some impacts onto the puller head.

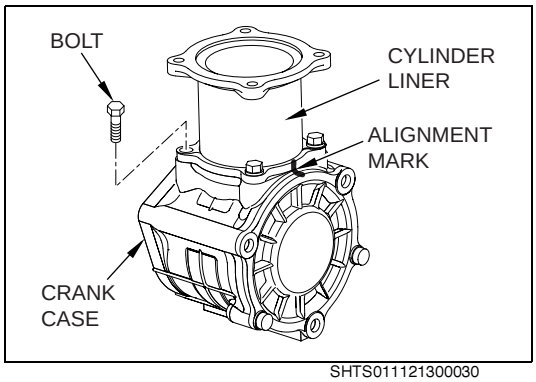


SHTS011121300029

2. DISASSEMBLE THE CYLINDER.

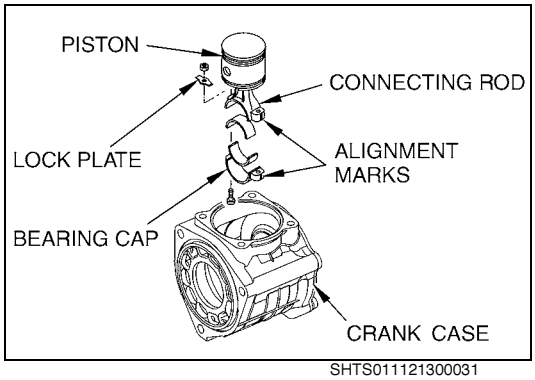
(1) After indicating an alignment mark from the cylinder head to the cylinder liner, remove a bolt. Remove the cylinder head, a gasket, a valve seat and an O-ring.

NOTICE
Do not disassemble the valve seat.



SHTS011121300030

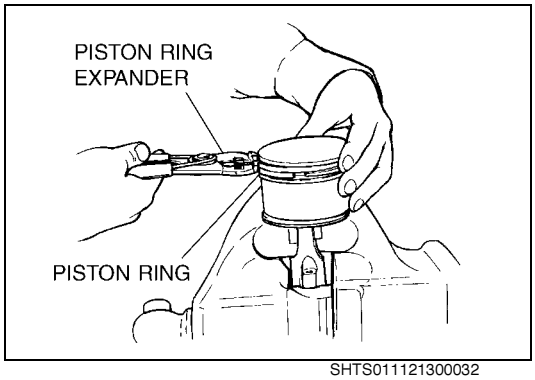
(2) Before removing the bolt, make the alignment marks to the cylinder liner and the crank case. Remove the bolt to remove the cylinder liner and O-ring.



SHTS011121300031

3. DISASSEMBLE THE PISTON AND THE CRANK.

(1) Release crimp on the lock plate on the connecting rod.
(2) Fix the crank case with a vise and remove the connecting rod bolt installation nut and lock plate.
(3) Pull the piston upward together with the connecting rod and disengage a bolt and a cap from the connecting rod. Paint an alignment mark on the connecting rod and the cap.
(4) Remove the bearing from the connecting rod and cap.

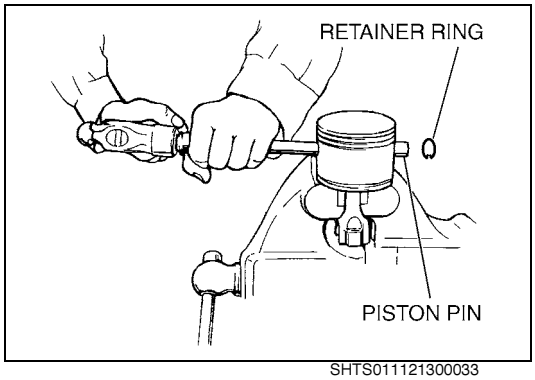


SHTS011121300032

(5) Fix the connecting rod with a vise and remove the piston ring using the special tool.

SST: Piston ring expander (S0944-21011)

NOTICE
The piston ring has vertical directionality. Use an oil-based marker to indicate a directional mark in order to prevent wrong positioning (top or bottom) in reassembly.

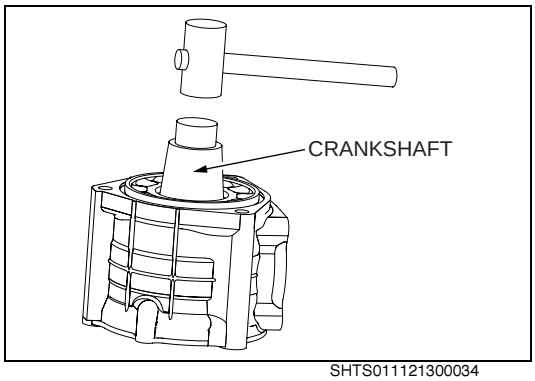


SHTS011121300033

(6) Using a snap ring plier, remove the retainer rings from the both sides of the piston.

⚠ CAUTION
Wear a pair of safety goggles, because the retainer ring may spring out the groove at the time of removal.

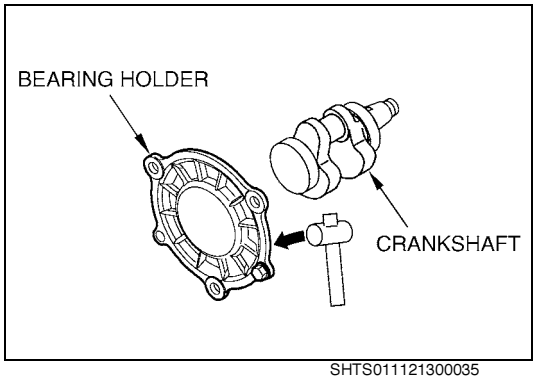
(7) Using a brass bar and hammer, drive out the piston pin and separate the piston from the connecting rod.
(8) Remove the bolt of the bearing holder.



SHTS011121300034

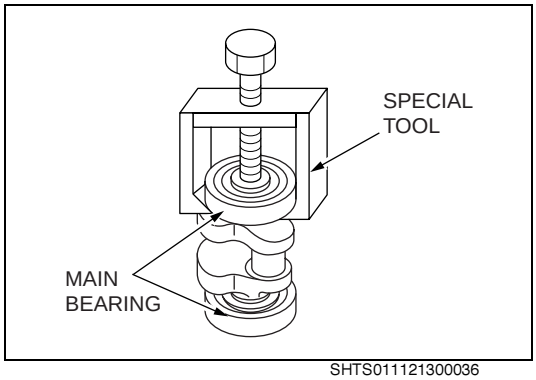
(9) Position the drive gear on top. Use a plastic hammer to tap at the crankshaft lightly to remove the crankshaft.

⚠ CAUTION
- **Do not damage the mounting flange surface.**
- **Take care not to drop and damage the crankshaft.**



SHTS011121300035

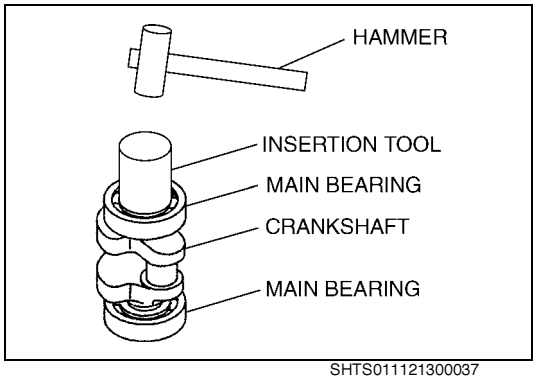
(10) Using a plastic hammer, strike the bearing holder and remove the bearing holder and O-ring from the crankshaft.



SHTS011121300036

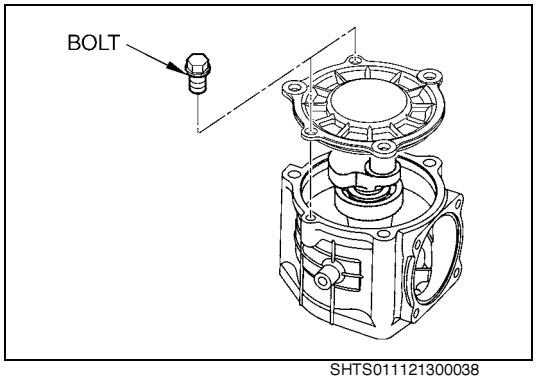
(11) Using the special tool, remove the main bearings from the both sides of the crankshaft.
SST: Bearing puller (S0965-01101)

ASSEMBLE THE AIR COMPRESSOR.



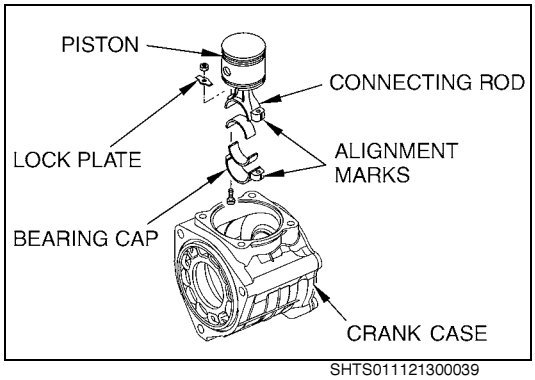
SHTS011121300037

1. INSTALL THE MAIN BEARING.
(1) Use an insertion tool and a hammer to fit the main bearing onto the crankshaft.



SHTS011121300038

2. INSTALL THE CRANKSHAFT.
(1) Replace the O-ring with new one. Install the crankshaft and the bearing holder to the crank case, and tighten the bolt.
Tightening Torque:
25-29 N·m {250-300 kgf·cm, 19-21 lbf·ft}

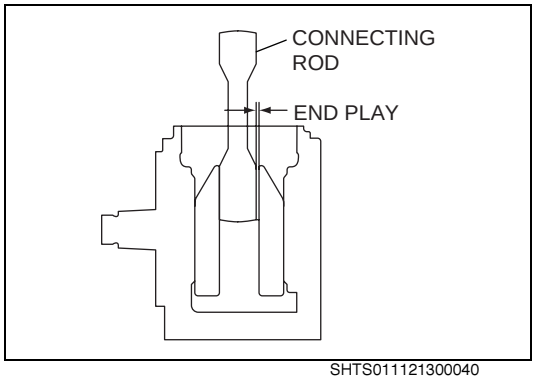


SHTS011121300039

3. INSTALL THE CONNECTING ROD.

(1) Apply engine oil to a bolt and the bearing surface. Attach the bearing to the connecting rod. Match alignment marks, and install a connecting rod, a cap, a bolt, a new lock plate and a nut.
Tightening Torque:
23-26 N·m {230-260 kgf·cm, 17-19 lbf·ft}

(2) Caulk the lock plate.

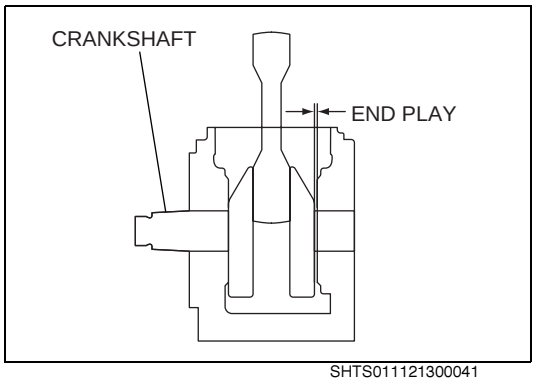


SHTS011121300040

4. MEASURE THE CONNECTING ROD END PLAY.

(1) Use a thickness gauge to measure end play in the connecting rod. If a measurement value exceeds the permissible limit, replace the connecting rod.

Standard	Limit
0.2-0.4 mm {0.0079-0.0157 in.}	0.5 mm {0.0197 in.}

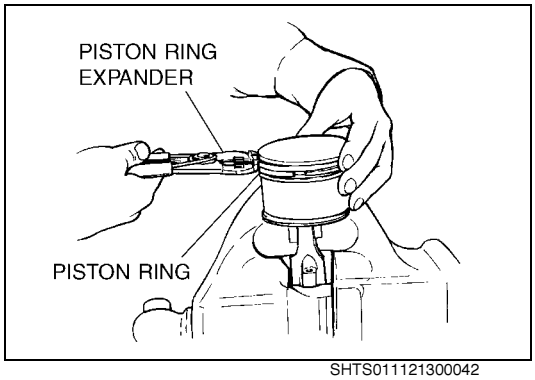


SHTS011121300041

5. MEASURE THE CRANKSHAFT END PLAY.

(1) Use a magnet stand to set a dial gauge at the end of the crankshaft. Measure the end play in the crankshaft. If a measurement value exceeds the permissible limit, replace the crankshaft or bearing.

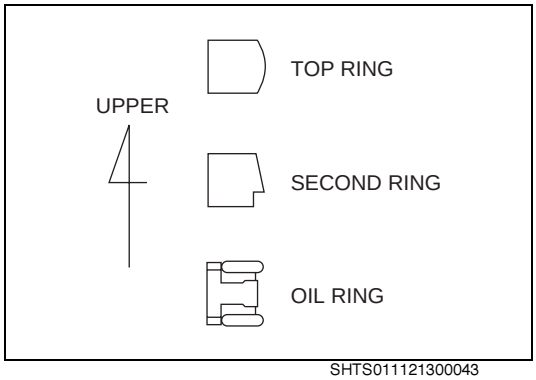
Standard	Limit
0-0.6mm {0-0.0236 in.}	1.0 mm {0.0394 in.}



SHTS011121300042

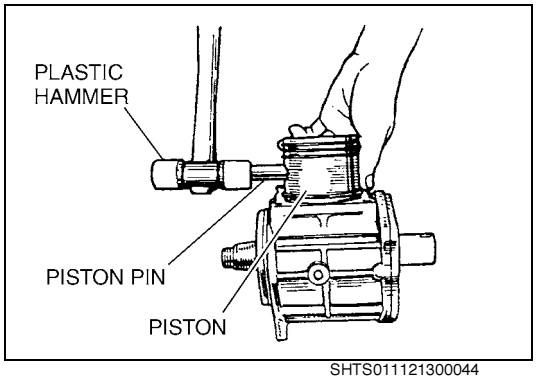
6. INSTALL THE PISTON RING.

(1) Using the special tool, install the piston rings to the piston.
SST: Piston ring expander (S0944-21011)



SHTS011121300043

NOTICE
Install the piston rings in order shown in the figure.



SHTS011121300044

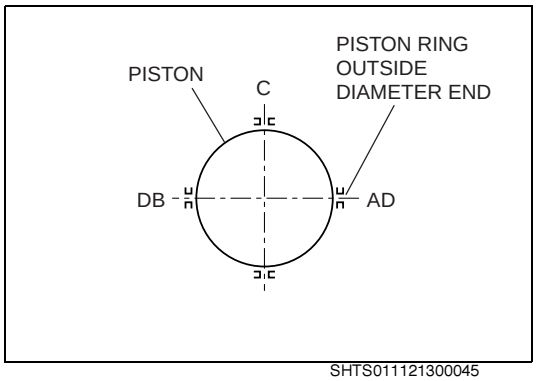
7. INSTALL THE PISTON.

(1) Using a snap ring plier, install the new retainer ring at one end of the piston pin hole.

⚠ CAUTION
Wear a safety goggle, because the retainer ring may spring out the groove at the time of installation.

(2) Apply engine oil to the piston pin.
(3) Using plastic hammer, install the piston pin into the piston and connection rod.
(4) Using a snap ring plier, install the retainer ring to other piston pin hole.

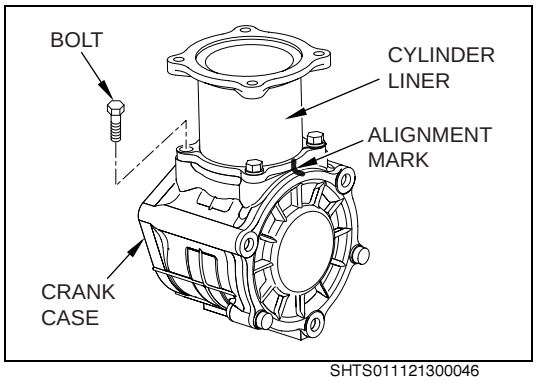
⚠ CAUTION
Wear a safety goggle, because the retainer ring may spring out the groove at the time of installation.



SHTS011121300045

8. INSTALL THE CYLINDER LINER.

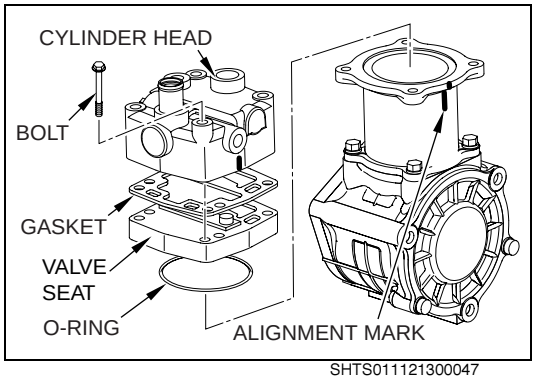
(1) Turn the crankshaft to set it to the top dead center.
(2) Position the piston ring end as shown in the figure.
A: Top ring end
B: Second ring end
C: Oil ring spacer end
D: Oil ring side rail end



SHTS011121300046

(3) Replace the O-ring with new one. Align the alignment marks. Install the cylinder liner to the crank case, and tighten the bolt.
Tightening Torque:
25-29 N·m {250-300 kgf·cm, 19-21 lbf·ft}

NOTICE
Do not twist the O-ring when installing the cylinder liner.

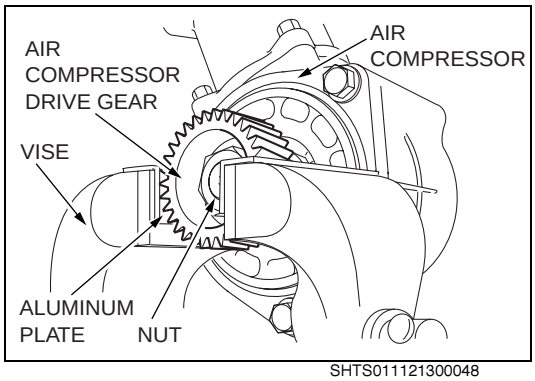


SHTS011121300047

9. INSTALL THE CYLINDER HEAD.

(1) Replace the O-ring and the gasket with new ones. Align the alignment marks. Install the valve seat and the cylinder head.
Tightening Torque:
29-34 N·m {300-350 kgf·cm, 22-25 lbf·ft} (Bolt)

NOTICE
Do not twist the O-ring when installing it on the cylinder.



SHTS011121300048

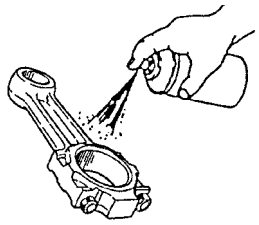
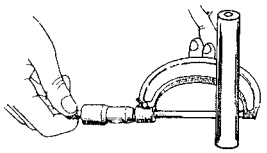
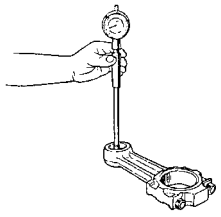
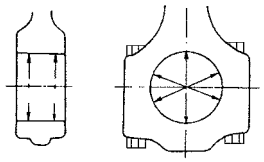
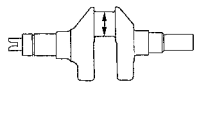
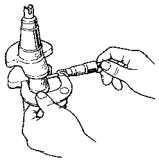
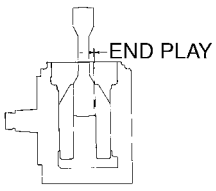
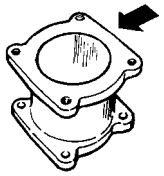
10. INSTALL THE AIR COMPRESSOR DRIVE GEAR.

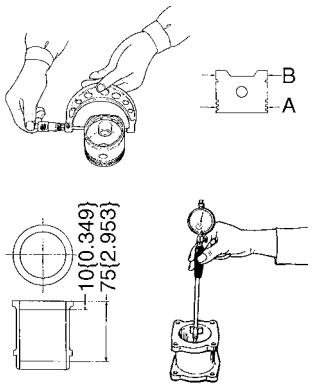
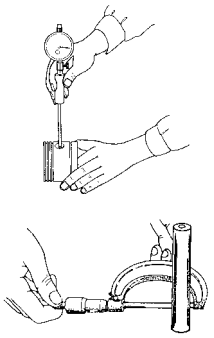
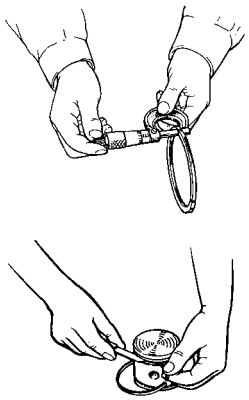
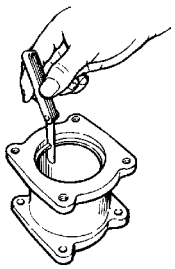
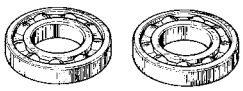
(1) After assembling the key to the crankshaft, make sure to insert the air compressor drive gear. Use a vise to fixate the air compressor drive gear and tighten a nut.
Tightening Torque:
142 N·m {1,450 kgf·cm, 105 lbf·ft}

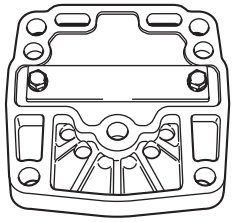
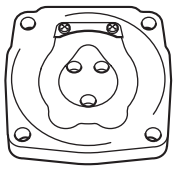
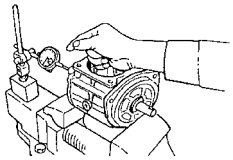
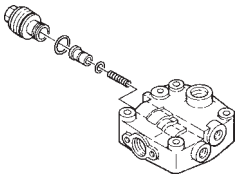
INSPECTION AND REPAIR

EN0111213H300001

Unit: mm {in.}

Inspection item	Standard	Limit	Remedy	Inspection procedure
Cracks or defects of the connecting rod	—	—	Replace.	Visual check 
Outside diameter of piston pin	18 {0.709}	—	Replace.	Measure
Clearance between the piston pin and connecting rod	0.016-0.044 {0.0007-0.0017}	0.07 {0.0028}		 
Inside diameter of the connecting rod (Tighten the bearing cap to the specified torque.)	34 {1.339}	—	Replace.	Measure 
Outside diameter of the crank pin	34 {1.339}	—		
Oil clearance between the connecting rod and the crank pin	0.025-0.075 {0.0010-0.0029}	0.1 {0.0039}		 
Connecting rod end play	0.2-0.4 {0.0079-0.0157}	0.5 {0.0197}	Replace connecting rod or crankshaft.	Measure 
Damage and scratches of the cylinder liner	—	—	Replace.	Visual check 

Inspection item		Standard	Limit	Remedy	Inspection procedure
Outside diameter of the piston		85 {3.346}	—	Replace.	Measure 
Inside diameter of the cylinder liner		85 {3.346}	—		
Clearance between the piston and the cylinder liner		A: 0.23-0.295 {0.0091-0.0116}	0.335 {0.0132}		
		B: 0.09-0.155 {0.0036-0.0061}	0.195 {0.0077}		
Clearance between the piston pin hole and the piston pin		0-0.028 {0-0.0011}	0.08 {0.0031}	Replace.	Measure 
Outer diameter of the piston pin		18 {0.709}	—		
Piston ring thickness	Compression ring	2.0 {0.0787}	—	Replace.	Measure 
	Oil ring	4.0 {0.1575}	—		
Piston ring groove	Compression ring	2.0 {0.0787}	—		
	Oil ring	4.0 {0.1575}	—		
Clearance between the ring groove and the compression ring		0.01-0.045 {0.0004-0.0017}	0.08 {0.0031}		
Gap between ends of piston ring	Top	0.1-0.3 {0.0040-0.0118}	1.0 {0.0394}	Replace.	Measure 
	2nd	0.1-0.3 {0.0040-0.0118}	1.0 {0.0394}		
Worn or damaged bearing		—	—	Replace.	Visual check 

Inspection item	Standard	Limit	Remedy	Inspection procedure
Worn or damaged delivery valve	**—**	**—**	**Replace valve seat.**	**Visual check** 
Worn or damaged suction valve	**—**	**—**	**Replace valve seat.**	**Visual check** 
Crankshaft end play	**0-0.6 {0-0.0236}**	**1.0 {0.0394}**	**Replace crank shaft and/or ball bearing.**	**Measure** 
Worn or damaged unloader valve piston	**—**	**—**	**Replace.**	**Visual check** 

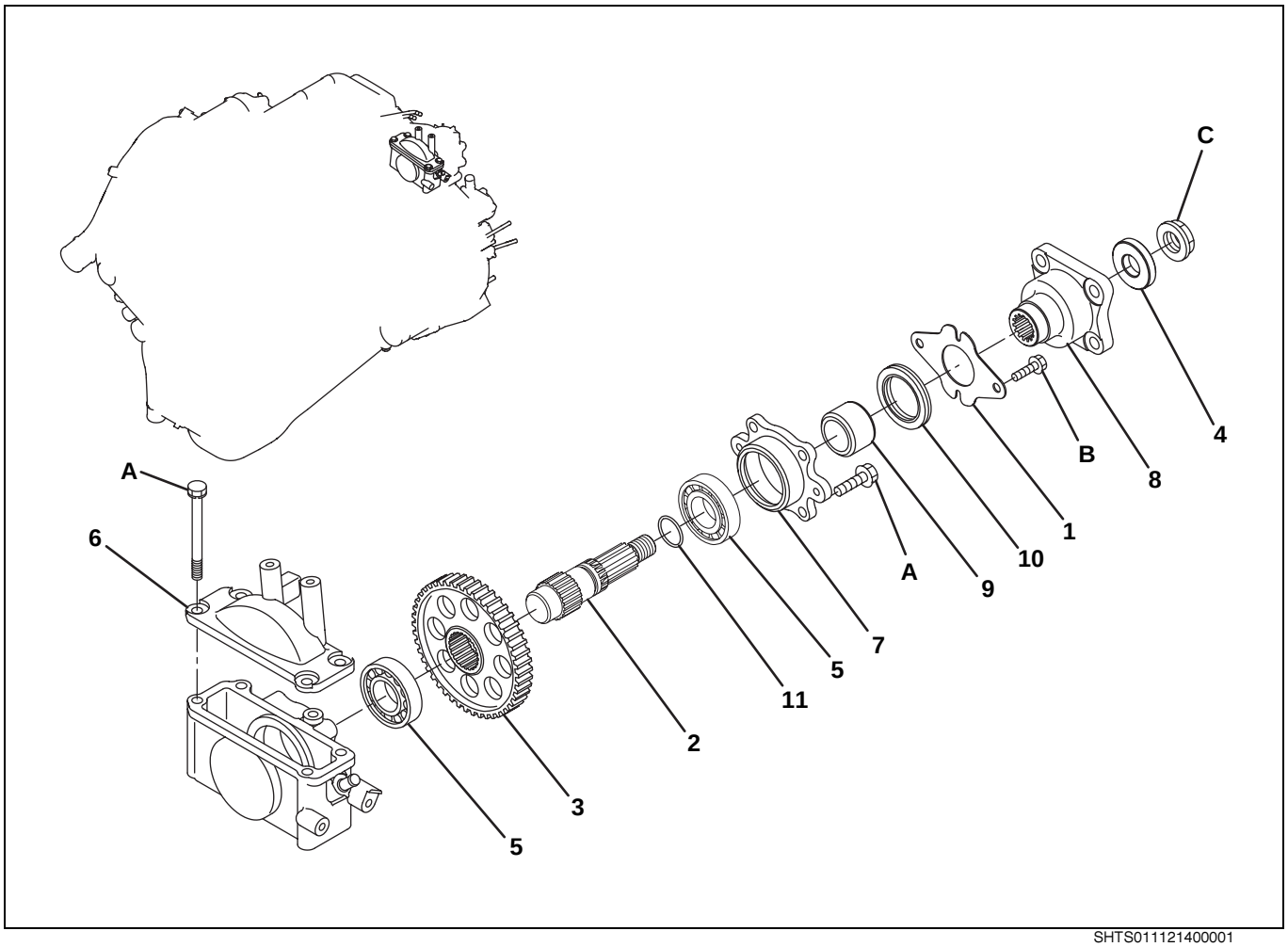
ENGINE P.T.O. (POWER TAKE-OFF) (A09C)

EN14-001

POWER TAKE-OFF ASSEMBLY

COMPONENT LOCATOR

EN0111214D100001



SHTS011121400001

1	Flywheel power take-off cover (Body side)	7	Flywheel power take-off cover (Engine side)
2	Input shaft	8	Output shaft
3	Flywheel power take-off drive gear	9	Sleeve
4	Collar	10	Oil seal
5	Bearing	11	O-ring
6	Cover		

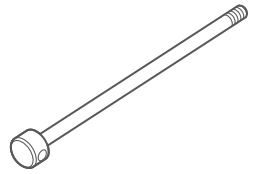
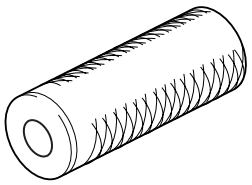
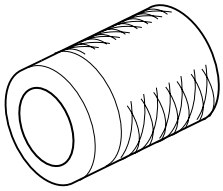
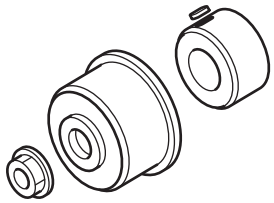
Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

A	55 {560, 41}	C	300 {3,060, 221}
B	28.5 {290, 21}		

SPECIAL TOOL

EN0111214K100001

Prior to starting a power take-off overhaul, it is necessary to have these special tools.

Illustration	Part number	Tool name	Remarks
	S0947-21830	BAR	
	S0947-21021	BAR	
	S0942-11270	PULLER	
	09220-E1010	OIL SEAL PRESS	

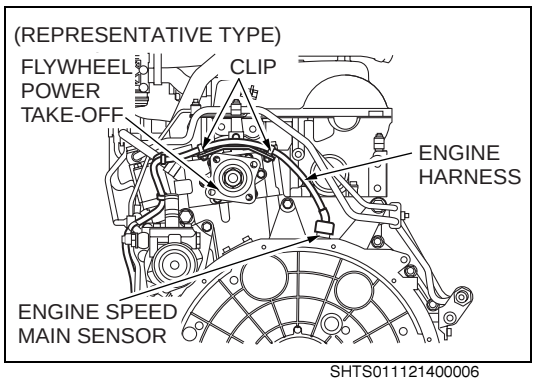
REPLACEMENT

EN0111214H100001

REMOVE THE FLYWHEEL POWER TAKE-OFF.

1. DRAIN THE COOLANT.

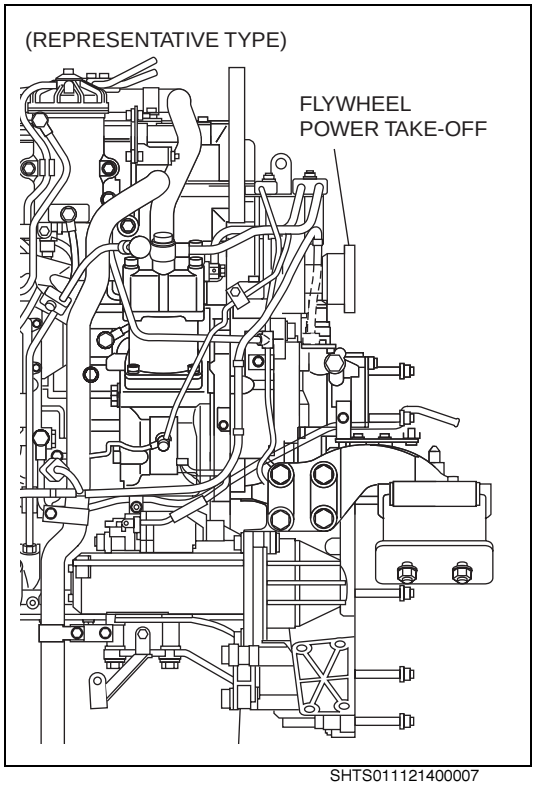
(1) Drain the coolant.
Refer to the section **"RADIATOR"** in the chapter **"COOLING SYSTEM"**.



SHTS011121400006

2. DISCONNECT THE HARNESS.

(1) Disconnect the connector of the engine speed main sensor. Remove two clips to remove the engine harness.



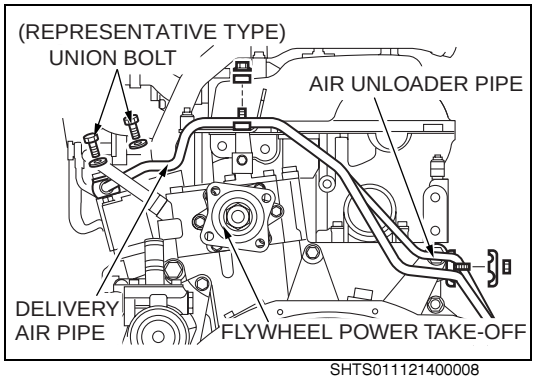
SHTS011121400007

3. REMOVE THE FUEL PIPE.

(1) Remove union bolt and remove the return pipe No.2.
Refer to the section **"SUPPLY PUMP"** in the chapter **"FUEL SYSTEM"**.
(2) Remove two union bolts and gasket.
(3) Remove the bolt and three nuts to remove three clips and return pipe No.1.

HINT

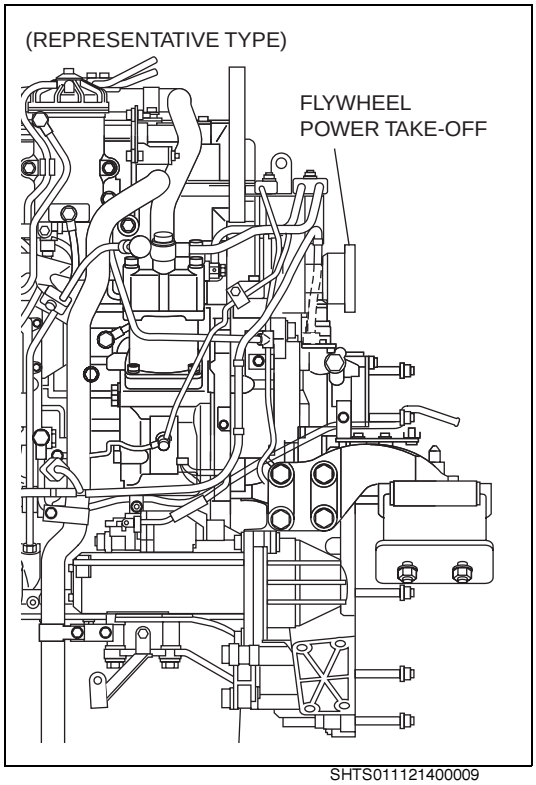
Use a container and a waste as fuel might drip off during removal of fuel pipe.



SHTS011121400008

4. REMOVE THE AIR PIPE.

(1) Remove two union bolts and gasket.
(2) Remove two nuts to remove two clips, the delivery air pipe and the air unloader pipe.



SHTS011121400009

5. REMOVE THE OIL PIPE.

(1) Remove the nut and the clip.

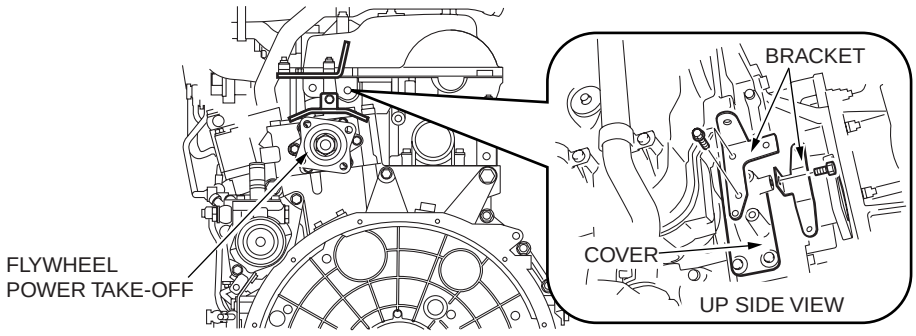
(2) Remove three union bolts to remove the oil pipe and gasket.

HINT

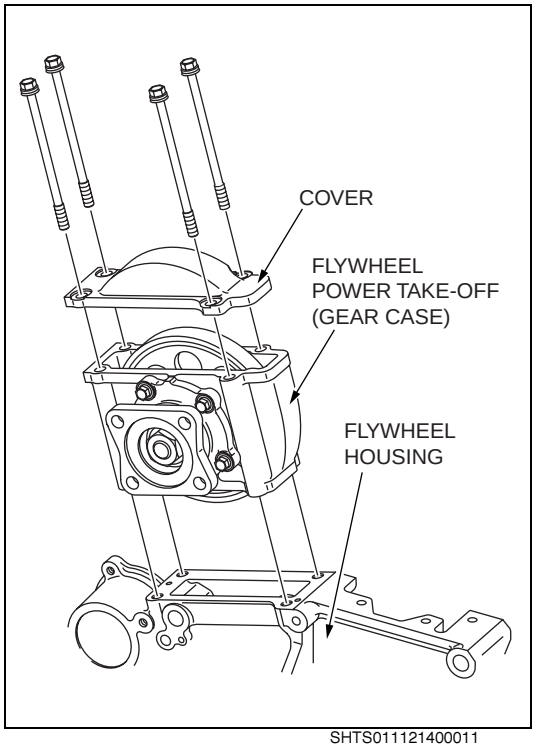
Use a container and a waste as engine oil might drip off during removal of oil pipe.

6. REMOVE THE FLYWHEEL POWER TAKE-OFF.

(1) Remove three bolts to remove two brackets from the flywheel power take-off upper cover.



SHTS011121400010



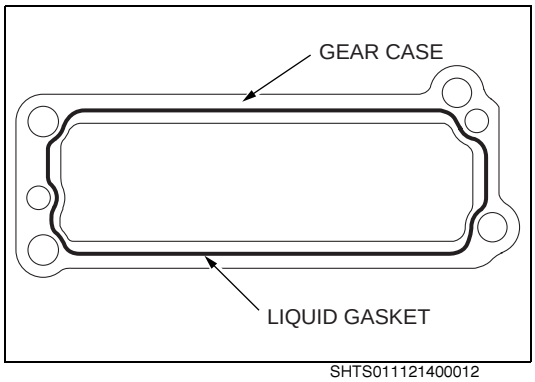
SHTS011121400011

(2) Remove four bolts to remove the flywheel power take-off and the cover from the flywheel housing.

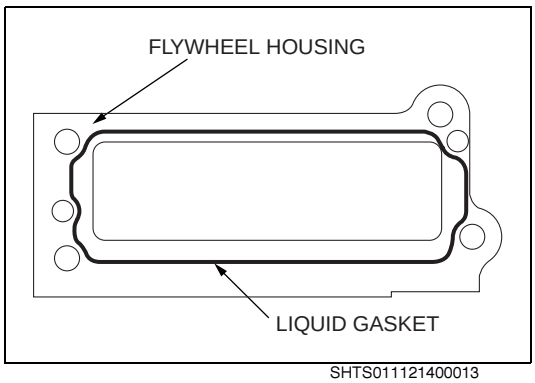
(3) Use a scraper to remove dirt from the mating surfaces of the cover, the flywheel power take-off and the flywheel housing.

NOTICE

- **Do not damage the mating surfaces.**
- **Do not allow old liquid gasket waste to fall into the flywheel power take-off or the flywheel housing.**



SHTS011121400012



SHTS011121400013

INSTALL THE FLYWHEEL POWER TAKE-OFF.

1. INSTALL THE FLYWHEEL POWER TAKE-OFF.

(1) Apply liquid gasket (ThreeBond TB1207D, silver) to the gear case installation part as shown in the figure.

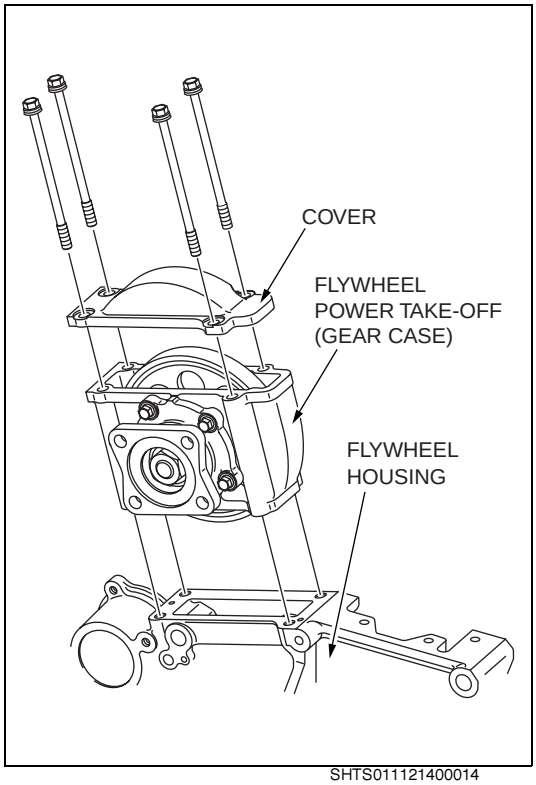
NOTICE

- **Apply liquid gasket at a width of 1.5 to 2.5 mm {0.0591 to 0.0984 in.}**
- **Apply liquid gasket without intermittence.**
- **Proceed with a next stop within 20 min. after applying liquid gasket.**

(2) Apply liquid gasket (ThreeBond TB1207D, silver) to the flywheel housing installation part as shown in the figure.

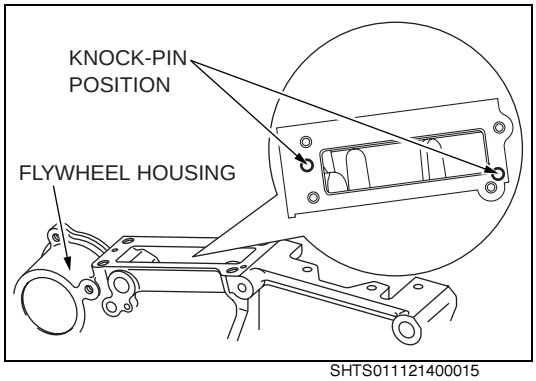
NOTICE

- **Apply liquid gasket at a width of 1.5 to 2.5 mm {0.0591 to 0.0984 in.}**
- **Apply liquid gasket without intermittence.**
- **Proceed with a next stop within 20 min. after applying liquid gasket.**



SHTS011121400014

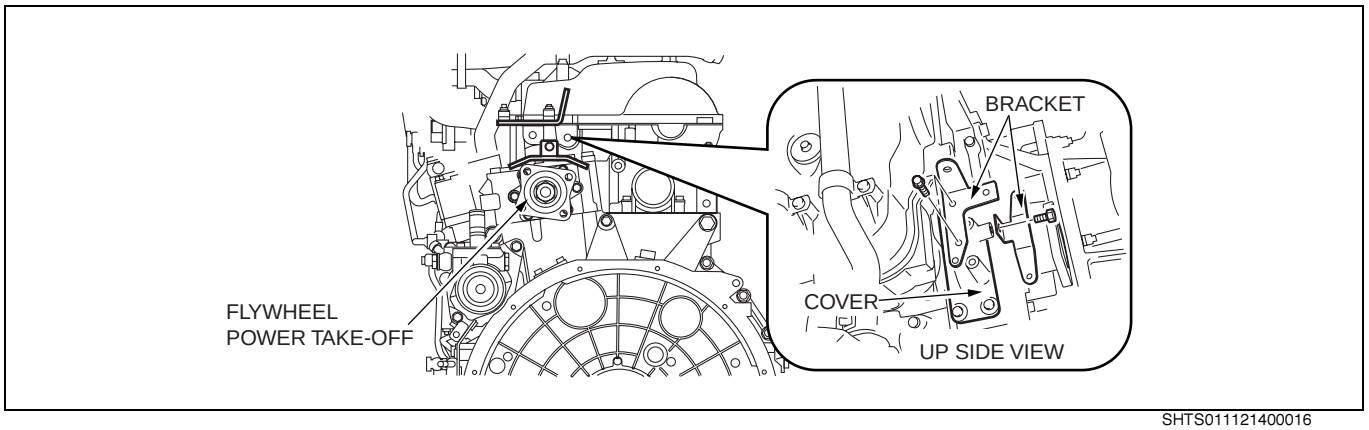
(3) Install the flywheel power take-off and the cover to the flywheel housing, and tighten four bolts.
Tightening Torque:
55 N·m {560 kgf·cm, 41 lbf·ft}



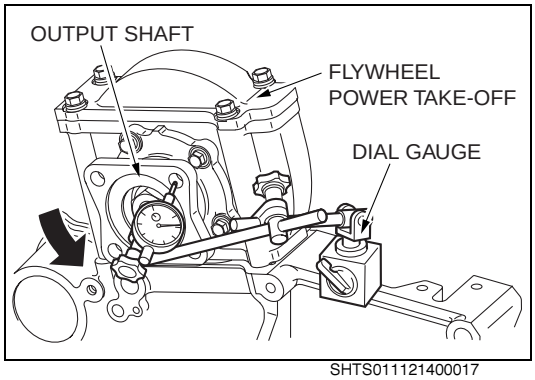
SHTS011121400015

NOTICE
Position the knock pins in place and install the flywheel power take-off.

(4) Install two brackets to the flywheel power take-off upper cover, and tighten three bolts.
Tightening Torque:
28.5 N·m {290 kgf·cm, 21 lbf·ft}



SHTS011121400016



SHTS011121400017

2. MEASUREMENT OF BACKLASH

(1) Set a dial gauge into the bolt hole in the output shaft, and measure backlash between the flywheel power take-off drive gear and the main idle gear.

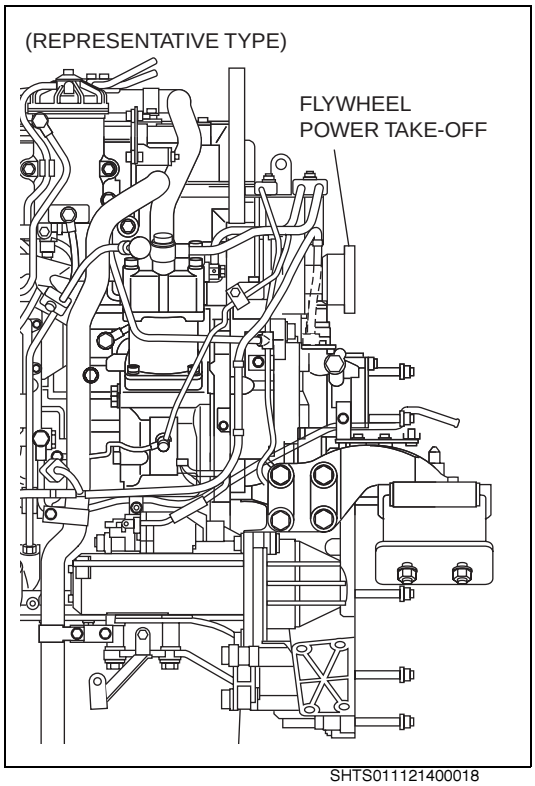
(2) Manually turn the output shaft in the direction shown with an arrow in the figure, and take measurement.

NOTICE

Take measurement in other three bolt holes by taking the same step.

(3) If a measurement reading multiplied by 1.48 exceeds the standard value, replace the flywheel power take-off drive gear and the main idle gear.

Standard	Limit
0.030-0.326 mm {0.0012-0.0128 in.}	0.40 mm {0.0157 in.}

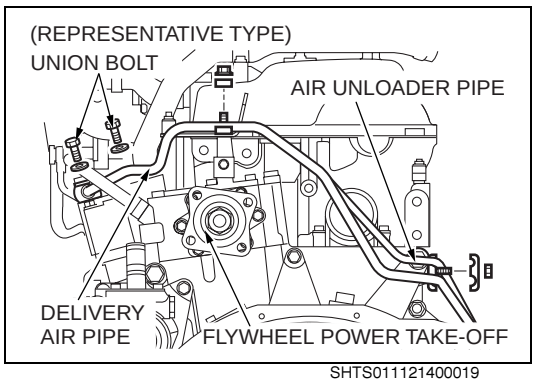


SHTS011121400018

3. INSTALL THE OIL PIPE.

(1) Replace the gasket with new one. Install the oil pipe, and tighten three union bolts.
Tightening Torque:
19.6 N·m {200 kgf·cm, 14 lbf·ft}

(2) Install the clip with the nut.



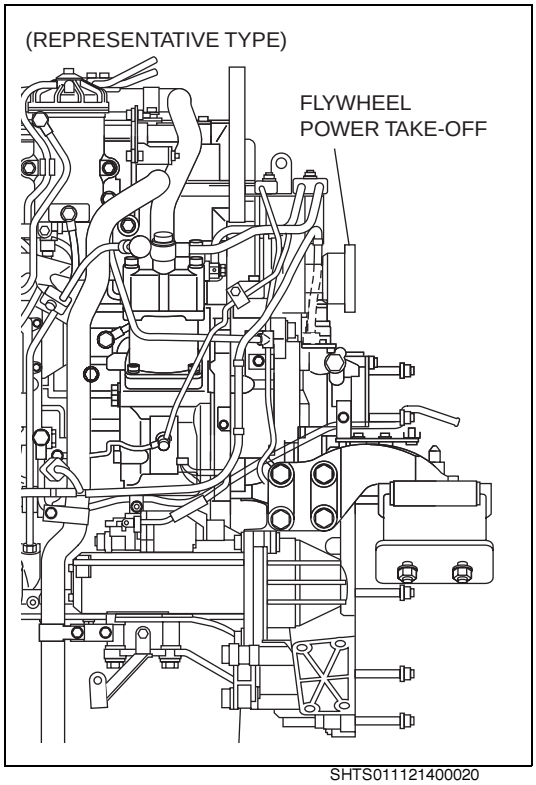
SHTS011121400019

4. INSTALL THE AIR PIPE.

(1) Replace the gasket with new one. Install the air unloader pipe and the delivery air pipe, and tighten two union bolts.

Tightening Torque:
Delivery air pipe: 68.5 N·m {700 kgf·cm, 51 lbf·ft}
Air unloader pipe: 19.6 N·m {200 kgf·cm, 14 lbf·ft}

(2) Install two clips with two nuts.



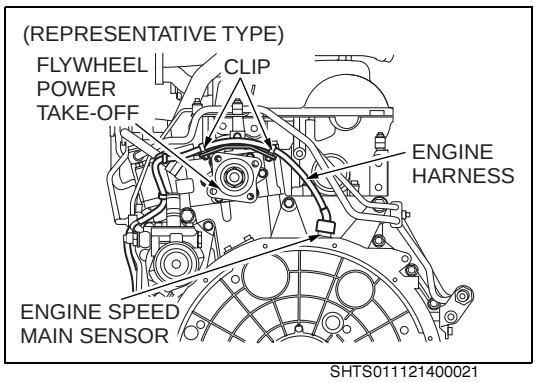
SHTS011121400020

5. INSTALL THE FUEL PIPE.

(1) Replace the gasket with new one, install the return pipe No.1 with two union bolts.

(2) Install three clips with the bolt and three nuts.

(3) Install the return pipe No.2 with the union bolt.
Refer to the section **"SUPPLY PUMP"** in the chapter **"FUEL SYSTEM"**.



SHTS011121400021

6. INSTALL THE HARNESS.

(1) Connect the connector of the engine speed main sensor and fix the engine harness with two clips.

7. FILL THE ENGINE OIL.

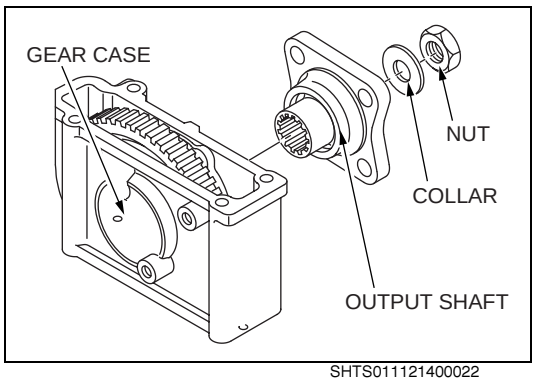
(1) Check the engine oil level, and refill the engine oil, if the engine oil level is low.
Refer to the section **"DISMOUNTING AND MOUNTING"** in the chapter **"ENGINE INTRODUCTION"**.

8. FILL THE COOLANT.

(1) Fill the coolant.
Refer to the section **"RADIATOR"** in the chapter **"COOLING SYSTEM"**.

OVERHAUL

EN0111214H200001

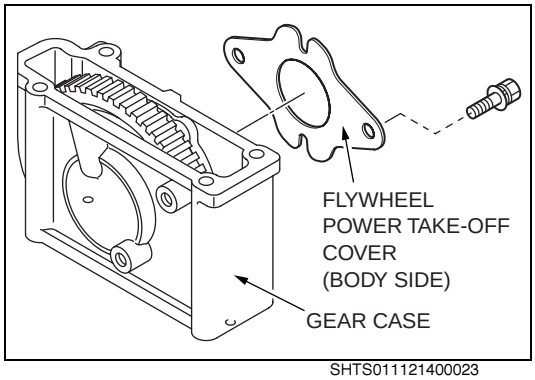


SHTS011121400022

DISASSEMBLE THE FLYWHEEL POWER TAKE-OFF.

1. REMOVE THE OUTPUT SHAFT.

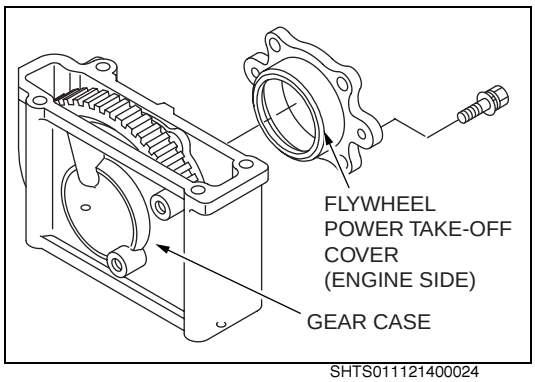
(1) Remove the nut to remove the collar and the output shaft from the gear case.



SHTS011121400023

2. REMOVE THE FLYWHEEL POWER TAKE-OFF COVER.

(1) Remove two bolts to remove the flywheel power take-off cover (body side) from the gear case.



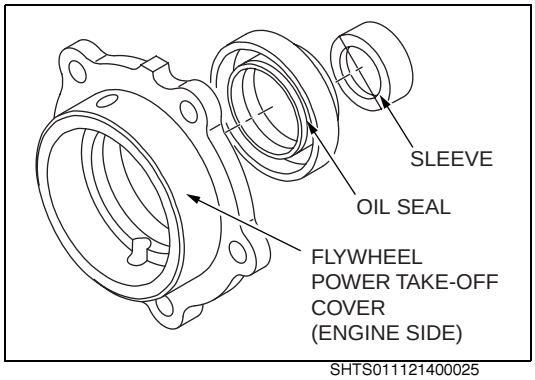
SHTS011121400024

(2) Remove four bolts to remove the flywheel power take-off cover (engine side) from the gear case.

HINT

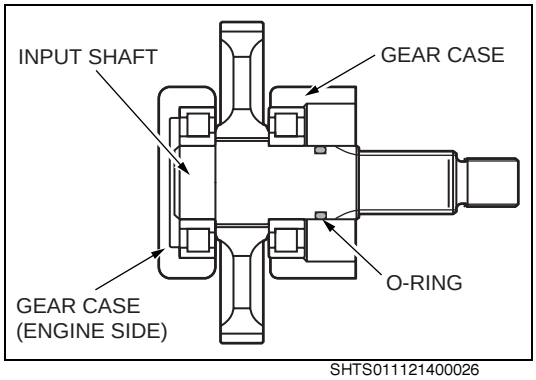
When removing the flywheel power take-off cover (engine side) from the gear case, utilize a gap and a collar of each part/component and use a flat head screwdriver for removal.

(3) Use a scraper to remove old liquid gasket from the flywheel power take-off cover (engine side) and the gear case.



SHTS011121400025

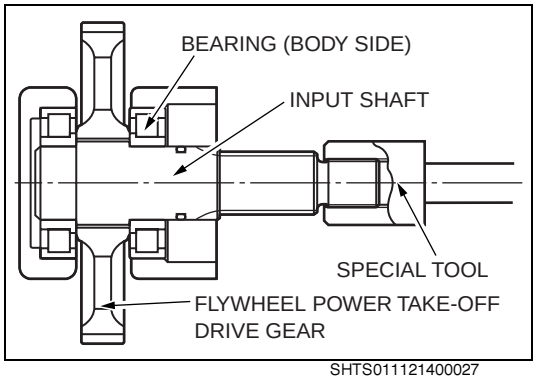
(4) Remove the oil seal and sleeve from the flywheel power take-off cover (engine side).



SHTS011121400026

3. REMOVE THE POWER TAKE-OFF DRIVEN GEAR.

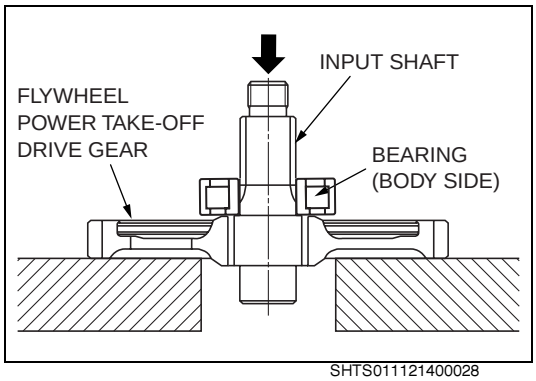
(1) Remove the O-ring from the input shaft.



SHTS011121400027

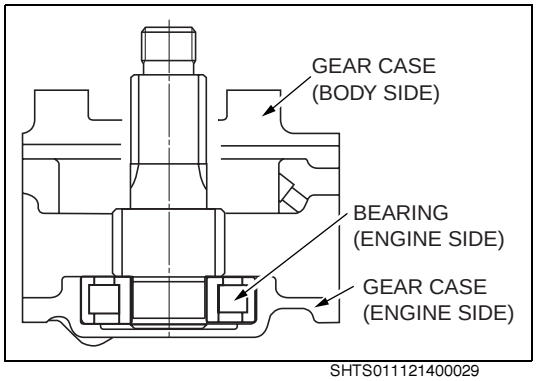
(2) Using the special tool, pull out the bearing (body side) together with the input shaft and remove the flywheel power take-off drive gear.

SST:
Bar (S0947-21830)
Bar (S0947-21021)
Puller (S0942-11270)



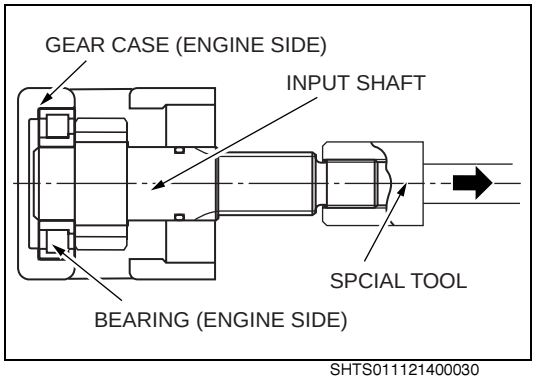
SHTS011121400028

(3) Install the flywheel power take-off drive gear to the input shaft again. With the side face of the flywheel power take-off drive gear as a press support point, push the rear end of the input shaft with a press to pull off the bearing (body side) and the flywheel power take-off drive gear.



SHTS011121400029

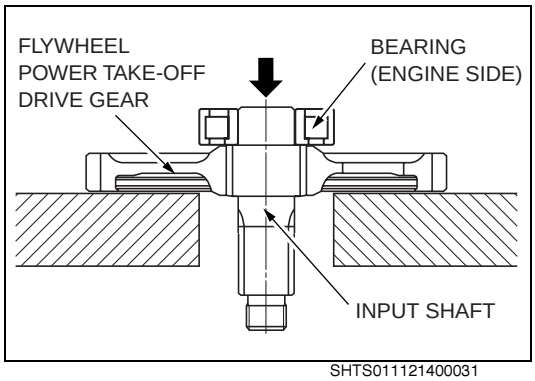
(4) Install the input shaft to the bearing (engine side) of the gear case (engine side) again.



SHTS011121400030

(5) Using the special tool, remove the bearing (engine side) with the input shaft from the gear case (engine side).

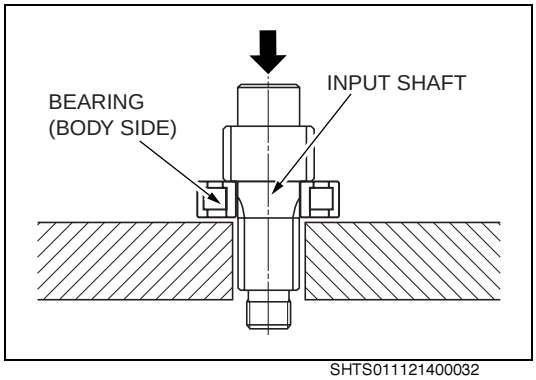
SST:
Bar (S0947-21830)
Bar (S0947-21021)
Puller (S0942-11270)



SHTS011121400031

(6) Install the flywheel power take-off drive gear to the input shaft again. Use the side face of the flywheel power take-off drive gear as a press supporting point, and push the rear end of the input shaft with a press to eject the bearing (engine side) and the flywheel power take-off drive gear.

ASSEMBLE THE FLYWHEEL POWER TAKE-OFF.



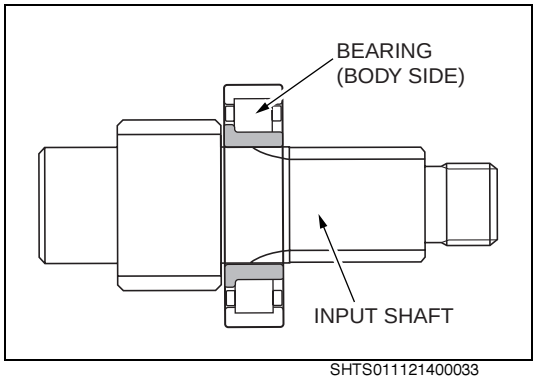
SHTS011121400032

1. INSTALL THE POWER TAKE-OFF DRIVEN GEAR.

(1) Apply engine oil to the bearing (body side) and press the bearing (body side) into the input shaft using a press.

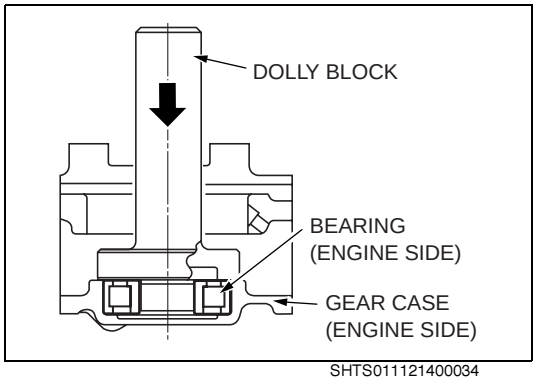
NOTICE

- **Fit the bearing straight.**



SHTS011121400033

- **Make sure of directionality of the bearing.**

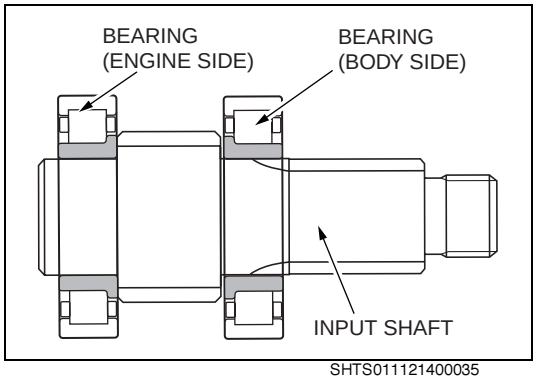


SHTS011121400034

(2) Use a dolly block and a hammer to fit the bearing (engine side) into the gear case (engine side).

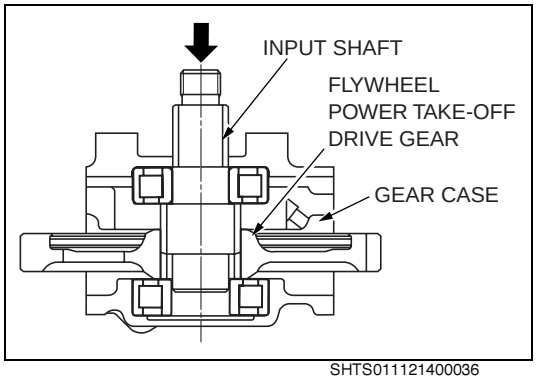
NOTICE

- **Fit the bearing straight.**



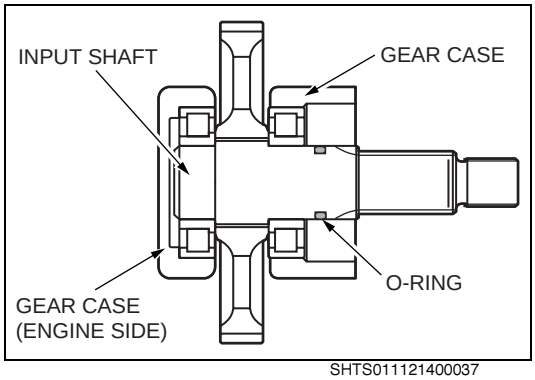
SHTS011121400035

- **Make sure of directionality of the bearing.**



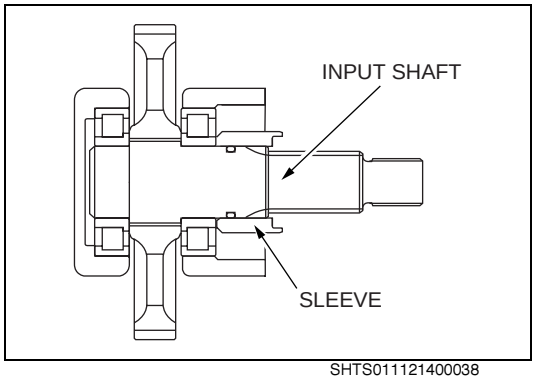
SHTS011121400036

(3) Install the flywheel power take-off drive gear to the gear case and press the input shaft using a press.



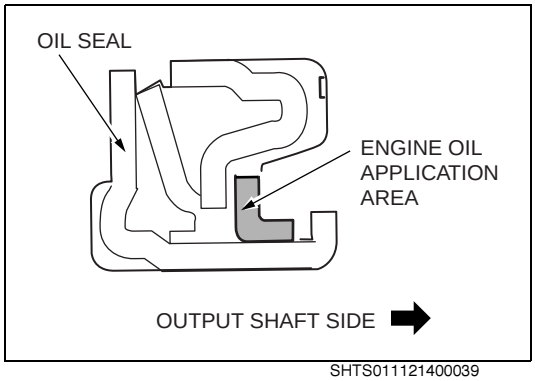
SHTS011121400037

(4) Install the new O-ring to the groove on the input shaft.



SHTS011121400038

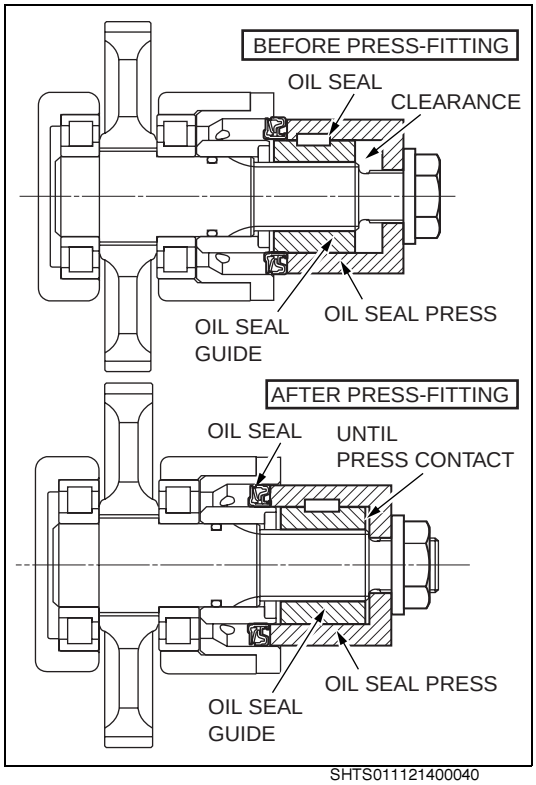
(5) Install the sleeve to the input shaft.



SHTS011121400039

2. INSTALL THE OIL SEAL.

(1) Apply engine oil to the new oil seal inner side.

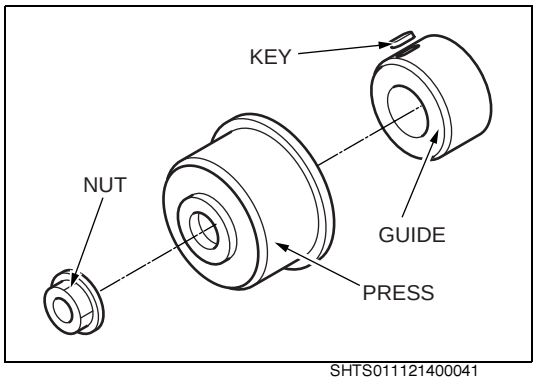


SHTS011121400040

(2) Using the special tool, press the oil seal to the flywheel power take-off cover (engine side).
SST: Oil seal press (09220-E1010)

NOTICE

- **Tighten a nut until the oil seal press contacts with the oil seal guide, and press-fit the oil seal evenly onto the whole periphery.**
- **After inserting the oil seal, use a waste to wipe off excessive engine oil.**



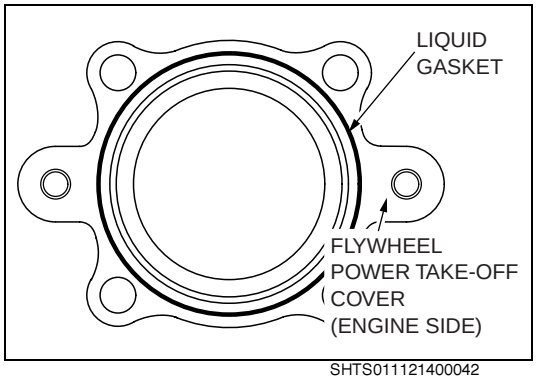
SHTS011121400041

HINT
This figure illustrates the structure of a press (special tool).

(3) After press-fitting the oil seal, check that the oil seal is properly fitted in.

3. INSTALL THE FLYWHEEL POWER TAKE-OFF COVER.

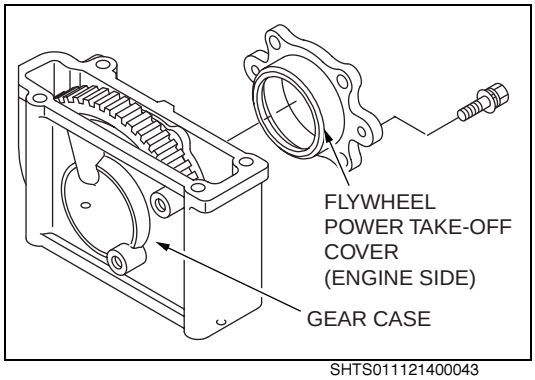
(1) Apply liquid gasket (ThreeBond TB1207D, silver) to the flywheel power take-off cover installation part of the gear case.



SHTS011121400042

NOTICE

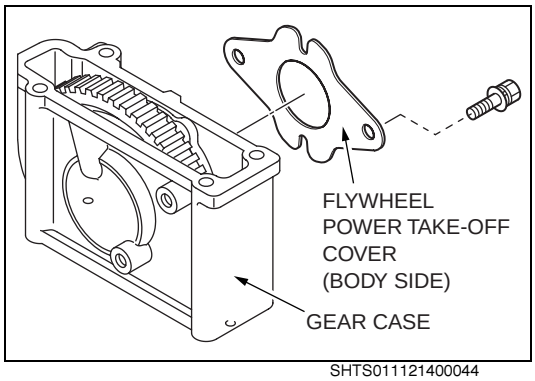
- **Apply liquid gasket at a width of 1.5 to 2.5 mm {0.0591 to 0.0984 in.}**
- **Apply liquid gasket without intermittence.**
- **Proceed with a next stop within 20 min. after applying liquid gasket.**



SHTS011121400043

(2) Install the flywheel power take-off cover (engine side) to the gear case, and tighten four bolts.

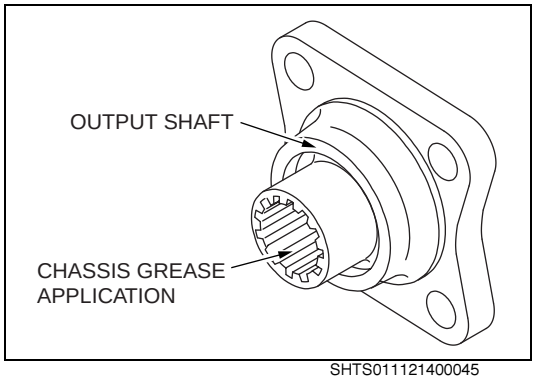
Tightening Torque:
55 N·m {560 kgf·cm, 41 lbf·ft}



SHTS011121400044

(3) Install the flywheel power take-off cover (body side) to the flywheel power take-off cover (engine side), and tighten two bolts.

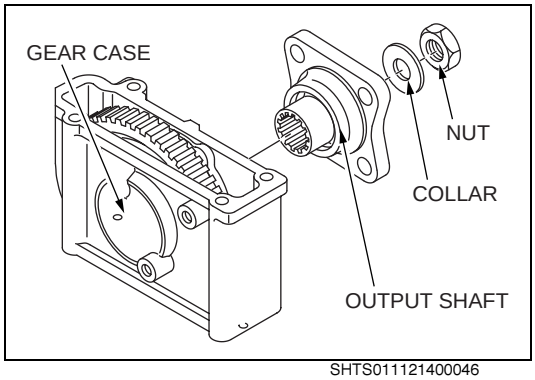
Tightening Torque:
28.5 N·m {290 kgf·cm, 21 lbf·ft}



SHTS011121400045

4. INSTALL THE OUTPUT SHAFT.

(1) Apply chassis grease to the output shaft spline.



SHTS011121400046

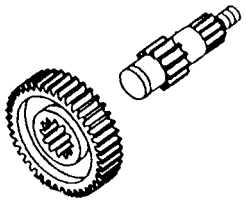
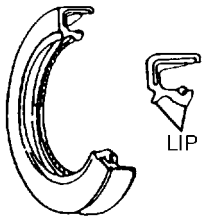
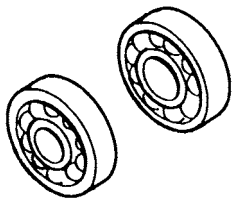
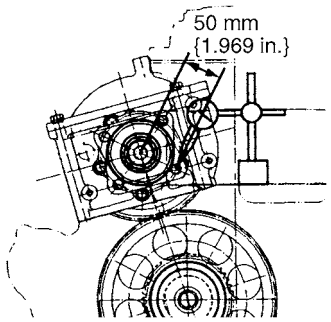
(2) Install the output shaft and collar to the input shaft with the nut.

Tightening Torque:
300 N·m {3,060 kgf·cm, 221 lbf·ft}

INSPECTION AND REPAIR

EN0111214H300001

Unit: mm {in.}

Inspection item	Standard	Limit	Remedy	Inspection procedure
Shaft and gear: Wear and damage	**—**	**—**	**Replace, if necessary.**	**Visual check** 
Oil seal lip: Wear and damage	**—**	**—**	**Replace, if necessary.**	**Visual check** 
Bearing improper rotation	**—**	**—**	**Replace, if necessary.**	**Visual check** 
Drive gear backlash (Measure at bolt of output coupling P.C.D: 100 mm {3.937 in.})	**0.030-0.326 {0.0011-0.0128}**	**0.4 {0.0157}**	**Replace, if necessary.**	**Measure** 

ENGINE RETARDER (A09C)

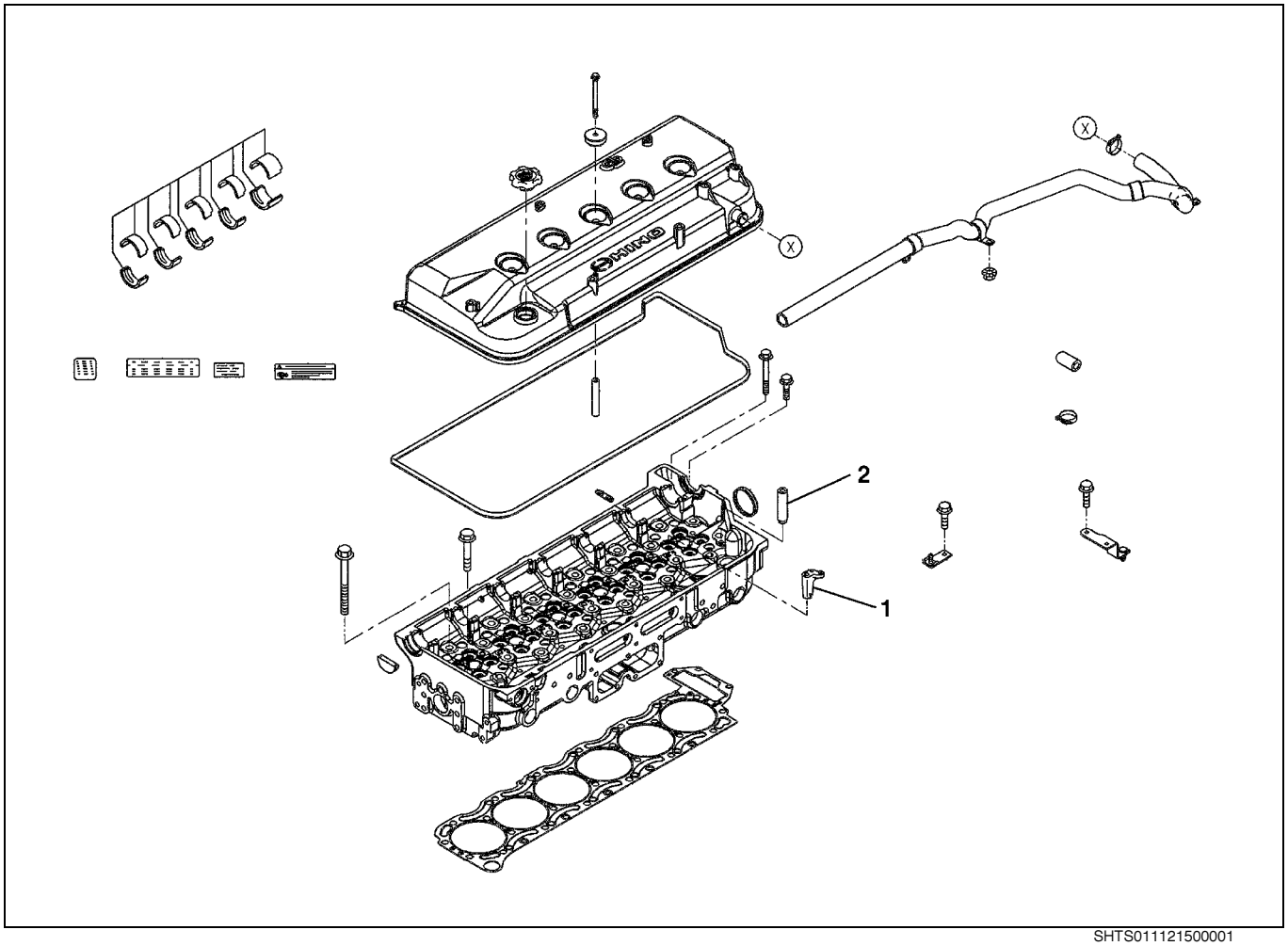
EN15-001

ENGINE RETARDER

COMPONENT LOCATOR

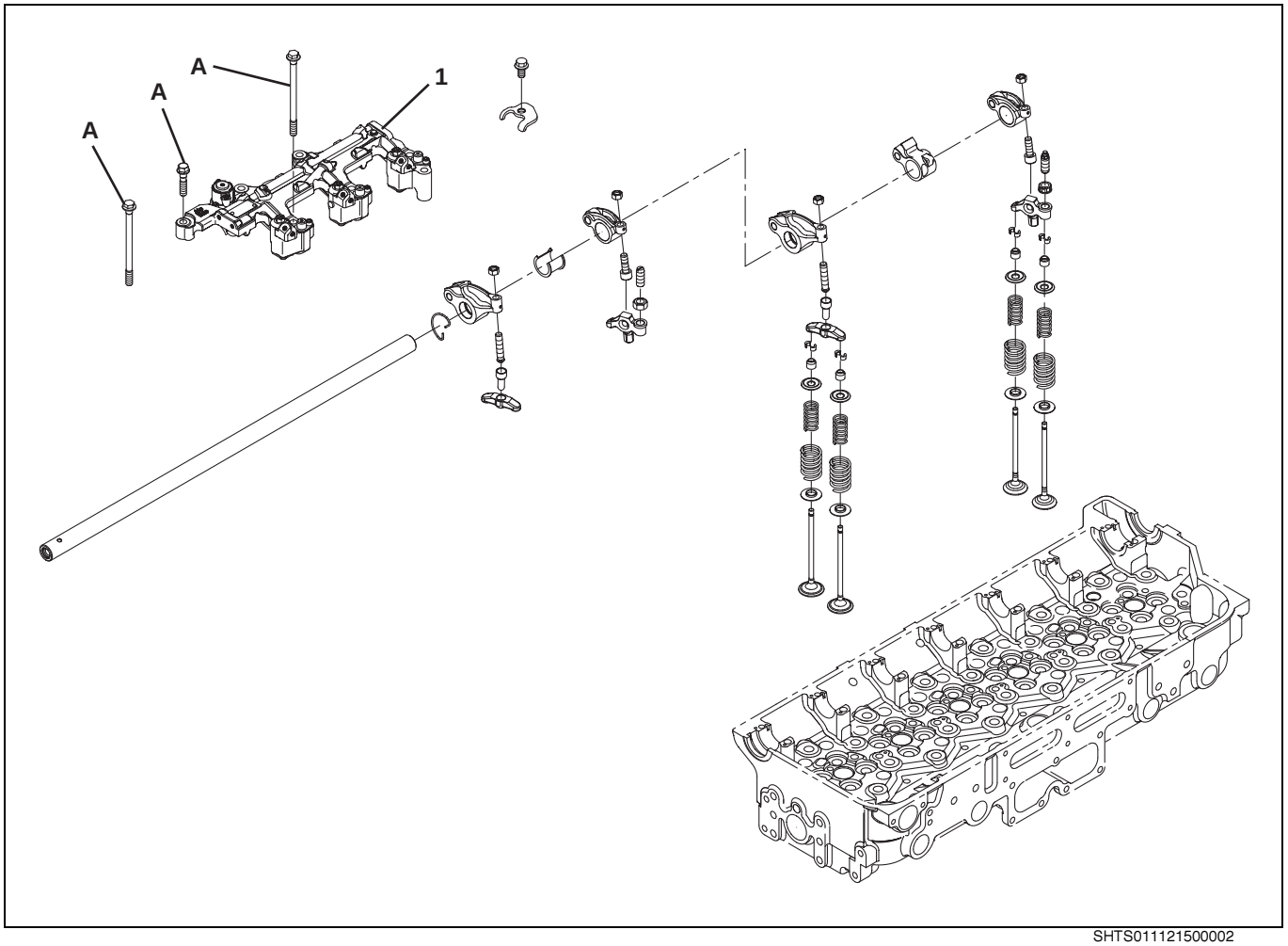
EN0111215D100001

3-CYLINDER RETARDATION TYPE



SHTS011121500001

1 Bracket	2 Retarder support

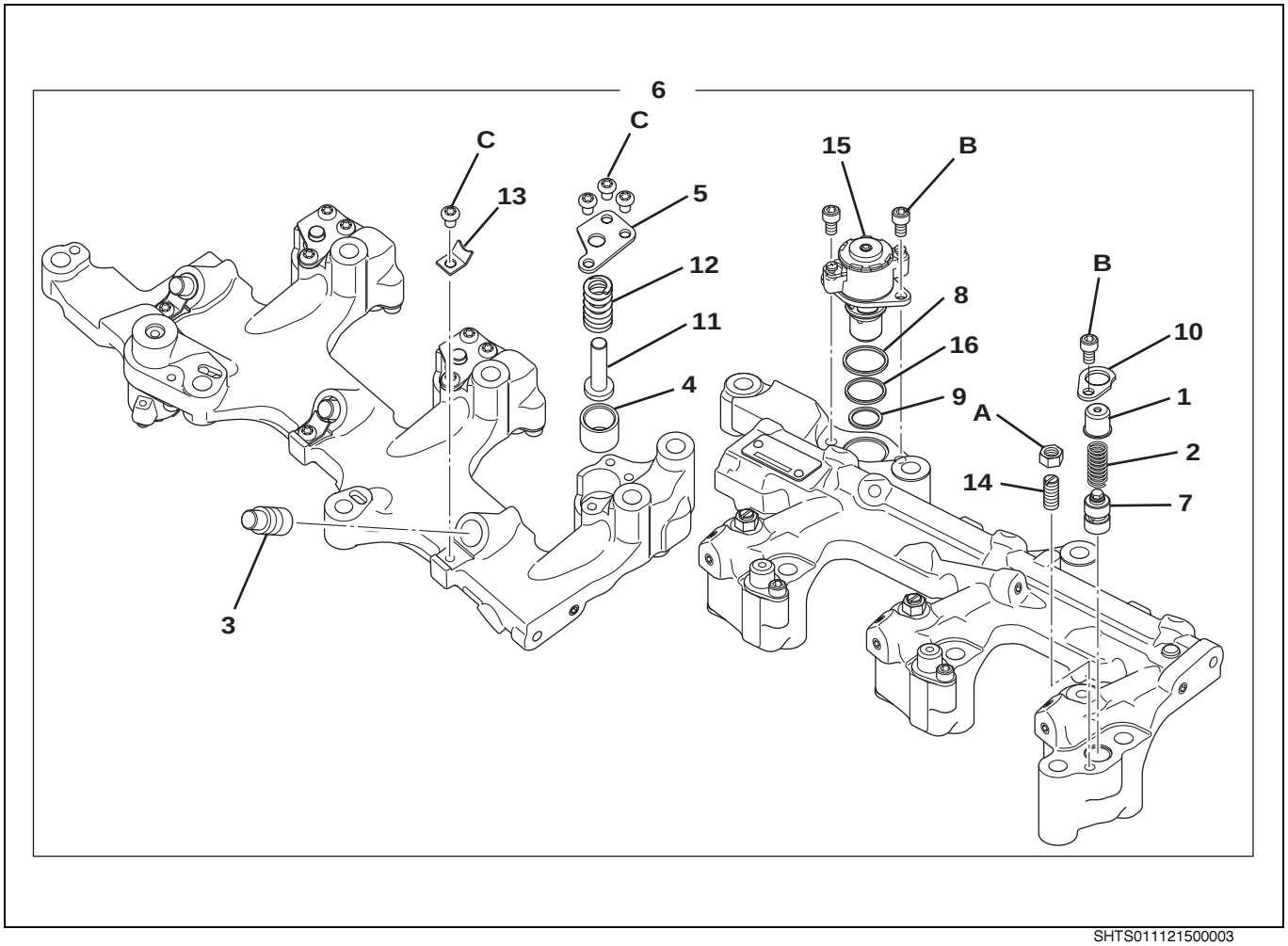


SHTS011121500002

1 Engine retarder	

Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

A 68.5 {700, 51}	



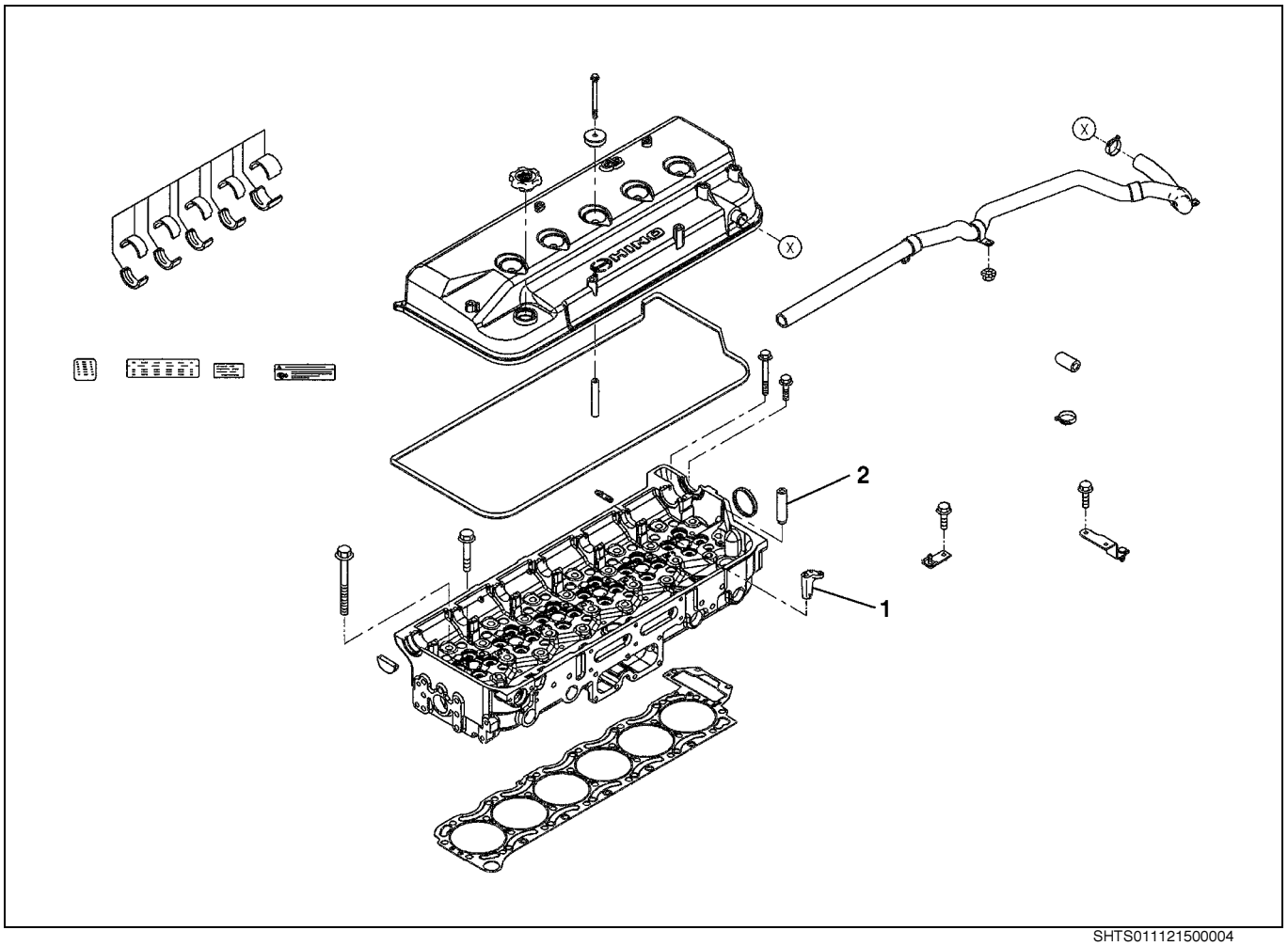
SHTS011121500003

1	Control valve cover	9	Seal ring (Lower)
2	Control valve spring	10	Control valve plate
3	Master piston	11	Push rod
4	Slave piston	12	Slave piston spring
5	Retainer plate	13	Master piston stopper plate
6	Engine retarder	14	Slave piston adjusting screw
7	Control valve	15	Solenoid valve
8	Seal ring (Upper)	16	Seal ring (Center)

Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

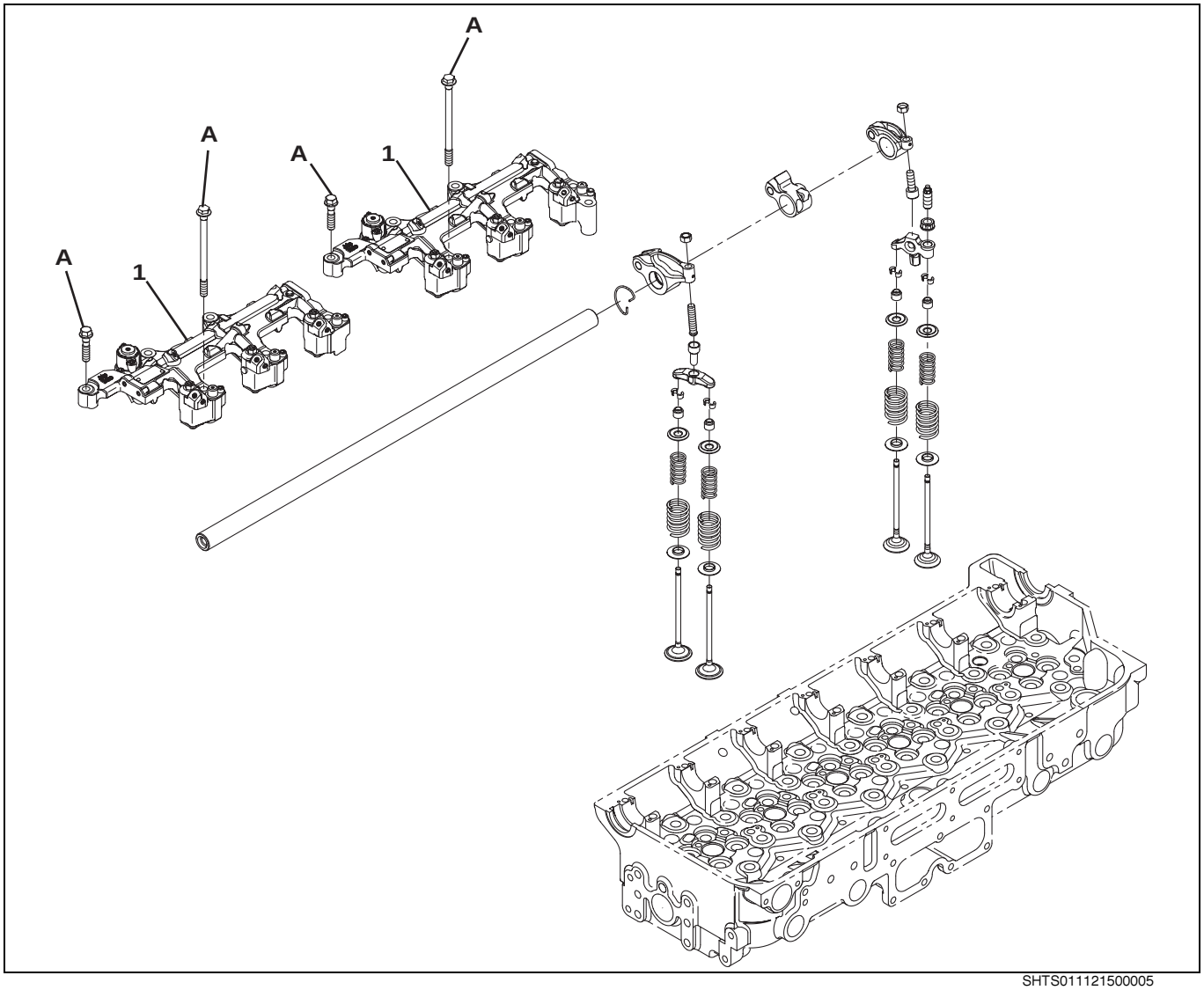
A	18 {184, 13}	C	5.5 {56, 4}
B	12.5 {128, 9}		

6-CYLINDER RETARDATION TYPE



SHTS011121500004

1 Bracket	2 Retarder support

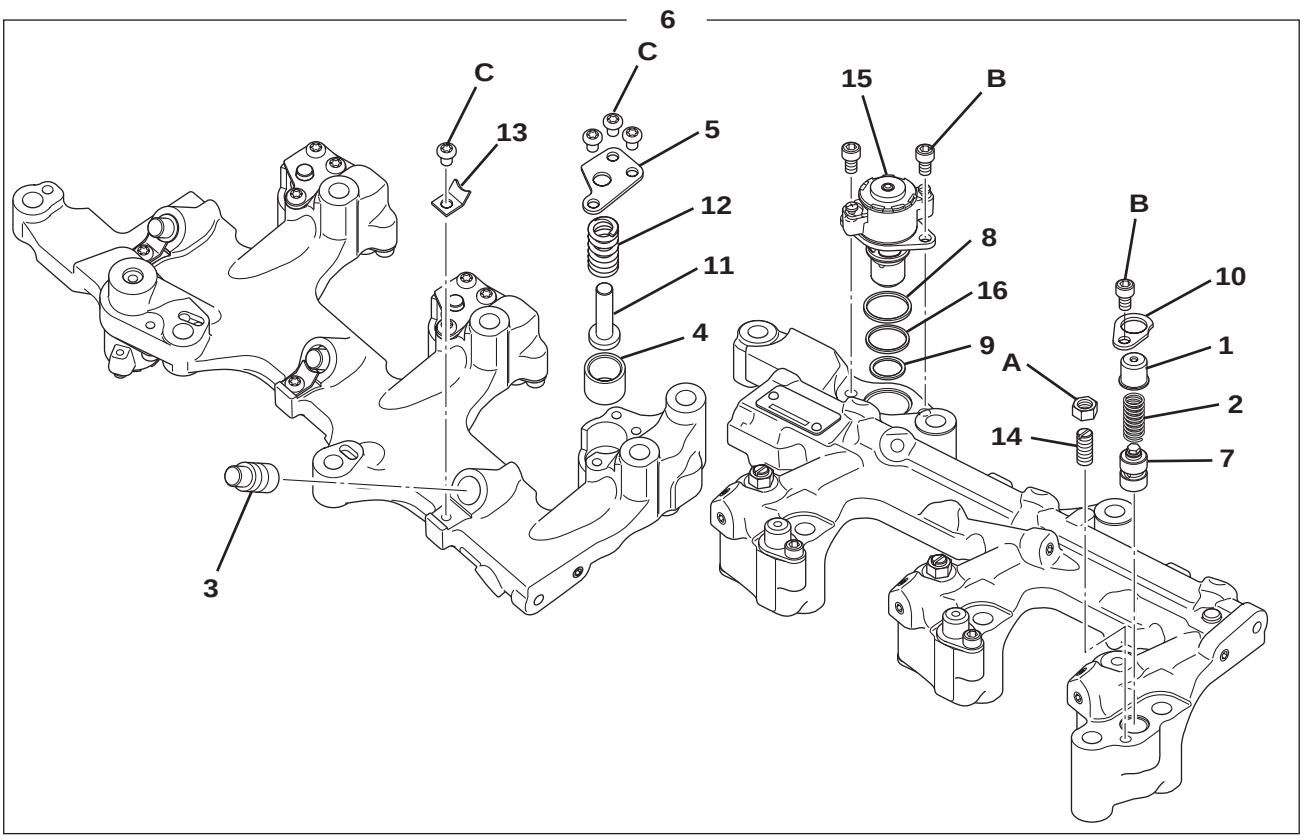


SHTS011121500005

1 Engine retarder	

Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

A 68.5 {700, 51}	



SHTS011121500006

1	Control valve cover	9	Seal ring (Lower)
2	Control valve spring	10	Control valve plate
3	Master piston	11	Push rod
4	Slave piston	12	Slave piston spring
5	Retainer plate	13	Master piston stopper plate
6	Engine retarder	14	Slave piston adjusting screw
7	Control valve	15	Solenoid valve
8	Seal ring (Upper)	16	Seal ring (Center)

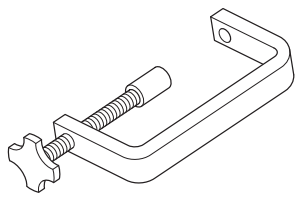
Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

A	18 {184, 13}	C	5.5 {56, 4}
B	12.5 {128, 9}		

SPECIAL TOOL

EN0111215K100001

Prior to starting an engine retarder overhaul, it is necessary to have this special tool.

Illustration	Part number	Tool name	Remarks
	S0940-91180	SLAVE PISTON SPRING PRESS	

OVERHAUL

EN0111215H200001

REMOVE THE ENGINE RETARDER.

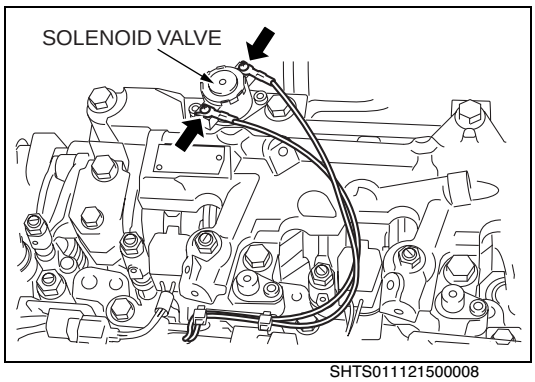
1. REMOVE THE HEAD COVER.

(1) Remove the head cover.
Refer to the section **"HEAD COVER"** in the chapter **"ENGINE MECHANICAL"**.

2. REMOVE THE ENGINE RETARDER.

HINT

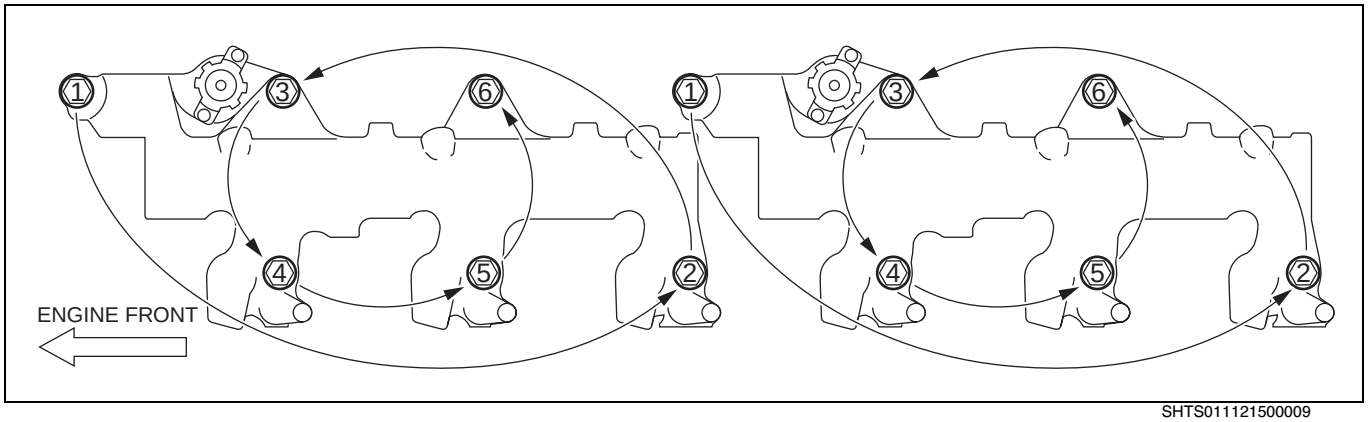
One unit of engine retarder handles three cylinders. Two variations are available: 3-cylinder retardation type having only one unit, and 6-cylinder retardation type having two units.



SHTS011121500008

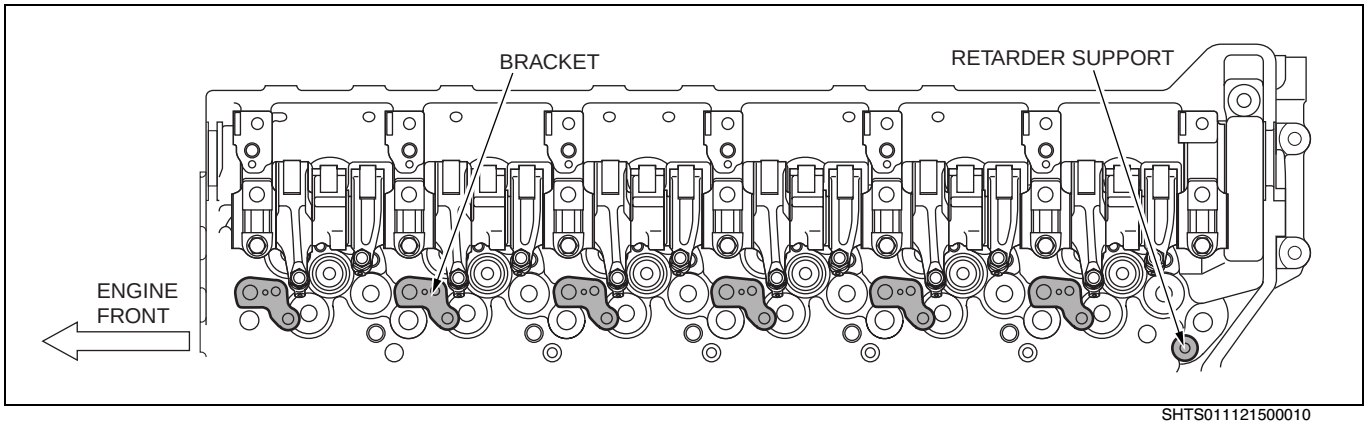
(1) Loosen the screws and disconnect the harness of the solenoid valve.

(2) Gradually loosen the bolts (turn approximately 90° at each time) in the order shown in the figure.



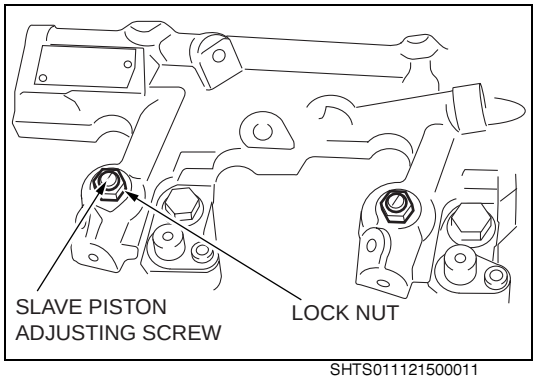
SHTS011121500009

(3) Remove six brackets and a retarder support from the cylinder head upper side.



SHTS011121500010

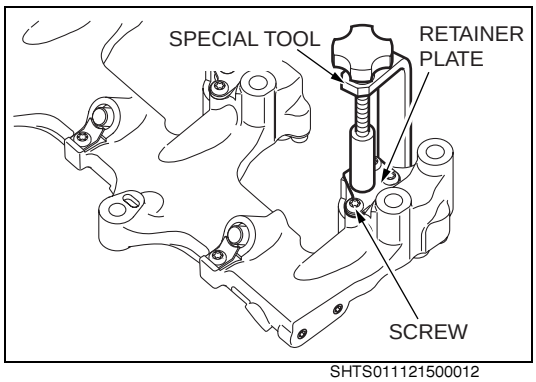
DISASSEMBLE THE ENGINE RETARDER.



SHTS011121500011

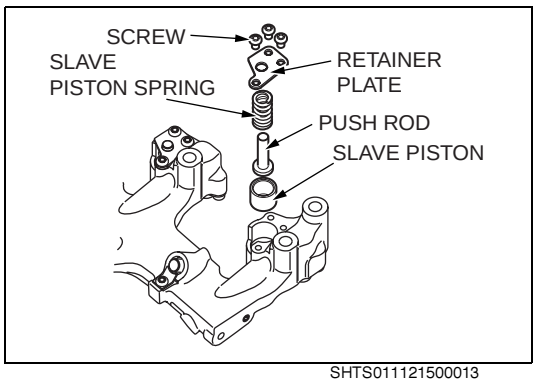
1. REMOVE THE SLAVE PISTON.

(1) Loosen a lock nut to lift the slave piston adjusting screw until it is released from a spring load.



SHTS011121500012

(2) Place a hole in the special tool on the top end of the adjusting screw and hold the retainer plate at the opposite side in such a way that a spring load will be received.
SST: Slave piston spring press (S0940-91180)

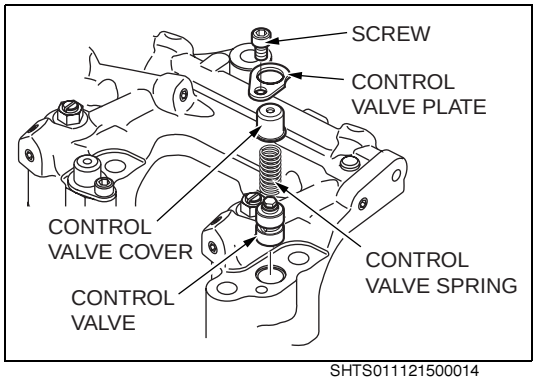


SHTS011121500013

(3) Use a torx wrench to remove screws while keeping the special tool held down.
(4) Gradually loosen the special tool to release the retainer plate, and remove the slave piston spring, the push rod and the slave piston.

NOTICE
The slave piston is subject to a large spring load. The designated special tool shall be used in removing the slave piston.

⚠ CAUTION
Wear safety glasses to protect your eyes against accidental fly-out of components/parts.

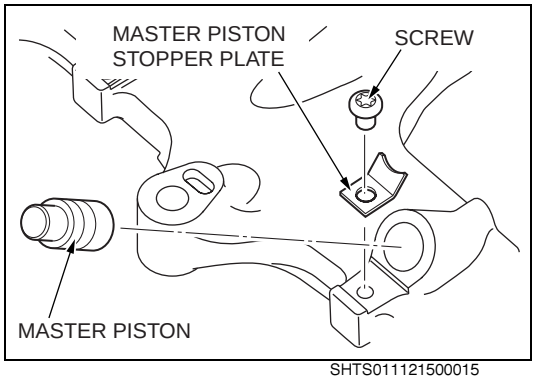


SHTS011121500014

2. REMOVE THE CONTROL VALVE.

(1) Hold the control valve plate with your fingers and gradually loosen a screw to remove the control valve plate.
(2) Remove the control valve cover, the control valve spring and the control valve.

HINT
If unsmoothness is found during removal of control valve, replace the valve.



SHTS011121500015

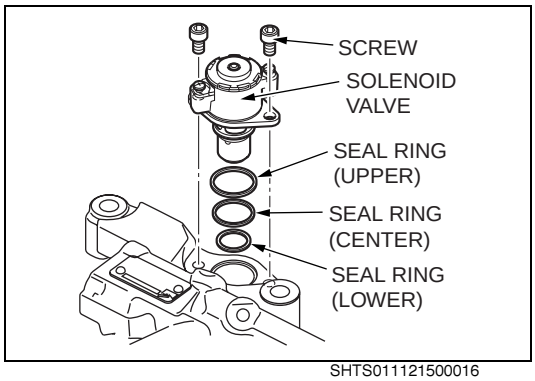
3. REMOVE THE MASTER PISTON.

(1) Remove a screw using a torx wrench to remove the master piston stopper plate.

(2) Remove the master piston.

HINT

If unsmoothness is found during removal of the master piston, check the outer surface of the piston for burrs or excessive wear. If a trouble is found, replace it.



SHTS011121500016

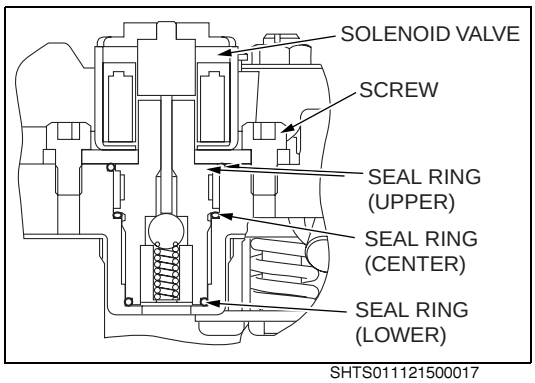
4. REMOVE THE SOLNOID VALVE.

(1) Remove the screws to remove the solenoid valve.

HINT

The solenoid valve must not be disassembled. If a trouble is found, replace it as an assembly.

(2) Remove three seal rings from the solenoid valve.



SHTS011121500017

ASSEMBLE THE ENGINE RETARDER.

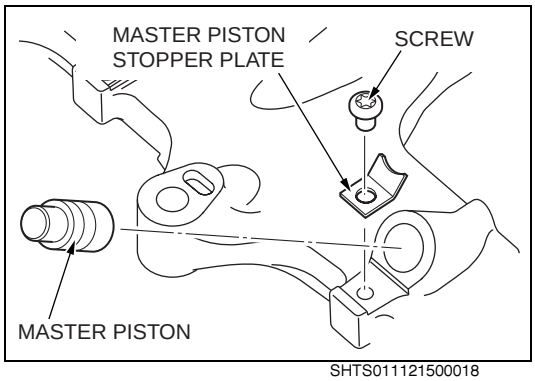
1. INSTALL THE SOLENOID VALVE.

(1) Apply enough engine oil to three new seal rings. Attach the upper and center seal rings to the solenoid valve and the lower seal ring to the bottom in the retarder housing, and insert the solenoid valve.

NOTICE

- **Each seal ring shall not be tilted and have tight contact.**
- **Insufficient application of engine oil will cause skew or drag-in of seal rings.**

(2) Tighten the screws to fix the solenoid valve.
Tightening Torque:
12.5 N·m {128 kgf·cm, 9 lbf·ft}

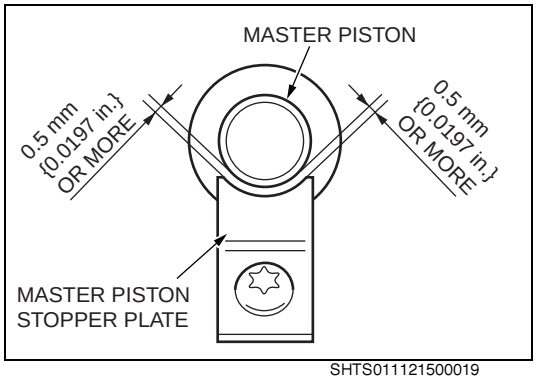


SHTS011121500018

2. INSTALL THE MASTER PISTON.

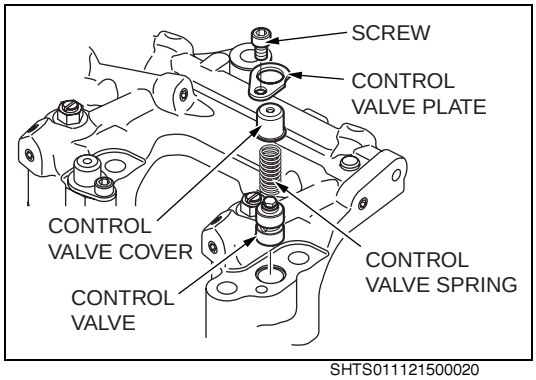
(1) Apply engine oil to the master piston and insert it to the housing.

(2) Using a torx wrench, install the master piston stopper plate with a screw.
Tightening Torque:
5.5 N·m {56 kgf·cm, 4 lbf·ft}



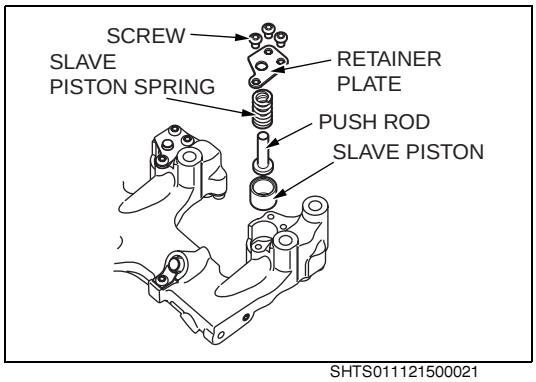
SHTS011121500019

(3) Check that a clearance between the master piston stopper plate leg and the master piston meets the standard value.
Standard value: 0.5 mm {0.0197 in.} or more



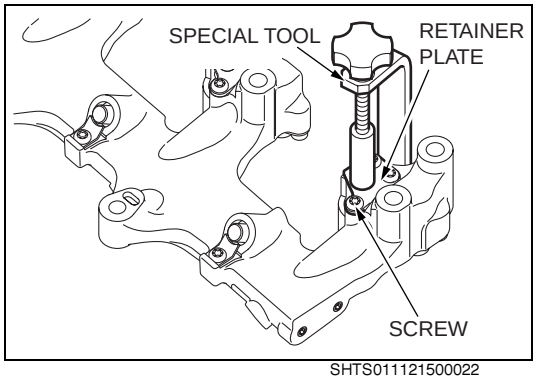
SHTS011121500020

3. INSTALL THE CONTROL VALVE.
(1) Apply engine oil to the control valve and insert it to the housing.
(2) Insert the control valve spring and the control valve cover. Hold the control valve plate with your fingers, and tighten a screw.
Tightening Torque:
12.5 N·m {128 kgf·cm, 9 lbf·ft}



SHTS011121500021

4. INSTALL THE SLAVE PISTON.
(1) Apply engine oil to the slave piston. Insert the slave piston, the push rod and the slave piston spring in the housing in this sequential order.
(2) Set the retainer plate to the mounting position and place it onto the slave piston spring.



SHTS011121500022

(3) Place a hole in the special tool on the top end of the adjusting screw and hold the retainer plate at the opposite side in such a way that a spring load will be received. Compress until screws are threaded in.
SST: Slave piston spring press (S0940-91180)

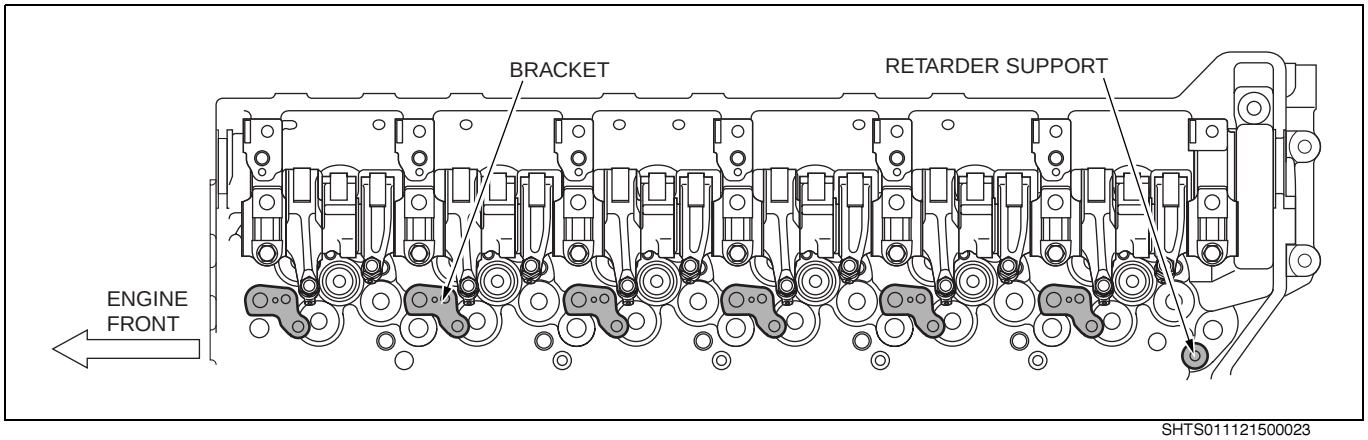
(4) Use a torx wrench to tighten screws for securing the retainer plate.

INSTALL THE ENGINE RETARDER.

1. INSTALL THE ENGINE RETARDER.

(1) Make sure that the rocker arm assembly is properly installed.

(2) Install six brackets and a retarder support on the cylinder head upper side.



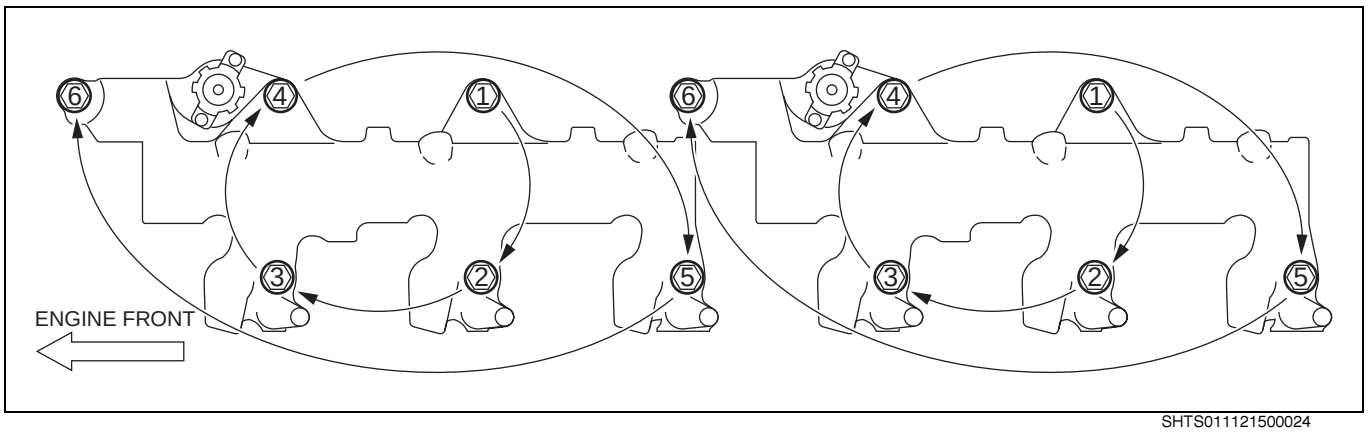
SHTS011121500023

(3) Install the engine retarder on the rocker arm support, six brackets and a retarder support.

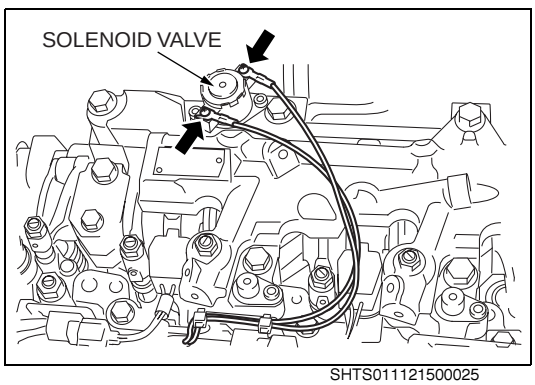
NOTICE

- **Before mounting, remove coating, dust or contaminant from the top mounting surface and the retarder mounting boss bottom surface.**
- **Proceed with this work step with a care not to damage the master piston or the slave piston.**

(4) Tighten the retarder installation bolts in order shown in the figure.
Tightening Torque:
68.5 N·m {700 kgf·cm, 51 lbf·ft}



SHTS011121500024



SHTS011121500025

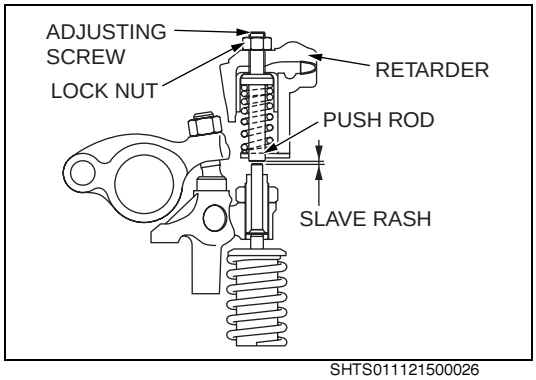
(5) Connect the harnesses to the solenoid valve and fix them with screws.
Tightening Torque:
0.8 N·m {8 kgf·cm, 0.6 lbf·ft}

NOTICE

Make sure that harnesses are inserted to the deepest point in the solenoid valve terminal before tightening the screws.

HINT

For easier works in this step, connect the harness while turning the screw.



SHTS011121500026

2. ADJUST THE SLAVE PISTON CLEARANCE.

(1) Set the No.1 cylinder to the top dead center of the compression stroke.
Refer to the section **"SUPPLY PUMP"** in the chapter **"FUEL SYSTEM"**.

(2) Recheck the valve clearance of the exhaust side.
Refer to the section **"ROCKER ARM ASSEMBLY"** in the chapter **"ENGINE MECHANICAL"**.

(3) Insert the thickness gauge between the slave piston of the No.1 cylinder and the push rod of the slave piston.
Slave piston clearance: 0.5-0.6 mm {0.0197-0.0236 in.}

(4) Turn the adjusting screw until the slave piston lightly contact with thickness gauge and tighten the lock nut to specified torque.
Tightening Torque:
18 N·m {184 kgf·cm, 13 lbf·ft}

(5) Position the each cylinder at top dead center of the compression stroke, then adjust the slave piston clearance for each cylinder in the firing order.

3. INSTALL THE HEAD COVER.

(1) Install the head cover.
Refer to the section **"HEAD COVER"** in the chapter **"ENGINE MECHANICAL"**.

INSPECTION AND REPAIR

EN0111215H300001

Unit: mm {in.}

Inspection item	Standard	Limit	Remedy	Inspection procedure
Slave piston top face sink	0.05 {0.0019}	—	Replace.	Measure

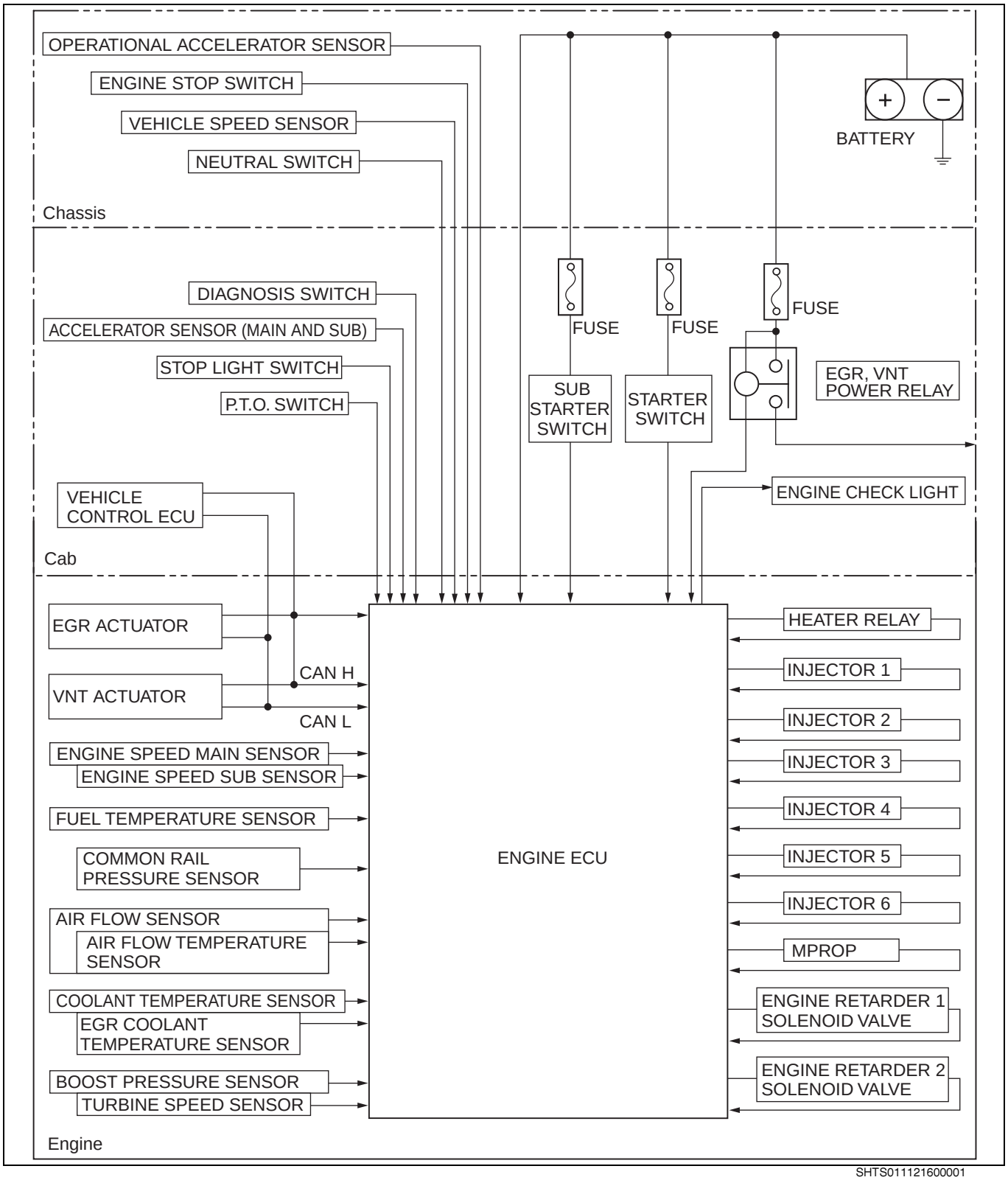
ENGINE CONTROL (A09C)

EN16-001

CONTROL PARTS

SYSTEM DIAGRAM

EN0111216J100001

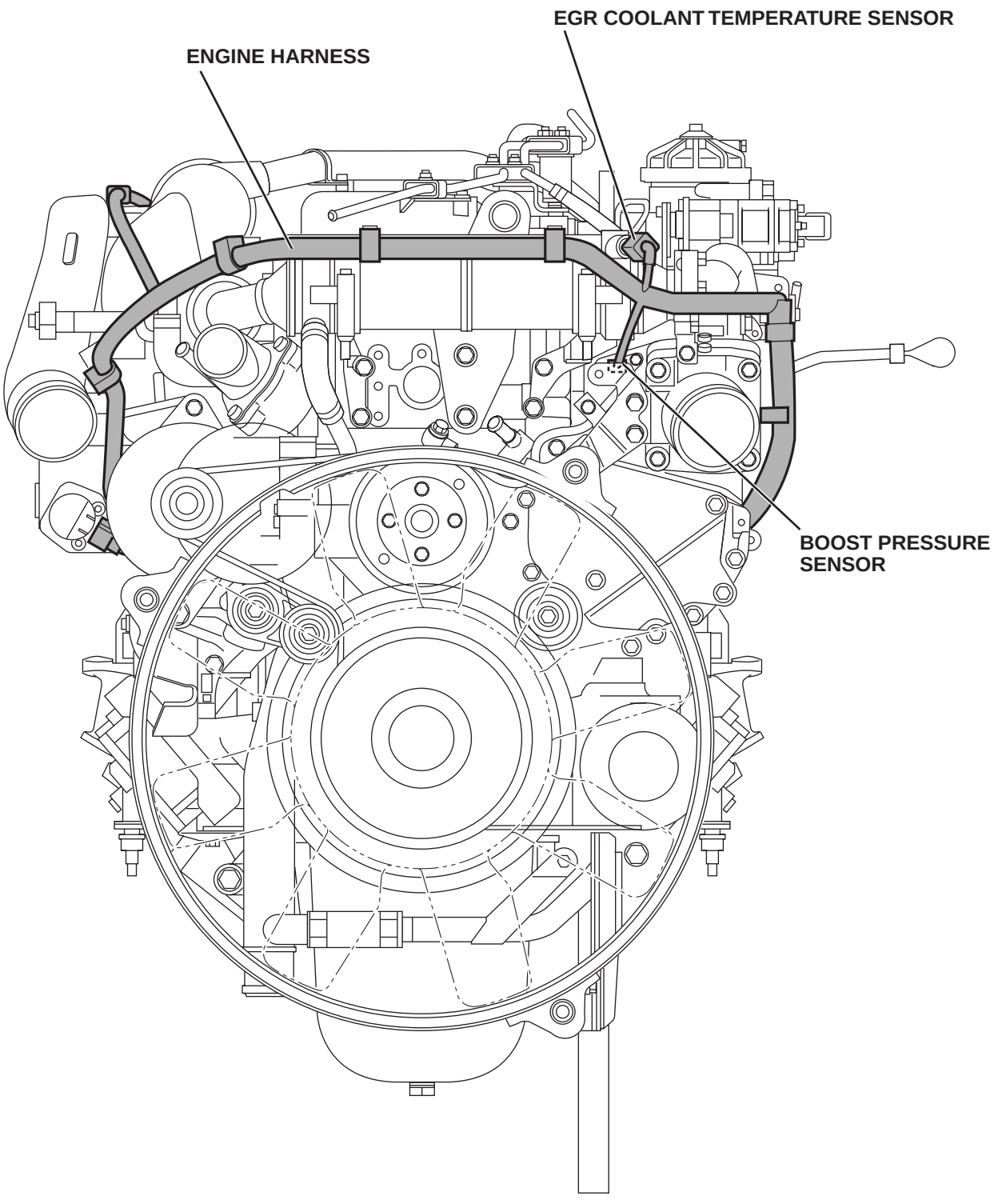


SHTS011121600001

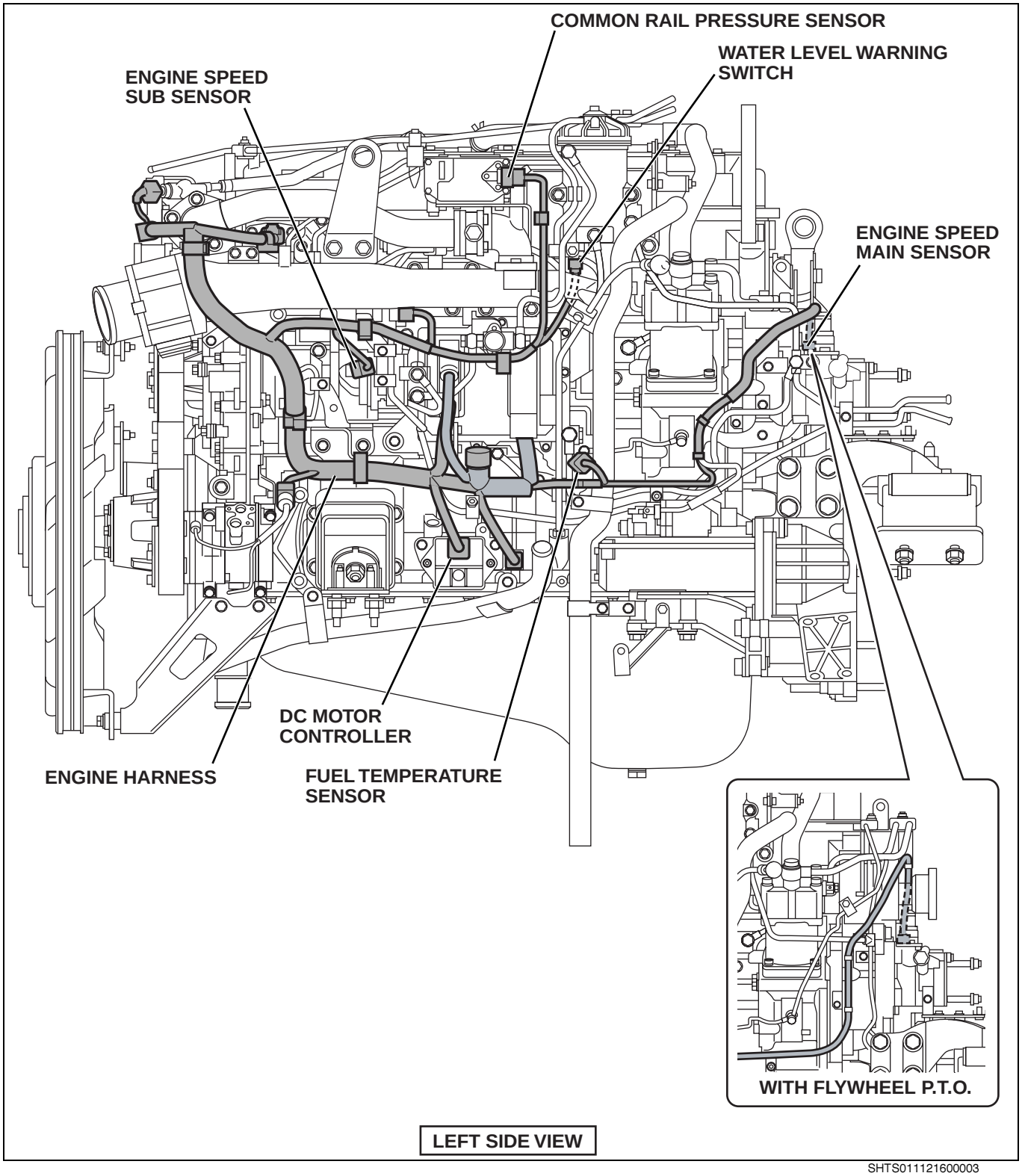
ENGINE HARNESS

COMPONENT LOCATOR

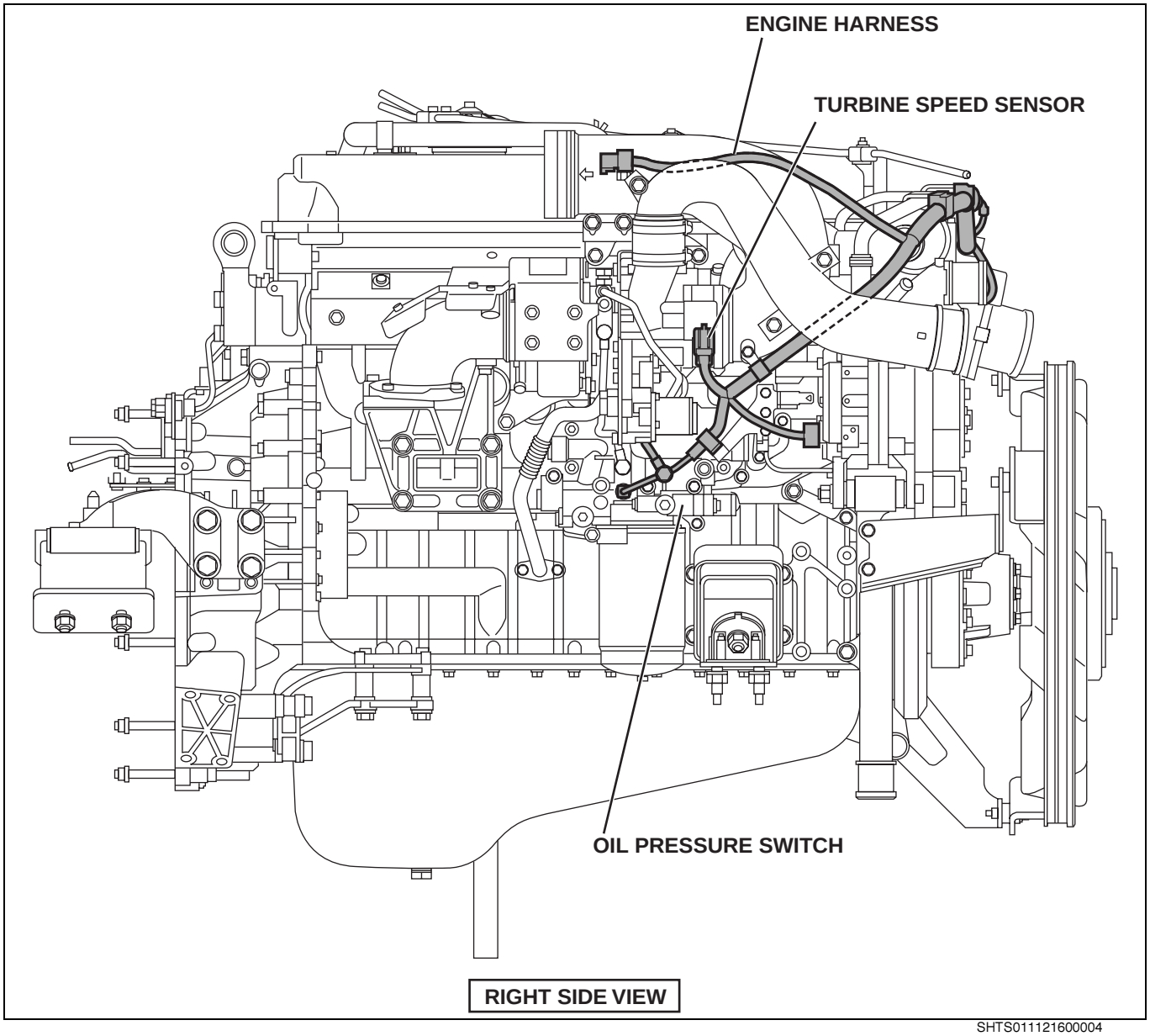
EN0111216D100001



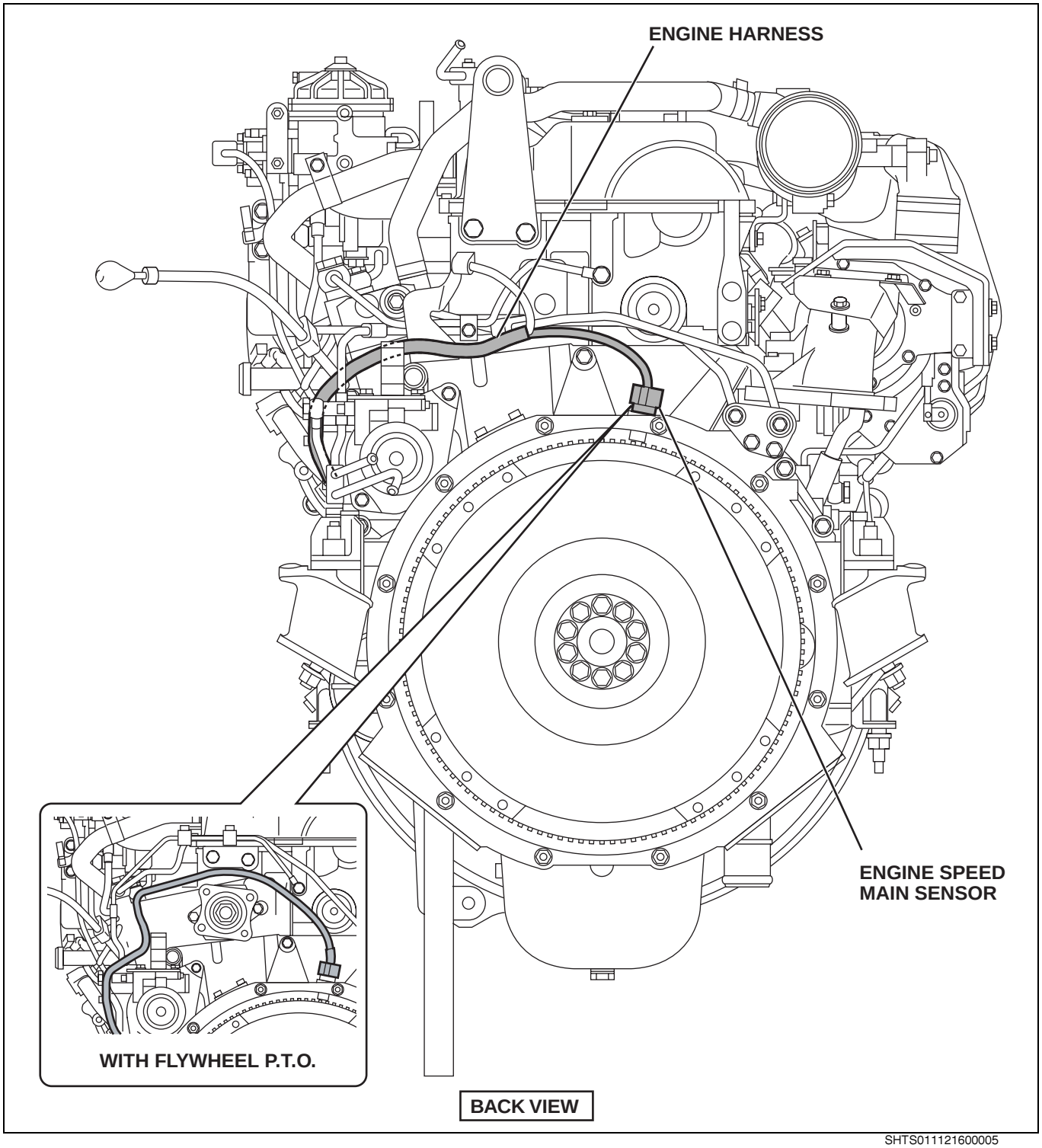
SHTS011121600002



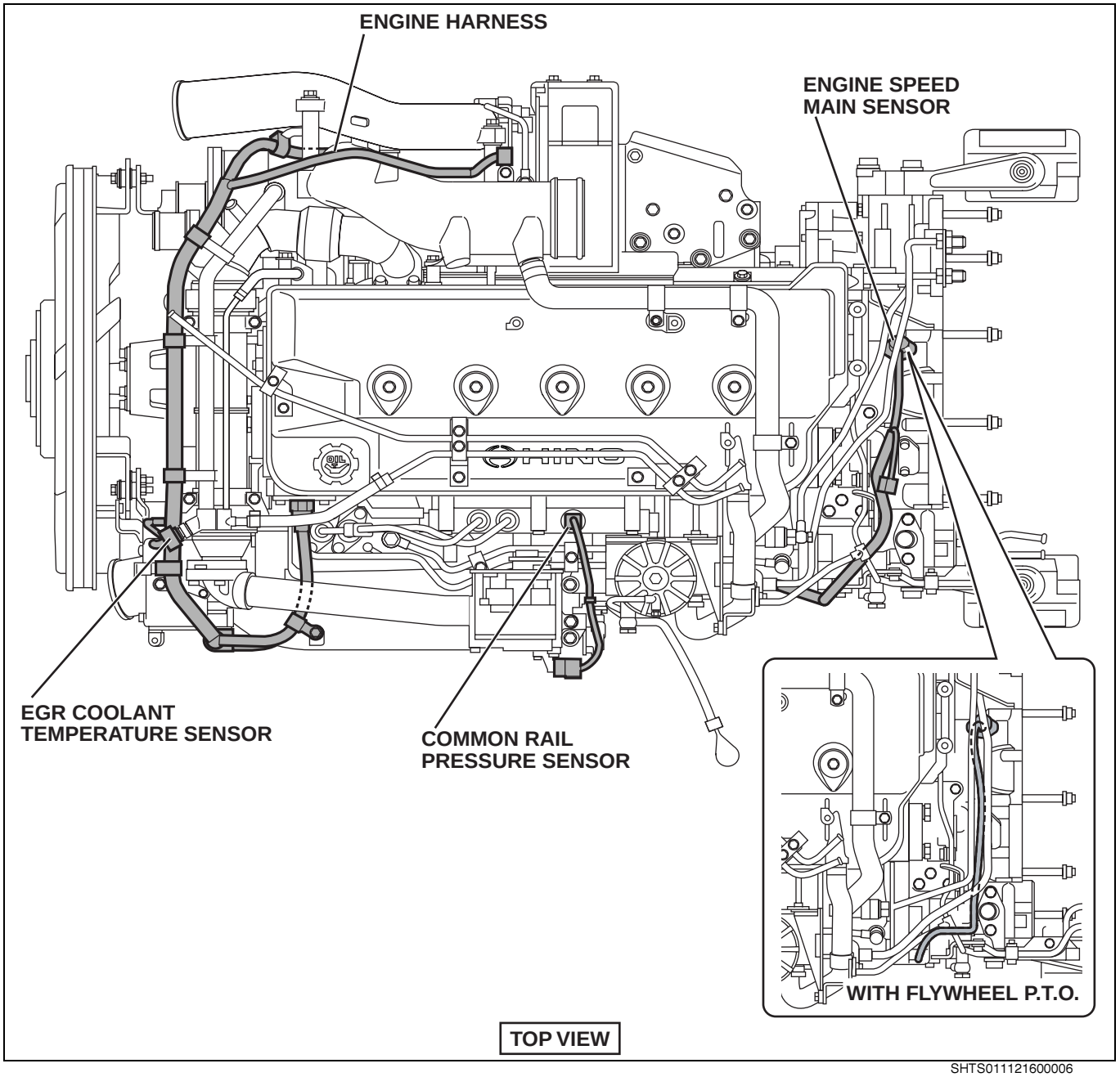
SHTS011121600003



SHTS011121600004



SHTS011121600005

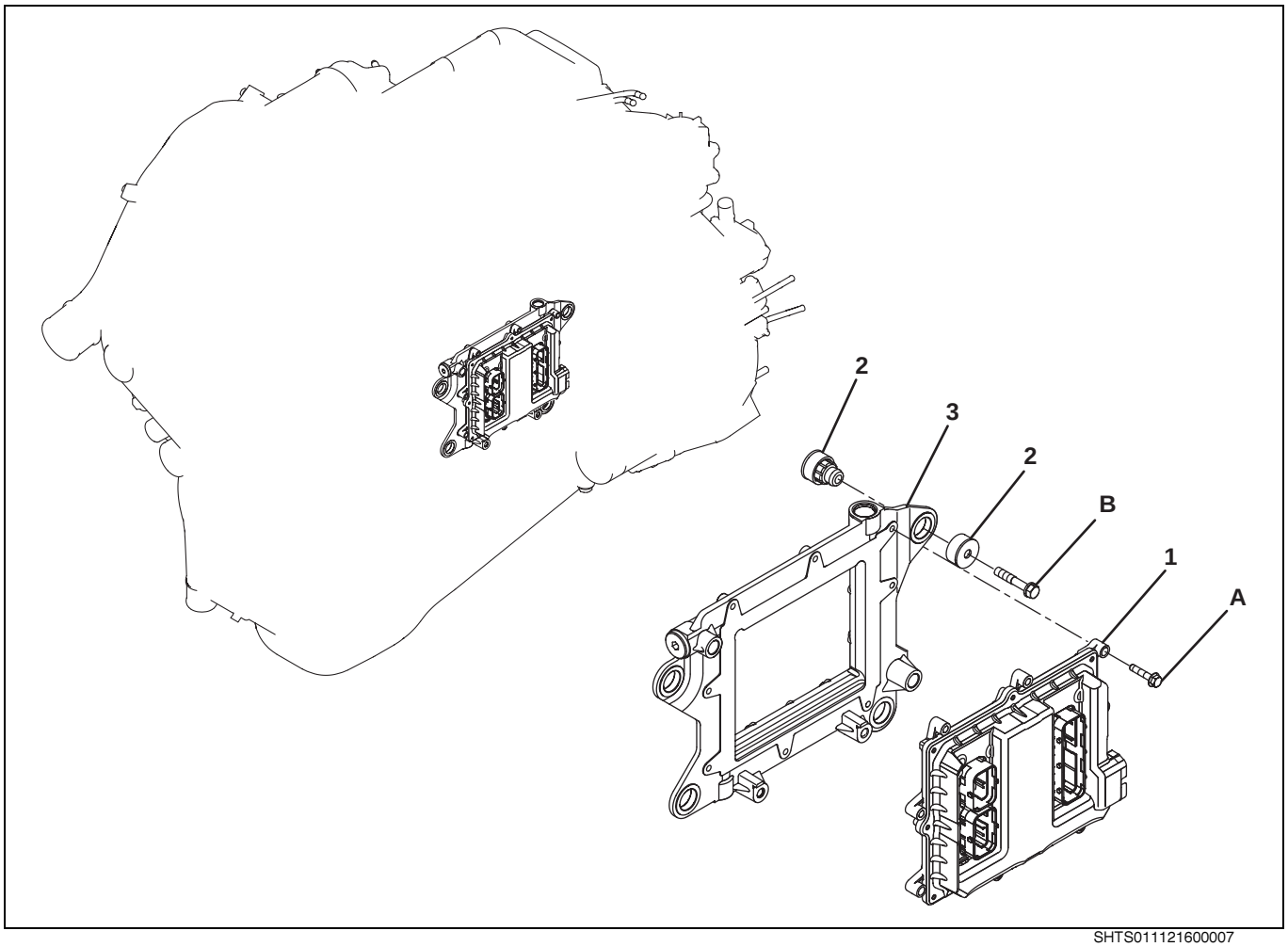


SHTS011121600006

ENGINE ECU AND ENGINE ECU COOLER

COMPONENT LOCATOR

EN0111216D100002



SHTS011121600007

1	Engine ECU	3	Engine ECU cooler
2	Rubber cushion		

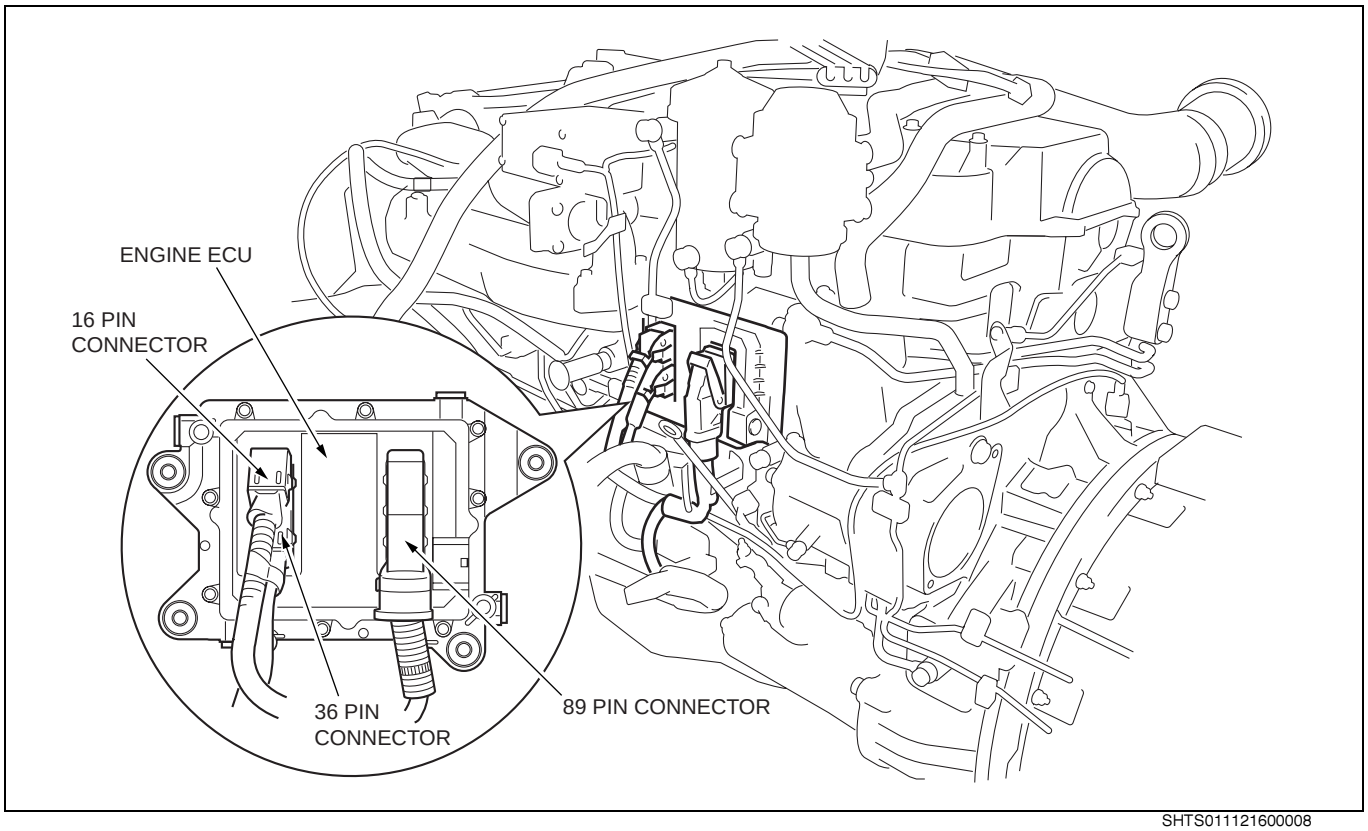
Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

A	8-12 {82-122, 6-8}	B	28.5 {290, 21}

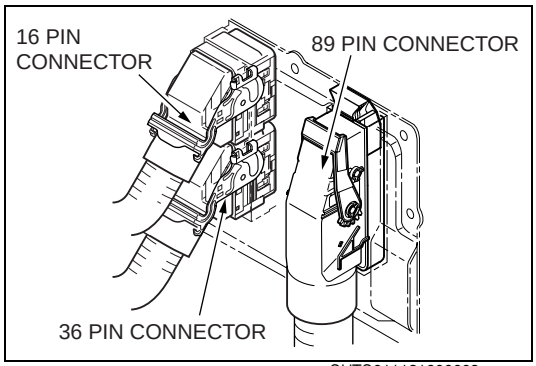
REPLACEMENT

EN0111216H100001

CLEANING OF THE ENGINE ECU CONNECTOR



SHTS011121600008



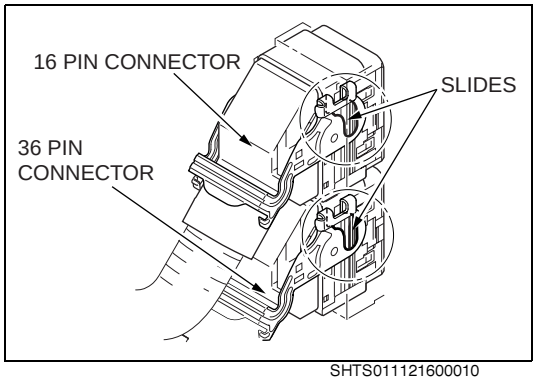
SHTS011121600009

1. CLEANING OF THE ENGINE ECU CONNECTOR

(1) Check that the engine ECU connectors are securely engaged with the engine ECU.

(2) Use a wet waste to clean the engine ECU connectors and the surface of the engine ECU.

(3) Blow air to remove dusts and contaminants from the engine ECU connectors and the surface of the engine ECU.

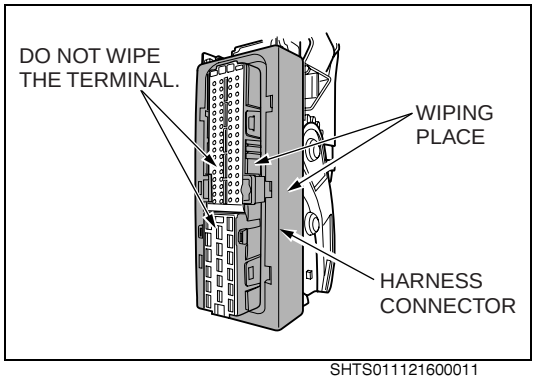


SHTS011121600010

(4) Use a small brush to thoroughly remove all dusts and contaminants remaining in the slides.

(5) Repeat the steps (1) to (4) if a lever motion is unsmooth.

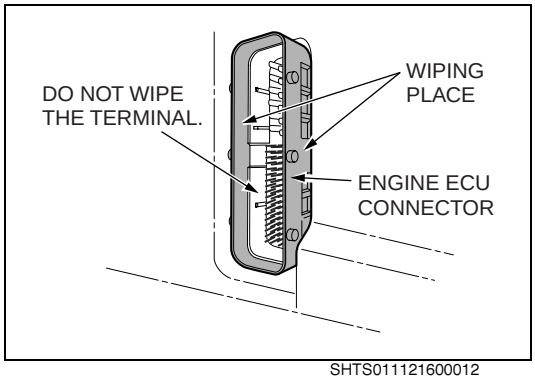
(6) Disconnect the engine ECU connectors and check for adhering dusts and contaminants.



SHTS011121600011

(7) If side faces of the harness connector are unclean, use a wet waste to wipe clean. In this step, reasonable cares must be used not to allow any dusts or contaminants from falling onto the terminals.

NOTICE
Wring a waste out before use.



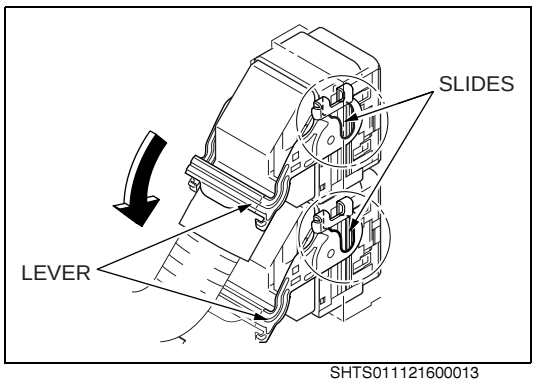
SHTS011121600012

(8) If side faces of the engine ECU connector are unclean, use a wet waste to wipe clean.

NOTICE

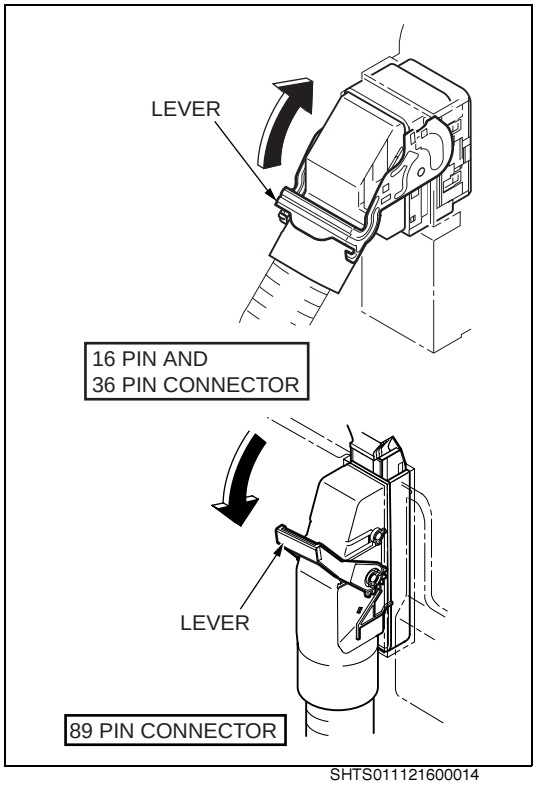
- **Wring a waste out before use.**
- **Do not touch inner surfaces of the terminal.**

(9) Blow air to remove dusts and contaminants from the terminal on the engine ECU connector.



SHTS011121600013

(10) Connect the connectors to the engine ECU. If a lever motion is unsmooth, apply some water drops onto the slide while moving a lever, in order to smoothen a lever motion.
(11) Move a lever to the direction shown with an arrow in this figure until it makes a click sound.

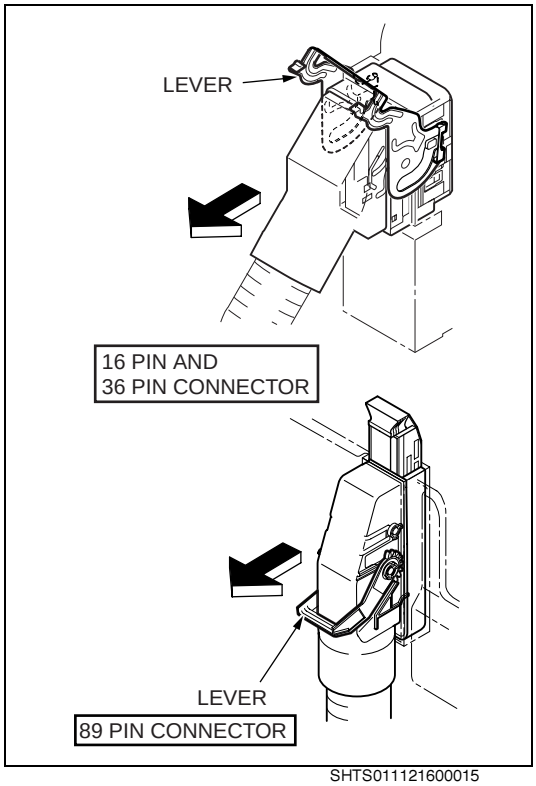


SHTS011121600014

REMOVE THE ENGINE ECU.

1. DISCONNECT THE ENGINE ECU CONNECTOR.

(1) Move a lever to the direction shown with an arrow in this figure until it makes a click sound. Disconnect a connector.



SHTS011121600015

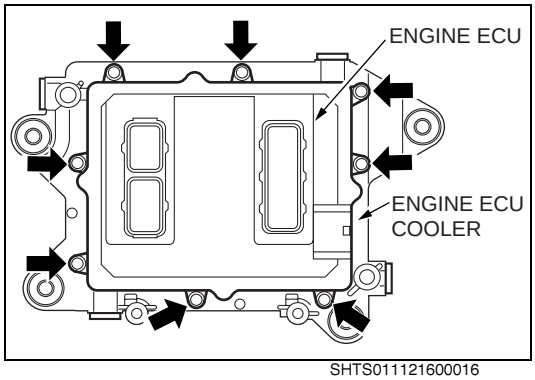
(2) Pull off a connector in the straight direction.

NOTICE

- **Connect/disconnect a connector only if so required.**
- **Do not pull nor twist a harness when disconnecting a connector. Inobservance of this instruction will cause wire damages and/or terminal deformation.**
- **Do not insert a test rod after connector.**
- **Do not apply paint or oil/grease to a connector. Inobservance of this instruction will degrade functionality and durability of a connector.**

HINT

If a connector cannot be pulled off with a small force, check whether a lever is fully released.



SHTS011121600016

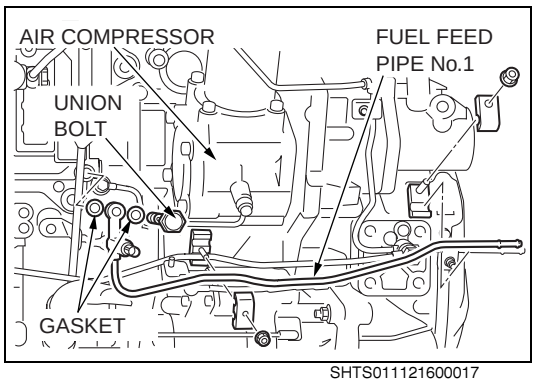
2. REMOVE THE ENGINE ECU.

(1) Remove eight bolts to remove the engine ECU from the engine ECU cooler.

NOTICE

- **Use a plastic cover to protect the engine ECU connector against incoming dusts and contaminants.**
- **Do not reuse the engine ECU if dropped.**
- **Do not touch a connector terminal with a hand.**
- **Do not disassemble the engine ECU.**
- **Do not apply paint or oil/grease to a connector. Inobservance of this instruction will degrade functionality and durability of the connector.**

REMOVE THE ENGINE ECU COOLER.



SHTS011121600017

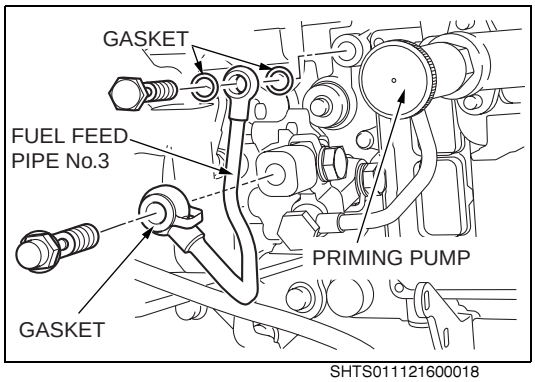
1. DISCONNECT THE FUEL PIPE.

(1) Remove two nuts and two clips.

(2) Remove a union bolt to disconnect the fuel feed pipe No.1.

HINT

Use a container and a waste as fuel might drip off during disconnection of fuel pipe.

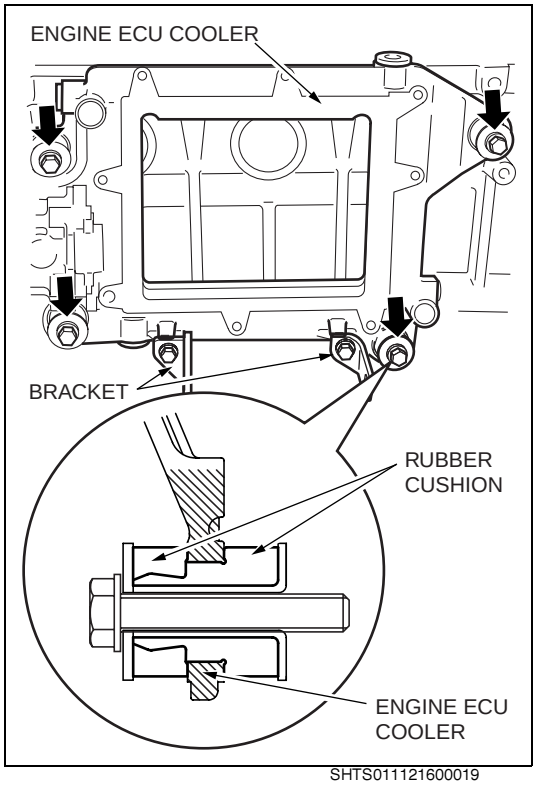


SHTS011121600018

(3) Remove two union bolts to disconnect the fuel feed pipe No.3 and remove gaskets.

HINT

Use a container and a waste as fuel might drip off during disconnection of fuel pipe.

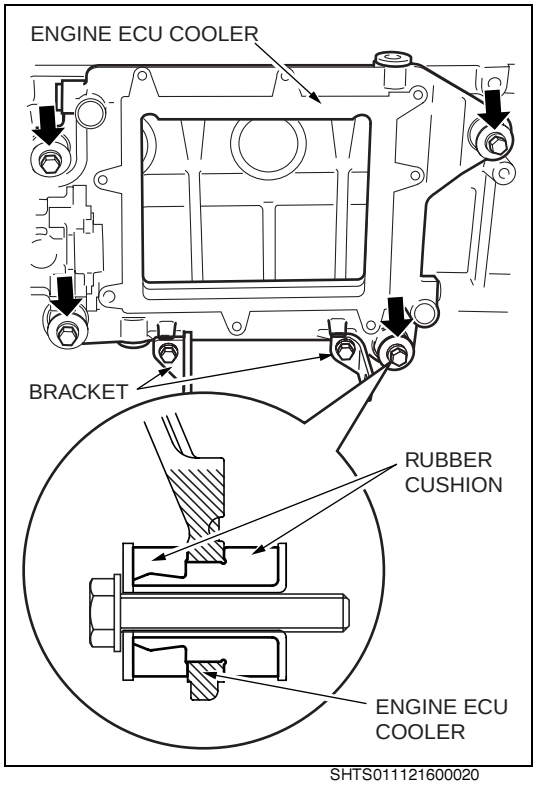


SHTS011121600019

2. REMOVE THE ENGINE ECU COOLER.

(1) Remove four bolts and four rubber cushions. Remove the engine ECU cooler from the cylinder block.

(2) Remove two bolts to remove the brackets from the engine ECU cooler.



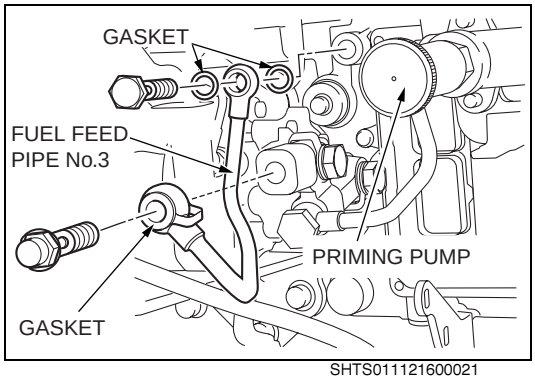
SHTS011121600020

INSTALL THE ENGINE ECU COOLER.

1. INSTALL THE ENGINE ECU COOLER.

(1) Install two brackets to the engine ECU cooler, and tighten two bolts.
Tightening Torque:
10 N·m {102 kgf·cm, 7 lbf·ft}

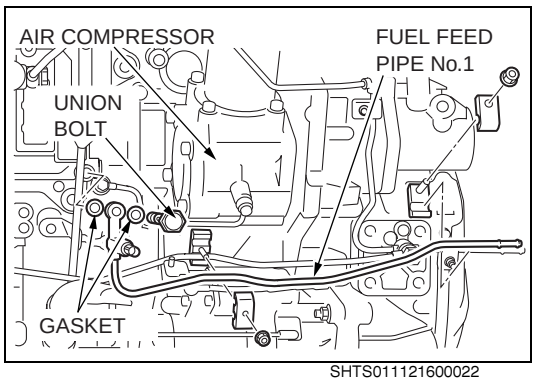
(2) Attach four rubber cushions. Install the engine ECU cooler to the cylinder block, and tighten four bolts.
Tightening Torque:
28.5 N·m {290 kgf·cm, 21 lbf·ft}



SHTS011121600021

2. CONNECT THE FUEL PIPE.

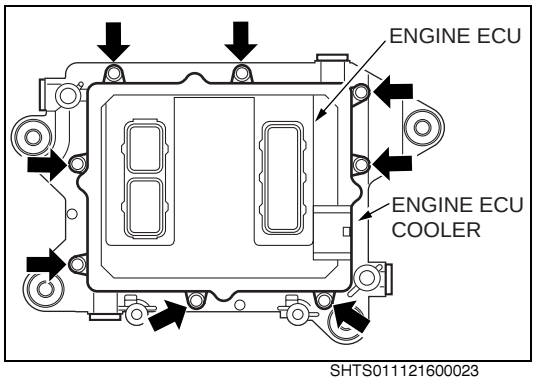
(1) Replace old gaskets with new ones. Connect the fuel feed pipe No.3, and tighten two union bolts.
Tightening Torque:
Fuel strainer side: 27 N·m {275 kgf·cm, 20 lbf·ft}
Engine ECU cooler side: 25 N·m {255 kgf·cm, 18 lbf·ft}



SHTS011121600022

(2) Replace old gaskets with new ones. Connect the fuel feed pipe No.1 to the engine ECU cooler, and tighten a union bolt.
Tightening Torque:
27 N·m {275 kgf·cm, 20 lbf·ft}

(3) Tighten two nuts to secure two clips.



SHTS011121600023

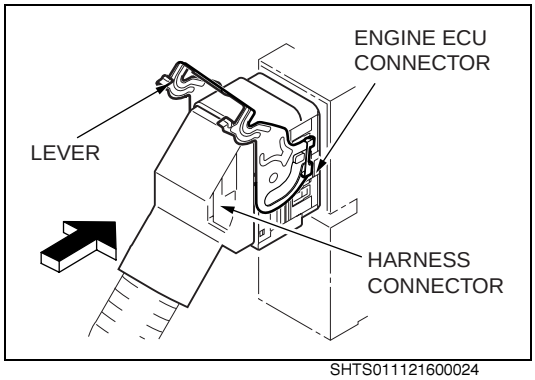
INSTALL THE ENGINE ECU.

1. INSTALL THE ENGINE ECU.

(1) Install the engine ECU to the engine ECU cooler, and tighten eight bolts in the diagonal order.
Tightening Torque:
8-12 N·m {82-122 kgf·cm, 6-8 lbf·ft}

NOTICE

- **Do not reuse the engine ECU if dropped.**
- **Do not tough a connector terminal with a hand.**
- **Do not apply paint or oil/grease to a connector. Inobservance of this instruction will degrade functionality and durability of a connector.**



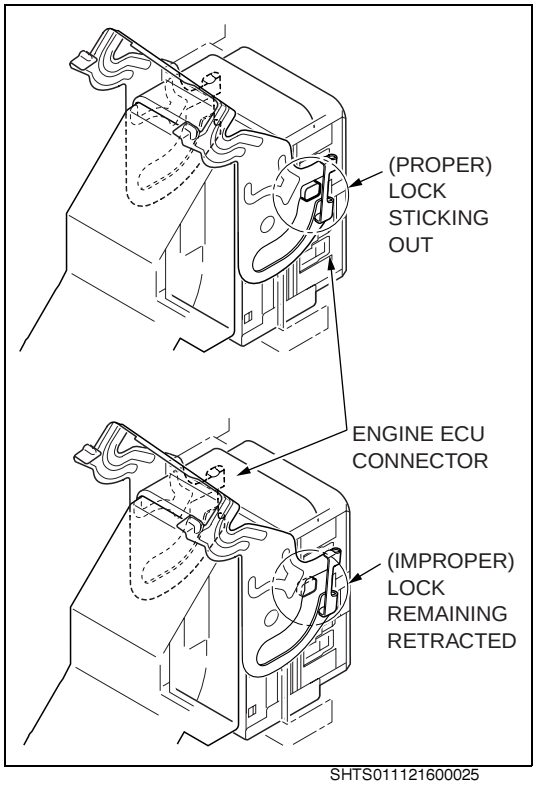
SHTS011121600024

2. CONNECT THE ENGINE ECU CONNECTOR (16 PIN CONNECTOR AND 36 PIN CONNECTOR).

(1) Make sure that a lever on the harness connector is fully released. Fit the harness connector in the straight direction onto the engine ECU connector.

NOTICE
Make sure that a lever is fully released in this step.

(2) Press the upper area of the harness connector and insert the connector evenly.

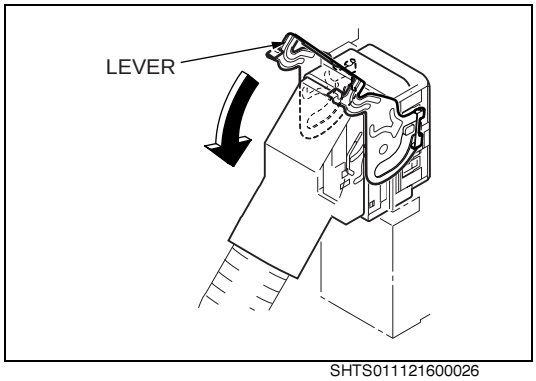


SHTS011121600025

(3) Check that the lock is sticking out.

NOTICE

If the lock remains retracted, repeat the steps (1) and (2).

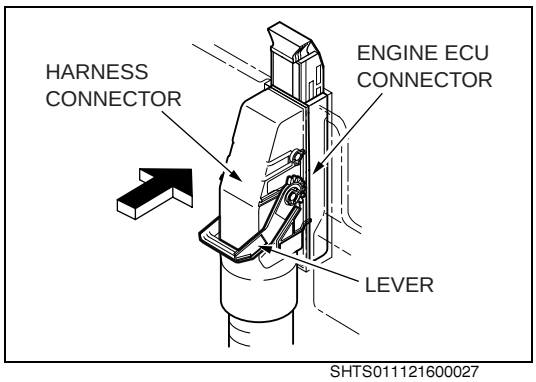


SHTS011121600026

(4) Move a lever to the direction shown with an arrow in this figure until it makes a click sound. Connect the connector.

NOTICE

If a lever motion is unsmooth, repeat the steps (1) to (3).



SHTS011121600027

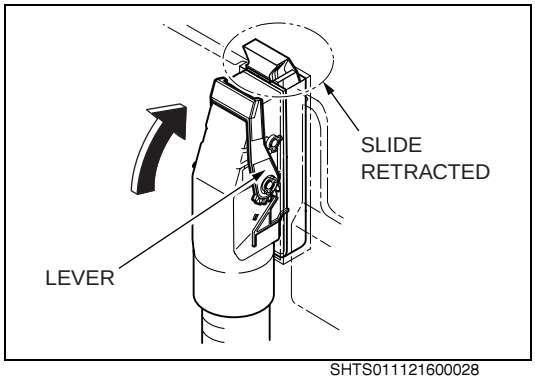
3. CONNECT THE ENGINE ECU CONNECTOR (89 PIN CONNECTOR).

(1) Make sure that a lever on the harness connector is fully released. Fit the harness connector in the straight direction onto the engine ECU connector.

NOTICE

Make sure that a lever is fully released this step.

(2) Press the upper area of the harness connector and insert the connector evenly.



SHTS011121600028

(3) Move a lever to the direction shown with an arrow in this figure until it makes a click sound. Connect a connector.

NOTICE

If a lever motion would be unsmooth, repeat the steps (1) and (2).

VEHICLE CONTROL ECU

REPLACEMENT

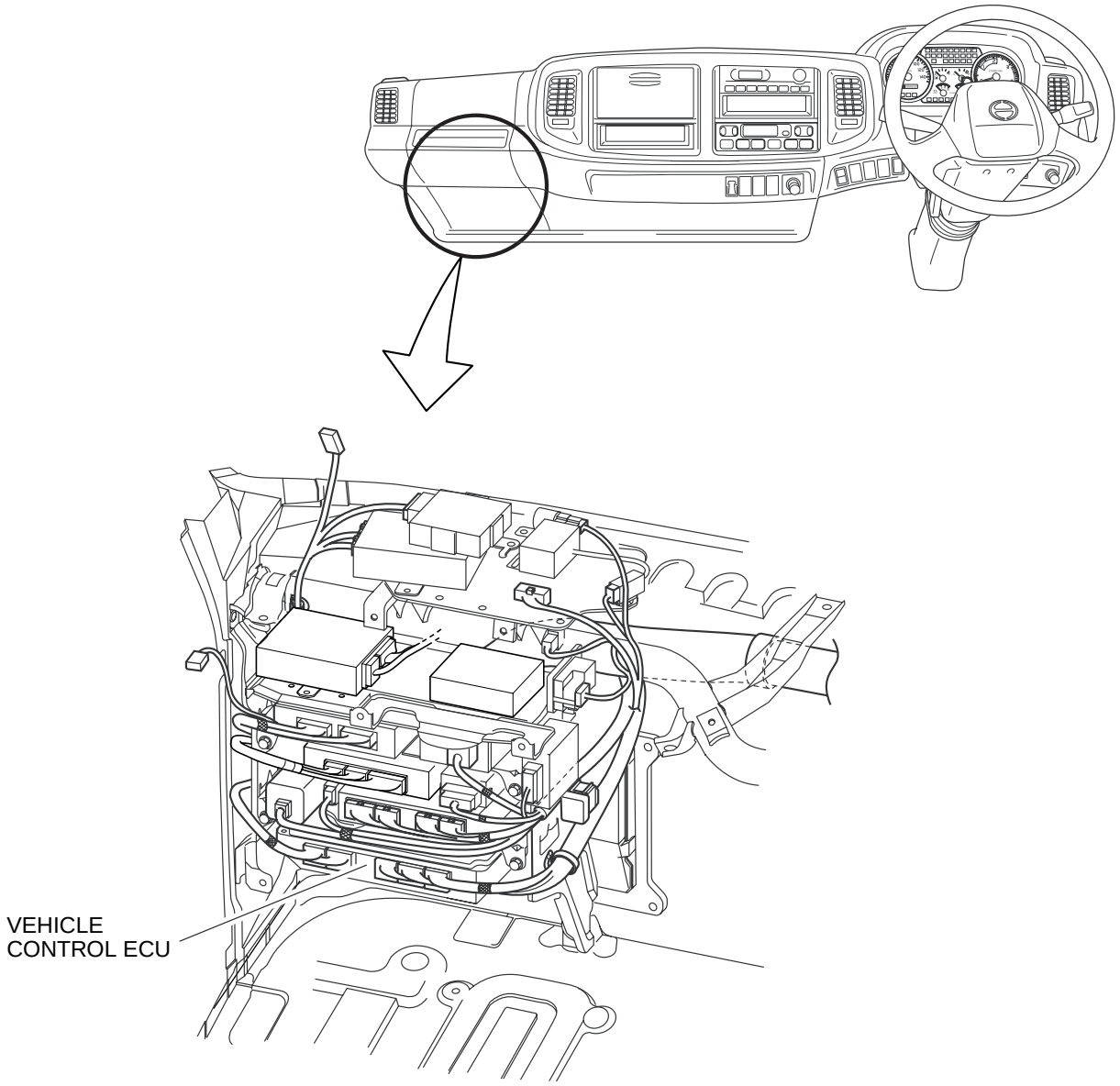
EN0111216H100002

REMOVE THE VEHICLE CONTROL ECU.

1. REMOVE THE INSTRUMENT PANEL.
(1) Remove the instrument panel lower cover.

2. DISCONNECT THE HARNESS.
(1) Disconnect the connector of the vehicle control ECU.

3. REMOVE THE ECU.
(1) Remove the vehicle control ECU.



SHTS011121600029

INSTALL THE VEHICLE CONTROL ECU.

1. INSTALL THE VEHICLE CONTROL ECU.
(1) Install the vehicle control ECU.

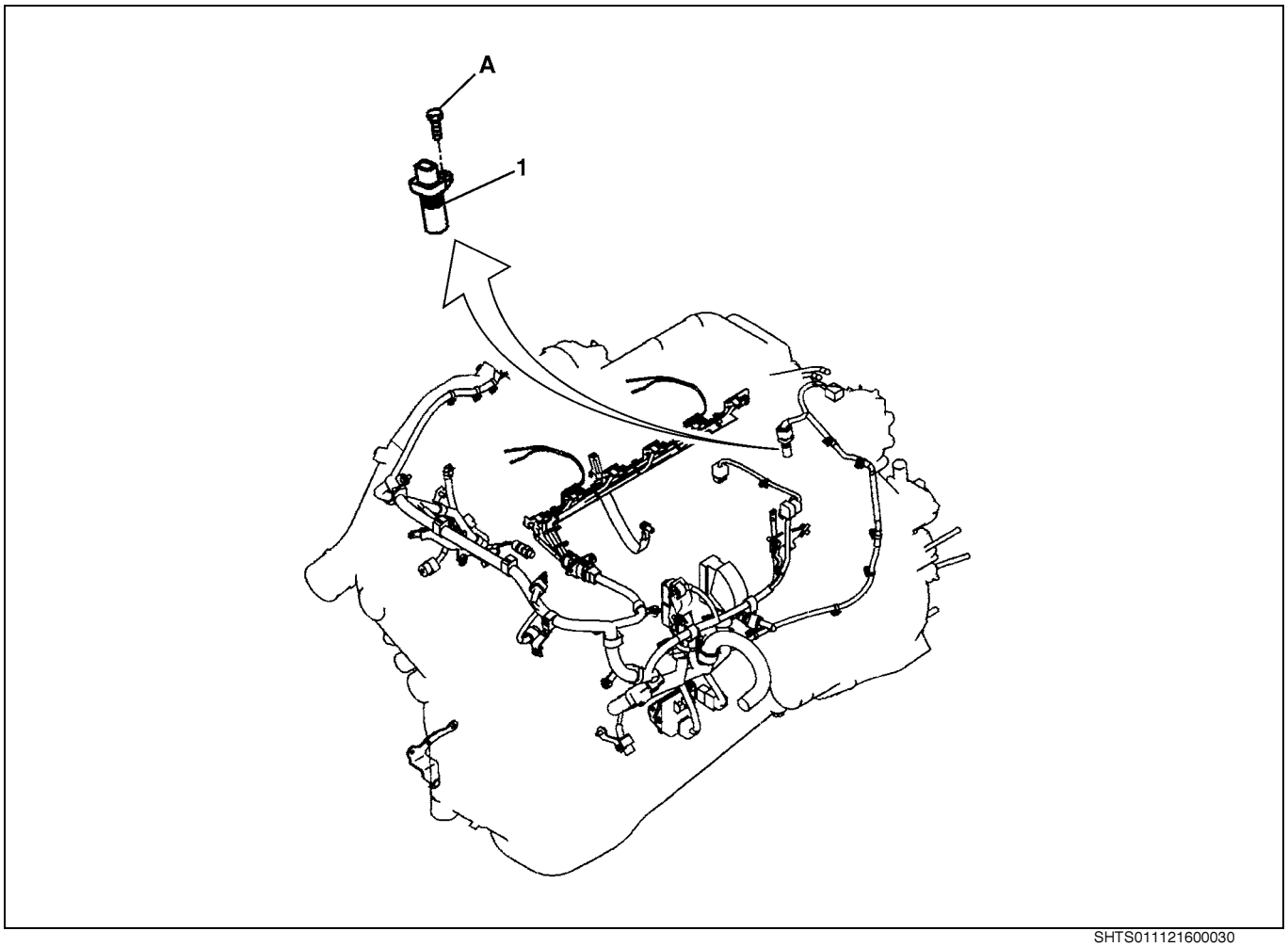
2. CONNECT THE HARNESS.
(1) Connect the connector of the vehicle control ECU.

3. INSTALL THE INSTRUMENT PANEL.
(1) Install the instrument panel lower cover.

ENGINE SPEED MAIN SENSOR

COMPONENT LOCATOR

EN0111216D100003



SHTS011121600030

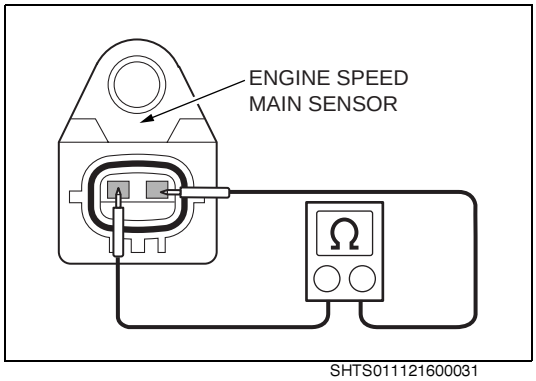
1 Engine speed main sensor	

Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

A 10 {102, 7}	

INSPECTION

EN0111216H300001



SHTS011121600031

1. CHECK A RESISTANCE.

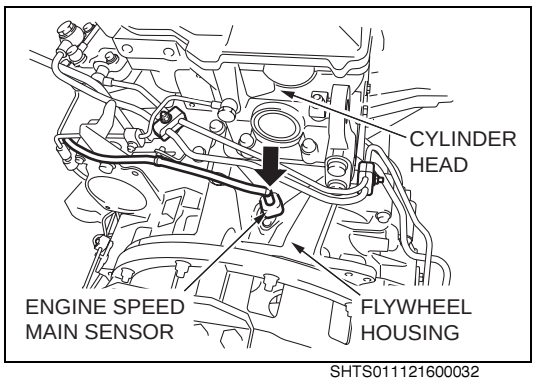
(1) Set the starter switch to the "LOCK" position.

(2) Use a circuit tester to measure the resistance between terminals. If a measurement reading exceeds the standard value, make replacement.

Standard value: 108.5-142.5 Ω

REPLACEMENT

EN0111216H100003

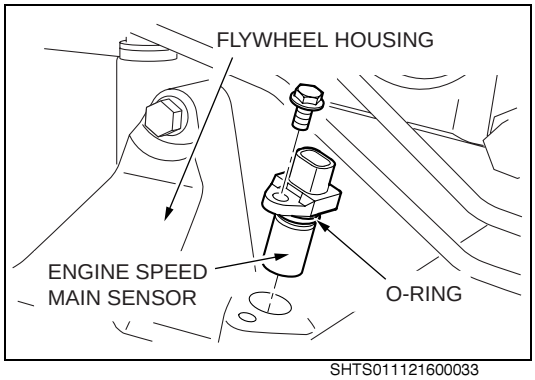


SHTS011121600032

REMOVE THE ENGINE SPEED MAIN SENSOR.

1. DISCONNECT THE HARNESS.

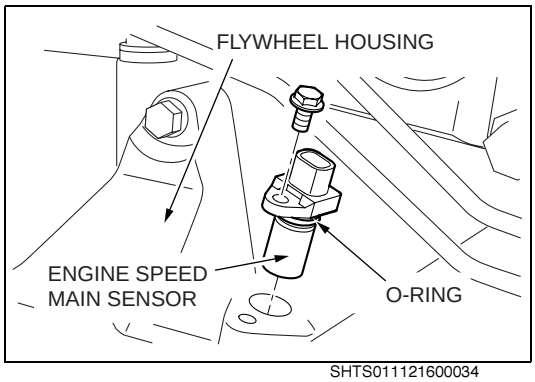
(1) Disconnect a connector from the engine speed main sensor.



SHTS011121600033

2. REMOVE THE ENGINE SPEED MAIN SENSOR.

(1) Remove a bolt to remove the engine speed main sensor from the flywheel housing.



SHTS011121600034

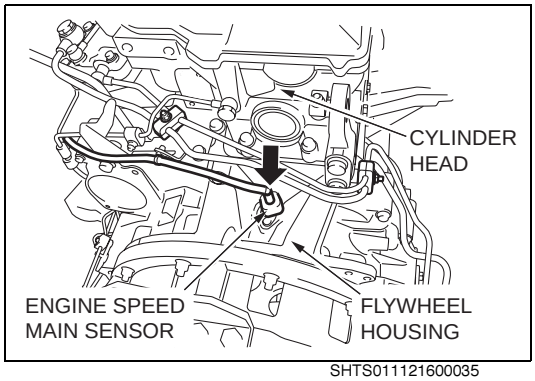
INSTALL THE ENGINE SPEED MAIN SENSOR.

1. INSTALL THE ENGINE SPEED MAIN SENSOR.

(1) Make sure that an O-ring is attached to the engine speed main sensor. Install the engine speed main sensor to the flywheel housing, and tighten a bolt.
Tightening Torque:
10 N·m {102 kgf·cm, 7 lbf·ft}

HINT

This sensor is of flange type that does not require any gap adjustments.



SHTS011121600035

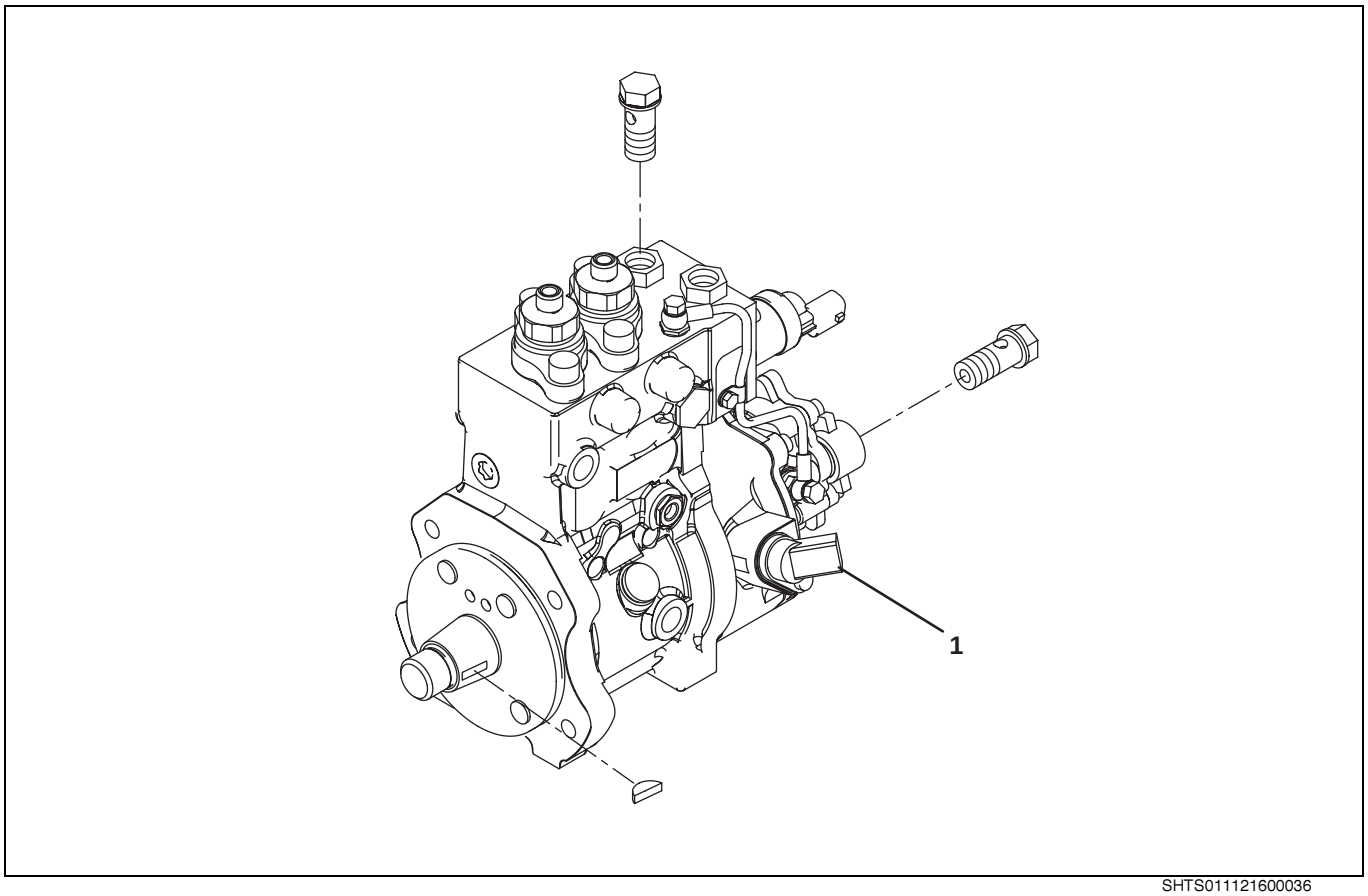
2. CONNECT THE HARNESS.

(1) Connect a connector to the engine speed main sensor.

ENGINE SPEED SUB SENSOR

COMPONENT LOCATOR

EN0111216D100004

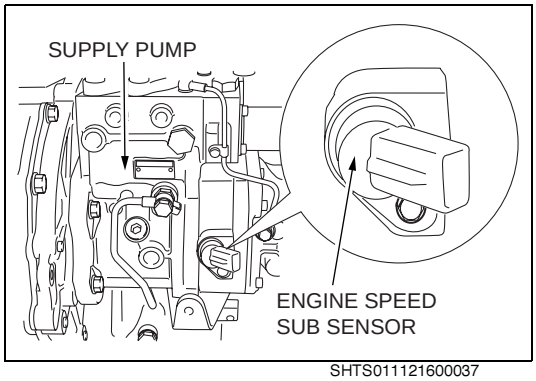


SHTS011121600036

1 Engine speed sub sensor	

INSPECTION

EN0111216H300002



SHTS011121600037

1. CHECK THE ENGINE SPEED SUB SENSOR.

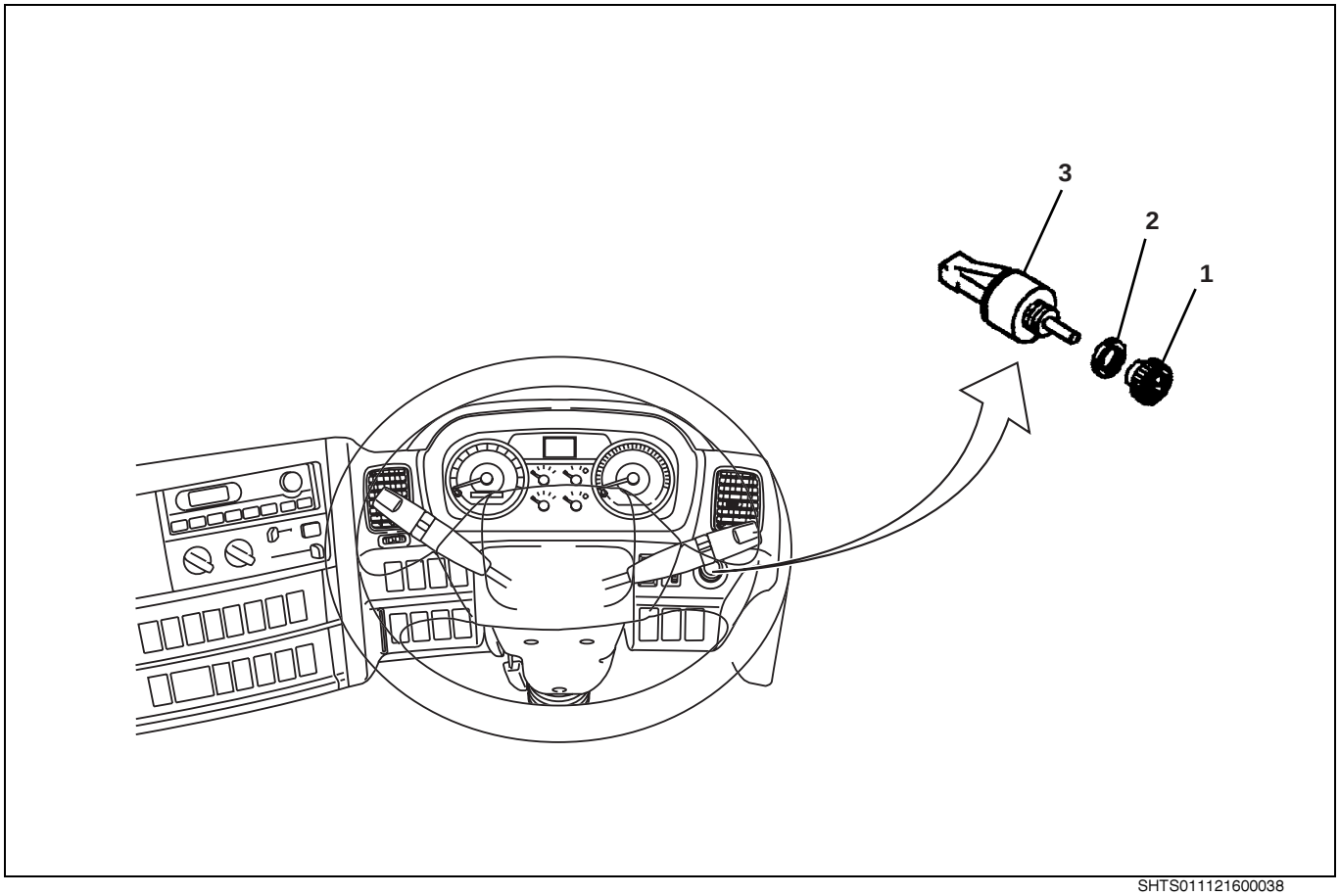
(1) A check on the engine speed sub sensor itself is infeasible with a circuit tester, thus must be conducted by using the Hino-DX to detect failure codes and using the signal check harness to check the circuit of the engine speed sub sensor.

(2) The engine speed sub sensor is assembled with a supply pump. If this sensor needed to be replaced, contact Bosch Service Shop.

IDLE SET VOLUME

COMPONENT LOCATOR

EN0111216D100005

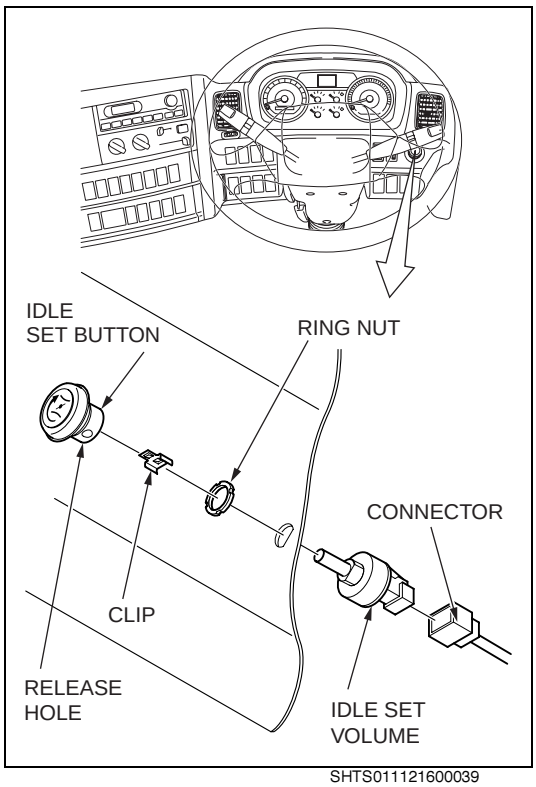


SHTS011121600038

1	Idle set button	3	Idle set volume
2	Ring nut		

REPLACEMENT

EN0111216H100004



SHTS011121600039

REMOVE THE IDLE SET VOLUME.

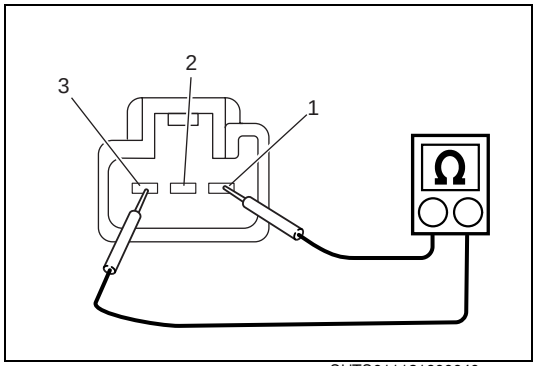
1. REMOVE THE IDLE SET VOLUME.

(1) Insert a piece of wire of 2.5 mm {0.0984 in.} in diameter into the idle set button release hole and unlatch a clip to pull off the idle set button.

NOTICE

The clip will come off when the idle set button is pulled off. Keep the unfastened clip in a reasonable storage area until remounting.

(2) Disconnect the harness connector. Remove a ring nut and the idle set volume.



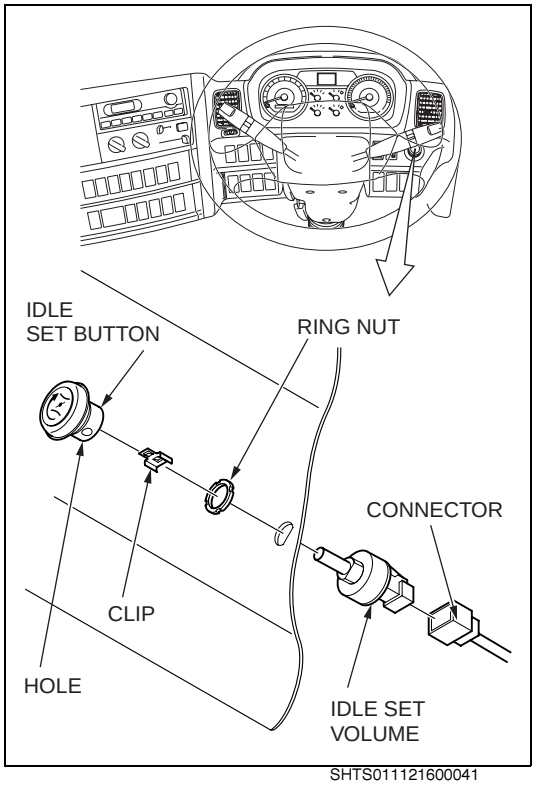
SHTS011121600040

COMPONENT CHECK

1. CHECK THE RESISTANCE OF THE IDLE SET VOLUME.

(1) Measure the resistance between No.1 and No.3 terminals of the connector (on the part side). If a measurement reading exceeds the standard value, make replacement.
Standard value: 1,180-1,620 Ω

(2) Measure the resistance between No.2 and No.3 terminals while turning a shaft of the idle set volume. Check that an ohmage changes smoothly in line with shaft rotations. If an ohmage changes intermittently or unevenly, make replacement.



SHTS011121600041

INSTALL THE IDLE SET VOLUME.

1. INSTALL THE IDLE SET VOLUME.

(1) Position the idle set volume in its proper orientation and insert it into a hole in the instrument panel. Fasten a ring nut.

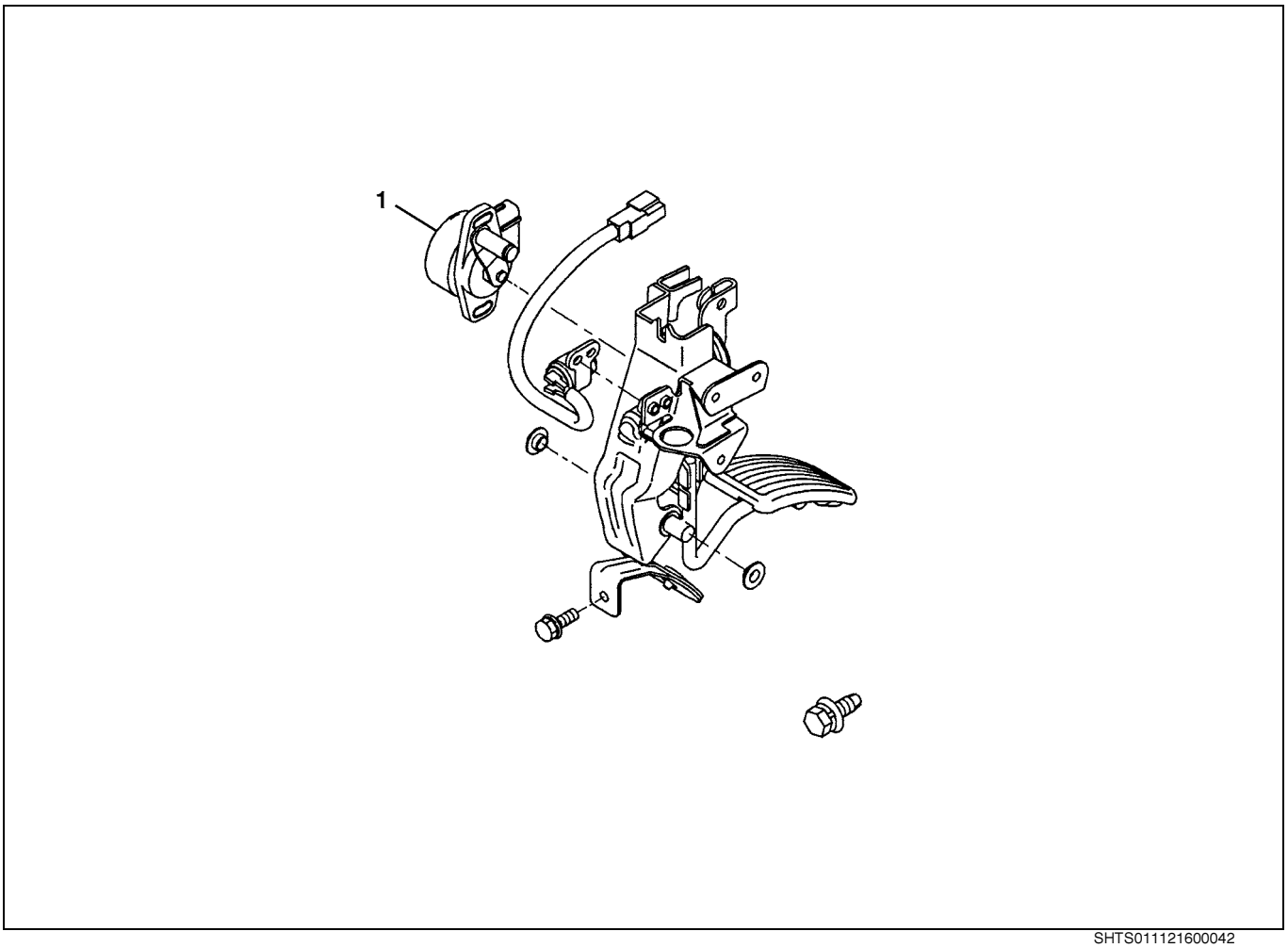
(2) Insert a clip into a hole in the idle set button. In this step, the smaller end of a clip must face the direction toward the hole.

(3) Install the idle set button in alignment with a shaft of the idle set volume. Attempt to pull the idle set button to check that it is fully engaged.

ACCELERATOR STROKE SENSOR

COMPONENT LOCATOR

EN0111216D100006

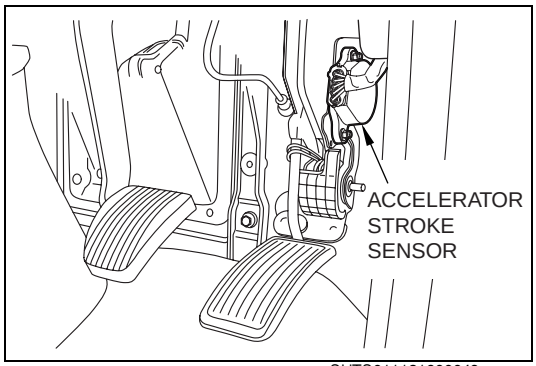


SHTS011121600042

1 Accelerator stroke sensor	

REPLACEMENT

EN0111216H100005

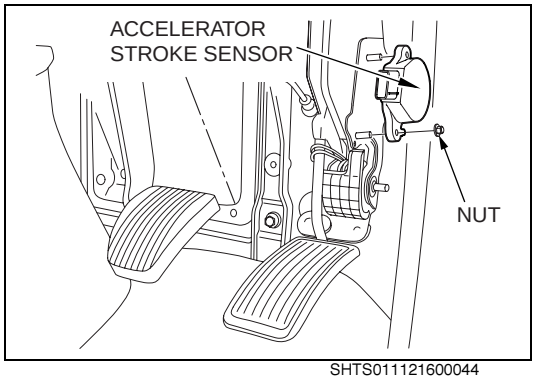


SHTS011121600043

REMOVE THE ACCELERATOR STROKE SENSOR.

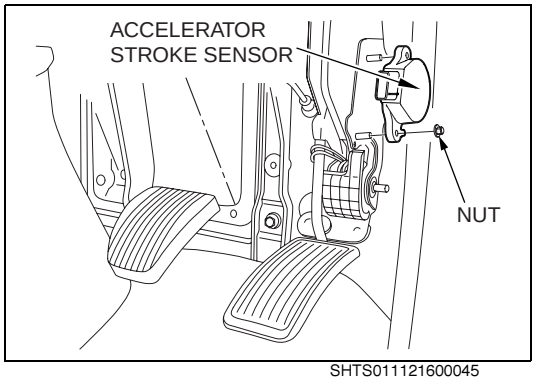
1. REMOVE THE ACCELERATOR STROKE SENSOR.

(1) Disconnect a connector of the accelerator stroke sensor.



SHTS011121600044

(2) Remove two nuts to remove the accelerator stroke sensor.

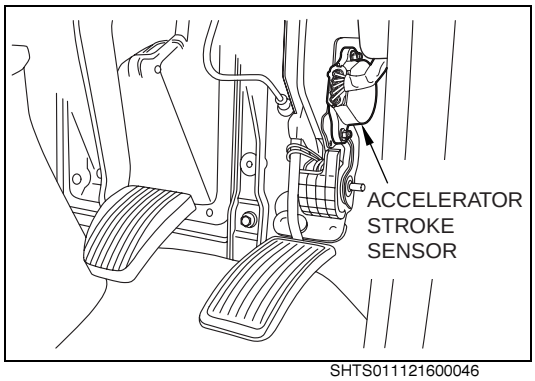


SHTS011121600045

INSTALL THE ACCELERATOR STROKE SENSOR.

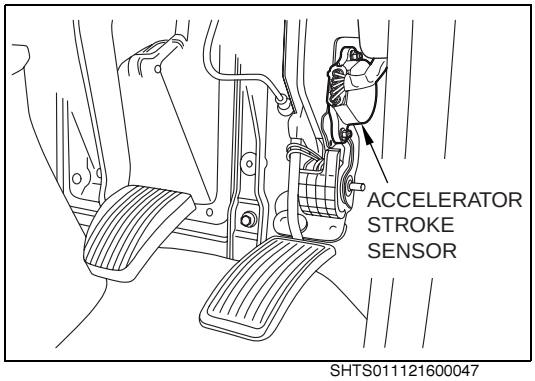
1. INSTALL THE ACCELERATOR STROKE SENSOR.

(1) Install the accelerator stroke sensor and tighten two nuts.



SHTS011121600046

(2) Connect a connector of the accelerator stroke sensor.



SHTS011121600047

ADJUSTING THE ACCELERATOR STROKE SENSOR

1. ADJUSTING AN OUTPUT VOLTAGE OF THE ACCELERATOR STROKE SENSOR

(1) Use the Hino-DX to check an output voltage.

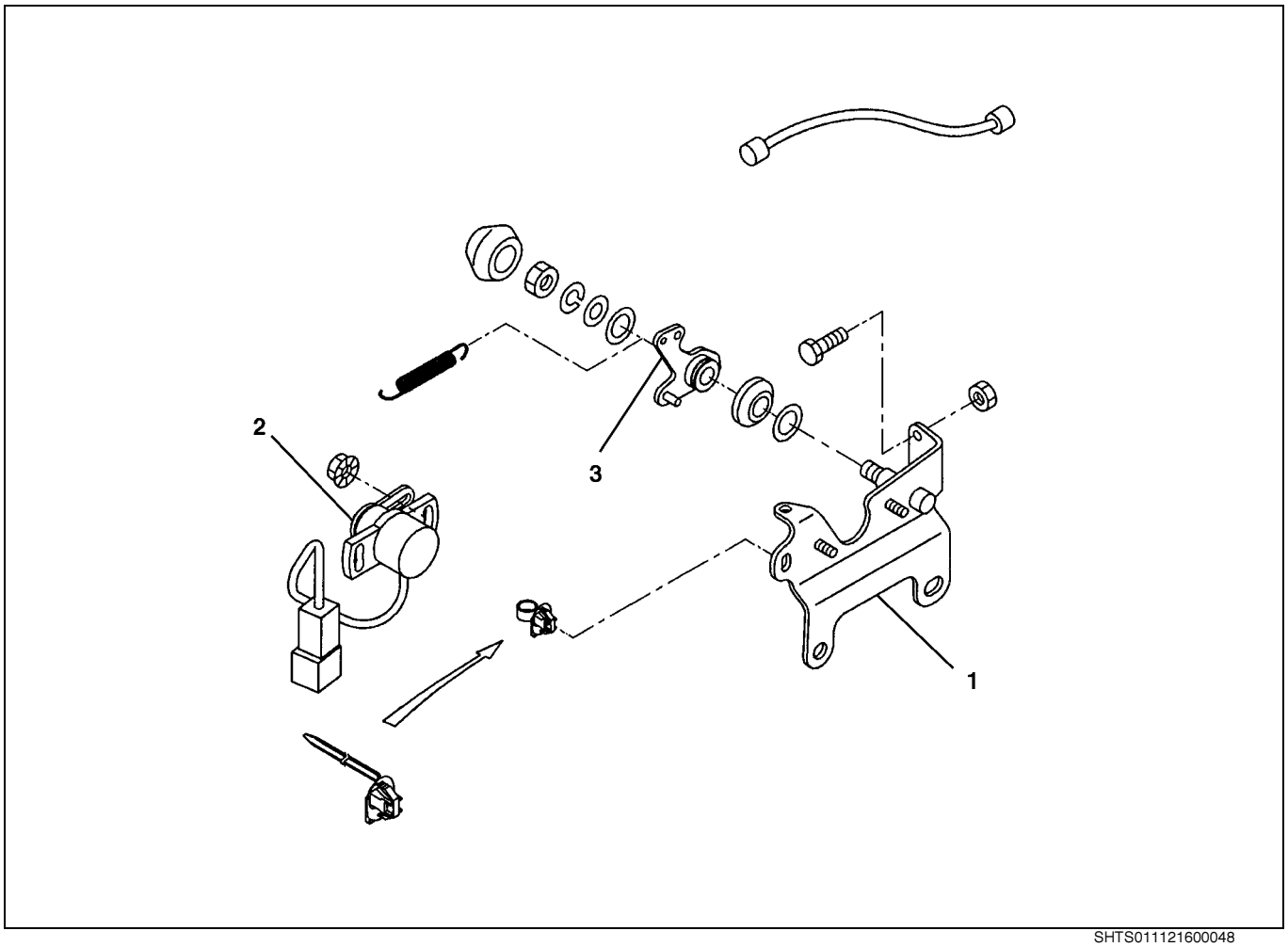
(2) If an output voltage would not meet the standard, adjust the mounted position of the accelerator stroke sensor in the rotational direction (oblong hole of the sensor) or replace the accelerator stroke sensor.

Measurement item	Standard value
Pedal in idle (pedal stroke: 0 mm)	**0.70-1.00 V**
Pedal in full (pedal stroke: max)	**3.61-3.91 V**
Engine retarder switch "ON"	**0.70-1.00 V**

OPERATIONAL ACCELERATOR SENSOR

COMPONENT LOCATOR

EN0111216D100007

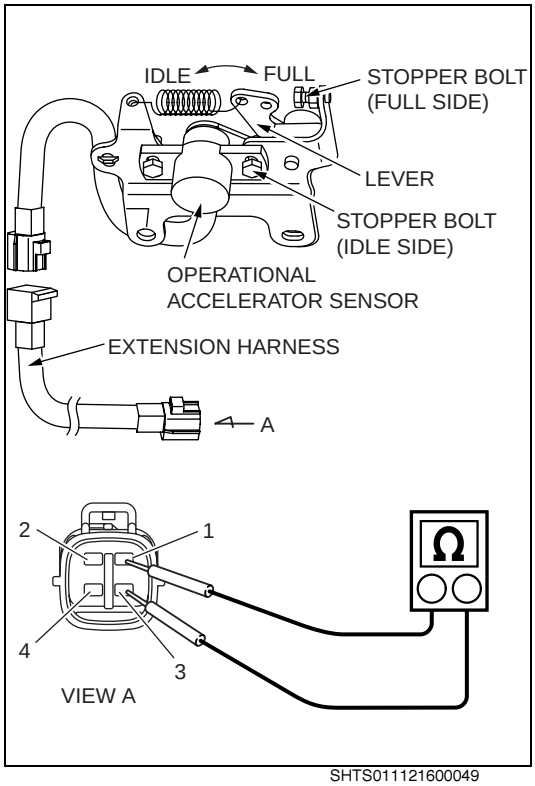


SHTS011121600048

1	Bracket	3	Lever
2	Operational accelerator sensor		

INSPECTION

EN0111216H300003

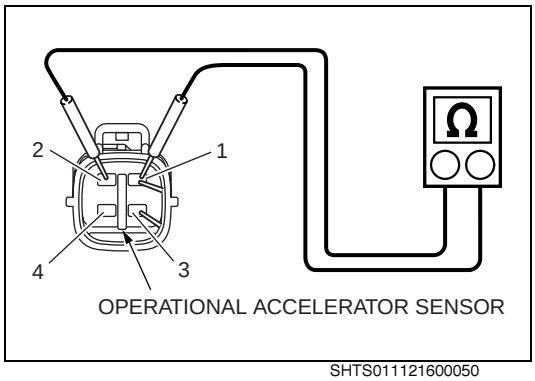


SHTS011121600049

1. CHECK THE RESISTANCE OF THE OPERATIONAL ACCELERATOR SENSOR.

(1) Connect an extension harness (waterproof) to the connector of the operational accelerator sensor.
Extension harness: S8207-11470

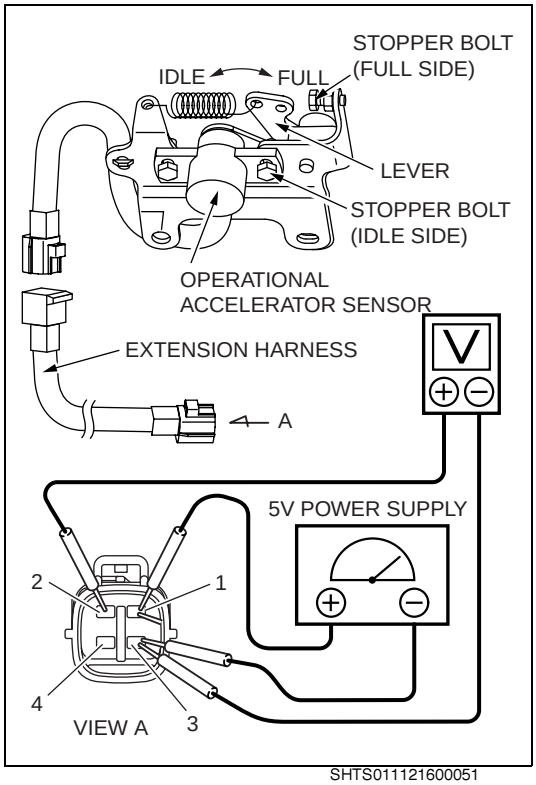
(2) Measure the resistance between No.1 and No.3 terminals of the extension harness. If a measurement reading exceeds the standard value, make replacement.
Standard value: 1,600-2,400 Ω



SHTS011121600050

(3) Measure the resistance between No.1 and No.2 terminals of the extension harness while moving a lever. Check that an ohmage changes smoothly in line with lever motions. If an ohmage changes intermittently or unevenly, make replacement.

NOTICE
Do not reuse the extension harness for the purpose of installation in vehicle because its terminals may have been damaged or deformed during checking works.



SHTS011121600051

2. CHECK THE OUTPUT VOLTAGE OF THE OPERATIONAL ACCELERATOR SENSOR

(1) Connect an extension harness (waterproof) to the connector of the operational accelerator sensor.
Extension harness: S8207-11470

(2) Connect the positive side of the 5 ± 0.1V DC stabilization power supply to No.1 terminal and the negative side to No.3 terminal.

(3) Keep a lever contacting with the stopper bolt (idle side) and measure voltages at No.2 and No.3 terminals. If a measurement reading exceeds the standard value, loosen the mounting nut for the operational accelerator sensor and make adjustment with an oblong hole of the sensor. After adjustment, tighten a nut.
Standard value: 0.70-1.00V

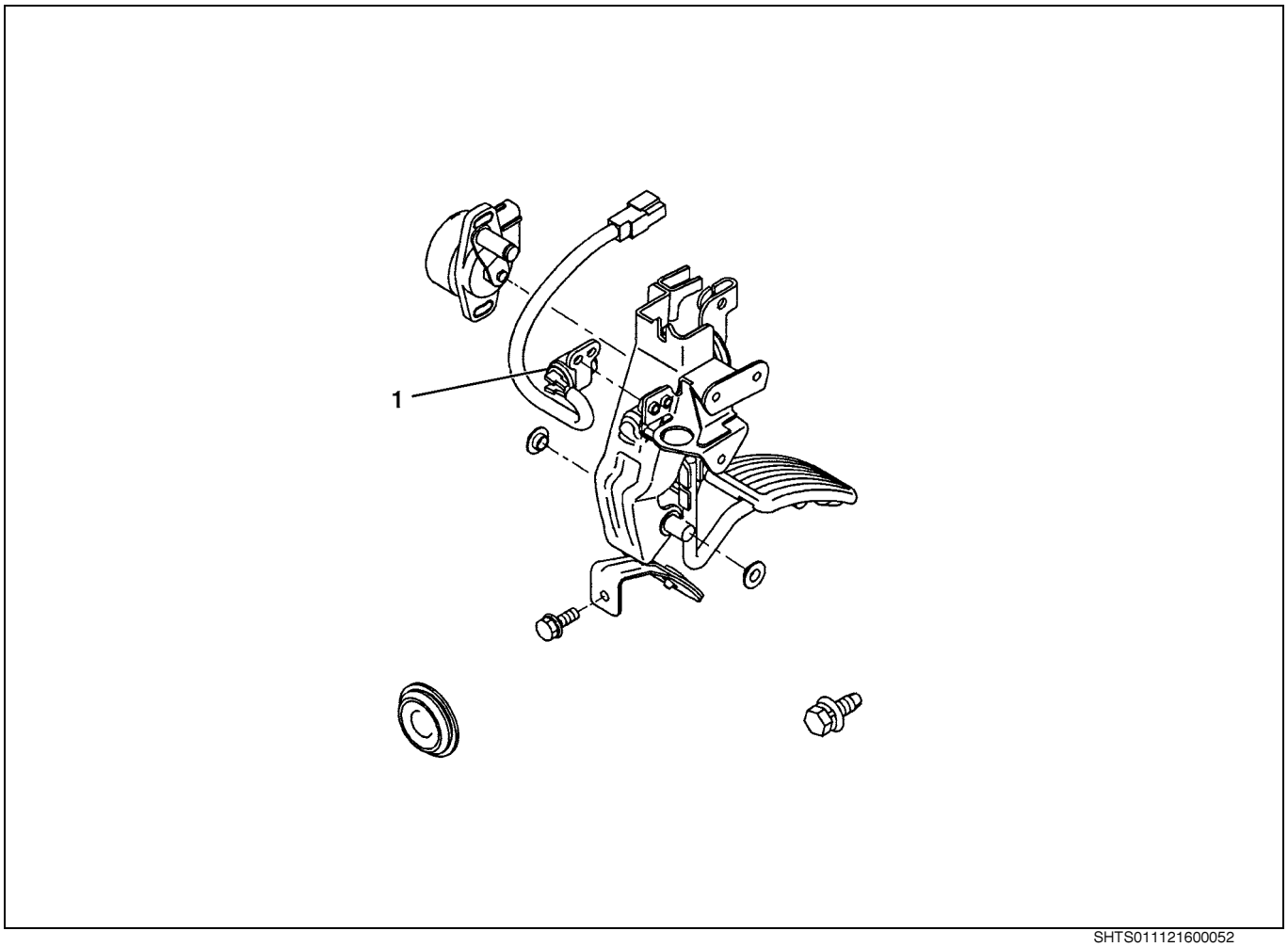
(4) Keep a lever contacting with the stopper bolt (full side) and measure voltages at No.2 and No.3 terminals. If a measurement reading exceeds the standard value, make adjustment with the stopper bolt (full side).
Standard value: 3.3-3.9V

NOTICE
Do not reuse the extension harness for the purpose of installation in vehicle because its terminals may have been damaged or deformed during checking works.

ACCELERATOR SWITCH

COMPONENT LOCATOR

EN0111216D100008

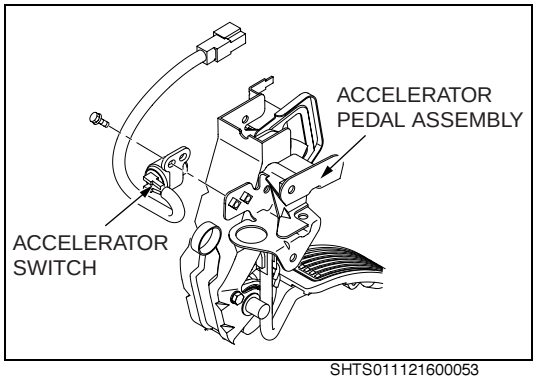


SHTS011121600052

1 Accelerator switch	

REPLACEMENT

EN0111216H100006



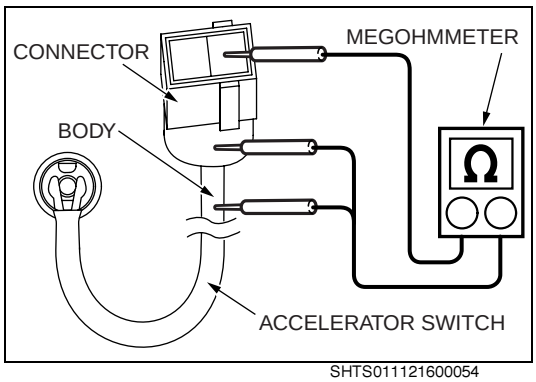
SHTS011121600053

REMOVE THE ACCELERATOR SWITCH.

1. REMOVE THE ACCELERATOR SWITCH.

(1) Remove the accelerator switch.
Refer to the section **"ACCELERATOR PEDAL"**.

(2) Remove two bolts to remove the accelerator switch from the accelerator pedal assembly.



SHTS011121600054

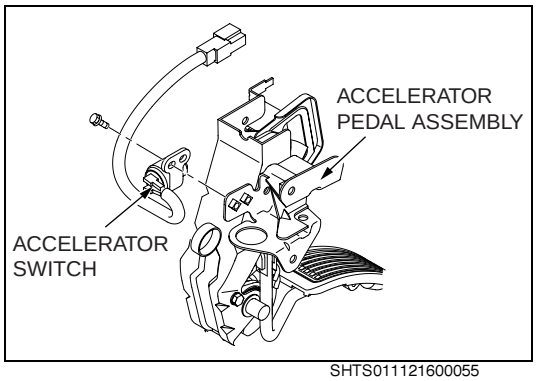
COMPONENT CHECK

1. CHECK THE RESISTANCE.

(1) Use a megohmmeter to measure insulation resistances between the connector and the terminal and between the terminal and the body. If a measurement reading exceeds the standard value, make replacement.
Standard value: 3 MΩ or more

NOTICE

Do not take measurement between terminals. Otherwise, the accelerator switch may be damaged.



SHTS011121600055

INSTALL THE ACCELERATOR SWITCH.

1. INSTALL THE ACCELERATOR SWITCH.

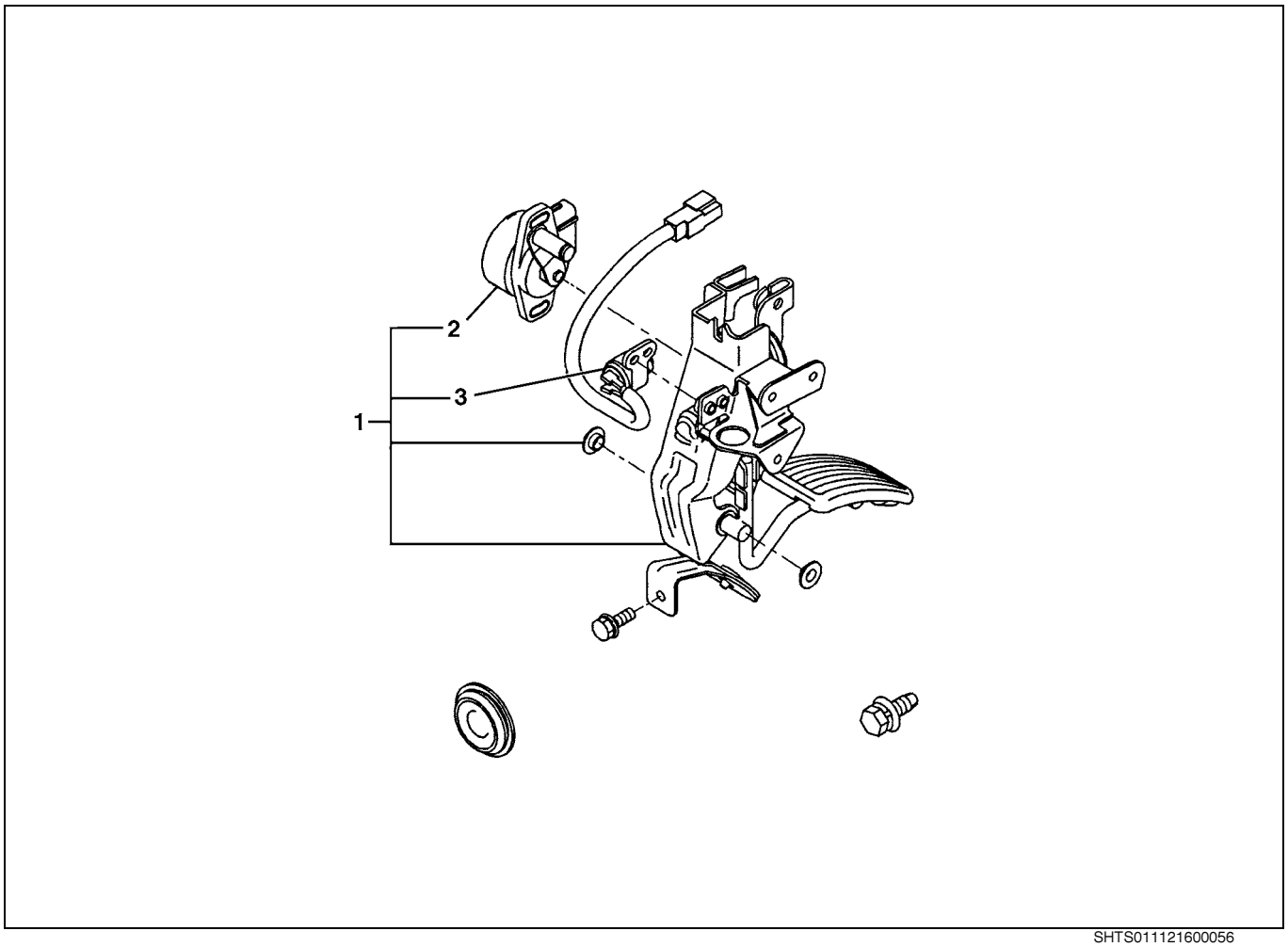
(1) Install the accelerator switch to the accelerator pedal assembly with two bolts.

(2) Install the accelerator pedal assembly.
Refer to the section **"ACCELERATOR PEDAL"**.

ACCELERATOR PEDAL

COMPONENT LOCATOR

EN0111216D100009

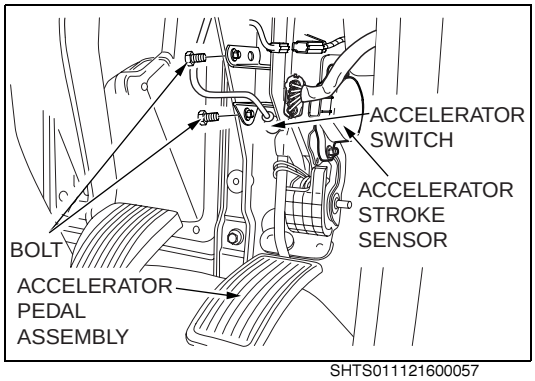


SHTS011121600056

1	Accelerator pedal assembly	3	Accelerator switch
2	Accelerator stroke sensor		

REPLACEMENT

EN0111216H100007



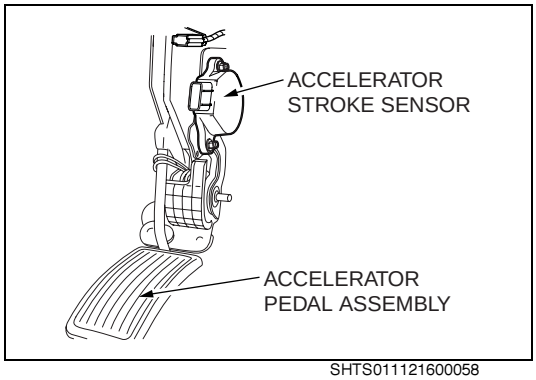
SHTS011121600057

REMOVE THE ACCELERATOR PEDAL ASSEMBLY.

1. REMOVE THE ACCELERATOR PEDAL ASSEMBLY.

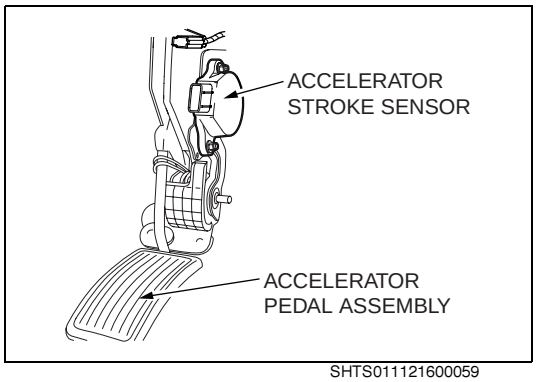
(1) Disconnect the connectors of accelerator stroke sensor and accelerator switch.

(2) Remove two bolts to remove the accelerator pedal assembly.



SHTS011121600058

(3) Remove two nuts, remove the accelerator stroke sensor from the accelerator pedal assembly.

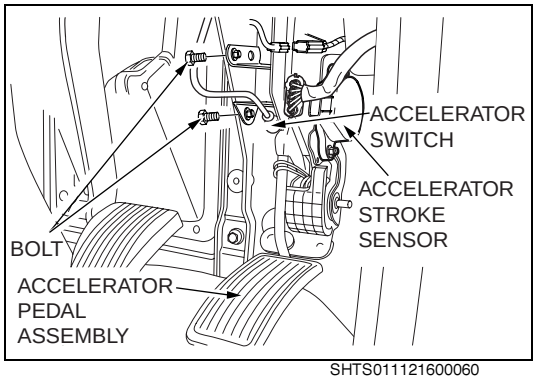


SHTS011121600059

INSTALL THE ACCELERATOR PEDAL ASSEMBLY.

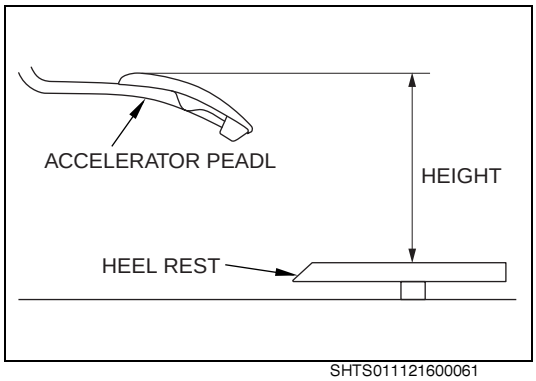
1. INSTALL THE ACCELERATOR PEDAL ASSEMBLY.

(1) Install the accelerator stroke sensor to the accelerator pedal assembly, and tighten two nuts.
Tightening Torque:
1.57-2.35 N·m {16.0-23.9 kgf·cm, 1.16-1.73 lbf·ft}



SHTS011121600060

(2) Install the accelerator pedal assembly with a bolt.
(3) Connect the connectors of accelerator stroke sensor and accelerator switch.



SHTS011121600061

(4) After installation, check the accelerator pedal height from the heel rest.
Standard value:
Approximately 124-134 mm {4.882-5.275 in.}

(5) Measure the output voltage of the accelerator stroke sensor.
If the value exceeds the standard value, adjust the accelerator stroke sensor.
Refer to the section **"ACCELERATOR STROKE SENSOR"**.

ENGINE CONTROL (A09C, VEHICLE CONTROL)

DN01-001

COMMON RAIL FUEL INJECTION SYSTEM

PRECAUTIONS FOR DIAGNOSIS

EN1611201F200001

- Ensure that individual connectors are certainly connected before start of checking works.
- Make sure to set the starter key to the "LOCK" position before disconnecting a connector.
- Replace the part or the component that have a failure or trouble. Do not fix and reuse it.
- Delete the past malfunction code after recording. Then conduct a diagnosis again to check for present failures.
- Delete the past failure memory after completion of a diagnostic analysis.

1. ILLUSTRATION OF CONNECTOR AND MEASUREMENT ON TERMINAL

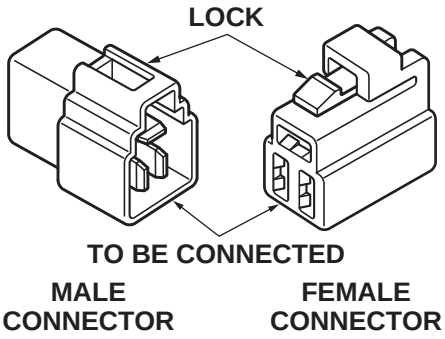
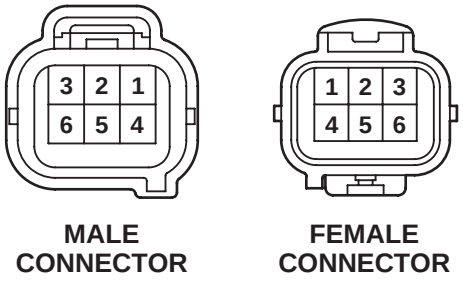


ILLUSTRATION OF CONNECTOR

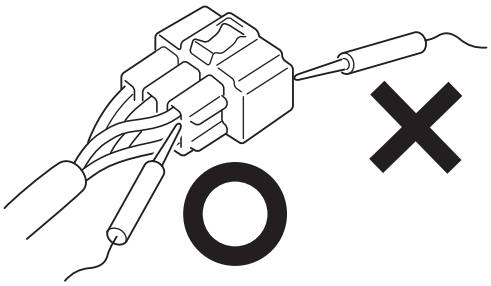
The illustration of a connector contained in this document represents an image of a connector with its lock positioned on top as viewed from the connecting face.



NUMBERING OF CONNECTOR TERMINALS

The terminals are symmetrically numbered (symmetrically reversed numbering) as viewed on the connecting faces of a pair of connectors.
The terminal #1 is located at the top right corner of a male connector and at the top left corner of a female connector respectively in this document.

PRECAUTIONS FOR TERMINAL MEASUREMENT



Unless otherwise specified in this document, the illustration of a connector represents an image of a connector as viewed from the connecting face. A test probe must access the back face of a connector.
However, some types of connector do not allow a test probe to contact with the back face such as a waterproof connector. In such case, a test probe may be allowed to access the front face of a connector but a special care must be used to avoid a risk of damage in terminals.

As to a connector that is designed to use the signal check harness for terminal measurement, do not place a test probe directly onto the front or back face. Use a contact box of the connected signal check harness to take measurement on terminals.

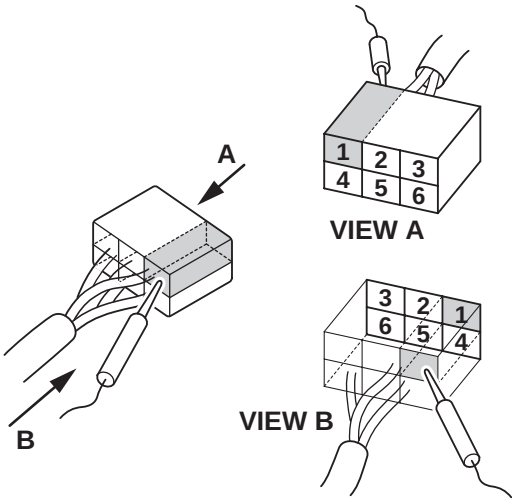


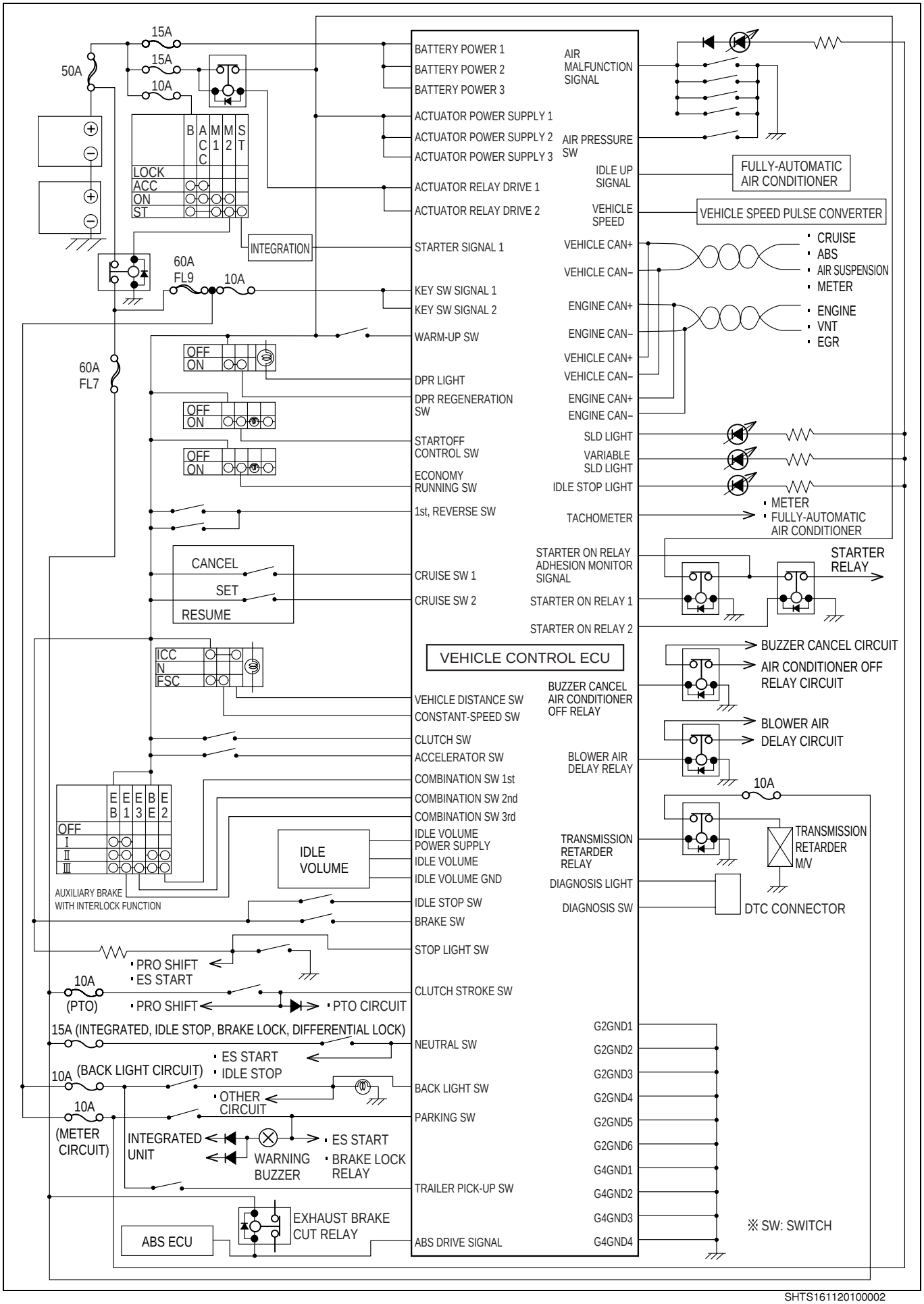
ILLUSTRATION OF CONNECTOR AND MEASUREMENT SURFACE

The illustration of a connector contained in this document represents an image of a connector as viewed from the connecting face. For example, the terminal #1 of a female connector is located at the top left corner of a connector as viewed from the connecting face.
In actual measurement on the terminal #1 of a female connector, a test probe must be placed onto the top right corner on the back face of a connector.

SHTS161120100001

ELECTRICAL

EN1611201F200002



SHTS161120100002

SIGNAL CHECK HARNESS

EN1611201F200003

1. MENTION OF THE SIGNAL CHECK HARNESS

(1) HINO provides a signal check harness to check the ECU.

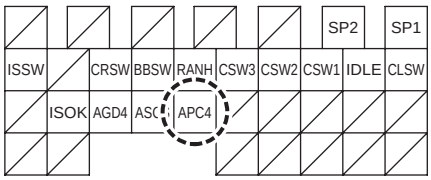
⚠ CAUTION

To prevent damage of the ECU connector, connect the signal check harness and perform measuring by bringing the test probe into contact with the signal check harness side (Contact box).

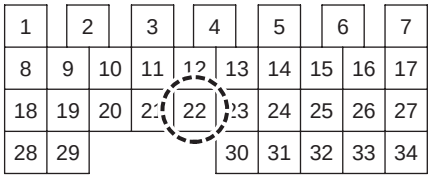
HINT

The terminal numbers referred in text or illustrations in this document correspond to the numbering in the next section "COMPUTER (ECU) PIN ASSIGNMENT" as shown in the figure below.

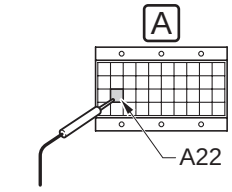
COMPUTER (ECU) TERMINAL SIGNAL



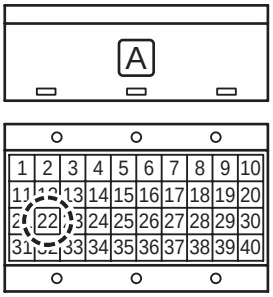
COMPUTER (ECU) TERMINAL No.



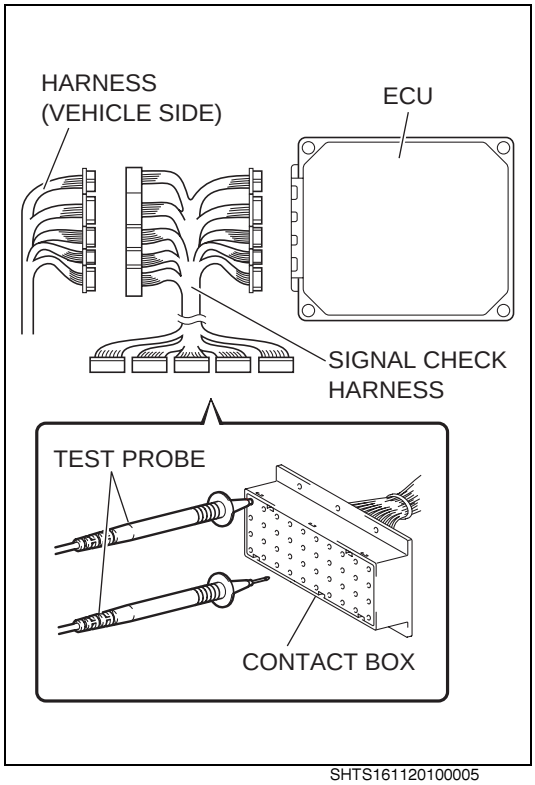
EXAMPLE: A22 TERMINAL



SIGNAL CHECK HARNESS (CONTACT BOX)



SHTS161120100004



SHTS161120100005

2. CONNECT THE SIGNAL CHECK HARNESS.

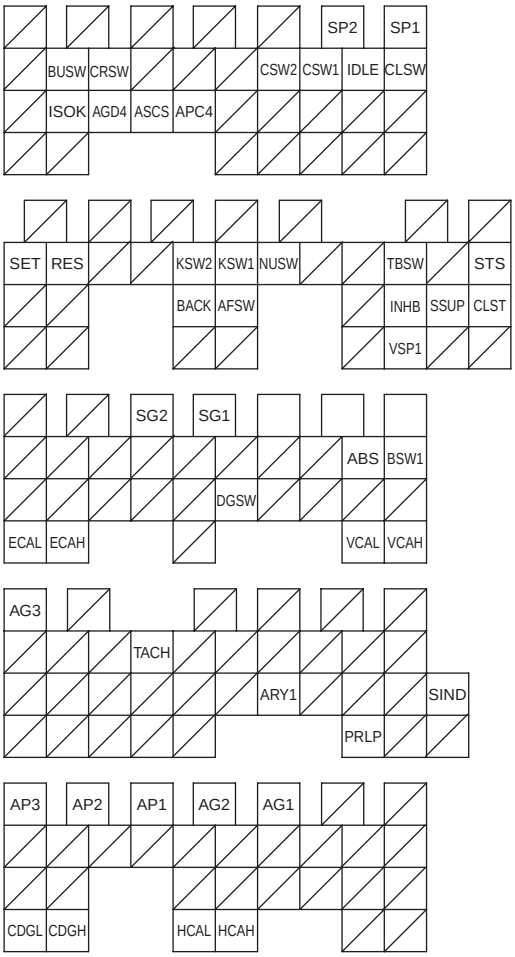
(1) Turn the starter switch to the "LOCK" position and disconnect the connectors from the vehicle control ECU.

(2) Connect a signal check harness to the vehicle harness and the vehicle control ECU.
SST: Signal check harness (S0904-91080)

COMPUTER (ECU) PIN ASSIGNMENT

EN1611201F200004

COMPUTER (ECU) TERMINAL SIGNAL



COMPUTER (ECU) TERMINAL No.

A

1	2	3	4	5	6	7
8	9	10	11	12	13	14	15	16	17
18	19	20	21	22	23	24	25	26	27
28	29			30	31	32	33	34	

B

1	2	3	4	5	6	7
8	9	10	11	12	13	14	15	16	17	18	19
20	21			22	23			24	25	26	27
28	29			30	31			32	33	34	35

C

1	2	3	4	5	6	7
8	9	10	11	12	13	14	15	16	17
18	19	20	21	22	23	24	25	26	27
28	29			30				31	32

D

1	2	3	4	5	6
7	8	9	10	11	12	13	14	15	16
17	18	19	20	21	22	23	24	25	26	27
28	29	30	31	32				33	34	35

E

1	2	3	4	5	6	7
8	9	10	11	12	13	14	15	16	17
18	19			20	21	22	23	24	25
26	27			28	29			30	31

SIGNAL CHECK HARNESS (CONTACT BOX) TERMINAL No.

A

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40

B

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40

C

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40

D

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40

E

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40

SHTS161120100006

COMPUTER (ECU) PIN CONNECTION

- The terminal number in the table correspond with the contact box of signal check harness.

CONTACT BOX (A)					
No.	**Signal**	**Connection destination**	**No.**	**Signal**	**Connection destination**
1	–		18	–	
2	–		19	ISOK	Diagnosis connector
3	–		20	AGD4	Idle volume switch
4	–		21	ASCS	Idle volume switch
5	–		22	APC4	Idle volume switch
6	SP2	Fuse 7B	23	–	
7	SP1	Fuse 7B	24	–	
8	–		25	–	
9	BUSW	Accelerator switch	26	–	
10	CRSW	Auto cruising switch	27	–	
11	–		28	–	
12	–		29	–	
13	–		30	–	
14	CSW2	Combination switch	31	–	
15	CSW1	Combination switch	32	–	
16	IDLE	Accelerator switch	33	–	
17	CLSW	Clutch switch	34	–	

CONTACT BOX (B)					
No.	**Signal**	**Connection destination**	**No.**	**Signal**	**Connection destination**
1	–		19	STS	Engine ECU
2	–		20	–	
3	–		21	–	
4	–		22	BACK	Back light switch
5	–		23	AFSW	Power mood switch
6	–		24	–	
7	–		25	INHB	Accelerator switch
8	SET	Auto cruising switch	26	SSUP	Idle up switch
9	RES	Auto cruising switch	27	CLST	Clutch stroke sensor
10	–		28	–	
11	–		29	–	
12	KSW2	Starter switch	30	–	
13	KSW1	Starter switch	31	–	
14	NUSW	Neutral switch	32	–	
15	–		33	VSP1	Combination meter
16	–		34	–	
17	TBSW	Stop light switch	35	–	
18	–				

CONTACT BOX (C)					
No.	**Signal**	**Connection destination**	**No.**	**Signal**	**Connection destination**
1	–		17	BSW1	Stop light switch
2	–		18	–	
3	SG2	Ground	19	–	
4	SG1	Ground	20	–	
5	–		21	–	
6	–		22	–	
7	–		23	DGSW	Diagnosis switch
8	–		24	–	
9	–		25	–	
10	–		26	–	
11	–		27	–	
12	–		28	ECAL	Junction CAN
13	–		29	ECAH	Junction CAN
14	–		30	–	
15	–		31	YCAL	Junction CAN
16	ABS	ABS cut relay	32	YCAH	Junction CAN

CONTACT BOX (D)					
No.	**Signal**	**Connection destination**	**No.**	**Signal**	**Connection destination**
1	AG3	Ground	19	–	
2	–		20	–	
3	–		21	–	
4	–		22	–	
5	–		23	ARY1	Actuator relay
6	–		24	–	
7	–		25	–	
8	–		26	–	
9	–		27	SIND	Diagnosis lamp
10	TACH	Tachometer	28	–	
11	–		29	–	
12	–		30	–	
13	–		31	–	
14	–		32	–	
15	–		33	PRLP	Combination meter
16	–		34	–	
17	–		35	–	
18	–				

CONTACT BOX (E)					
No.	**Signal**	**Connection destination**	**No.**	**Signal**	**Connection destination**
1	AP3	Fuse 7B	17	–	
2	AP2	Fuse 7B	18	–	
3	AP1	Fuse 7B	19	–	
4	AG2	Ground	20	–	
5	AG1	Ground	21	–	
6	–		22	–	
7	–		23	–	
8	–		24	–	
9	–		25	–	
10	–		26	CDGL	Junction CAN
11	–		27	CDGH	Junction CAN
12	–		28	HCAL	Junction CAN
13	–		29	HCAH	Junction CAN
14	–		30	–	
15	–		31	–	
16	–				

PRIOR CHECK

EN1611201F200005

1. CHECKING THE BATTERY VOLTAGE.

(1) Check the battery voltage.
Standard: 20V or more

HINT

- **If power would not be supplied to the vehicle control ECU, a vehicle could still run, but various troubles might occur as described below.**
- **The tachometer might not work.**
- **The water temperature gauge might not work.**
- **The function listed below might not properly operate.**
- **FS cruise**
- **Economy running**
- **Auxiliary brake (Engine retarder, exhaust brake, transmission retarder)**
- **Idle volume**
- **Starting idle up control**

2. CHECKING THE FUSE.

(1) Check the fuse.

3. CHECKING THE CONNECTION OF THE VEHICLE CONTROL ECU CONNECTOR.

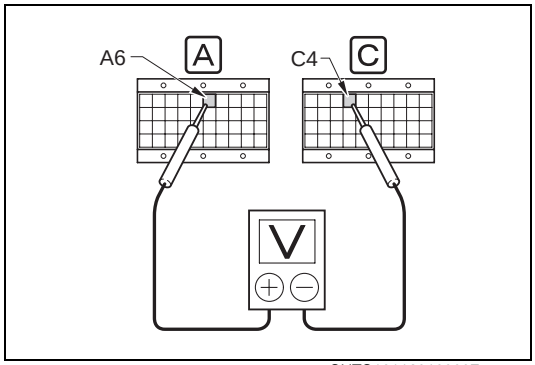
(1) Check that the vehicle control ECU connector is surely connected.

4. CHECKING THE ENGINE ECU.

(1) Diagnose the engine ECU and check that diagnosis codes would not output.

VEHICLE CONTROL ECU INSPECTION

EN1611201F200006



SHTS161120100007

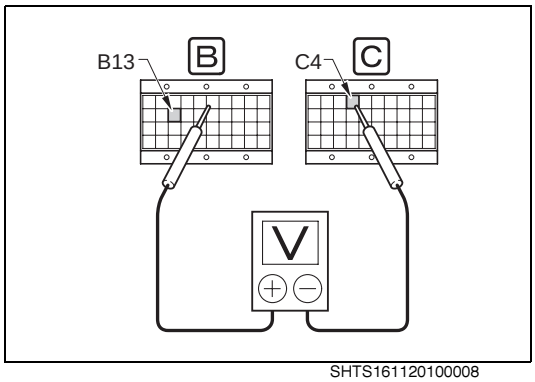
1. CHECK THE VEHICLE CONTROL ECU INPUT VOLTAGE.

(1) Set the starter switch to the "LOCK" position and connect the signal check harness to the vehicle control ECU.
(2) Measure the voltage between the terminals A6 and C4 of the signal check harness.
Standard: 10-16V

NO

Trouble of harness between vehicle control ECU and battery

YES



SHTS161120100008

2. CHECK THE VEHICLE CONTROL ECU INPUT VOLTAGE.

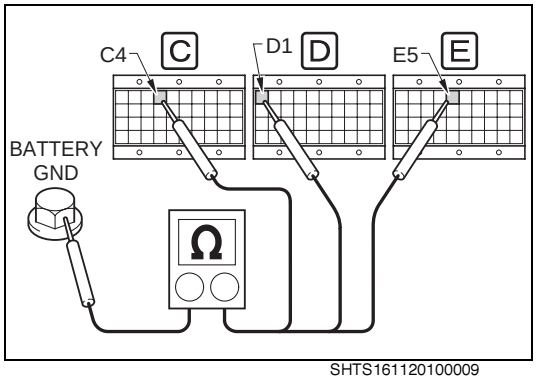
(1) Set the starter switch to the "ON" position, and measure the voltage between the terminals B13 and C4 of the signal check harness.
Standard: 10-16V

NO

Trouble of harness between vehicle control ECU and starter switch

YES

Proceed to 3.



SHTS161120100009

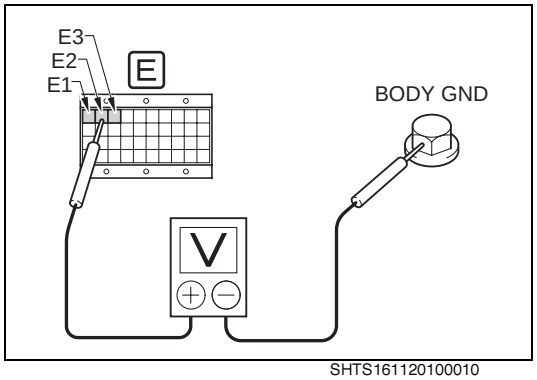
3. CHECK THE RESISTANCE BETWEEN VEHICLE CONTROL ECU AND GND.

(1) Set the starter switch to the "LOCK" position and measure the resistance between the terminals C4, D1, E5 of the signal check harness and battery GND.
Standard: 1 Ω or less

NO

- Disconnection of GND harness
- Loose connection

YES



SHTS161120100010

4. CHECK THE VEHICLE CONTROL ECU ACTUATOR RELAY ACTIVATION.

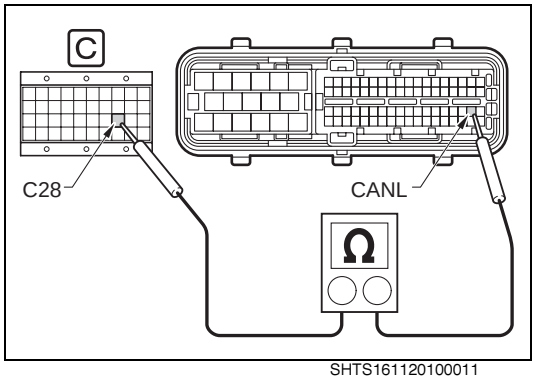
(1) Set the starter switch to the "ON" position and measure the voltage between the terminals E1, E2, E3 of the signal check harness and body GND.
Standard: 24V or more

NO

Trouble of actuator power supply circuit

YES

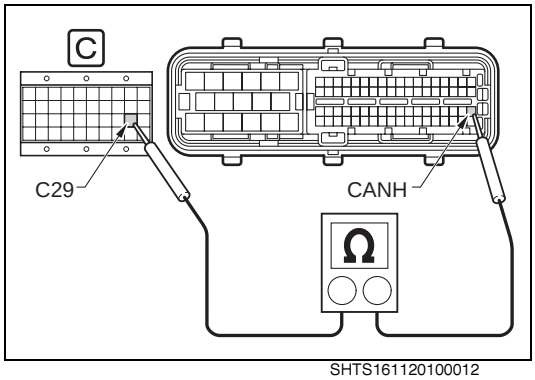
Proceed to 5.



SHTS161120100011

5. CHECK THE RESISTANCE BETWEEN VEHICLE CONTROL ECU AND ENGINE CAN LINE.

(1) Set the starter switch to the "LOCK" position and disconnect the engine ECU connector.
(2) Measure the resistance between C28 terminal of the signal check harness and CANL terminal of engine ECU.
Standard: 1 Ω or less



SHTS161120100012

(3) Measure the resistance between C29 terminal of the signal check harness and CANH terminal of engine ECU.
Standard: 1 Ω or less

NO

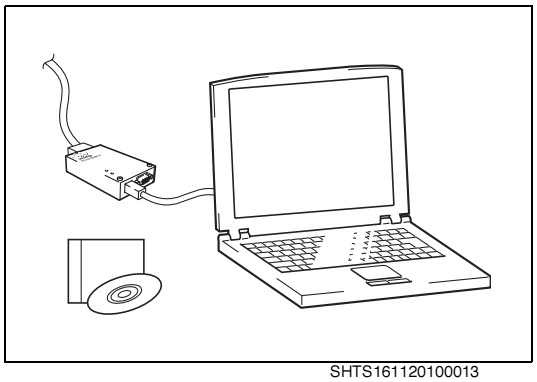
Trouble of CAN harness between vehicle control ECU and engine ECU

YES

Normal

DIAGNOSIS USING THE PC (PERSONAL COMPUTER) DIAGNOSIS TOOL WITH INTERFACE

EN1611201F200007



SHTS161120100013

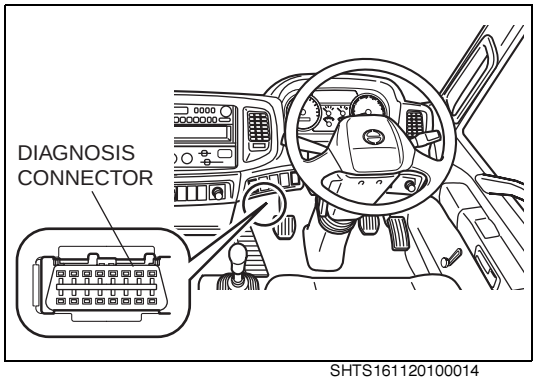
1. INTRODUCTION TO HINO-DX

(1) The Hino-DX is designed to diagnose the vehicle control ECU. For connection to the vehicle, the Hino-Bowie (interface box) and dedicated cables must be used.

SST:
Communication interface assembly (Hino-Bowie) (09993-E9070)
Cable communication (S0904-21220)
Diagnosis software: HINO Diagnostic explorer (Hino-DX)

HINT

- **The Hino-Bowie and the cable to connect computer are included in the Hino-Bowie kit.**
  Select the RS-232C cable or the USB cable.
- **Also, read the operation manual of the Hino-Bowie.**
- **Install the Hino Diagnostic eXplorer (Hino-DX) software on a personal computer. For installation procedures, read the manual supplied with a CD.**



SHTS161120100014

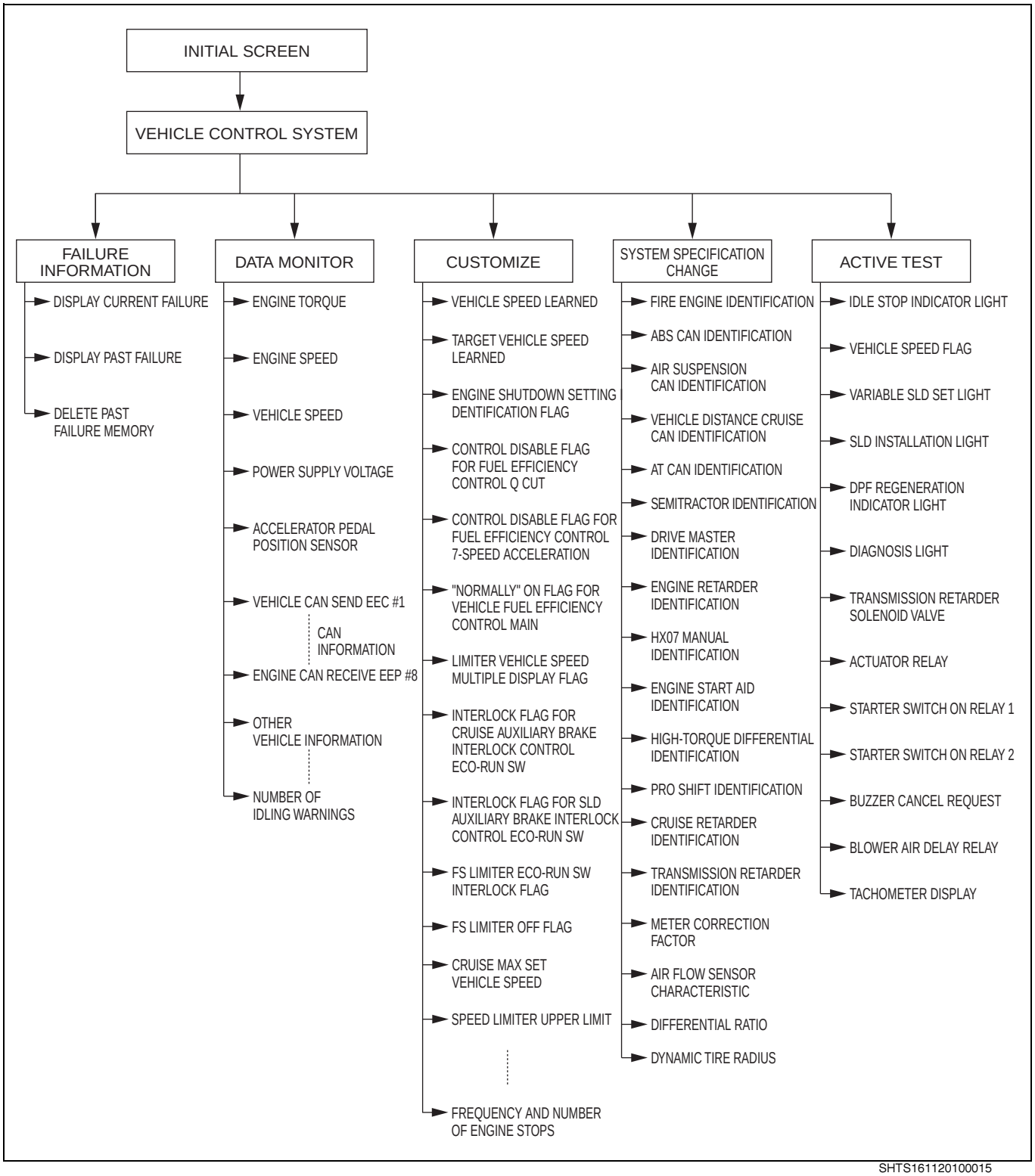
2. CONNECT THE PC DIAGNOSIS TOOL (Hino-DX).

(1) Turn the starter switch to the "LOCK" position.
(2) Connect the diagnosis cable between diagnosis connector and interface.
(3) Connect the interface to the PC.
(4) Turn the starter switch to the "ON" position.
(Do not start the engine.)
(5) The opening menu will be displayed on the PC screen.

HINT

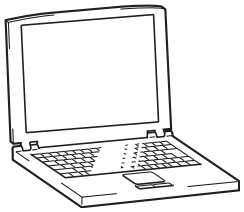
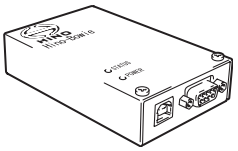
When the Hino-Bowie is connected to a vehicle, the power supply will turn on and the power light (red) on the Hino-Bowie will light on.

3. FUNCTION OF Hino-DX



SHTS161120100015

4. LIST OF DIAGNOSTIC TOOLS

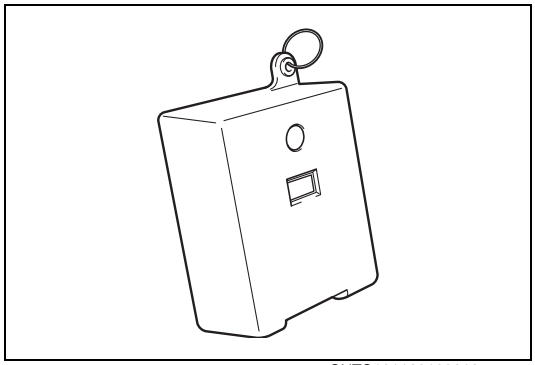
Part name	Part No.	Appearance	Outline/feature
Personal computer (DOS/V standard)	—		• **Operating system (OS): Windows 95, Windows 98 (IE 5.0 or later), Windows 2000 (SP3, IE 5.0 or later), Windows XP (SP1a, IE 6.0 or later)** • **CPU and memory: Must be guaranteed for the performances of the aforesaid operating systems.** • **Display: 800 x 600 (Resolution), 256 or more colors**
Hino-Bowie (Interface box)	**09993-E9070 Interface box the body and cables (For RS-232C and USB)** **S0904-21220 Cable of between vehicle and Hino-Bowie**		• **Personal computer interface**

5. OPERATION OF THE HINO-DX SYSTEM SPECIFICATION CHNAGE FUNCTION WHEN THE PARTS REPLACEMENT

(1) By compare with the factory manufactured vehicle between the retrofitted vehicle, If would retrofit the different size of tire or the differential from default installation, use the system specification change function of the Hino-DX, to update the ECU data.

DIAGNOSIS USING THE DIAGNOSIS MONITOR

EN1611201F200008

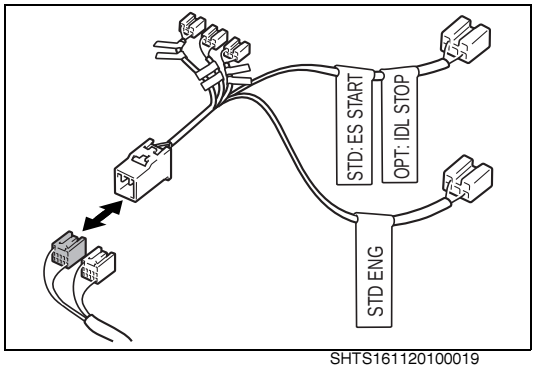


SHTS161120100018

1. DIAGNOSIS MONITOR

(1) Trouble diagnosis also could be performed using the diagnosis monitor. The malfunction codes are indicated by sound and light.

SST: Diagnosis monitor (S0963-01370)

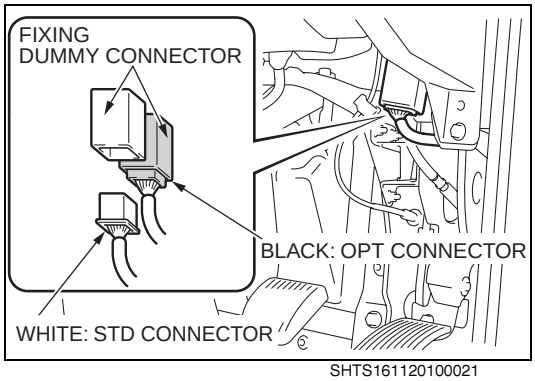


SHTS161120100019

2. CONNECTING THE DIAGNOSIS MONITOR

(1) Connect the dedicated harness connector to a white one of two centralized diagnosis connectors, located on the lower right side in front of the driver seat. then, connect the diagnosis monitor to the connector having a "STD ENG" tag.

SST: Dedicated Harness (S0963-02300)



SHTS161120100021

NOTICE

The centralized diagnosis connectors are generally connected to the fixing dummy connectors. Pull the centralized diagnosis connectors out when using the centralized diagnosis connctor, and connect the centralized diagnosis connctor with the fixing dummy connectors after use.

(2) Turn the starter switch to the "ON" position.

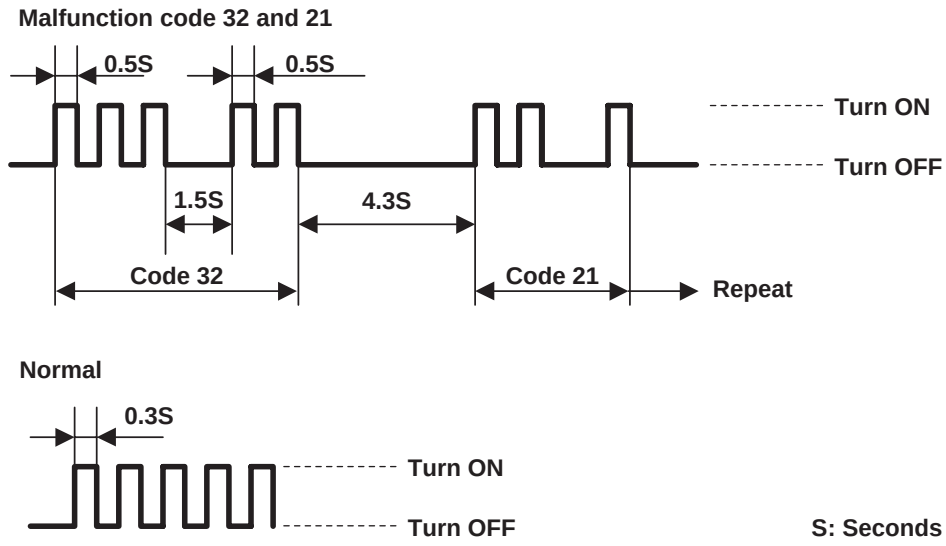
3. READ OUT THE MALFUNCTION CODE.

(1) Read out the malfunction codes and write down the malfunction codes that are indicated.

NOTICE

Malfunction codes are indicated, starting from the lowest and progressing to higher one, with no distinction between present and past malfunction codes.

MALFUNCTION CODE INDICATION PATTERN



SHTS161120100022

DIAGNOSIS MONITOR CODE AND DIAGNOSIS TROUBLE CODE TABLE

EN1611201F200009

NOTICE
MC No.: Diagnosis Monitor Code (Using the diagnosis monitor)
DTC No.: Diagnosis Trouble Code (Using the PC diagnosis tool)

MC No.	DTC No.	DIAGNOSIS ITEM	PRESUMED CAUSE OF TROUBLE
41	P0704	Clutch switch malfunction	No clutch change, during in a vehicle speed range from 0 km/h to 80 km/h or from 80 km/h to 0 km/h.
43	P1565	Cruise switch malfunction	The cruise switch 1 or switch 2 is ON when the starter is ON.
47	P0850	Neutral switch malfunction	No neutral change, during a vehicle speed range from 0 km/h to 80 km/h or from 80 km/h to 0 km/h.
24	P0501	Excessive vehicle speed sensor input	A vehicle speed pulse equivalent to 200 km/h is detected.
	P0500	Vehicle speed sensor input open/short	The engine speed is 800 r/min or more, the water temperature is 80°C {176°F} or more and the vehicle speed is zero.
45	P0617	Starter switch battery short	The engine speed is 1,000 r/min or more and the starter switch is ON.
5	P0563	VBB fail trouble (High range)	Voltage of 32V or more.
	P0562	VBB fail trouble (Low range)	Voltage of 0V.
44	P1143	VIMC fail trouble (High range)	Idle volume voltage of 4.59V or more.
	P1142	VIMC fail trouble (Low range)	Idle volume voltage of 0V.
2	P0605	Flash ROM data error	Flash ROM mirror check error.
24	P0501	Vehicle speed sensor signal error	A deviation in the vehicle speed is 200 km/h or more in a cycle of 16 msec.
22	U0121	Disconnection of bus line between ABS/ASR and vehicle control	EBC1 blackout in the vehicle CAN.
	U0104	Disconnection of bus line between vehicle distance cruise and vehicle control	ACC1 blackout in the vehicle CAN.
	U0132	Disconnection of bus line between ASC and vehicle control	ASC1 blackout in the vehicle CAN.
	U0101	Disconnection of bus line between AT and vehicle control	ETC1 blackout in the vehicle CAN.
		Disconnection of bus line between mechanical auto and vehicle control	DISP_TM blackout in the vehicle CAN.
	U0155	Disconnection of bus line between meter and vehicle control	DISP_METER blackout in the vehicle CAN.
23	U0105	Blackout in the engine CAN (EEC1)	EEC1 blackout in the engine CAN.
		Blackout in the engine CAN (EEC2)	EEC2 blackout in the engine CAN.

MC No.	DTC No.	DIAGNOSIS ITEM	PRESUMED CAUSE OF TROUBLE
23	U0105	Blackout in the engine CAN (EEC3)	EEC3 blackout in the engine CAN.
		Blackout in the engine CAN (CCVS)	CCVS blackout in the engine CAN.
		Blackout in the engine CAN (ERC1_ER)	ERC1_ER blackout in the engine CAN.
		Blackout in the engine CAN (ET1)	ET1 blackout in the engine CAN.
		Blackout in the engine CAN (DPR1)	DPR1 blackout in the engine CAN.
		Blackout in the engine CAN (DIAG)	DIAG blackout in the engine CAN.
		Blackout in the engine CAN (TAVG)	TAVG blackout in the engine CAN.
		Blackout in the engine CAN (EEP1)	EEP1 blackout in the engine CAN.
		Blackout in the engine CAN (EC)	EC blackout in the engine CAN.
		Blackout in the engine CAN (RC_ER)	RC_ER blackout in the engine CAN.
		Blackout in the engine CAN (RC_EXR)	RC_EXR blackout in the engine CAN.

CLUTCH SWITCH MALFUNCTION

EN1611201F200010

MC No.	41	DTC No.	P0704	Clutch switch malfunction

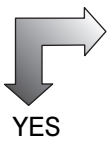
1. INSPECTION

(1) Prior check and check to see that there is no abnormal.
Refer to the section **"PRIOR CHECK"**.

Repair the trouble

2. CHECK THE CLUTCH SWITCH.

(1) Check the clutch switch and check to see that there is no abnormal.
Refer to the section **"CLUTCH SWITCH INSPECTION"**.



Trouble of connector and terminal or harness

Normal

CRUISE SWITCH MALFUNCTION

EN1611201F200011

MC No.	43	DTC No.	P1565	Cruise switch malfunction

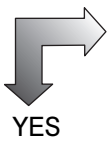
1. INSPECTION

(1) Prior check and check to see that there is no abnomal.
Refer to the section **"PRIOR CHECK"**.

Repair the trouble

2. CHECK THE CRUISE MAIN SWITCH.

(1) Check the cruisecruise main switch and check to see that there is no abnomal.
Refer to the section **"CRUISE MAIN SWITCH INSPECTION"**.



Trouble of connector and terminal or harness

Normal

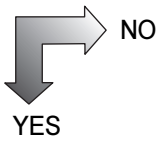
NEUTRAL SWITCH MALFUNCTION

EN1611201F200012

MC No.	47	DTC No.	P0850	Neutral switch malfunction

1. INSPECTION

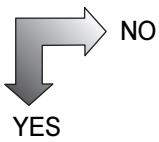
(1) Prior check and check to see that there is no abnomal.
Refer to the section **"PRIOR CHECK"**.



Repair the trouble

2. CHECK THE NEUTRAL SWITCH.

(1) Check the neutral switch and check to see that there is no abnomal.
Refer to the section **"NEUTRAL SWITCH INSPECTION"**.



Trouble of connector and terminal or harness

Normal

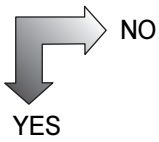
EXCESSIVE VEHICLE SPEED SENSOR INPUT

EN1611201F200013

MC No.	24	DTC No.	P0501	Excessive vehicle speed sensor input

1. INSPECTION

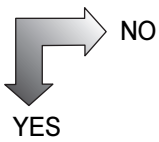
(1) Prior check and check to see that there is no abnomal.
Refer to the section **"PRIOR CHECK"**.



Repair the trouble

2. CHECK THE VEHICLE SPEED SENSOR.

(1) Check the vehicle speed sensor and check to see that there is no abnomal.
Refer to the section **"VEHICLE SPEED SENSOR INSPECTION"**.



Trouble of connector and terminal or harness

Normal

VEHICLE SPEED SENSOR INPUT OPEN/SHORT

EN1611201F200014

MC No.	24	DTC No.	P0500	Vehicle speed sensor input open/short

1. INSPECTION ITEM

(1) Take the same procedures as described in the section "Excessive vehicle speed sensor input".
Refer to the section **"EXCESSIVE VEHICLE SPEED SENSOR INPUT (DTC No.P0501/MC No.24)"**.

STARTER SWITCH BATTERY SHORT

EN1611201F200015

MC No.	45	DTC No.	P0617	Starter switch battery short

1. INSPECTION

(1) Prior check and check to see that there is no abnomal.
Refer to the section **"PRIOR CHECK"**.

NO → Repair the trouble

YES

2. CHECK THE STARTER SWITCH.

(1) Check the starter switch and check to see that there is no abnomal.
Refer to the section **"STARTER SWITCH INSPECTION"**.

NO → Trouble of connector and terminal or harness

YES

Normal

VBB FAIL TROUBLE (HIGH/LOW RANGE)

EN1611201F200016

MC No.	5	DTC No.	P0563	VBB fail trouble (High range)
MC No.	5	DTC No.	P0562	VBB fail trouble (Low range)

1. INSPECTION

(1) Prior check and check to see that there is no abnomal.
Refer to the section **"PRIOR CHECK"**.

NO → Repair the trouble

YES

Normal

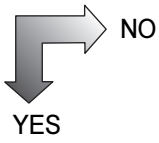
VIMC FAIL TROUBLE (HIGH/LOW RANGE)

EN1611201F200017

MC No.	44	DTC No.	P1143	VIMC fail trouble (High range)
MC No.	44	DTC No.	P1142	VIMC fail trouble (Low range)

1. INSPECTION

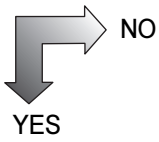
(1) Prior check and check to see that there is no abnomal.
Refer to the section **"PRIOR CHECK"**.



Repair the trouble

2. CHECK THE IDLE VOLUME.

(1) Check the idle volume and check to see that there is no abnomal.
Refer to the section **"IDLE VOLUME INSPECTION"**.



Trouble of connector and terminal or harness

Normal

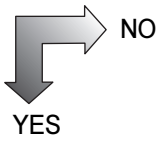
FLASH ROM DATA ERROR

EN1611201F200018

MC No.	2	DTC No.	P0605	Flash ROM data error

1. INSPECTION

(1) Prior check and check to see that there is no abnomal.
Refer to the section **"PRIOR CHECK"**.



Repair the trouble

Normal

VEHICLE SPEED SENSOR SIGNAL ERROR

EN1611201F200019

MC No.	24	DTC No.	P0501	Vehicle speed sensor signal error

1. INSPECTION ITEM

(1) Take the same procedures as described in the section "Excessive vehicle speed sensor input".
Refer to the section **"EXCESSIVE VEHICLE SPEED SENSOR INPUT (DTC No.P0501/MC No.24)"**.

DISCONNECTION OF BUS LINE BETWEEN ABS/ASR AND VEHICLE CONTROL

EN1611201F200020

MC No.	22	DTC No.	U0121	Disconnection of bus line between ABS/ASR and vehicle control

1. INSPECTION ITEM

(1) Check the CAN communication line.
Refer to the chapter **"OTHERS (CAN COMMUNICATION)"** in the **"WORKSHOP MANUAL (CHASSIS)"**.

DISCONNECTION OF BUS LINE BETWEEN VEHICLE DISTANCE CRcruiseUISE AND VEHICLE CONTROL

EN1611201F200021

MC No.	22	DTC No.	U0104	Disconnection of bus line between vehicle distance cruise and vehicle control

1. INSPECTION ITEM

(1) Check the CAN communication line.
Refer to the chapter **"OTHERS (CAN COMMUNICATION)"** in the **"WORKSHOP MANUAL (CHASSIS)"**.

DISCONNECTION OF BUS LINE BETWEEN ASC AND VEHICLE CONTROL

EN1611201F200022

MC No.	22	DTC No.	U0132	Disconnection of bus line between ASC and vehicle control

1. INSPECTION ITEM

(1) Check the CAN communication line.
Refer to the chapter **"OTHERS (CAN COMMUNICATION)"** in the **"WORKSHOP MANUAL (CHASSIS)"**.

DISCONNECTION OF BUS LINE BETWEEN AT AND VEHICLE CONTROL

EN1611201F200023

MC No.	22	DTC No.	U0101	Disconnection of bus line between AT and vehicle control

1. INSPECTION ITEM

(1) Check the CAN communication line.
Refer to the chapter **"OTHERS (CAN COMMUNICATION)"** in the **"WORKSHOP MANUAL (CHASSIS)"**.

DISCONNECTION OF BUS LINE BETWEEN MECHANICAL AUTO AND VEHECLE CONTROL

EN1611201F200024

MC No.	22	DTC No.	U0101	Disconnection of bus line between mechanical auto and vehicle control

1. INSPECTION ITEM

(1) Check the CAN communication line.
Refer to the chapter **"OTHERS (CAN COMMUNICATION)"** in the **"WORKSHOP MANUAL (CHASSIS)"**.

DISCONNECTION OF BUS LINE BETWEEN METER AND VEHICLE CONTROL

EN1611201F200025

MC No.	22	DTC No.	U0155	Disconnection of bus line between meter and vehicle control

1. INSPECTION ITEM

(1) Check the CAN communication line.
Refer to the chapter **"OTHERS (CAN COMMUNICATION)"** in the **"WORKSHOP MANUAL (CHASSIS)"**.

BLACKOUT IN THE ENGINE CAN

EN1611201F200026

MC No.	23	DTC No.	U0105	Blackout in the engine CAN

1. INSPECTION ITEMINSPECTION ITEM

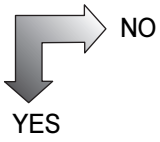
(1) Check the CAN communication line.
Refer to the chapter **"OTHERS (CAN COMMUNICATION)"** in the **"WORKSHOP MANUAL (CHASSIS)"**.

NO ACTIVATION OF AUXILIARY BRAKE

EN1611201F200027

1. INSPECTION

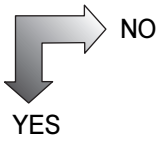
(1) Prior check and check to see that there is no abnomal.
Refer to the section **"PRIOR CHECK"**.



Repair the trouble

2. CHECK THE VEHICLE SPEED SENSOR.

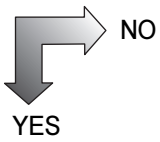
(1) Check the vehicle speed sensor and check to see that there is no abnomal.
Refer to the section **"VEHICLE SPEED SENSOR INSPECTION"**.



Trouble of connector and terminal or harness

3. CHECK THE NEUTRAL SWITCH.

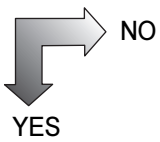
(1) Check the neutral switch and check to see that there is no abnomal.
Refer to the section **"NEUTRAL SWITCH INSPECTION"**.



Trouble of connector and terminal or harness

4. CHECK THE ACCELERATOR SWITCH.

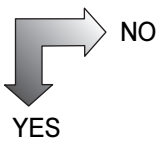
(1) Check the accelerator switch and check to see that there is no abnomal.
Refer to the section **"ACCELERATOR SWITCH INSPECTION"**.



Trouble of connector and terminal or harness

5. CHECK THE CLUTCH SWITCH.

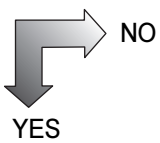
(1) Check the clutch switch and check to see that there is no abnomal.
Refer to the section **"CLUTCH SWITCH INSPECTION"**.



Trouble of connector and terminal or harness

6. CHECK THE RETARDER SWITCH.

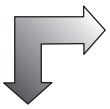
(1) Check the retarder switch and check to see that there is no abnomal.
Refer to the section **"RETARDER SWITCH INSPECTION"**.



Trouble of connector and terminal or harness

7. CHECK THE STOP LIGHT SWITCH.

(1) Check the stop light switch and check to see that there is no abnomal.
Refer to the section **"STOP LIGHT SWITCH INSPECTION"**.

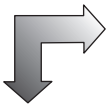


Trouble of connector and terminal or harness

8. CHECK THE AUXILIARY BRAKE ACTIVATION CONDITION.

(1) Check whether under condition of the auxiliary brake activation.

- Engine retarder activation conditions
  (Under all of the conditions 1 to 9.)
- One of the requests listed below:
  —Driver's request for engine retarder (1st or 2nd lever position)
  —Engine retardation by auxiliary brake interlock function
  —Engine retardation by cruise interlock
  —Engine retardation by external request
- No engine stall
- PTO inactive
- Engine retarder setting selected
- Engine speed predetermined for engine retarder activation
  (850 r/min or more)
- Water temperature predetermined for engine retarder activation (40°C {104°F} or more)
- Injection flow predetermined for engine retarder activation
- No cut in engine retarder (clutch pedal not depressed; accelerator opening of 0%; ABS not activated)
- No auxiliary brake control stop



Repair the trouble

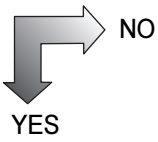
Normal

NO ACTIVATION/RELEASE OF STARTING IDLE UP CONTROL FUNCTION

EN1611201F200028

1. INSPECTION

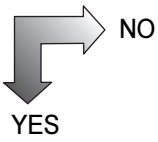
(1) Prior check and check to see that there is no abnomal.
Refer to the section **"PRIOR CHECK"**.



Repair the trouble

2. CHECK THE STARTING IDLE UP CONTROL SWITCH.

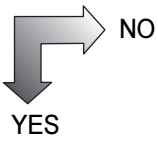
(1) Check the starting idle up control switch and check to see that there is no abnomal.
Refer to the section **"STARTING IDLE UP CONTROL SWITCH INSPECTION"**.



Trouble of connector and terminal or harness

3. CHECK THE CLUTCH STROKE SWITCH.

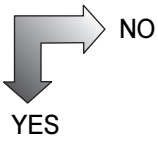
(1) Check the clutch stroke switch and check to see that there is no abnomal.
Refer to the section **"CLUTCH STROKE SWITCH INSPECTION"**.



Trouble of connector and terminal or harness

4. CHECK THE NEUTRAL SWITCH.

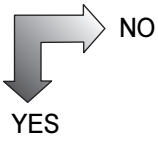
(1) Check the neutral switch and check to see that there is no abnomal.
Refer to the section **"NEUTRAL SWITCH INSPECTION"**.



Trouble of connector and terminal or harness

5. CHECK THE STOP LIGHT SWITCH.

(1) Check the stop light switch and check to see that there is no abnomal.
Refer to the section **"STOP LIGHT SWITCH INSPECTION"**.



Trouble of connector and terminal or harness

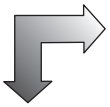
Normal

NO ACTIVATION/RELEASE OF CRUISE FUNCTION

EN1611201F200029

1. INSPECTION

(1) Prior check and check to see that there is no abnomal.
Refer to the section **"PRIOR CHECK"**.



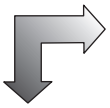
NO

Repair the trouble

YES

2. CHECK THE CRUISE MAIN SWITCH.

(1) Check the crcruiseuise main switch and check to see that there is no abnomal.
Refer to the section **"CRUISE MAIN SWITCH INSPECTION"**.



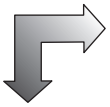
NO

Trouble of connector and terminal or harness

YES

3. CHECK THE CRUISE SWITCH 1, 2.

(1) Check the crcruiseuise switch 1, 2 and check to see that there is no abnomal.
Refer to the section **"CRUISE SWITCH 1 & 2 INSPECTION"**.



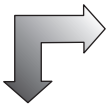
NO

Trouble of connector and terminal or harness

YES

4. CHECK THE VEHICLE SPEED SENSOR.

(1) Check the vehicle speed sensor and check to see that there is no abnomal.
Refer to the section **"VEHICLE SPEED SENSOR INSPECTION"**.



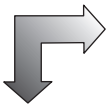
NO

Trouble of connector and terminal or harness

YES

5. CHECK THE CLUTCH SWITCH.

(1) Check the clutch switch and check to see that there is no abnomal.
Refer to the section **"CLUTCH SWITCH INSPECTION"**.



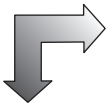
NO

Trouble of connector and terminal or harness

YES

6. CHECK THE NEUTRAL SWITCH.

(1) Check the neutral switch and check to see that there is no abnomal.
Refer to the section **"NEUTRAL SWITCH INSPECTION"**.



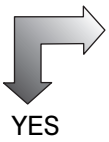
NO

Trouble of connector and terminal or harness

YES

7. CHECK THE STOP LIGHT SWITCH.

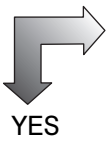
(1) Check the stop light switch and check to see that there is no abnomal.
Refer to the section **"STOP LIGHT SWITCH INSPECTION"**.



Trouble of connector and terminal or harness

8. CHECK THE BRAKE SWITCH.

(1) Check the brake switch and check to see that there is no abnomal.
Refer to the section **"BRAKE SWITCH INSPECTION"**.



Trouble of connector and terminal or harness

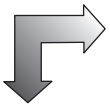
Normal

NO ACTIVATION OF POWER MODE

EN1611201F200030

1. INSPECTION

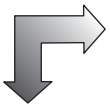
(1) Prior check and check to see that there is no abnomal.
Refer to the section **"PRIOR CHECK"**.



Repair the trouble

2. CHECK THE POWER MODE SWITCH.

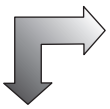
(1) Check the power mode switch and check to see that there is no abnomal.
Refer to the section **"POWER MODE SWITCH INSPECTION"**.



Trouble of connector and terminal or harness

3. CHECK THE CLUTCH SWITCH.

(1) Check the clutch switch and check to see that there is no abnomal.
Refer to the section **"CLUTCH SWITCH INSPECTION"**.



Trouble of connector and terminal or harness

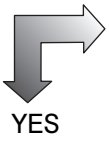
Normal

NO RELEASE OF POWER MODE

EN1611201F200031

1. INSPECTION

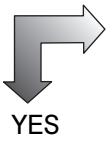
(1) Prior check and check to see that there is no abnomal.
Refer to the section **"PRIOR CHECK"**.



Repair the trouble

2. CHECK THE POWER MODE SWITCH.

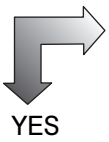
(1) Check the power mode switch and check to see that there is no abnomal.
Refer to the section **"POWER MODE SWITCH INSPECTION"**.



Trouble of connector and terminal or harness

3. CHECK THE VEHICLE SPEED SENSOR.

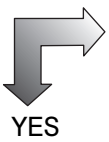
(1) Check the vehicle speed sensor and check to see that there is no abnomal.
Refer to the section **"VEHICLE SPEED SENSOR INSPECTION"**.



Trouble of connector and terminal or harness

4. CHECK THE CLUTCH SWITCH.

(1) Check the clutch switch and check to see that there is no abnomal.
Refer to the section **"CLUTCH SWITCH INSPECTION"**.

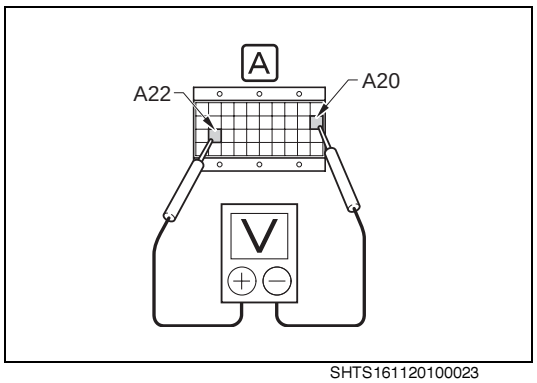


Trouble of connector and terminal or harness

Normal

IDLE VOLUME INSPECTION

EN1611201F200032



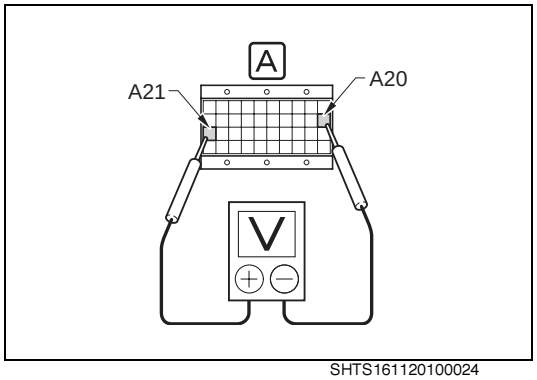
SHTS161120100023

1. CHECK THE IDLE VOLUME POWER SUPPLY VOLTAGE.

(1) Set the starter switch to the "LOCK" position and connect the signal check harness to the vehicle control ECU.

(2) Set the starter switch to the "ON" position, and measure the voltage between the terminals A22 and A20 of the signal check harness.

Standard: 4.5V or more



SHTS161120100024

2. CHECK THE IDLE VOLUME VOLTAGE.

(1) Measure the voltage between the terminals A21 and A20 of the signal check harness.
Check that a voltage increases when the idle volume is turned clockwise.
Standard: 1.5-4.0V

NO

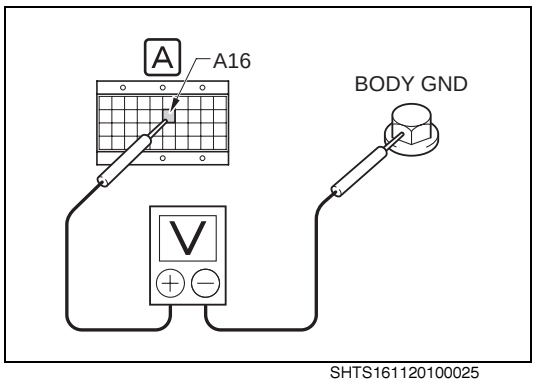
Trouble of connector and terminal or harness

YES

Normal

ACCELERATOR SWITCH INSPECTION

EN1611201F200033



SHTS161120100025

1. MEASURE THE ACCELERATOR SWITCH SIGNAL.

(1) Set the starter switch to the "LOCK" position and connect the signal check harness to the vehicle control ECU.

(2) Set the starter switch to the "ON" position, and measure the voltage between the body GND and the terminal A16 of the signal check harness when the accelerator pedal would be step on and would be step off.

Standard:

Accelerator pedal depressed: APPROX. 0V

Accelerator pedal released: 20V or more

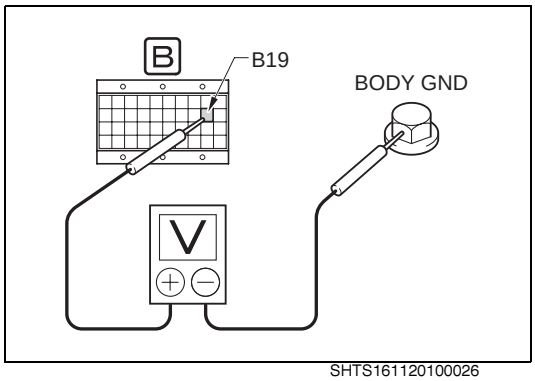
NO → Trouble of connector and terminal or harness

YES

Normal

STARTER SWITCH INSPECTION

EN1611201F200034



SHTS161120100026

1. MEASURE THE STARTER SWITCH SIGNAL.

(1) Set the starter switch to the "LOCK" position and connect the signal check harness to the vehicle control ECU.

(2) With the starter running, measuring the voltage between the body GND and the terminal B19 of the signal check harness.

Standard:

Starter activated: 9V or more

Other: APPROX. 0V

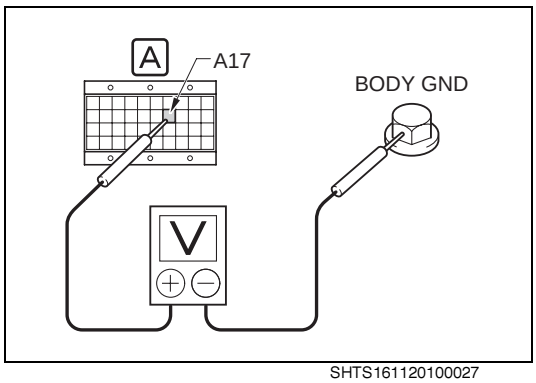
NO → Trouble of connector and terminal or harness

YES

Normal

CLUTCH SWITCH INSPECTION

EN1611201F200035



SHTS161120100027

1. MEASURE THE CLUTCH SWITCH SIGNAL.

(1) Set the starter switch to the "LOCK" position and connect the signal check harness to the vehicle control ECU.

(2) Set the starter switch to the "ON" position, and measure the voltage between the body GND and the terminal A17 of the signal check harness when the clutch pedal would be step on and would be step off.

Standard:

Clutch pedal depressed: 20V or more

Clutch pedal released: APPROX. 0V

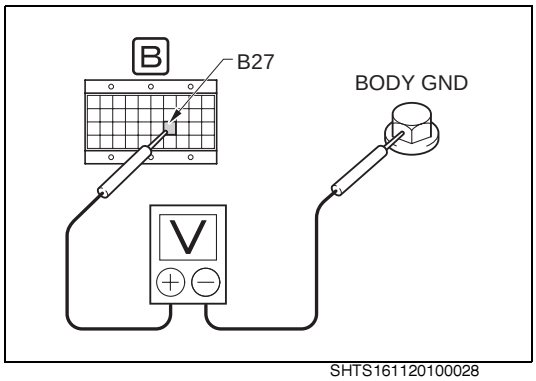
NO → Trouble of connector and terminal or harness

YES

Normal

CLUTCH STROKE SWITCH INSPECTION

EN1611201F200036



SHTS161120100028

1. MEASURE THE CLUTCH STROKE SWITCH SIGNAL.

(1) Set the starter switch to the "LOCK" position and connect the signal check harness to the vehicle control ECU.

(2) Set the starter switch to the "ON" position, and measure the voltage between the body GND and the terminal B27 of the signal check harness when the clutch pedal would be step on and would be step off.

Standard:

Clutch pedal depressed: APPROX. 0V

Clutch pedal released: 20V or more

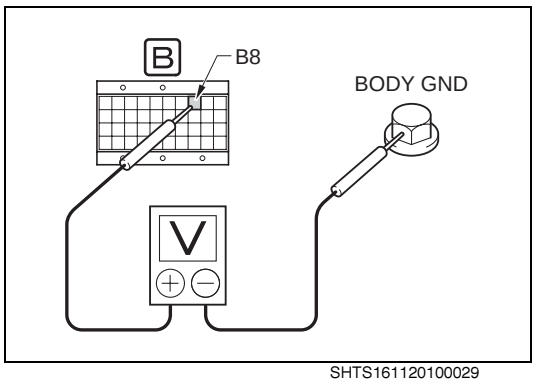
NO → Trouble of connector and terminal or harness

YES

Normal

CRUISE SWITCH 1 & 2 INSPECTION

EN1611201F200037

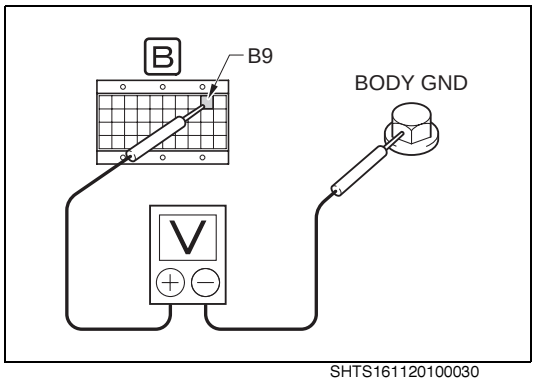


SHTS161120100029

1. MEASURE THE SIGNALS OF CRUISE SWITCHES 1 & 2.

(1) Set the starter switch to the "LOCK" position and connect the signal check harness to the vehicle control ECU.

(2) Set the starter switch to the "ON" position, and measure the voltage between the body GND and the terminal B8 of the signal check harness when the cruise set switch is ON and OFF.
Standard:
Set switch "ON": 20V or more
Set switch "OFF": APPROX. 0V



SHTS161120100030

(3) Also measure the voltage between the body GND and the terminal B9 of the signal check harness when the resume switch is ON and OFF.
Standard:
Resume switch "ON": 20V or more
Resume switch "OFF": APPROX. 0V

NO

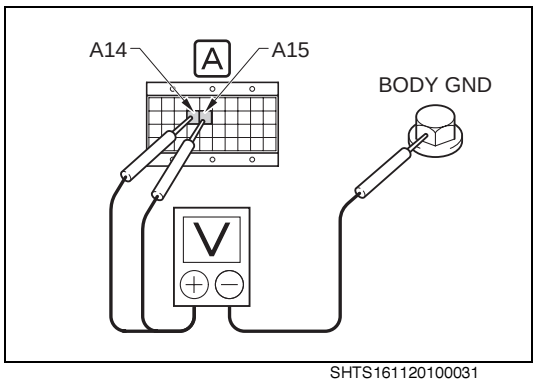
Trouble of connector and terminal or harness

YES

Normal

RETARDER SWITCH INSPECTION

EN1611201F200038



SHTS161120100031

1. MEASURE THE SIGNAL OF RETARDER SWITCH.

(1) Set the starter switch to the "LOCK" position and connect the signal check harness to the vehicle control ECU.

(2) Set the starter switch to the "ON" position, and measure the voltage between the body GND and the A14 and A15 of the signal check harness when the retarder switch is set to each position as listed below.

Standard:

	Terminal A14	Terminal A15
No switch operation	**0V**	**0V**
1st position	**0V**	**20V or more**
2nd position	**20V or more**	**20V or more**

NO

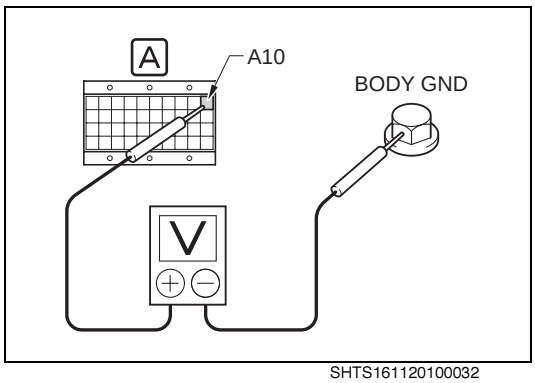
Trouble of connector and terminal or harness

YES

Normal

CRUISE MAIN SWITCH INSPECTION

EN1611201F200039

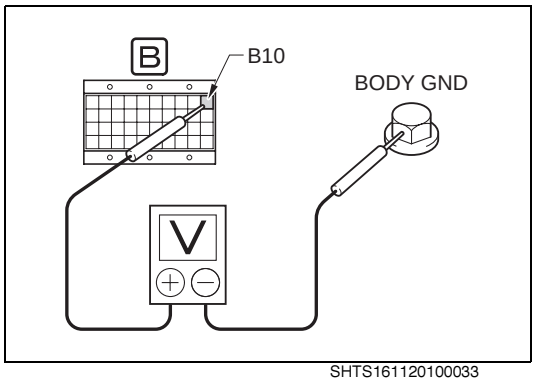


SHTS161120100032

1. MEASURE THE CRUISE MAIN SWITCH SIGNAL.

(1) Set the starter switch to the "LOCK" position and connect the signal check harness to the vehicle control ECU.

(2) Set the starter switch to the "ON" position, and measure the voltage between the body GND and the terminal A10 of the signal check harness when the constant-speed switch is ON and OFF.
Standard:
Constant-speed switch "ON": 20V or more
Constant-speed switch "OFF": APPROX. 0V



SHTS161120100033

(3) Measure the voltage between the body GND and the terminal B10 of the signal check harness when the vehicle distance switch is ON and OFF.
Standard:
Vehicle distance switch "ON": 20V or more
Vehicle distance switch "OFF": APPROX. 0V

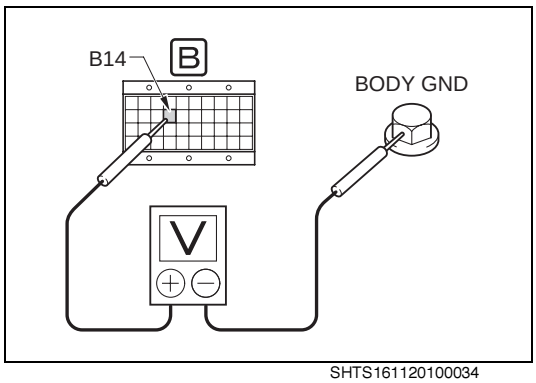
NO → Trouble of connector and terminal or harness

YES

Normal

NEUTRAL SWITCH INSPECTION

EN1611201F200040



SHTS161120100034

1. MEASURE THE NEUTRAL SWITCH SIGNAL.

(1) Set the starter switch to the "LOCK" position and connect the signal check harness to the vehicle control ECU.

(2) Set the starter switch to the "ON" position, and measure the voltage between the body GND and the terminal B14 of the signal check harness when the shift lever is set to and not set to the neutral position.

Standard:

In neutral position: 20V or more

Not in neutral position: APPROX. 0V

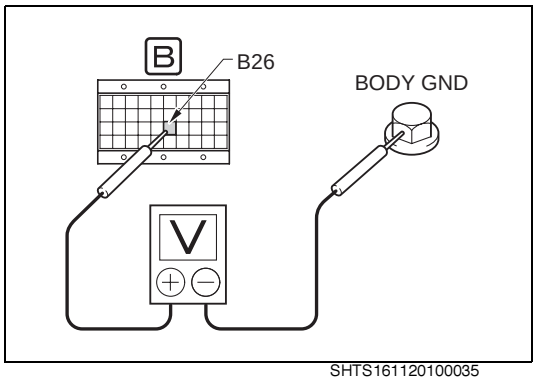
NO → Trouble of connector and terminal or harness

YES

Normal

STARTING IDLE UP CONTROL SWITCH INSPECTION

EN1611201F200041



SHTS161120100035

1. MEASURE THE STARTING IDLE UP CONTROL SWITCH SIGNAL.

(1) Set the starter switch to the "LOCK" position and connect the signal check harness to the vehicle control ECU.

(2) Set the starter switch to the "ON" position, and measure the voltage between the body GND and the terminal B26 of the signal check harness when the starting idle up control switch is ON and OFF.

Standard:

Starting idle up control switch "ON": 20V or more

Starting idle up control switch "OFF": APPROX. 0V

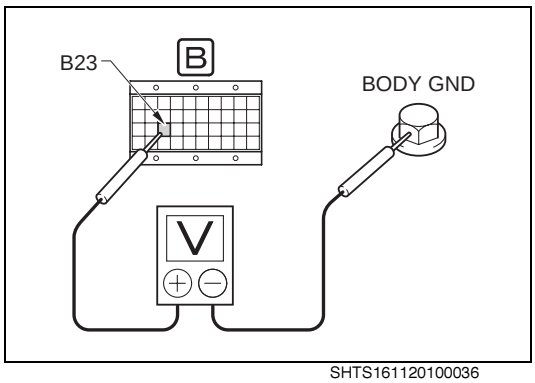
NO → Trouble of connector and terminal or harness

YES

Normal

POWER MODE SWITCH INSPECTION

EN1611201F200042



SHTS161120100036

1. MEASURE THE POWER MODE SWITCH SIGNAL.

(1) Set the starter switch to the "LOCK" position and connect the signal check harness to the vehicle control ECU.

(2) Set the starter switch to the "ON" position, and measure the voltage between the body GND and the terminal B23 of the signal check harness when the power mode switch is ON and OFF.

Standard:

Power mode switch "ON": 20V or more

Power mode switch "OFF": APPROX. 0V

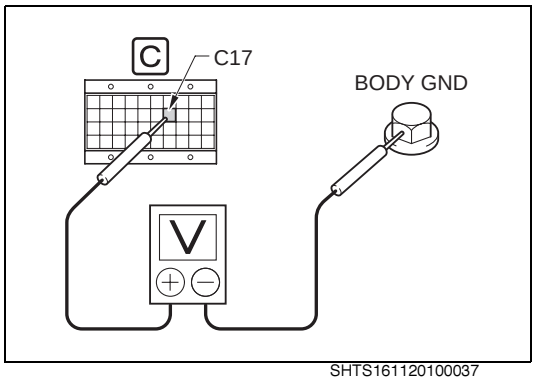
NO → Trouble of connector and terminal or harness

YES

Normal

BRAKE SWITCH INSPECTION

EN1611201F200043



SHTS161120100037

1. MEASURE THE BRAKE SWITCH SIGNAL.

(1) Set the starter switch to the "LOCK" position and connect the signal check harness to the vehicle control ECU.

(2) Set the starter switch to the "ON" position, and measure the voltage between the body GND and the terminal C17 of the signal check harness when the brake pedal is depressed and released.

Standard:

Brake pedal released: 20V or more

Brake pedal depressed: APPROX. 0V

NO → Trouble of connector and terminal or harness

YES

Normal

FUEL CONTROL (A09C)

DN02-001

COMMON RAIL FUEL INJECTION SYSTEM

PRECAUTIONS FOR DIAGNOSIS

EN1611202F200001

- Ensure that individual connectors are certainly connected before start of checking works.
- Make sure to set the starter key to the "LOCK" position before disconnecting a connector.
- Replace the part or the component that have a failure or trouble. Do not fix and reuse it.
- Delete the past malfunction code after recording. Then conduct a diagnosis again to check for present failures.
- Delete the past failure memory after completion of a diagnostic analysis.

1. ILLUSTRATION OF CONNECTOR AND MEASUREMENT ON TERMINAL

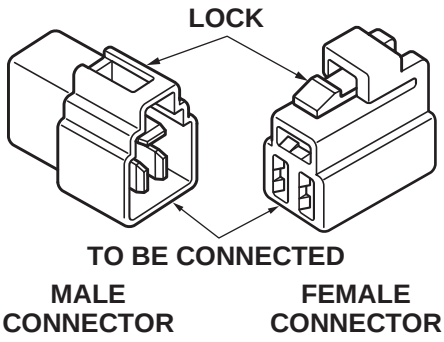
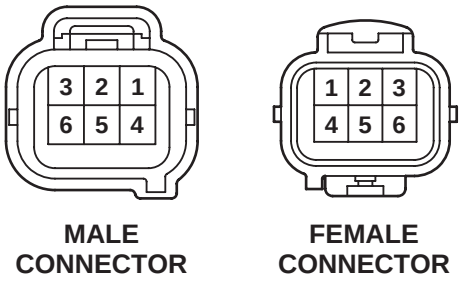


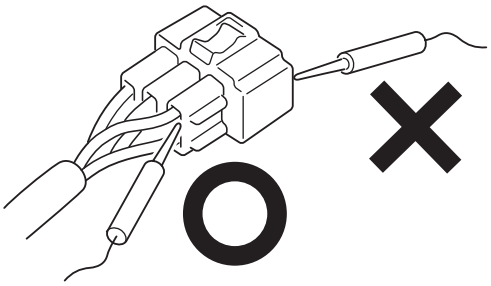
ILLUSTRATION OF CONNECTOR

The illustration of a connector contained in this document represents an image of a connector with its lock positioned on top as viewed from the connecting face.



NUMBERING OF CONNECTOR TERMINALS

The terminals are symmetrically numbered (symmetrically reversed numbering) as viewed on the connecting faces of a pair of connectors.
The terminal #1 is located at the top right corner of a male connector and at the top left corner of a female connector respectively in this document.



PRECAUTIONS FOR TERMINAL MEASUREMENT

Unless otherwise specified in this document, the illustration of a connector represents an image of a connector as viewed from the connecting face. A test probe must access the back face of a connector.
However, some types of connector do not allow a test probe to contact with the back face such as a waterproof connector. In such case, a test probe may be allowed to access the front face of a connector but a special care must be used to avoid a risk of damage in terminals.

As to a connector that is designed to use the signal check harness for terminal measurement, do not place a test probe directly onto the front or back face. Use a contact box of the connected signal check harness to take measurement on terminals.

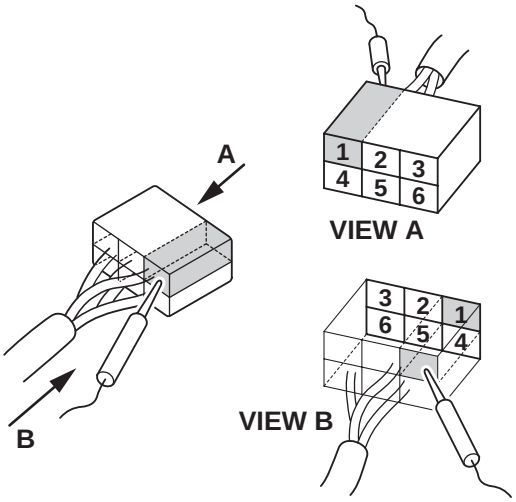


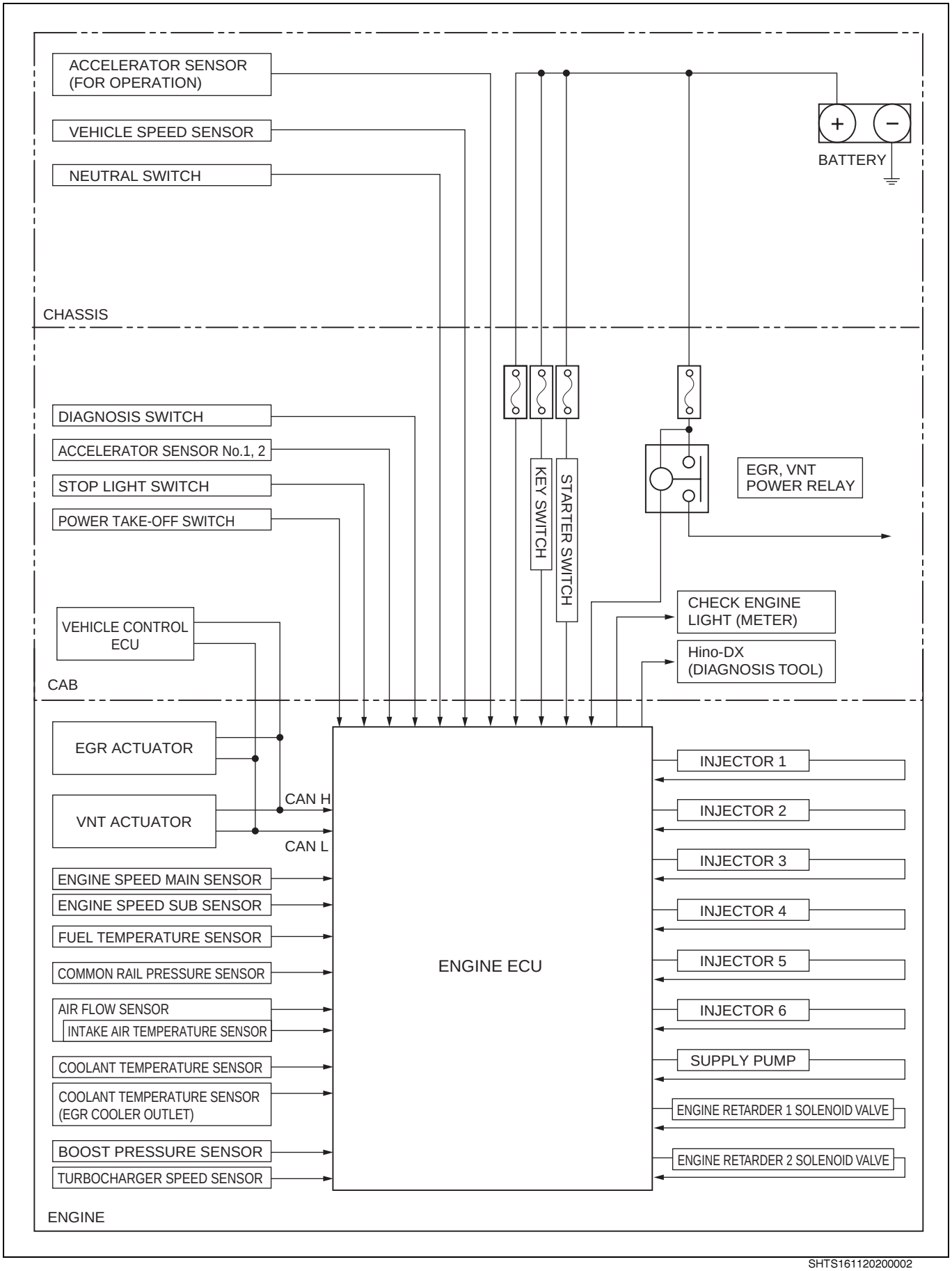
ILLUSTRATION OF CONNECTOR AND MEASUREMENT SURFACE

The illustration of a connector contained in this document represents an image of a connector as viewed from the connecting face. For example, the terminal #1 of a female connector is located at the top left corner of a connector as viewed from the connecting face.
In actual measurement on the terminal #1 of a female connector, a test probe must be placed onto the top right corner on the back face of a connector.

SHTS161120200001

ELECTRICAL

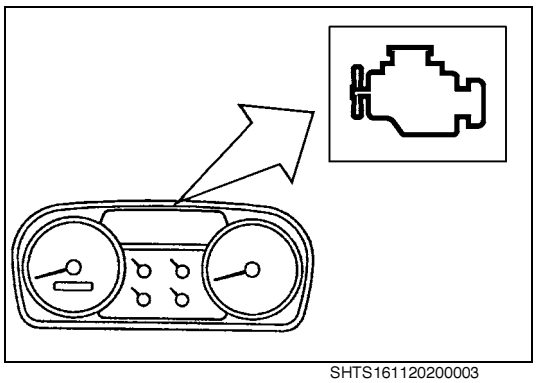
EN1611202F200002



SHTS161120200002

INSPECTION

EN1611202F200003



SHTS161120200003

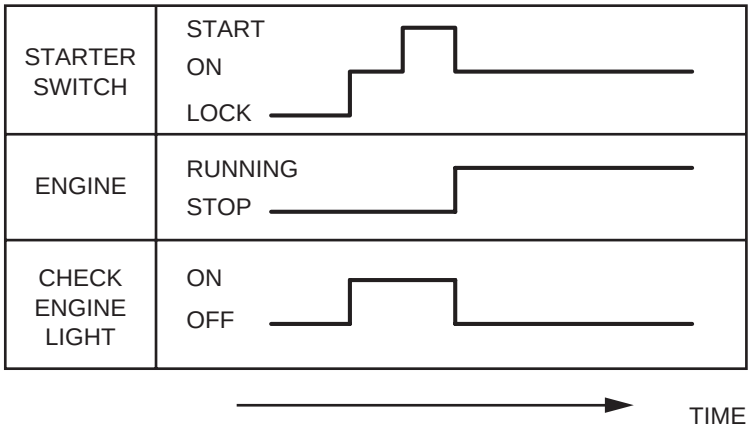
1. PRIOR CHECK

(1) Set the starter switch to the "ON" position (do not start the engine) and confirm that the check engine light in the indicator area lights up.

HINT

If the check engine light does not go out, the system is abnormal. Check the system according to diagnosis on the following page.

CHECK ENGINE LIGHT ILLUMINATION PATTERN



SHTS161120200004

SIGNAL CHECK HARNESS

EN1611202F200004

1. MENTION OF THE SIGNAL CHECK HARNESS

(1) **HINO provides a signal check harness to check the ECU.**

⚠ CAUTION

- To prevent damage of the ECU connector, connect the signal check harness and perform measuring by bringing the test probe into contact with the signal check harness side (Contact box).

HINT

The terminal numbers referred in text or illustrations in this document correspond to the numbering in the next section "COMPUTER (ECU) PIN ASSIGNMENT" as shown in the figure below.

COMPUTER (ECU) TERMINAL SIGNAL

	TACH																
HRY 2	+BF 2	+BF 1	PGD 2	PGD 1													
	VB 1	VB 2		CGD 1	CGD 2												

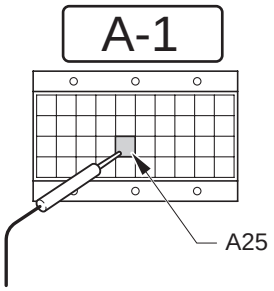
					EBMV	TH1	EXT +		ETHW	AGDT		CE/G	ST				
				SSWS	NUSW	BSW 2					AT		STOP			CANL	CANH
PWEV								ET2 +			TH2G	PTO					VS
				AGD 2	AVC 3	AGD 1	ACS 1	ACS 2	EXPS		AGD 3	AVC 5	DGSW				ISOK

COMPUTER (ECU) TERMINAL No.

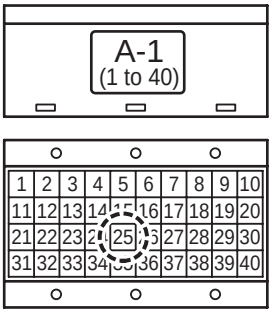
A12	A13	A14	A15	A16	A17
A7	A8	A9	A10	A11	
A1	A2	A3	A4	A5	A6

A18	A19	A20	A21	A22	A23	A2	A25	A26	A27	A28	A29	A30	A31	A32	A33	A34	A35
A36	A37	A38	A39	A40	A41	A42	A43	A44	A45	A46	A47	A48	A49	A50	A51	A52	A53
A54	A55	A56	A57	A58	A59	A60	A61	A62	A63	A64	A65	A66	A67	A68	A69	A70	A71
A72	A73	A74	A75	A76	A77	A78	A79	A80	A81	A82	A83	A84	A85	A86	A87	A88	A89

EXAMPLE: A25 TERMINAL



SIGNAL CHECK HARNESS (CONTACT BOX)

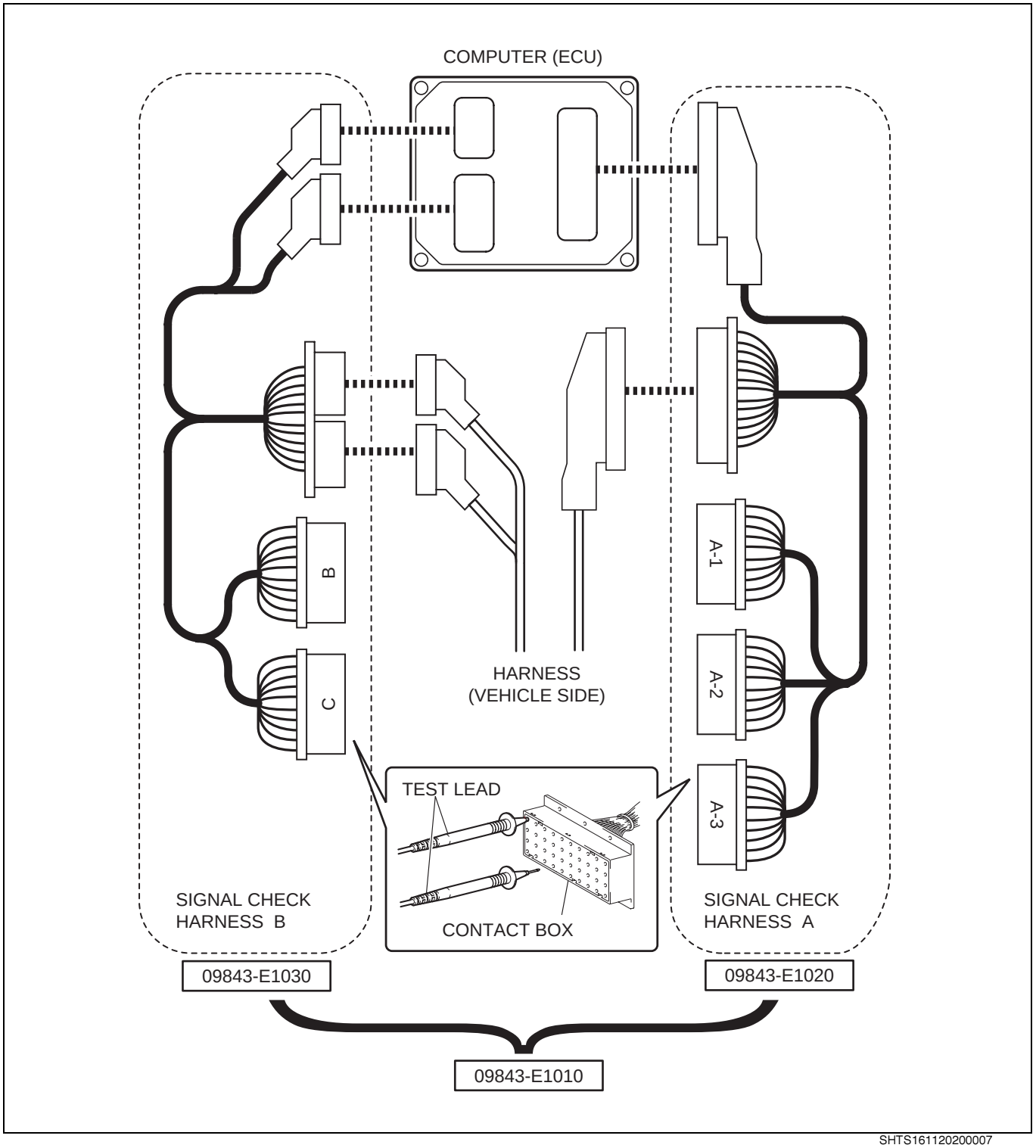


SHTS161120200006

2. CONNECT THE SIGNAL CHECK HARNESS.

(1) Set the starter switch to the "LOCK" position and disconnect the connectors from the ECU.

(2) Connect a signal check harness to the vehicle harness and the engine ECU.
SST: Signal check harness (09843-E1010)



SHTS161120200007

COMPUTER (ECU) PIN ASSIGNMENT

EN1611202F200005

COMPUTER (ECU) TERMINAL SIGNAL

CONNECTOR A

										ETHW	AGDT		CE/G	ST				
					SSWS	NUSW	BSW2										CANL	CANH
PWEV													PTO					VS
				AGD 2		AGD 1	ACS 1	ACS 2		AVC 2		AVC 5	DGSW					ISOK

	+BF 2	+BF 1	PGD 2	PGD 1		
	VB 1	VB 2		CGD 1	CGD 2	

CONNECTOR C

IJ2 +	IJ1 +	IJ5 +	IJ6 +	IJ4 +	
IJ3 +	SPV 1	SP1S			INJ 3
INJ 4	INJ 6	INJ 5	INJ 1	INJ 2	

CONNECTOR B

	THF +	PIM			ASVC	TBSG
AFT +		ASCS	THW -	AGD 1	ASGN	NE1 +
	AFSG	TBGN	NE1 -	AGD 4	AFGN	AVC 1
THW +	PCR 1	AVC 2	PCR -		G1-	G1+

RTPW	AFVB	
	RTD 1	RTD 2

COMPUTER (ECU) TERMINAL No.

CONNECTOR A

A12	A13	A14	A15	A16	A17	A18	A19	A20	A21	A22	A23	A24	A25	A26	A27	A28	A29	A30	A31	A32	A33	A34	A35
A7	A8	A9	A10	A11		A36	A37	A38	A39	A40	A41	A42	A43	A44	A45	A46	A47	A48	A49	A50	A51	A52	A53
						A54	A55	A56	A57	A58	A59	A60	A61	A62	A63	A64	A65	A66	A67	A68	A69	A70	A71
A1	A2	A3	A4	A5	A6	A72	A73	A74	A75	A76	A77	A78	A79	A80	A81	A82	A83	A84	A85	A86	A87	A88	A89

CONNECTOR C

C5	C4	C3	C2	C1		
C11	C10	C9	C8	C7	C6	
C16	C15	C14	C13	C12		

CONNECTOR B

B36	B35	B34	B33	B32	B31	B30
B29	B28	B27	B26	B25	B24	B23
B22	B21	B20	B19	B18	B17	B16
B15	B14	B13	B12	B11	B10	B9

B3	B2	B1
	B5	B4
B8	B7	B6

SIGNAL CHECK HARNESS (CONTACT BOX) TERMINAL No.

A-1 (1 to 40)

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40

A-2 (41 to 80)

41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70
71	72	73	74	75	76	77	78	79	80

A-3 (81 to 90)

81	82	83	84	85	86	87	88	89	

B (1 to 36)

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36				

C (1 to 16)

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16				

SHTS161120200008

COMPUTER (ECU) PIN CONNECTION

- The terminal number in the table correspond with the contact box of signal check harness.

CONTACT BOX (A-1)					
No.	**Signal**	**Connection destination**	**No.**	**Signal**	**Connection destination**
1	–		21	–	
2	VB1	Fuse 7D	22	–	
3	VB2	Fuse 7D	23	–	
4	–		24	–	
5	CGD1	Ground	25	–	
6	CGD2	Ground	26	–	
7	–		27	ETHW	EGR coolant temperature sensor
8	+BF2	Fuse 7D	28	AGDT	EGR coolant temperature sensor
9	+BF1	Fuse 7D	29	–	
10	PGD2	Ground	30	CE/G	Combination meter
11	PGD1	Ground	31	ST	Starter switch
12	–		32	–	
13	–		33	–	
14	–		34	–	
15	–		35	–	
16	–		36	–	
17	–		37	–	
18	–		38	–	
19	–		39	–	
20	–		40	SSWS	Fuse 39

CONTACT BOX (A-2)					
No.	**Signal**	**Connection destination**	**No.**	**Signal**	**Connection destination**
41	NUSW	Neutral switch	61	–	
42	BSW2	Stop light switch	62	–	
43	–		63	–	
44	–		64	–	
45	–		65	–	
46	–		66	PTO	P.T.O. position switch
47	–		67	–	
48	–		68	–	
49	–		69	–	
50	–		70	–	
51	–		71	VS	Vehicle speed sensor
52	CANL	Junction CAN	72	–	
53	CANH	Junction CAN	73	–	
54	PWEV	EGR VNT power relay	74	–	
55	–		75	–	
56	–		76	AGD2	Accelerator sensor
57	–		77	–	
58	–		78	AGD1	Accelerator sensor
59	–		79	ACS1	Accelerator sensor
60	–		80	ACS2	Accelerator sensor

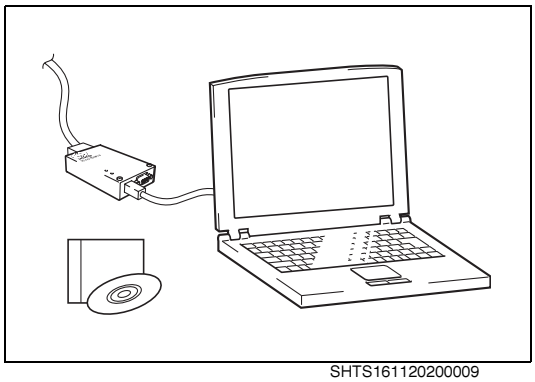
CONTACT BOX (A-3)					
No.	**Signal**	**Connection destination**	**No.**	**Signal**	**Connection destination**
81	–		86	–	
82	AVC2	Accelerator sensor	87	–	
83	–		88	–	
84	AVC5	Accelerator sensor	89	ISOK	Diagnosis connector
85	DGSW	Diagnosis connector			

CONTACT BOX (B)					
No.	**Signal**	**Connection destination**	**No.**	**Signal**	**Connection destination**
1	–		19	NE1-	Engine speed sub sensor
2	AFVB	Air flow sensor	20	TBGN	Turbine speed sensor
3	RTPW	Engine retarder	21	AFSG	Air flow sensor
4	–		22	–	
5	–		23	NE1+	Engine speed sub sensor
6	RTD2	Engine retarder	24	ASGN	P.T.O. accelerator sensor
7	RTD1	Engine retarder	25	AGD1	Boost pressure sensor
8	–		26	THW-	Coolant temperature sensor
9	G1+	Engine speed main sensor	27	ASCS	P.T.O. accelerator sensor
10	G1-	Engine speed main sensor	28	–	
11	–		29	AFT+	Air flow sensor
12	PCR-	Common rail pressure sensor	30	TBSG	Turbine speed sensor
13	AVC2	Common rail pressure sensor	31	ASVC	P.T.O. accelerator sensor
14	PCR1	Common rail pressure sensor	32	–	
15	THW+	Coolant temperature sensor	33	–	
16	AVC1	Boost pressure sensor	34	PIM	Boost pressure sensor
17	AFGN	Air flow sensor	35	THF+	Fuel temperature sensor
18	AGD4	Fuel temperature sensor	36	–	

CONTACT BOX (C)					
No.	**Signal**	**Connection destination**	**No.**	**Signal**	**Connection destination**
1	IJ4+	Injector 4	9	SP1S	Supply pump
2	IJ6+	Injector 6	10	SPV1	Supply pump
3	IJ5+	Injector 5	11	IJ3+	Injector 3
4	IJ1+	Injector 1	12	INJ2	Injector 2
5	IJ2+	Injector 2	13	INJ1	Injector 1
6	INJ3	Injector 3	14	INJ5	Injector 5
7	–		15	INJ6	Injector 6
8	–		16	INJ4	Injector 4

DIAGNOSIS USING THE PC (PERSONAL COMPUTER) DIAGNOSIS TOOL WITH INTERFACE

EN1611202F200006



SHTS161120200009

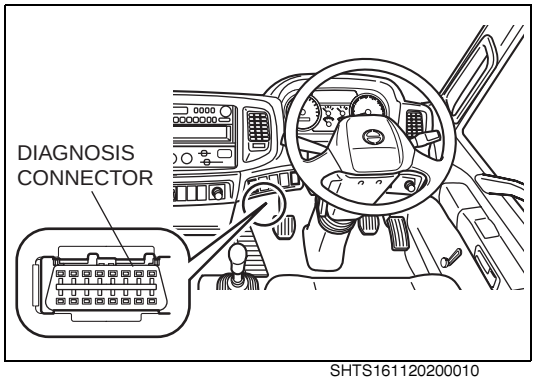
1. INTRODUCTION TO HINO-DX

(1) The Hino-DX is designed to diagnose the common rail fuel injection system and the chassis system. For connection to the vehicle, the Hino-Bowie (interface box) and dedicated cables must be used.

SST:
Communication interface assembly (Hino-Bowie) (09993-E9070)
Cable communication (S0904-21220)
Diagnosis software: HINO Diagnostic explorer (Hino-DX)

HINT

- **Use the Hino-Bowie designated above as an interface.**
- **Cables to be routed between the Hino-Bowie and a computer are included in the Hino-Bowie kit.**
  Select either the RS-232C cable or the USB cable.
- **Install the Hino Diagnostic eXplorer (Hino-DX) software on a personal computer. For installation procedures, read the manual supplied with a CD.**



SHTS161120200010

2. CONNECT THE PC DIAGNOSIS TOOL (Hino-DX)

(1) Set the starter switch to the "LOCK" position.
(2) Connect the diagnosis cable between diagnosis connector and interface.
(3) Connect the interface to the PC.
(4) Set the starter switch to the "ON" position.
(Do not start the engine.)
(5) The opening menu will be displayed on the PC screen.

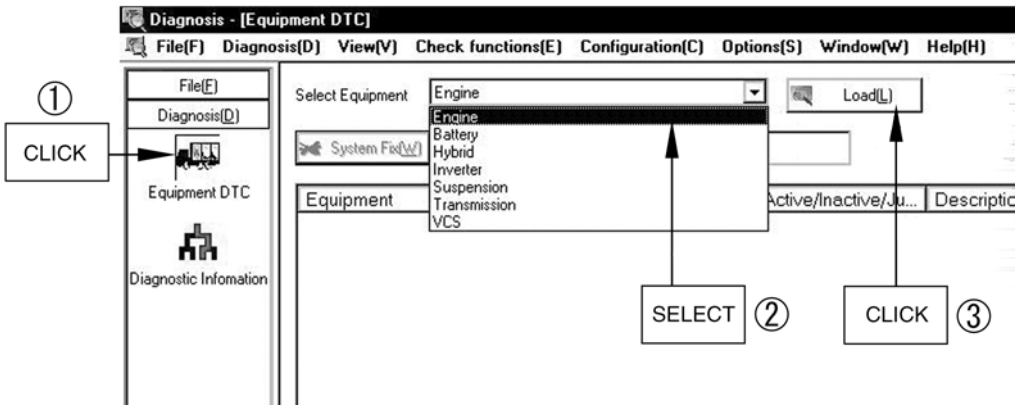
HINT

When the Hino-Bowie is connected to a vehicle, the power supply will turn on and the POWER light (red) on the Hino-Bowie will light on.

3. STARTING THE DIAGNOSIS

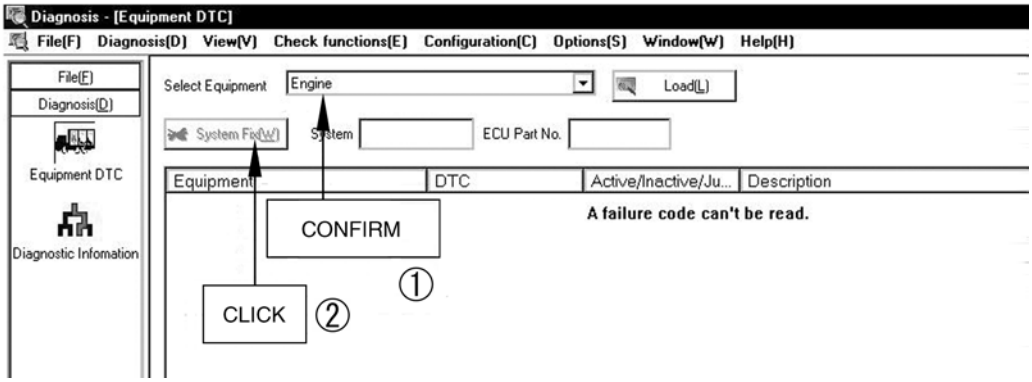
(1) Boot the Hino-DX.

(2) Click on the [Equipment DTC] button and select "Engine" from a pull-down menu in the [Select System Category]. Then, click on the [Load] button.



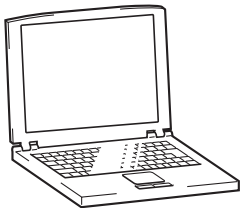
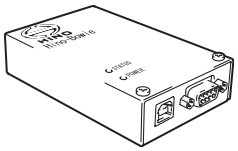
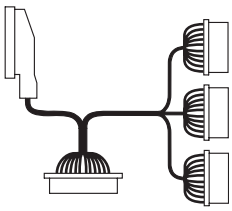
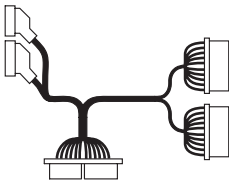
SHTS161120200011

(3) Make sure that "Engine" is indicated in the [Select System Category] box. Click on the [System Fix] button to diagnose the engine.



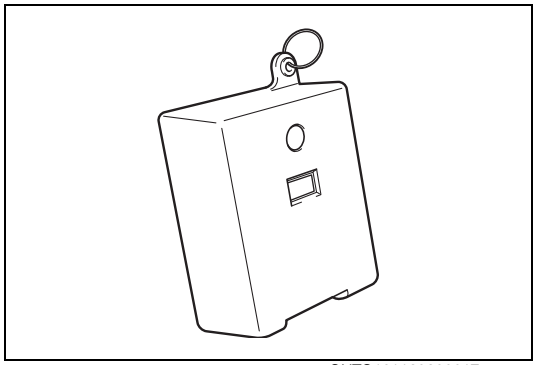
SHTS161120200012

4. LIST OF DIAGNOSTIC TOOLS

Part name	Part No.	Appearance	Outline/feature
Personal computer (DOS/V standard)	—		• **Operating system (OS): Windows 95, Windows 98 (IE 5.0 or later), Windows 2000 (SP3, IE 5.0 or later), Windows XP (SP1a, IE 6.0 or later)** • **CPU and memory: Must be guaranteed for the performances of the aforesaid operating systems.** • **Display: 800 x 600 (Resolution), 256 or more colors**
Hino-Bowie (Interface box)	**09993-E9070** **Interface box the body and cables** **(For RS-232C and USB)** **S0904-21220** **Cable of between vehicle and Hino-Bowie**		• **Personal computer interface**
Signal check harness	**09843-E1010** **(For common rail fuel injection system)**	 A (09843-E1020)  B (09843-E1030)	• **This signal check harness is designed to be routed between the vehicle harness and the ECU and allows a check to be conducted with a test probe while power is being supplied.** **Both of types A and B are used.**

DIAGNOSIS USING THE DIAGNOSIS MONITOR

EN1611202F200007

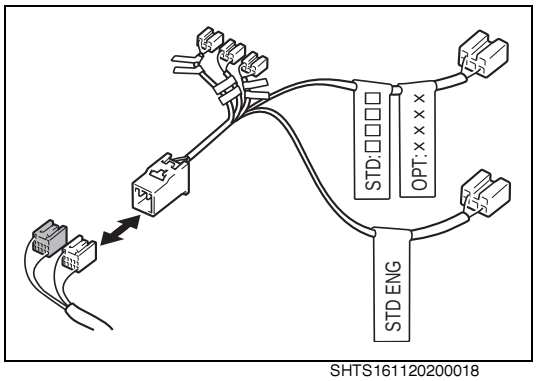


SHTS161120200017

1. DIAGNOSIS MONITOR

(1) Trouble diagnosis also can be performed using the diagnosis monitor. The malfunction codes are indicated by sound and light.

SST: Diagnosis monitor (S0963-01370)



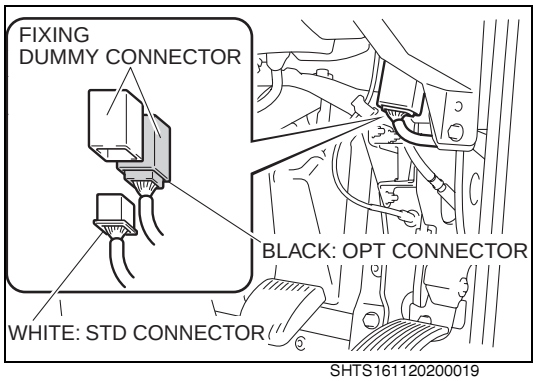
SHTS161120200018

2. CONNECTING THE DIAGNOSIS MONITOR

(1) Set the starter switch to the "LOCK" position.

(2) Connect the dedicated harness connector to a white one of two centralized diagnosis connectors, located on the lower right side in front of the driver's seat. then, connect the diagnosis monitor to the connector having a "STD ENG" tag.
SST: Dedicated Harness (S0963-02300)

(3) Set the starter switch to the "ON" position.



SHTS161120200019

NOTICE

he centralized diagnosis connectors are generally connected to the fixing dummy connectors. Pull the centralized diagnosis connectors out when using the centralized diagnosis connctor, and connect the centralized diagnosis connctor with the fixing dummy connectors after use.

HINT

Add a new tag to your dedicated harness (S0963-02300) if the aforesaid tag is not attached.

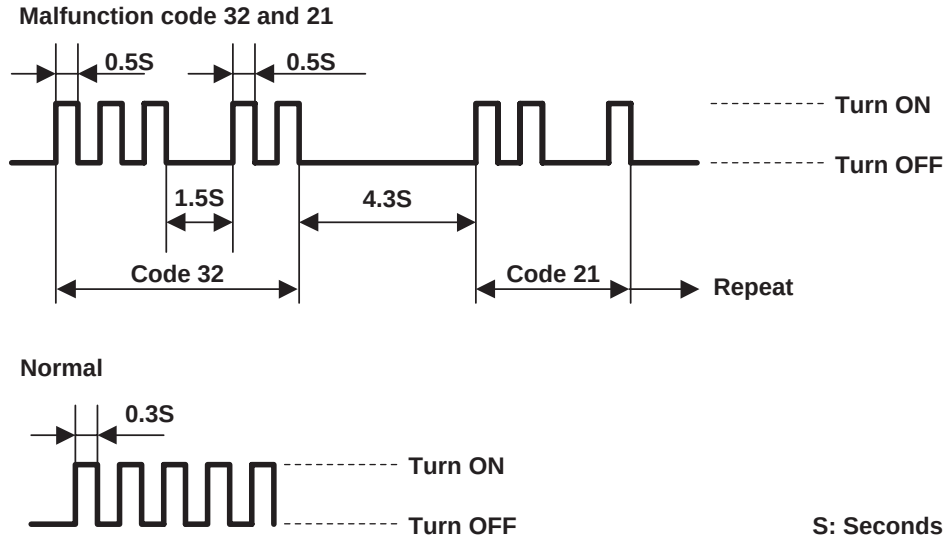
3. READ OUT THE MALFUNCTION CODE.

(1) Read out the malfunction codes and write down the malfunction codes that are indicated.

NOTICE

Malfunction codes are indicated, starting from the lowest and progressing to higher one, with no distinction between present and past malfunction codes.

MALFUNCTION CODE INDICATION PATTERN



SHTS161120200020

DIAGNOSIS MONITOR CODE AND DIAGNOSIS TROUBLE CODE TABLE

EN1611202F200008

NOTICE
MC No.: Diagnosis Monitor Code (Using the diagnosis monitor)
DTC No.: Diagnosis Trouble Code (Using the PC diagnosis tool)

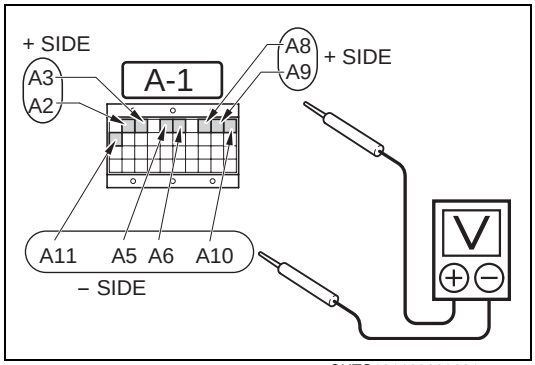
[a] SYMPTOM [b] CHECK ENGINE LIGHT	MC No.	DTC No.	PRESUMED CAUSE OF TROUBLE
a. Engine does not start Engine stops b. Check engine light: light	78	P0093	Fuel leakage
	13	P0335	Engine speed main sensor malfunction (Main and sub sensor malfunction)
	3	P0606	ECU malfunction (Hard detection)
	3	P0607	ECU malfunction (Monitoring IC malfunction in ECU)
a. Engine has low power b. Check engine light: light	22	P2120	Accelerator sensor 1 and 2 malfunction
a. Engine has low power b. Check engine light: Not light	6	P0217	Engine overheat
a. Engine has low power b. Check engine light: Not light	39	P0049	Turbocharger overrun
	39	P0234	Turbocharger over boost
a. Engine has low power b. Check engine light: light	74	P0629	Supply pump MPROP malfunction (Short circuit to battery)
	75	P0628	Supply pump MPROP malfunction (Open circuit, short circuit to ground)
	57	P1211	Injector solenoid valve drive system common 1 malfunction (Short circuit in the "–" side harness)
	58	P1214	Injector solenoid valve drive system common 2 malfunction (Short circuit in the "–" side harness)
	57	P1212	Injector solenoid valve drive system common 1 malfunction (Short circuit in the "+" side harness)
	58	P1215	Injector solenoid valve drive system common 2 malfunction (Short circuit in the "+" side harness)
	17	P0102	Air flow sensor malfunction (Input too low)
	17	P0103	Air flow sensor malfunction (Input too high)
	51	P0201	Injector 1 solenoid valve drive system malfunction (Wire breaking)
	52	P0202	Injector 2 solenoid valve drive system malfunction (Wire breaking)
	53	P0203	Injector 3 solenoid valve drive system malfunction (Wire breaking)
	54	P0204	Injector 4 solenoid valve drive system malfunction (Wire breaking)
	55	P0205	Injector 5 solenoid valve drive system malfunction (Wire breaking)
	56	P0206	Injector 6 solenoid valve drive system malfunction (Wire breaking)
	13	P0335	Engine speed main sensor malfunction
	13	P0336	Engine speed main sensor pulse abnormal
	35	P0045	VNT controller malfunction (Major fault)

[a] SYMPTOM [b] CHECK ENGINE LIGHT	MC No.	DTC No.	PRESUMED CAUSE OF TROUBLE
a. Engine has low power b. Check engine light: light	36	P0045	VNT controller malfunction (Minor fault)
	81	P1458	EGR actuator 1 malfunction (Major fault)
	81	P1459	EGR actuator 2 malfunction (Minor fault)
	76	P0088	Excessive common rail pressure
	67	P0192	Common rail pressure sensor malfunction (Input too low)
	67	P0193	Common rail pressure sensor malfunction (Input too high)
	67	P0191	Common rail pressure sensor stuck
	77	P1266	Supply pump malfunction (Force feed)
	68	P0088	Excessive common rail pressure (1st step)
	69	P0088	Excessive common rail pressure (2nd step)
	37	P0237	Boost pressure sensor malfunction (Input too low)
	37	P0108	Boost pressure sensor malfunction (Input too high)
	8	U1122	CAN communication error (EGR)
	8	U1123	CAN communication error (VNT)
a. Other phenomena b. Check engine light: light	22	P2122	Accelerator sensor 1 malfunction (Input too low)
	22	P2123	Accelerator sensor 1 malfunction (Input too high)
	22	P2127	Accelerator sensor 2 malfunction (Input too low)
	22	P2128	Accelerator sensor 2 malfunction (Input too high)
	22	P2121	Accelerator sensor 1 abnormal voltage (Stuck close)
	22	P2121	Accelerator sensor 1 abnormal voltage (Stuck open)
	22	P2126	Accelerator sensor 2 abnormal voltage (Stuck close)
	22	P2126	Accelerator sensor 2 abnormal voltage (Stuck open)
	15	P2228	Atmospheric pressure sensor malfunction (Input too low)
	15	P2229	Atmospheric pressure sensor malfunction (Input too high)
	11	P0117	Coolant temperature sensor malfunction (Input too low)
	11	P0118	Coolant temperature sensor malfunction (Input too high)
	14	P0187	Fuel temperature sensor malfunction (Input too low)
	14	P0188	Fuel temperature sensor malfunction (Input too high)
	8	P0610	No vehicle information recorded
	16	P0112	Intake air temperature sensor malfunction (Input too low)
	16	P0113	Intake air temperature sensor malfunction (Input too high)
	12	P0340	Engine speed sub sensor malfunction
	12	P0341	Engine speed sub sensor pulse abnormal
	5	P0686	Main relay malfunction
	2	P1601	Injector correction data conforming error

[a] SYMPTOM [b] CHECK ENGINE LIGHT	MC No.	DTC No.	PRESUMED CAUSE OF TROUBLE
a. Other phenomena b. Check engine light: light	21	P0501	Vehicle speed sensor malfunction (Input too high) (Overhigh frequency)
	21	P0500	Vehicle speed sensor malfunction (Input too low) (Open/short circuit)
a. Other phenomena b. Check engine light: Not light	42	P0510	Idle switch malfunction
	23	P1133	P.T.O. accelerator sensor malfunction
	19	P1417	EGR coolant temperature sensor malfunction (Input too low)
	19	P1418	EGR coolant temperature sensor malfunction (Input too high)
	26	P1462	Engine retarder 1 open circuit, short circuit to ground
	26	P1463	Engine retarder 1 short circuit to battery
	27	P1467	Engine retarder 2 open circuit, short circuit to ground
	27	P1468	Engine retarder 2 short circuit to battery
	47	P0850	Neutral switch malfunction
	61	P0263	Cylinder 1 contribution/balance fault
	62	P0266	Cylinder 2 contribution/balance fault
	63	P0269	Cylinder 3 contribution/balance fault
	64	P0272	Cylinder 4 contribution/balance fault
	65	P0275	Cylinder 5 contribution/balance fault
	66	P0278	Cylinder 6 contribution/balance fault
	7	P0219	Engine overrun
	85	P1416	EGR cooler overheat
	45	P0617	Starter switch malfunction
	9	U0101	CAN communication error (Transmission)
	9	U0121	CAN communication error (ABS)
	9	U0104	CAN communication error (Cruise)
	9	U0155	CAN communication error (Meter)
	9	U0132	CAN communication error (Air suspension)
a. Engine has low power b. Check engine light: light	8	U0073	CAN malfunction (Engine)
a. Other phenomena b. Check engine light: light	8	U110A	CAN communication error (Vehicle control ECU)

CHECK OF THE ECU POWER SUPPLY VOLTAGE

EN1611202F200009



SHTS161120200021

1. CHECK THE VOLTAGE BETWEEN TERMINALS.

(1) Set the starter switch to the "LOCK" position and connect the signal check harness.
(2) Set the starter switch to the "ON" position and measure the voltage between terminals.

Terminals to measure the voltage	
+ side	**- side**
A2, A3, A8, A9	A5, A6, A10, A11

Standard: 20V or more

NO

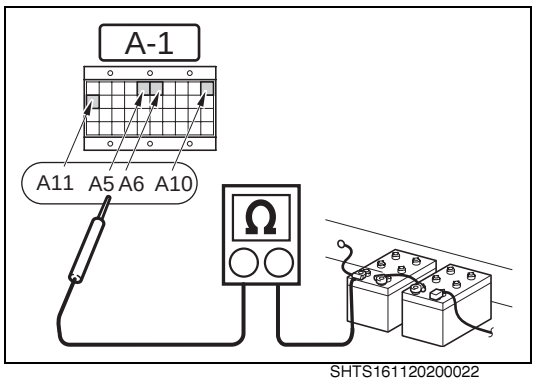
YES

- 0V: Fuse blows, harness malfunction, ground malfunction
- 20V or less: Battery retrogradation, ground malfunction

Normal

CHECK OF THE GROUND

EN1611202F200010



SHTS161120200022

1. CHECK THE RESISTANCE BETWEEN TERMINALS.

(1) Set the starter switch to the "LOCK" position and connect the signal check harness.
(2) Disconnect the signal check harness connector on the ECU side.
(3) Measure the resistance between A5, A6, A10, A11 terminals and battery (–) terminal.

Terminals to measure the resistance
A5 ↔ Battery (–)
A6 ↔ Battery (–)
A10 ↔ Battery (–)
A11 ↔ Battery (–)

Standard: 1 Ω or less

NO

YES

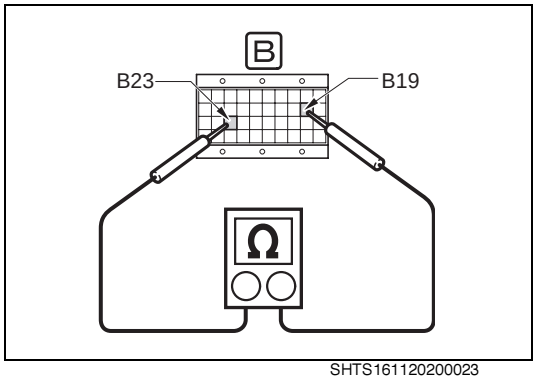
- Ground harness disconnection
- Bad contact of terminal

Normal

ENGINE SPEED MAIN SENSOR

EN1611202F200011

MC No.	13	DTC No.	P0335	Engine speed main sensor malfunction

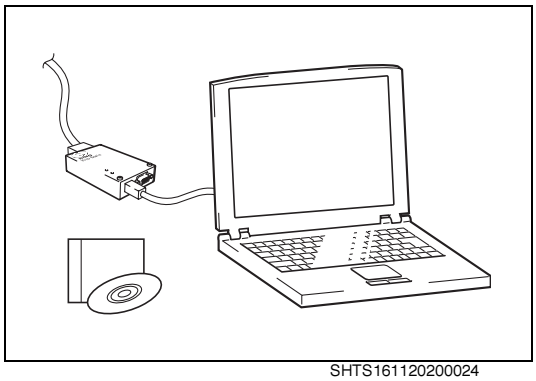


SHTS161120200023

1. CHECK THE RESISTANCE BETWEEN TERMINALS.
(1) Set the starter switch to the "LOCK" position and connect the signal check harness.
(2) Disconnect the signal check harness connector on the ECU side.
(3) Measure the resistance between B19 and B23 terminals.
Standard: APPROX. 108.5-142.5 Ω at 20°C {68°F}

NO → Proceed to 3.

YES

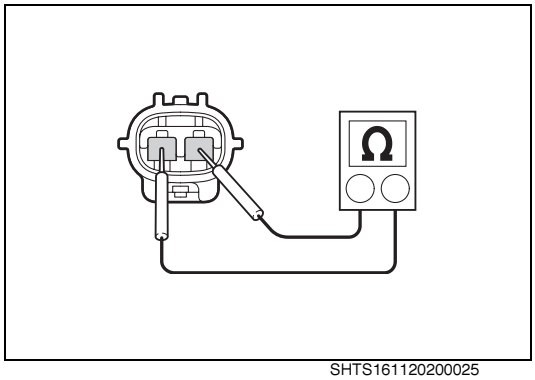

SHTS161120200024

2. RECHECK THE MC OR DTC.
(1) Connect the PC DIAGNOSIS TOOL. (Refer to the page DN02-14.)
(2) Connect the signal check harness connector on the ECU side.
(3) Erase the MC or DTC memory.
(4) Start the engine.
(5) After performing warm-up at engine speed idling, stop the engine.
(6) Check the MC or DTC.
Standard: Normal

NO
- Malfunction of engine ECU
- Bad contact of ECU connectors
- Malfunction of harness (Short circuit)

YES

Normal
(Temporary malfunction because of radio interference noise.)



SHTS161120200025

3. CHECK THE RESISTANCE BETWEEN TERMINALS.

(1) Disconnect the connectors of engine speed main sensor.

(2) Measure the resistance between No.1 and No.2 terminals of engine speed main sensor.

Standard: APPROX. 108.5-142.5 Ω at 20°C {68°F}

NO → Malfunction of engine speed main sensor

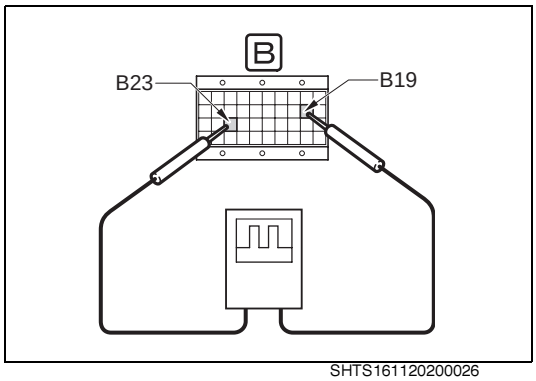
YES

- Malfunction of harness (Short circuit)
- Bad contact of connectors

ENGINE SPEED MAIN SENSOR (PULSE)

EN1611202F200012

MC No.	13	DTC No.	P0336	Engine speed main sensor pulse abnormal



SHTS161120200026

1. CHECK THE INPUT PULSE GENERATION TO ENGINE ECU.

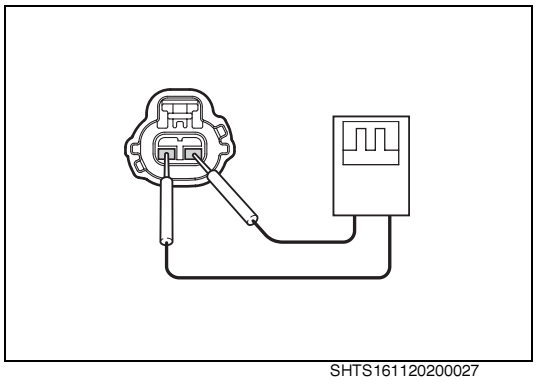
(1) Set the starter switch to the "LOCK" position and connect the signal check harness.
(2) Start the engine.
(3) Measure the pulse generation between B19 and B23 terminals of the signal check harness using an oscilloscope.
Standard: 56 pulse (Between non-signal holes)
(4) After measurement, stop the engine.

NO

Proceed to 2.

YES

- Malfunction of engine ECU
- Malfunction of ECU connectors


SHTS161120200027

2. CHECK THE INPUT PULSE GENERATION FROM ENGINE SPEED MAIN SENSOR.

(1) Connector of engine speed main sensor remains connected.
(2) Start the engine.
(3) Measure the pulse generation between No.1 and No.2 terminals of engine speed main sensor (Vehicle harness side).

NOTICE
This figure is viewed from the vehicle harness side.

Standard: 56 pulse (Between non-signal holes)

(4) After measurement, stop the engine.

NO

- Engine speed main sensor malfunction
- Flywheel signal hole abnormal
- Bad contact of connectors

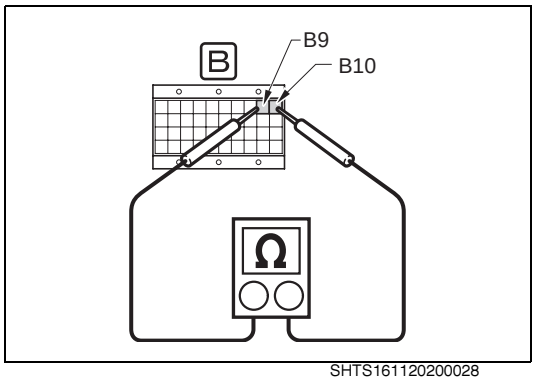
YES

- Malfunction of harness

ENGINE SPEED SUB SENSOR

EN1611202F200013

MC No.	12	DTC No.	P0340	Engine speed sub sensor malfunction



SHTS161120200028

1. CHECK THE RESISTANCE BETWEEN TERMINALS.

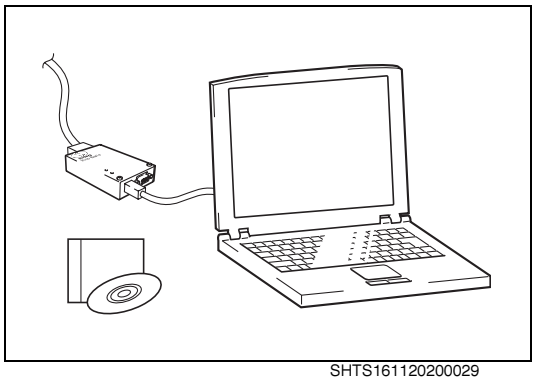
(1) Set the starter switch to the "LOCK" position and connect the signal check harness.
(2) Disconnect the signal check harness connector on the ECU side.
(3) Measure the resistance between B9 and B10 terminals.

Standard: 774-946 Ω at 20°C {68°F}

NO

Proceed to 3.

YES


SHTS161120200029

2. RECHECK THE MC OR DTC.

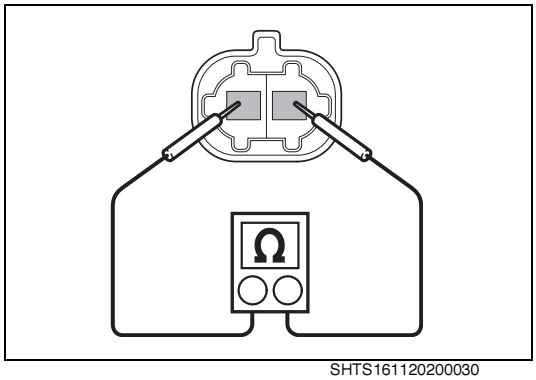
(1) Connect the PC DIAGNOSIS TOOL. (Refer to the page DN02-14.)
(2) Connect the signal check harness connector on the ECU side.
(3) Erase the MC or DTC memory.
(4) Start the engine.
(5) After performing warm-up at engine speed idling, stop the engine.
(6) Check the MC or DTC.
Standard: Normal

NO

- Malfunction of engine ECU
- Bad contact of ECU connectors
- Malfunction of harness (Short circuit)

YES

Normal
(Temporary malfunction because of radio interference noise.)



SHTS161120200030

3. CHECK THE RESISTANCE BETWEEN TERMINALS.

(1) Disconnect the connector of engine speed sub sensor.

(2) Measure the resistance between terminals of engine speed sub sensor.

Standard: 774-946 Ω at 20°C {68°F}

NO

Malfunction of engine speed sub sensor

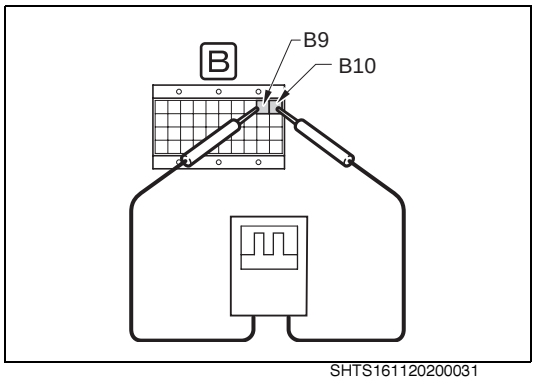
YES

- Malfunction of harness
- Bad contact of connectors

ENGINE SPEED SUB SENSOR (PULSE)

EN1611202F200014

MC No.	12	DTC No.	P0341	Engine speed sub sensor pulse abnormal



SHTS161120200031

1. CHECK THE INPUT PULSE GENERATION TO ENGINE ECU.

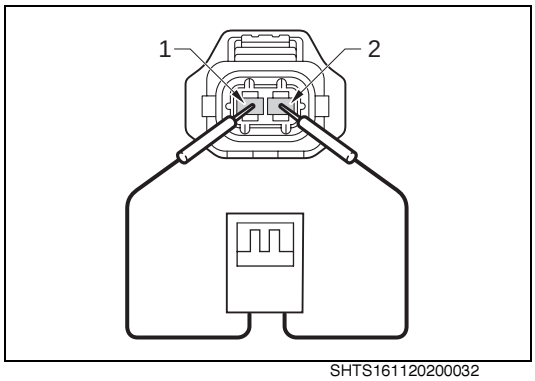
(1) Set the starter switch to the "LOCK" position and connect the signal check harness.
(2) Start the engine.
(3) Measure the pulse generation between B9 and B10 terminals of the signal check harness using an oscilloscope.
Standard: 7 pulse (Including extra signal pin)
(4) After measurement, stop the engine.

NO

Proceed to 2.

YES

- Malfunction of engine ECU
- Malfunction of ECU connectors



SHTS161120200032

2. CHECK THE INPUT PULSE GENERATION FROM ENGINE SPEED SUB SENSOR.

(1) Connector of engine speed sub sensor remains connected.
(2) Start the engine.
(3) Measure the pulse generation between No.1 and No.2 terminals of engine speed sub sensor (Vehicle harness side).

NOTICE
This figure is viewed from the vehicle harness side.

Standard: 7 pulse (Including extra signal pin)

(4) After measurement, stop the engine.

NO

Bad contact of connectors

YES

Malfunction of harness

ENGINE SPEED MAIN AND SUB SENSOR

EN1611202F200015

MC No.	13	DTC No.	P0335	Engine speed main and sub sensor malfunction

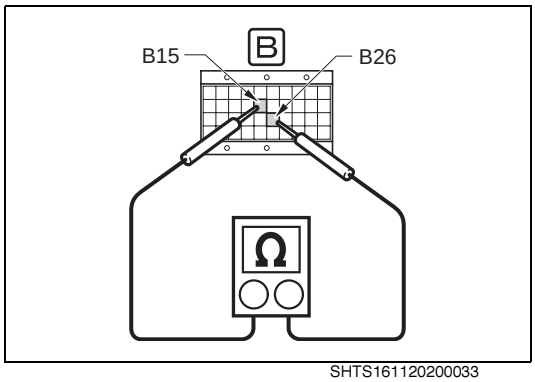
1. INSPECTION ITEM

(1) Make sure to inspect it in accordance with the contents of MC No.12, 13 or DTC No. P0335, P0340.
Refer to the section **"ENGINE SPEED MAIN SENSOR (DTC No. P0335/MC No.13)"** .
Refer to the section **"ENGINE SPEED SUB SENSOR (DTC No. P0340/MC No.12)"** .

COOLANT TEMPERATURE SENSOR

EN1611202F200016

MC No.	11	DTC No.	P0117	Coolant temperature sensor malfunction (Input too low)
MC No.	11	DTC No.	P0118	Coolant temperature sensor malfunction (Input too high)



SHTS161120200033

1. CHECK THE RESISTANCE BETWEEN TERMINALS.

(1) Set the starter switch to the "LOCK" position and connect the signal check harness.
(2) Disconnect the signal check harness connector on the ECU side.
(3) Measure the resistance between B15 and B26 terminals.

HINT

Measure the resistance under any of the following conditions.

Standard:

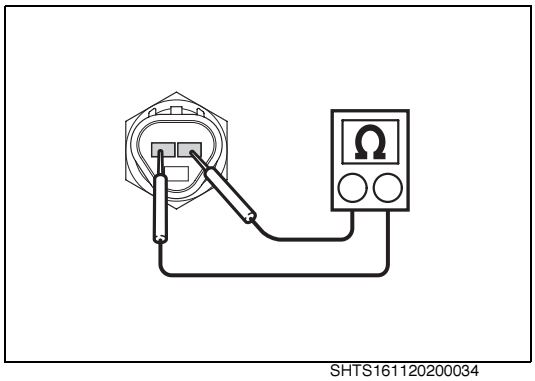
Coolant temperature	Resistance
20°C {68°F}	**2.45 kΩ**
40°C {104°F}	**1.15 kΩ**
60°C {140°F}	**584 Ω**
80°C {176°F}	**318 Ω**

NO

Proceed to 2.

YES

Proceed to 3.



SHTS161120200034

2. CHECK THE RESISTANCE BETWEEN TERMINALS.

(1) Disconnect the connector of coolant temperature sensor.
(2) Measure the resistance between No.1 and No.2 terminals of coolant temperature sensor.

HINT

Measure the resistance under any of the following conditions.

Standard:

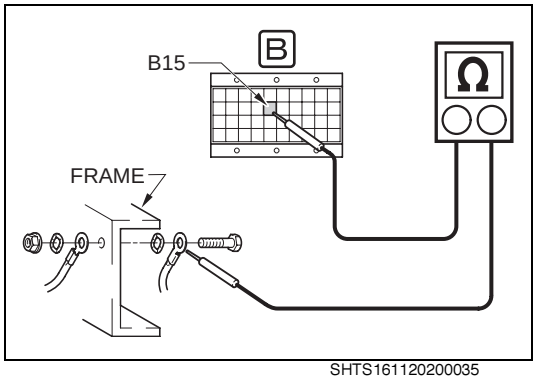
Coolant temperature	Resistance
20°C {68°F}	**2.45 kΩ**
40°C {104°F}	**1.15 kΩ**
60°C {140°F}	**584 Ω**
80°C {176°F}	**318 Ω**

NO

Malfunction of coolant temperature sensor

YES

- Malfunction of harness
- Malfunction of connectors



SHTS161120200035

3. CHECK THE CONTINUITY OF HARNESS.

(1) Measure the resistance between B15 terminal of the signal check harness and chassis GND.

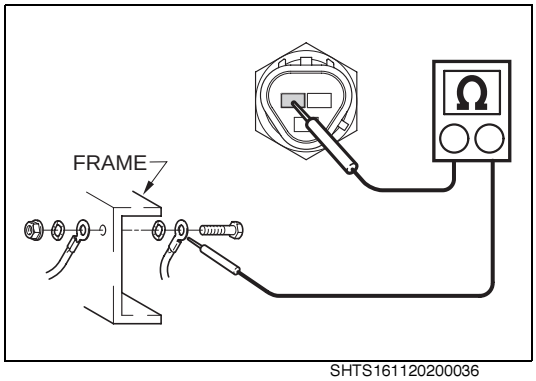
Standard: ∞ Ω

NO

Proceed to 4.

YES

Proceed to 5.



SHTS161120200036

4. CHECK THE COOLANT TEMPERATURE SENSOR.

(1) Disconnect the connector of coolant temperature sensor.

(2) Measure the resistance between No.1 terminal of coolant temperature sensor and chassis GND.

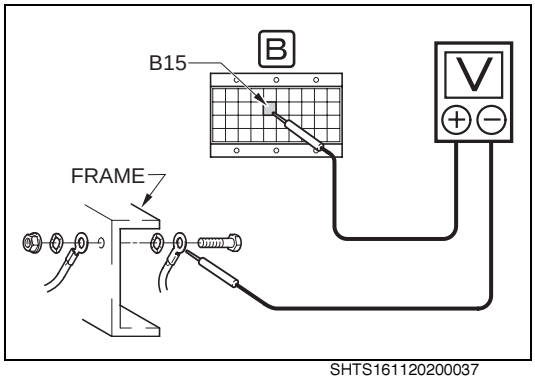
Standard: ∞ Ω

NO

Malfunction of coolant temperature sensor

YES

- Malfunction of harness
- Malfunction of connectors



SHTS161120200037

5. CHECK THE VOLTAGE BETWEEN TERMINALS.

(1) Set the starter switch to the "ON" position.

(2) Measure the voltage between B15 terminal of the signal check harness and chassis GND.

Standard: 1V or less

NO

- Malfunction of harness
- Malfunction of connectors

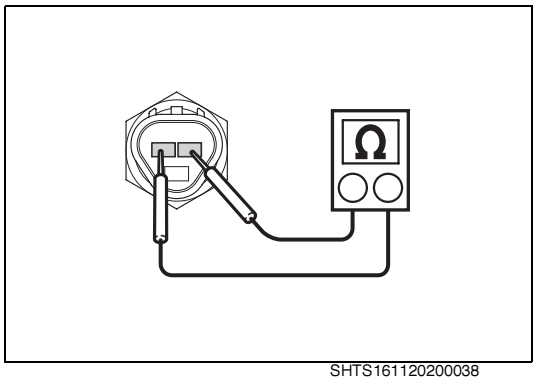
YES

- Malfunction of engine ECU
- Malfunction of ECU connectors

ENGINE OVERHEAT

EN1611202F200017

MC No.	6	DTC No.	P0217	Engine overheat



SHTS161120200038

1. CHECK THE RESISTANCE BETWEEN TERMINALS.

(1) Set the starter switch to the "LOCK" position.
(2) Disconnect the connector of coolant temperature sensor.
(3) Measure the resistance between No.1 and No.2 terminals.

HINT

Measure the resistance under any of the following conditions.

Standard:

Coolant temperature	Resistance
20°C {68°F}	**2.45 kΩ**
40°C {104°F}	**1.15 kΩ**
60°C {140°F}	**584 Ω**
80°C {176°F}	**318 Ω**

HINT

- **This code would be displayed when the coolant temperature sensor operates normally and coolant temperature ascends over 105°C {221°F}.**
- **Also, while the MC or DTC is being detected, Max. volume of fuel injection will be limited and will return back to normal control volume when it descends 80°C {176°F} or less.**

NO → Malfunction of coolant temperature sensor

YES

Malfunction of engine cooling system

ENGINE OVERRUN

EN1611202F200018

MC No.	7	DTC No.	P0219	Engine overrun

1. The MC or DTC will be displayed, once detected over 2,650 r/min. in the engine revolution. Also, the fuel injection will be suspended during the MC or DTC to be detected and the fuel injection will be resumed when engine revolution goes down 2,550 r/min or less.

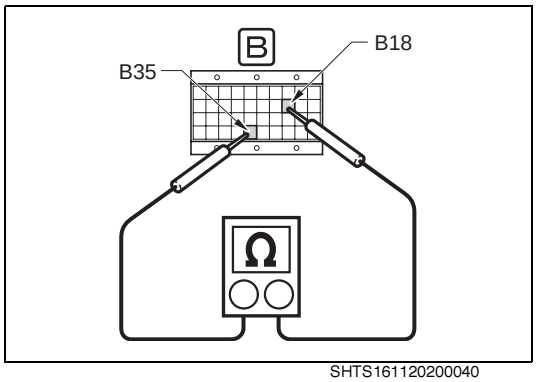
HINT

- **This MC or DTC aim is not for detecting the engine overrun under abnormal operation of the system, but for storing in memory the high revolution of the engine. (For example, detection of wrong shifting, etc.)**
- **Also, there is a case in which "overrun" would be detected by misunderstanding the engine revolution, with a noise to be generated by harness malfunction and its modification.**

FUEL TEMPERATURE SENSOR

EN1611202F200019

MC No.	14	DTC No.	P0187	Fuel temperature sensor malfunction (Input too low)
MC No.	14	DTC No.	P0188	Fuel temperature sensor malfunction (Input too high)



SHTS161120200040

1. CHECK THE RESISTANCE BETWEEN TERMINALS.

(1) Set the starter switch to the "LOCK" position and connect the signal check harness.
(2) Disconnect the signal check harness connector on the ECU side.
(3) Measure the resistance between B35 and B18 terminals.

HINT

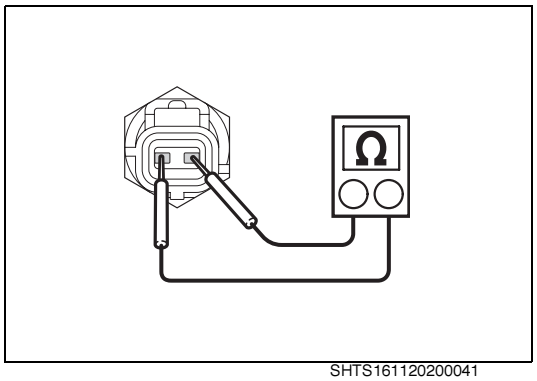
Measure the resistance under any of the following conditions.

Standard:

Coolant temperature	Resistance
20°C {68°F}	**2.45 kΩ**
40°C {104°F}	**1.15 kΩ**
60°C {140°F}	**584 Ω**
80°C {176°F}	**318 Ω**

NO → Proceed to 2.

YES → Proceed to 3.



SHTS161120200041

2. CHECK THE RESISTANCE BETWEEN TERMINALS.

(1) Disconnect the connector of fuel temperature sensor.
(2) Measure the resistance between No.1 and No.2 terminals of fuel temperature sensor.

HINT

Measure the resistance under any of the following conditions.

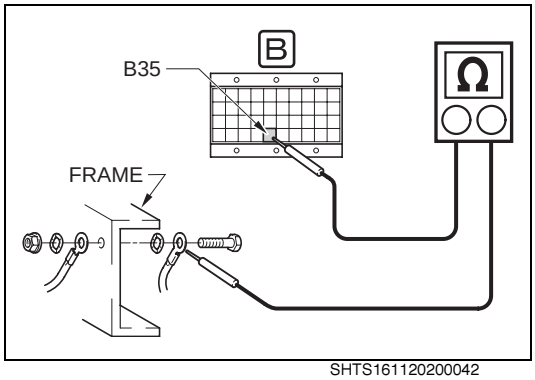
Standard:

Coolant temperature	Resistance
20°C {68°F}	**2.45 kΩ**
40°C {104°F}	**1.15 kΩ**
60°C {140°F}	**584 Ω**
80°C {176°F}	**318 Ω**

NO → Malfunction of fuel temperature sensor

YES →

- Malfunction of harness
- Malfunction of connectors



SHTS161120200042

3. CHECK THE CONTINUITY OF HARNESS.

(1) Measure the resistance between B35 terminal of the signal check harness and chassis GND.

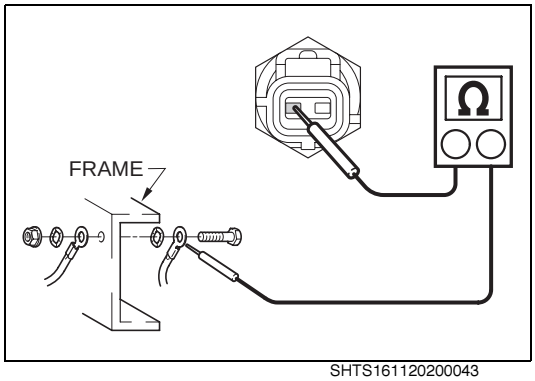
Standard: ∞ Ω

NO

Proceed to 4.

YES

Proceed to 5.



SHTS161120200043

4. CHECK THE FUEL TEMPERATURE SENSOR.

(1) Disconnect the connector of fuel temperature sensor.

(2) Measure the resistance between No.1 terminal of fuel temperature sensor and chassis GND.

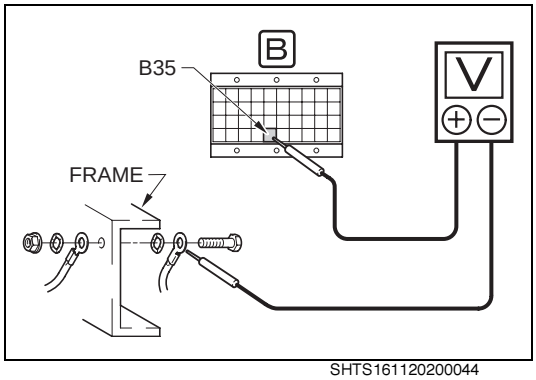
Standard: ∞ Ω

NO

Malfunction of fuel temperature sensor

YES

- Malfunction of harness
- Malfunction of connectors



SHTS161120200044

5. CHECK THE VOLTAGE BETWEEN TERMINALS.

(1) Set the starter switch to the "ON" position.

(2) Measure the voltage between B35 terminal of the signal check harness and chassis GND.

Standard: 1V or less

NO

- Malfunction of harness
- Malfunction of connectors

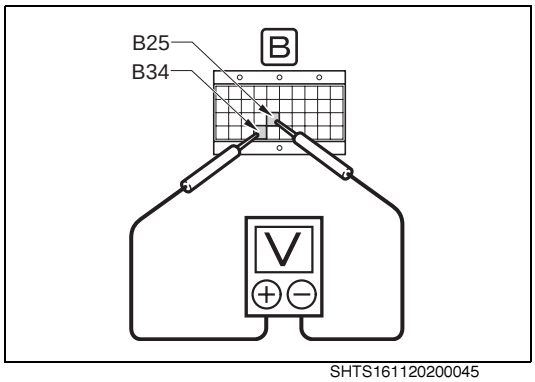
YES

- Malfunction of engine ECU
- Malfunction of ECU connectors

BOOST PRESSURE SENSOR

EN1611202F200020

MC No.	37	DTC No.	P0108	Boost pressure sensor malfunction (Input too high)
MC No.	37	DTC No.	P0237	Boost pressure sensor malfunction (Input too low)



SHTS161120200045

1. CHECK THE VOLTAGE BETWEEN TERMINALS.

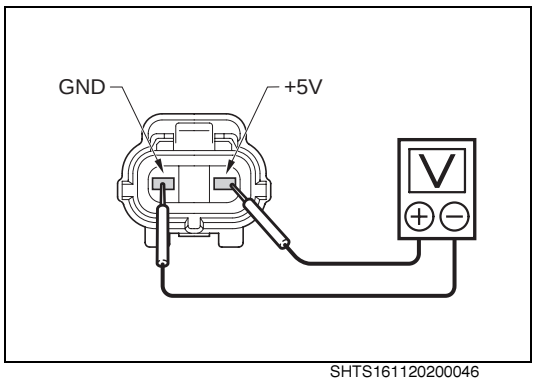
(1) Set the starter switch to the "LOCK" position and connect the signal check harness.
(2) Set the stater switch to the "ON" position.
(3) Measure the voltage between B34 and B25 terminals of the signal check harness.
Standard: 0.2-4.8V
(After measurement, turn the starter switch to "LOCK" position.)

NO

Proceed to 2.

YES

- Malfunction of engine ECU
- Malfunction of ECU connectors



SHTS161120200046

2. CHECK THE VOLTAGE BETWEEN TERMINALS.

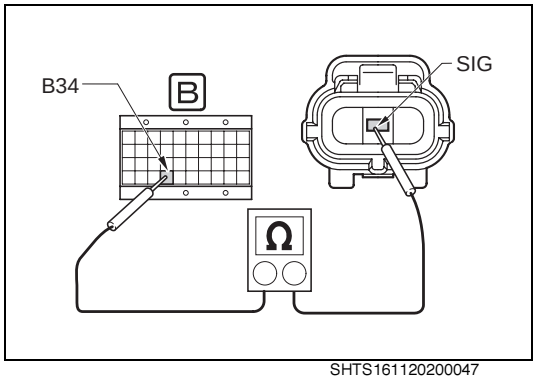
(1) Disconnect the connector of boost pressure sensor.
(2) Set the stater switch to the "ON" position.
(3) Measure the voltage between +5V and GND terminals of boost pressure sensor (Vehicle harness side).
Standard: 4.75-5.25V

NO

Proceed to 5.

YES

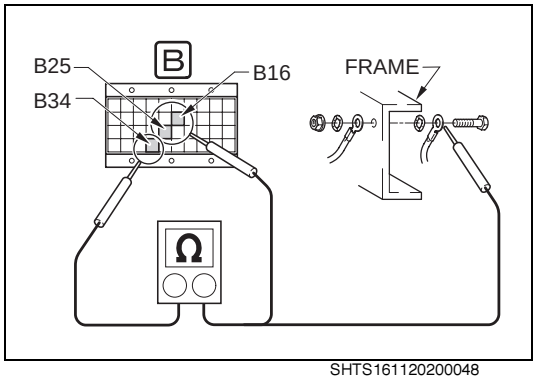
Proceed to 3.



SHTS161120200047

3. CHECK THE CONTINUITY OF HARNESS.

(1) Set the starter switch to the "LOCK" position.
(2) Disconnect the signal check harness connector on the ECU side.
(3) Measure the resistance between B34 terminal of the signal check harness and SIG terminal of boost pressure sensor (Vehicle harness side).
Standard: 2 Ω or less



SHTS161120200048

(4) Measure the resistance between terminals of the signal check harness and chassis GND.

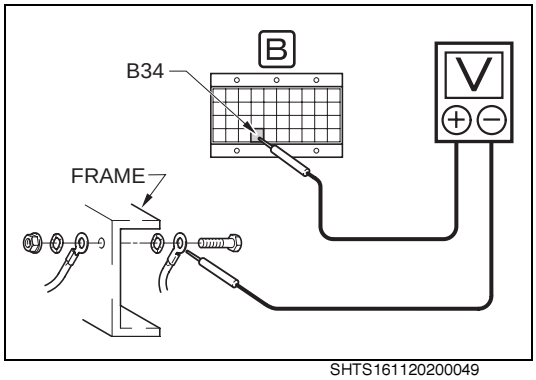
Terminals to measure the resistance
B34 ↔ B16
B34 ↔ B25
B34 ↔ Chassis GND

Standard: ∞ Ω

NO → Malfunction of harness

YES

4. CHECK THE VOLTAGE BETWEEN TERMINALS.



SHTS161120200049

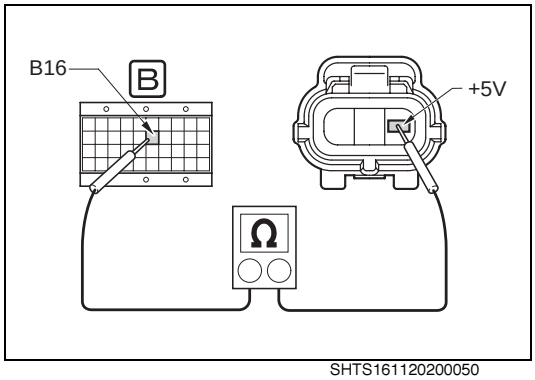
(1) Set the starter switch to the "ON" position.
(2) Measure the voltage between B34 terminal of the signal check harness and chassis GND.

Standard: 1V or less

NO → Malfunction of harness

YES

- Malfunction of boost pressure sensor
- Malfunction of connectors



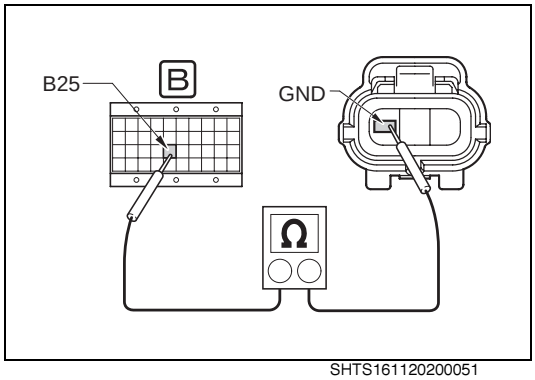
SHTS161120200050

5. CHECK THE CONTINUITY OF HARNESS.

(1) Set the starter switch to the "LOCK" position.

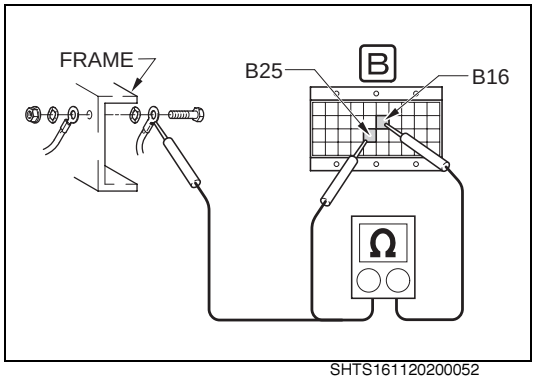
(2) Disconnect the signal check harness connector on the ECU side.

(3) Measure the resistance between B16 terminal of the signal check harness and +5V terminal of boost pressure sensor (Vehicle harness side).
Standard: 2 Ω or less



SHTS161120200051

(4) Measure the resistance between B25 terminal of the signal check harness and GND terminal of boost pressure sensor (Vehicle harness side).
Standard: 2 Ω or less



SHTS161120200052

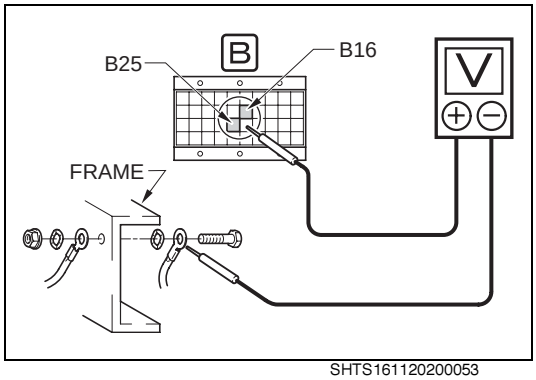
(5) Measure the resistance between terminals of the signal check harness and chassis GND.

Terminals to measure the resistance
B16 ↔ B25
B16 ↔ Chassis GND

Standard: ∞ Ω

NO → Malfunction of harness

YES → Proceed to 6.



SHTS161120200053

6. CHECK THE VOLTAGE BETWEEN TERMINALS.

(1) Set the starter switch to the "ON" position.

(2) Measure the voltage between terminal of the signal check harness and chassis GND.

Terminals to measure the voltage	
+ side	**- side**
B16	Chassis GND
B25	

Standard: 1V or less

NO

Malfunction of harness

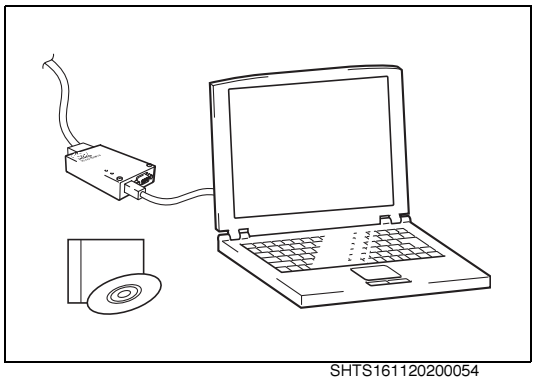
YES

- Malfunction of engine ECU
- Malfunction of ECU connectors

TURBOCHARGER OVER BOOST

EN1611202F200021

MC No.	39	DTC No.	P0234	Turbocharger over boost



SHTS161120200054

1. CHECK THE VNT CONTROL SYSTEM, USING THE PC DIAGNOSIS TOOL (Hino-DX).

(1) Connect the PC DIAGNOSIS TOOL (Hino-DX) (Refer to the page DN02-14).

(2) Set the starter switch to the "ON" position (The engine is stopped).

(3) Select the "Activation Test" menu and check the VNT operation.

Standard: Normal

NO

- Malfunction of VNT
  (Replace the VNT assembly.)

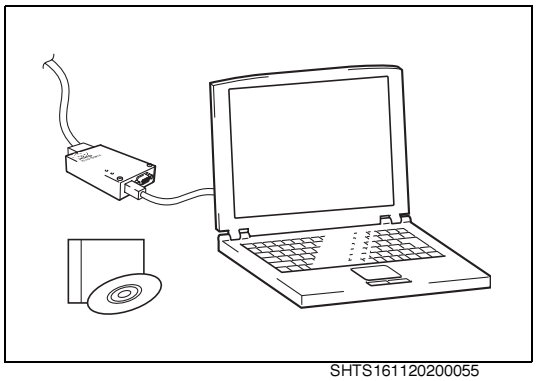
YES

Erace diagnosis of the boost pressure sensor MC No.37 or DTC No. P0108, P0237.

TURBOCHARGER OVERRUN

EN1611202F200022

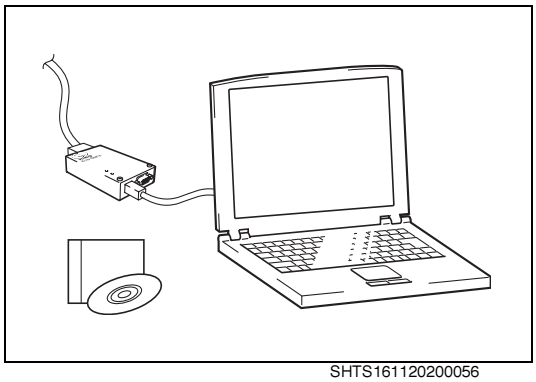
MC No.	39	DTC No.	P0049	Turbocharger overrun



SHTS161120200055

1. CHECK THE TURBOCHARGER, USING THE PC DIAGNOSIS TOOL (Hino-DX).

(1) Connect the PC DIAGNOSIS TOOL (Hino-DX) (Refer to the page DN02-14).
(2) Start the engine.
(3) Select the "Check turbocharger" menu and check the turbocharger operation.



SHTS161120200056

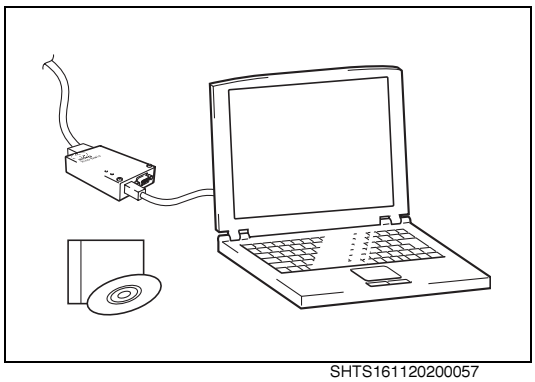
2. CHECK THE VNT CONTROL SYSTEM, USING THE PC DIAGNOSIS TOOL (Hino-DX).

(1) Connect the PC DIAGNOSIS TOOL (Hino-DX) (Refer to the page DN02-14).
(2) Set the starter switch to the "ON" position.
(3) Select the "Activation Test" menu and check the VNT operation.

AIR FLOW SENSOR

EN1611202F200023

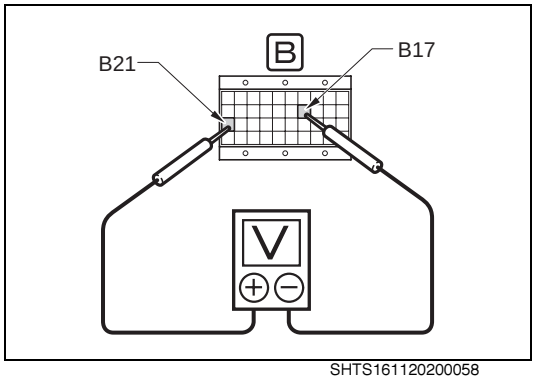
MC No.	17	DTC No.	P0102	Air flow sensor malfunction (Input too low)
MC No.	17	DTC No.	P0103	Air flow sensor malfunction (Input too high)



SHTS161120200057

1. CHECK THE AIR FLOW SENSOR, USING THE DIAGNOSIS TOOL (HINO DX).

(1) Connect the PC DIAGNOSIS TOOL (Hino-DX) (Refer to the page DN02-14).
(2) Check the intake air flow.



SHTS161120200058

2. CHECK THE VOLTAGE BETWEEN TERMINALS.

(1) Set the starter switch to the "LOCK" position and connect the signal check harness.
(2) Set the starter switch to the "ON" position.
(3) Measure the voltage between B21 and B17 terminals of the signal check harness.

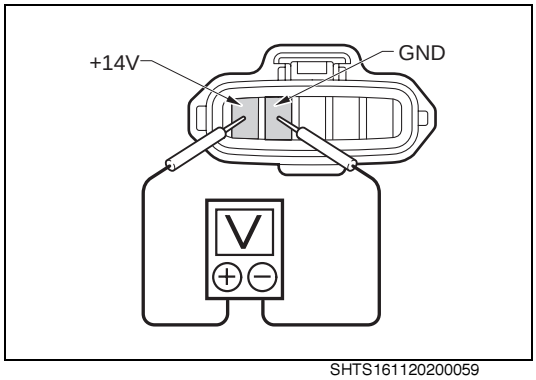
Standard: 0.15-4.85V

NO

Proceed to 3.

YES

- Malfunction of engine ECU
- Malfunction of ECU connectors



SHTS161120200059

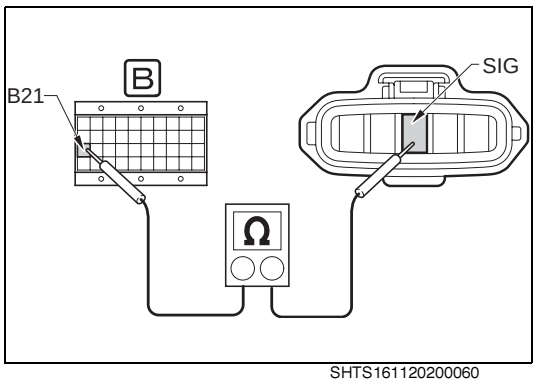
3. CHECK THE VOLTAGE BETWEEN TERMINALS.
(1) Disconnect the air flow sensor connector.
(2) Set the starter switch to the "ON" position.
(3) Measure the voltage between +14V and GND terminals of air flow sensor (Vehicle harness side).

Standard: 10-16V

NO

Proceed to 6.

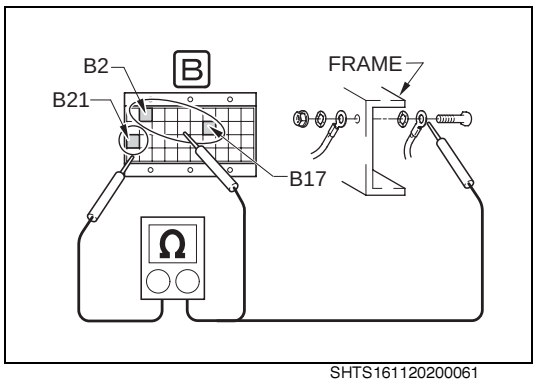
YES



SHTS161120200060

4. CHECK THE CONTINUITY OF HARNESS.
(1) Set the starter switch to the "LOCK" position.
(2) Disconnect the signal check harness connector on the ECU side.
(3) Measure the resistance between B21 terminal of the signal check harness and SIG terminal of air flow sensor (Vehicle harness side).

Standard: 2 Ω or less



SHTS161120200061

(4) Measure the resistance between terminals of the signal check harness and chassis GND.

Terminals to measure the resistance
B21 ↔ B2
B21 ↔ B17
B21 ↔ Chassis GND

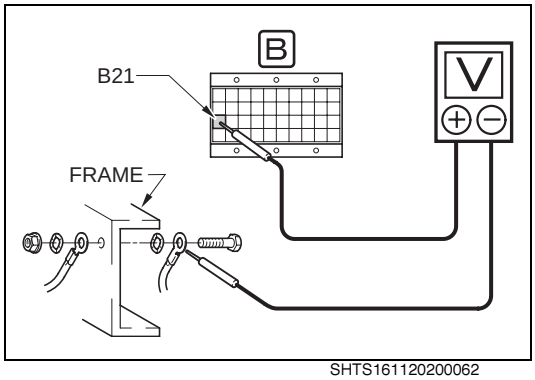
Standard: ∞ Ω

NO

Malfunction of harness

YES

Proceed to 5.



SHTS161120200062

5. CHECK THE VOLTAGE BETWEEN TERMINALS.

(1) Set the starter switch to the "ON" position.

(2) Measure the voltage between B21 terminal of the signal check harness and chassis GND.

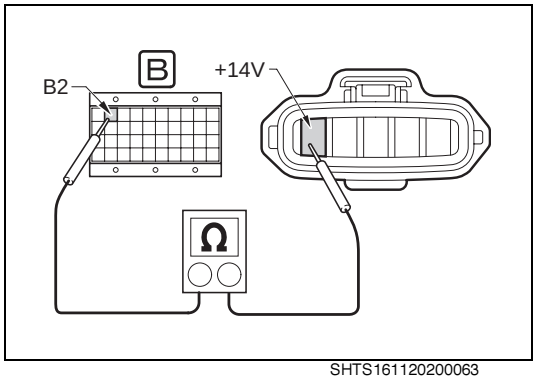
Standard: 1V or less

NO

Malfunction of harness

YES

- Malfunction of air flow sensor
- Malfunction of connectors



SHTS161120200063

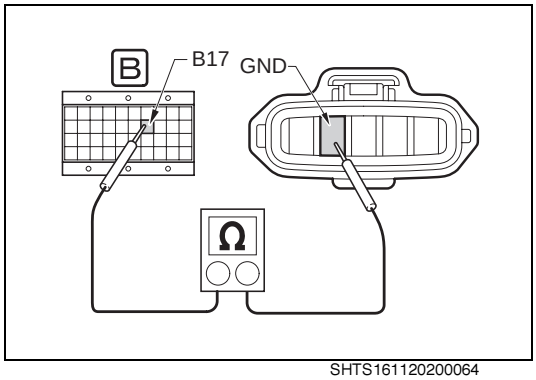
6. CHECK THE CONTINUITY OF HARNESS.

(1) Set the starter switch to the "LOCK" position.

(2) Disconnect the signal check harness connector on the ECU side.

(3) Measure the resistance between B2 terminal of the signal check harness and +14V terminal of air flow sensor (Vehicle harness side).

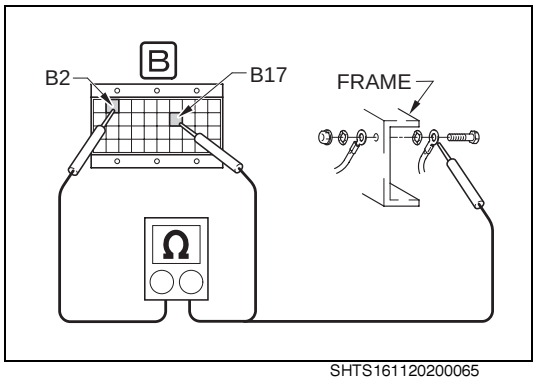
Standard: 2 Ω or less



SHTS161120200064

(4) Measure the resistance between B17 terminal of the signal check harness and GND terminal of air flow sensor (Vehicle harness side).

Standard: 2 Ω or less



SHTS161120200065

(5) Measure the resistance between terminal of the signal check harness and chassis GND.

Terminals to measure the resistance
B2 ↔ Chassis GND
B17 ↔ Chassis GND

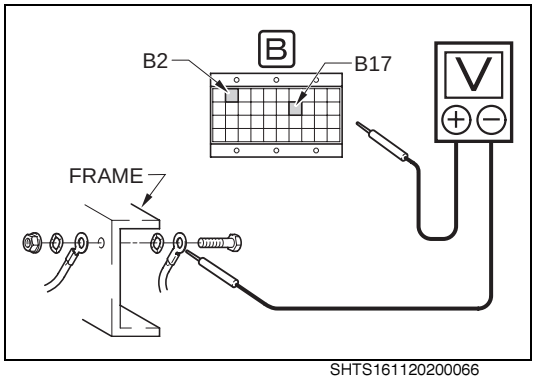
Standard: ∞ Ω

NO

Malfunction of harness

YES

Proceed to 7.



SHTS161120200066

7. CHECK THE VOLTAGE BETWEEN TERMINALS.

(1) Set the starter switch to the "ON" position.

(2) Measure the voltage between terminal of the signal check harness and chassis GND.

Terminals to measure the voltage	
+ side	**- side**
B2	Chassis GND
B17	

Standard: 1V or less

NO

Malfunction of harness

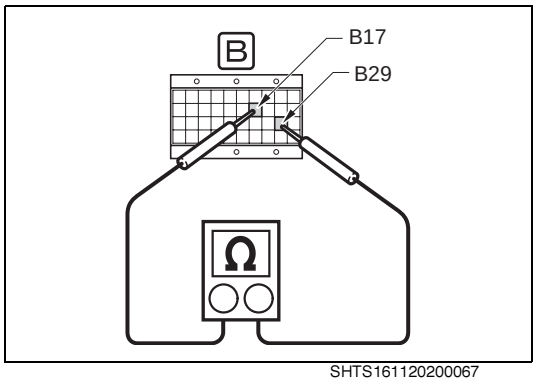
YES

- Malfunction of engine ECU
- Malfunction of ECU connectors

INTAKE AIR TEMPERATURE SENSOR

EN1611202F200024

MC No.	16	DTC No.	P0112	Intake air temperature sensor malfunction (Input too low)
MC No.	16	DTC No.	P0113	Intake air temperature sensor malfunction (Input too high)



SHTS161120200067

1. CHECK THE RESISTANCE BETWEEN TERMINALS.

(1) Set the starter switch to the "LOCK" position and connect the signal check harness.
(2) Disconnect the signal check harness connector on the ECU side.
(3) Measure the resistance between B29 and B17 terminals of the signal check harness.

HINT

Measure the resistance under any of the following conditions.

Standard:

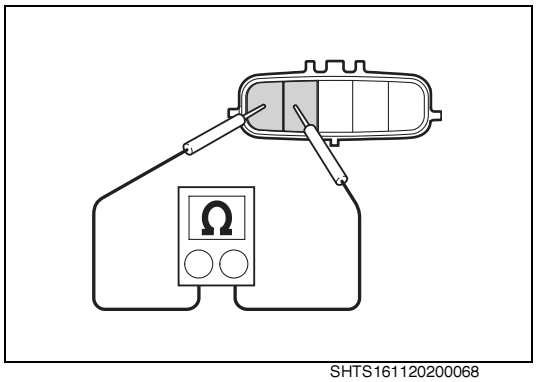
Intake air temperature	Resistance
-20°C {-4°F}	**12.5-16.9 kΩ**
20°C {68°F}	**1.80-2.20 kΩ**
60°C {140°F}	**0.50-0.68 kΩ**

NO

Proceed to 2.

YES

Proceed to 3.



SHTS161120200068

2. CHECK THE RESISTANCE BETWEEN TERMINALS.

(1) Disconnect the connector of intake air temperature (air flow) sensor.
(2) Measure the resistance between No.1 and No.2 terminals of the intake air temperature (air flow) sensor.

HINT

Measure the resistance under any of the following conditions.

Standard:

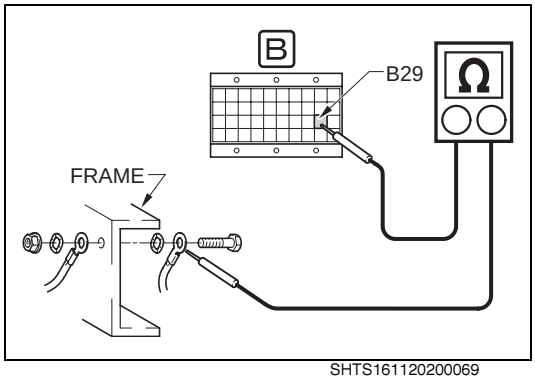
Intake air temperature	Resistance
-20°C {-4°F}	**12.5-16.9 kΩ**
20°C {68°F}	**1.80-2.20 kΩ**
60°C {140°F}	**0.50-0.68 kΩ**

NO

Malfunction of intake air temperature (air flow) sensor

YES

- Malfunction of harness
- Malfunction of connectors



SHTS161120200069

3. CHECK THE CONTINUITY OF HARNESS.

(1) Measure the resistance between B29 terminal of the signal check harness and chassis GND.

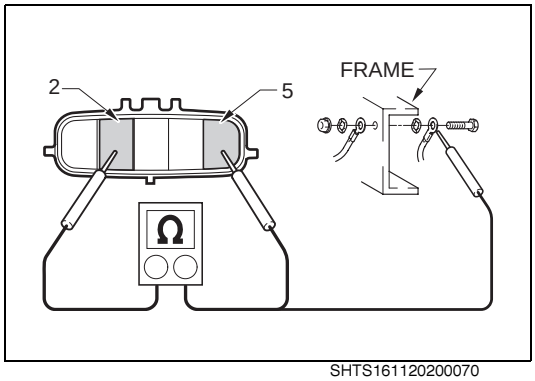
Standard: ∞ Ω

NO

Proceed to 4.

YES

Proceed to 5.



SHTS161120200070

4. CHECK THE INTAKE AIR TEMPERATURE SENSOR.

(1) Disconnect the connector of intake air temperature (air flow) sensor.

(2) Measure the resistance between terminals of intake air temperature (air flow) sensor and chassis GND.

Terminals to measure the resistance
2 ↔ 5
2 ↔ Chassis GND

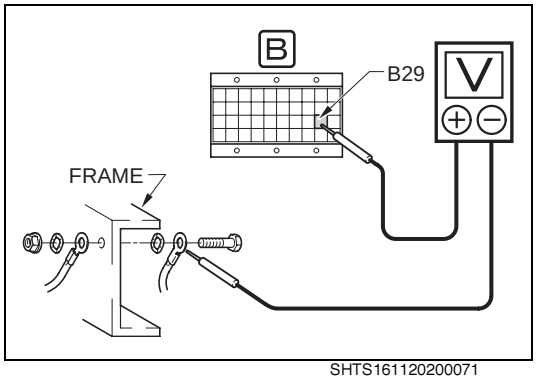
Standard: ∞ Ω

NO

Malfunction of intake air temperature (air flow) sensor

YES

- Malfunction of harness
- Malfunction of connectors



SHTS161120200071

5. CHECK THE VOLTAGE BETWEEN TERMINALS.

(1) Set the starter switch to the "ON" position.

(2) Measure the voltage between B29 terminal of the signal check harness and chassis GND.

Standard: 1V or less

NO

Proceed to 4.

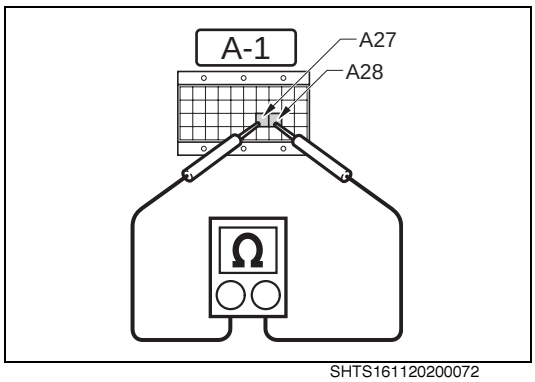
YES

- Malfunction of engine ECU
- Malfunction of ECU connectors

EGR COOLANT TEMPERATURE SENSOR

EN1611202F200025

MC No.	19	DTC No.	P1417	EGR coolant temperature sensor malfunction (Input too low)
MC No.	19	DTC No.	P1418	EGR coolant temperature sensor malfunction (Input too high)



SHTS161120200072

1. CHECK THE RESISTANCE BETWEEN TERMINALS.

(1) Set the starter switch to the "LOCK" position and connect the signal check harness.
(2) Disconnect the signal check harness connector on the ECU side.
(3) Measure the resistance between A27 and A28 terminals of the signal check harness.

HINT

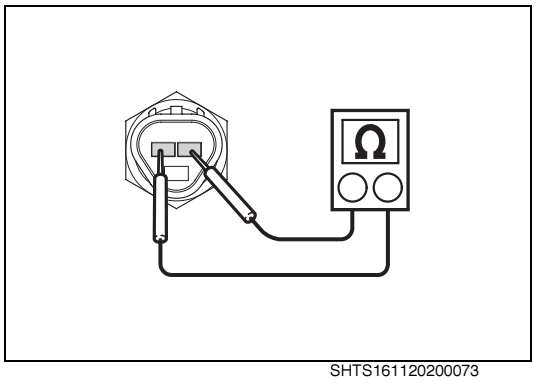
Measure the resistance under any of the following conditions.

Standard:

Coolant temperature	Resistance
20°C {68°F}	**2.45 kΩ**
40°C {104°F}	**1.15 kΩ**
60°C {140°F}	**584 Ω**
80°C {176°F}	**318 Ω**

NO → Proceed to 2.

YES → Proceed to 3.



SHTS161120200073

2. CHECK THE RESISTANCE BETWEEN TERMINALS.

(1) Disconnect the connector of EGR coolant temperature sensor.
(2) Measure the resistance between No.1 and No.2 terminals of EGR coolant temperature sensor.

HINT

Measure the resistance under any of the following conditions.

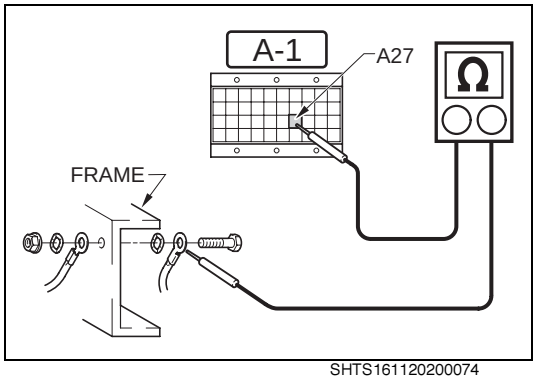
Standard:

Coolant temperature	Resistance
20°C {68°F}	**2.45 kΩ**
40°C {104°F}	**1.15 kΩ**
60°C {140°F}	**584 Ω**
80°C {176°F}	**318 Ω**

NO → Malfunction of EGR coolant temperature sensor

YES →

- Malfunction of harness
- Malfunction of the connector



SHTS161120200074

3. CHECK THE CONTINUITY OF HARNESS.

(1) Measure the resistance between A27 terminal of the signal check harness and chassis GND.

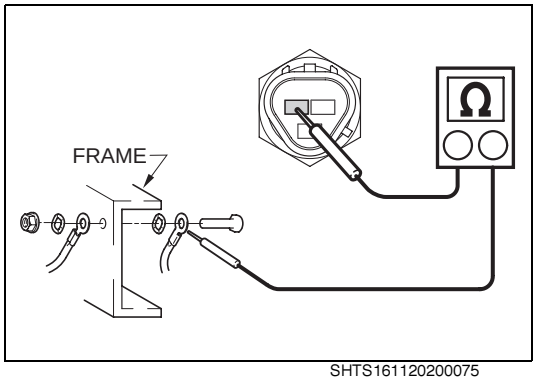
Standard: ∞ Ω

NO

Proceed to 4.

YES

Proceed to 5.



SHTS161120200075

4. CHECK THE EGR COOLANT TEMPERATURE SENSOR.

(1) Disconnect the connector of EGR coolant temperature sensor.

(2) Measure the resistance between No.1 terminal of EGR coolant temperature sensor and chassis GND.

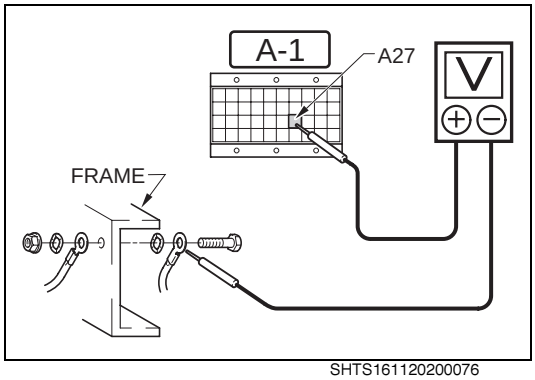
Standard: ∞ Ω

NO

Malfunction of EGR coolant temperature sensor

YES

- Malfunction of harness
- Malfunction of connectors



SHTS161120200076

5. CHECK THE VOLTAGE BETWEEN TERMINALS.

(1) Set the starter switch to the "ON" position.

(2) Measure the voltage between A27 terminal of the signal check harness and chassis GND.

Standard: 1V or less

NO

- Malfunction of harness
- Malfunction of connectors

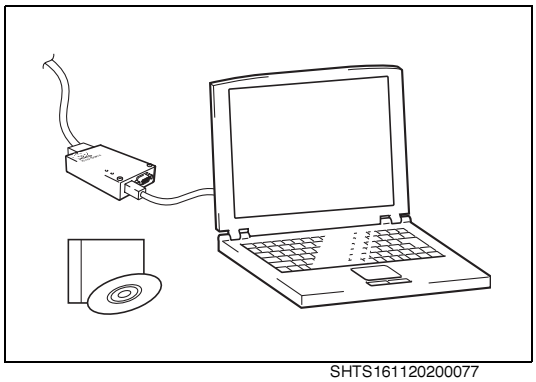
YES

- Malfunction of engine ECU
- Malfunction of ECU connectors

COMMON RAIL PRESSURE, CONTROL SYSTEM

EN1611202F200026

MC No.	68	DTC No.	P0088	Excessive common rail pressure (1st step)
MC No.	69	DTC No.	P0088	Excessive common rail pressure (2nd step)



SHTS161120200077

1. INSPECTION ITEM

(1) When a valve opening or closing failure occurs in the pressure limiter due to an excessive common rail pressure rise, the diagnosis determines such phenomenon as a trouble.
If this failure code is output, there may be troubles such as:

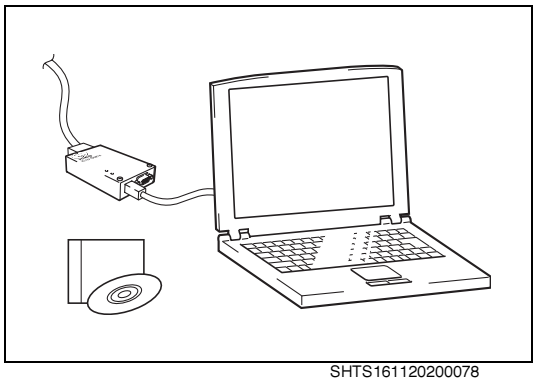
- malfunction of supply pump,
- malfunction of common rail pressure sensor,
- excessive fuel flow due to trouble in fuel supply system,
- leakage trouble inside the injector, and
- malfunction of engine ECU, harness or connector.

(2) Replace the pressure limiter. More detailed diagnosis should be done by PC DIAGNOSIS TOOL (Hino-DX).

COMMON RAIL PRESSURE

EN1611202F200027

MC No.	76	DTC No.	P0088	Excessive common rail pressure



SHTS161120200078

1. INSPECTION ITEM

(1) When no failures are found with the DTC No. P0628, P0629, P0088, P0191, P0192 and P0193/MC No. 74, 75, 68, 69, 76 and 67 but an actual common rail pressure exceeds the target pressure by 15 MPa or greater for a certain duration of time at the engine speed of 450 r/min or more, the diagnosis will determine such phenomenon as a trouble.

(2) Use the Hino-DX to check that no other failure codes are output.
If other failure codes are output, fix to clear such failure codes.

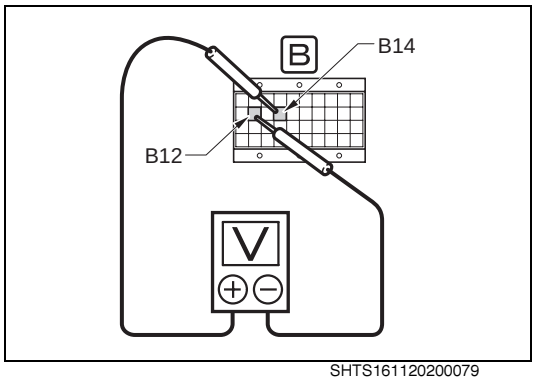
(3) Check the supply pump set timing. If installation would fail to be set to the top dead center of 0, correct installation.

(4) If no troubles are found by the aforesaid checks, use the Hino-DX to delete the past failures and start the engine.
If the same code is output again, there may be a trouble in the supply pump or the common rail pressure sensor, an excessive fuel flow due to a trouble in the fuel supply system, a leakage trouble inside the injector, and/or a trouble in the engine ECU, harnesses or connectors.
More detailed diagnosis should be done by PC DIAGNOSIS TOOL (Hino-DX).

COMMON RAIL PRESSURE SENSOR

EN1611202F200028

MC No.	67	DTC No.	P0191	Common rail pressure sensor stuck



SHTS161120200079

1. CHECK THE VOLTAGE BETWEEN TERMINALS.

(1) Set the starter switch to the "LOCK" position and connect the signal check harness.

(2) Start and warm up the engine until an indicator of the coolant temperature gauge starts reading. Then stop the engine.

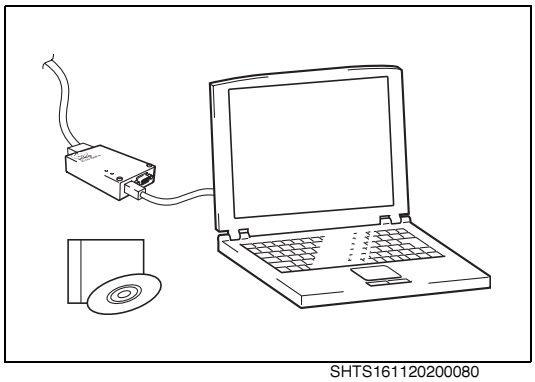
(3) After an engine coolant temperature lowers 10°C {50°F}, set the starter switch to the "ON" position and measure the voltage between B12 and B14 terminals of the signal check harness.
Standard: 0.39-0.66V

NO

Proceed to 2.

YES

- Malfunction of engine ECU
- Malfunction of ECU connectors


SHTS161120200080

2. CHECK THE MC OR DTC.

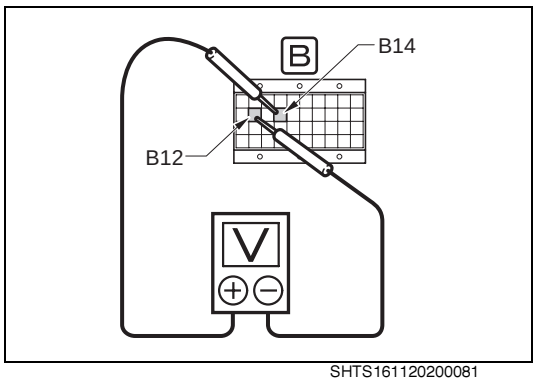
(1) Replace the common rail pressure sensor and conduct the same check again.

(2) If the same failure code is output again, there may be a trouble in harnesses, connectors or engine ECU, a leakage trouble inside the injector, or clogging in the leak pipe.
More detailed diagnosis should be done by PC DIAGNOSIS TOOL (Hino-DX).

COMMON RAIL PRESSURE SENSOR

EN1611202F200029

MC No.	67	DTC No.	P0192	Common rail pressure sensor malfunction (Input too low)
MC No.	67	DTC No.	P0193	Common rail pressure sensor malfunction (Input too high)



SHTS161120200081

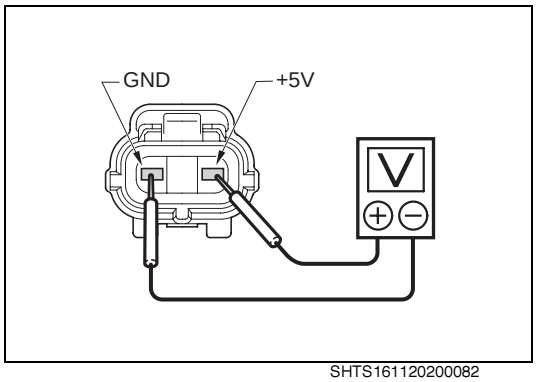
1. CHECK THE VOLTAGE BETWEEN TERMINALS.

(1) Set the starter switch to the "LOCK" position and connect the signal check harness.
(2) Set the starter switch to the "ON" position.
(3) Measure the voltage between B14 and B12 terminals of the signal check harness.
Standard: 0.2-4.8V
(After measurement, turn the starter switch to "LOCK" position.)

NO → Proceed to 2.

YES →

- Malfunction of engine ECU
- Malfunction of ECU connectors



SHTS161120200082

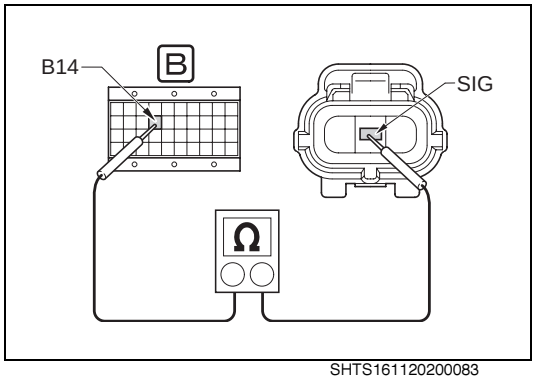
2. CHECK THE VOLTAGE BETWEEN TERMINALS.

(1) Disconnect the connector of common rail pressure sensor.
(2) Set the starter switch to the "ON" position.
(3) Measure the voltage between +5V and GND terminals of common rail pressure sensor (Vehicle harness side).
Standard: 4.75-5.25V

NO → Proceed to 5.

YES →

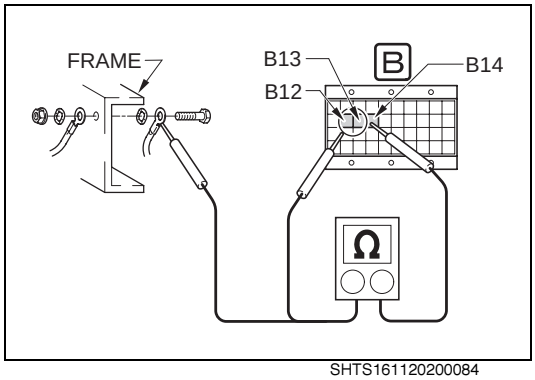
Proceed to 3.



SHTS161120200083

3. CHECK THE CONTINUITY OF HARNESS.

(1) Set the starter switch to the "LOCK" position.
(2) Disconnect the signal check harness connector on the ECU side.
(3) Measure the resistance between B14 terminal of the signal check harness and SIG terminal of common rail pressure sensor (Vehicle harness side).
Standard: 2 Ω or less



SHTS161120200084

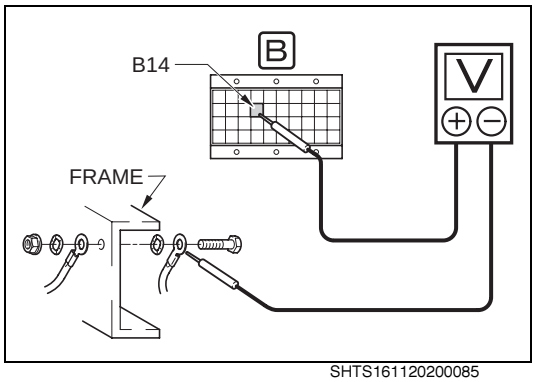
(4) Measure the resistance between terminals of the signal check harness and chassis GND.

Terminals to measure the resistance
B14 ↔ B12
B14 ↔ B13
B14 ↔ Chassis GND

Standard: ∞ Ω

NO → Malfunction of harness

YES



SHTS161120200085

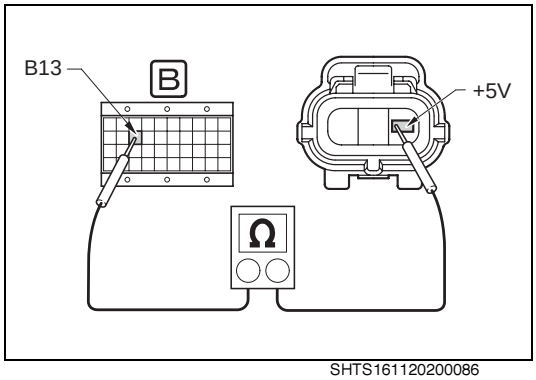
4. CHECK THE VOLTAGE BETWEEN TERMINALS.

(1) Set the starter switch to the "ON" position.
(2) Measure the voltage between B14 terminal of the signal check harness and chassis GND.
Standard: 1V or less

NO → Malfunction of harness

YES

- Malfunction of common rail pressure sensor
- Malfunction of connectors



SHTS161120200086

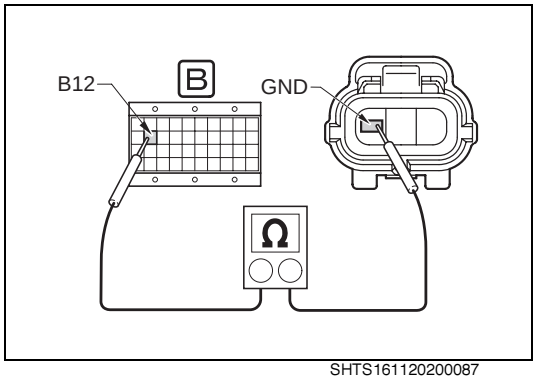
5. CHECK THE CONTINUITY OF HARNESS.

(1) Set the starter switch to the "LOCK" position.

(2) Disconnect the signal check harness connector on the ECU side.

(3) Measure the resistance between B13 terminal of the signal check harness and +5V terminal of common rail pressure sensor (Vehicle harness side).

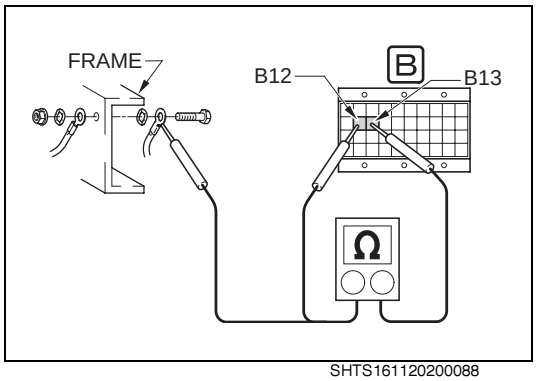
Standard: 2 Ω or less



SHTS161120200087

(4) Measure the resistance between B12 terminal of the signal check harness and GND terminal of common rail pressure sensor (Vehicle harness side).

Standard: 2 Ω or less



SHTS161120200088

(5) Measure the resistance between terminals of the signal check harness and chassis GND.

Terminals to measure the resistance
B13 ↔ B12
B13 ↔ Chassis GND

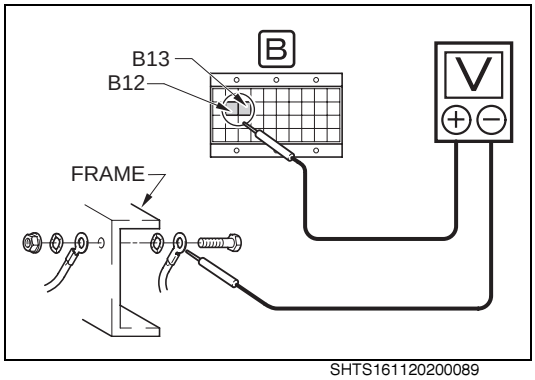
Standard: ∞ Ω

NO

Malfunction of harness

YES

Proceed to 6.



SHTS161120200089

6. CHECK THE VOLTAGE BETWEEN TERMINALS.

(1) Set the starter switch to the "ON" position.

(2) Measure the voltage between terminal of the signal check harness and chassis GND.

Terminals to measure the voltage	
+ side	**- side**
B12	Chassis GND
B13	

Standard: 1V or less

NO → Malfunction of harness

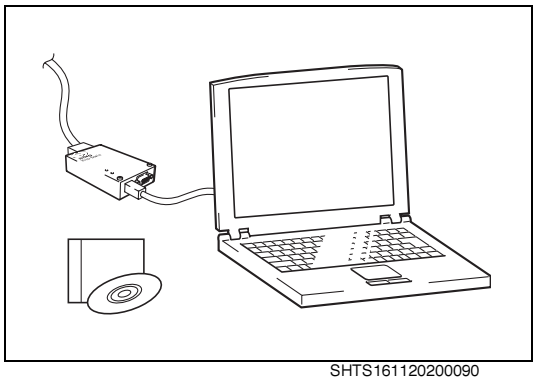
YES →

- Malfunction of engine ECU
- Malfunction of ECU connectors

FUEL LEAKAGE

EN1611202F200030

MC No.	78	DTC No.	P0093	Fuel leakage



SHTS161120200090

1. INSPECTION ITEM

(1) When no failures are found with the DTC No. P0628, P0629, P0191, P0192 and P0193 but a phenomenon described below is detected at the engine speed of 450 r/min or more, the diagnosis will determine such phenomenon as a trouble.

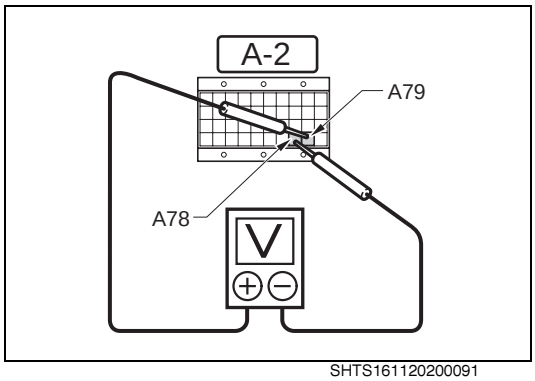
- In case the supply pump is running at a maximum discharge rate but an actual common rail pressure (RailCo-pPeak) is 15 MPa {153 kgf/cm^2} lower than the target pressure (Rail-psetpoint) for a certain duration of time.
  When this failure is detected, both an injection flow and an injection pressure will be limited thus the engine power will be kept low. Check the fuel supply system for clogging. If no troubles are found in the high-pressure piping, there may be a trouble in the supply pump.

(2) More detailed diagnosis should be done by PC DIAGNOSIS TOOL (Hino-DX).

ACCELERATOR SENSOR 1

EN1611202F200031

MC No.	22	DTC No.	P2121	Accelerator sensor 1 abnormal voltage (Stuck close/open)



SHTS161120200091

1. CHECK THE VOLTAGE BETWEEN TERMINALS.

(1) Set the starter switch to the "LOCK" position and connect the signal check harness.

(2) Set the starter switch to the "ON" position. Depress the accelerator pedal to measure the voltage between A78 and A79 terminals of the signal check harness.

NOTICE

The standard value at full throttle is based on an actual measurement value.

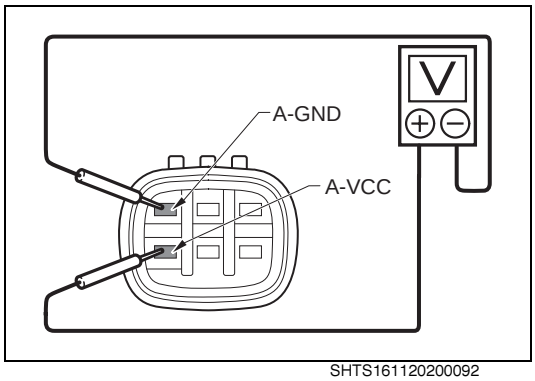
Standard:
0.7-1.0V (Accelerator pedal released)
3.7-4.4V (Full throttle)
A voltage over 1.0V shall change in proportion to an accelerator pedal travel.

NO

Proceed to 2.

YES

- Malfunction of engine ECU
- Malfunction of ECU connectors



SHTS161120200092

2. CHECK THE VOLTAGE BETWEEN TERMINALS.

(1) Disconnect the connector of accelerator sensor.

(2) Set the starter switch to the "ON" position.

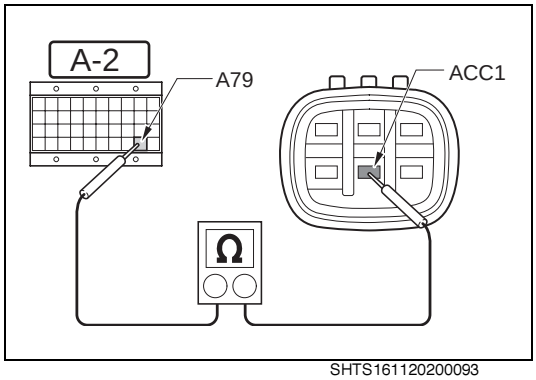
(3) Measure the voltage between A-VCC and A-GND terminals of accelerator sensor (Vehicle harness side).
Standard: 4.7-5.3V

NO

Proceed to 5.

YES

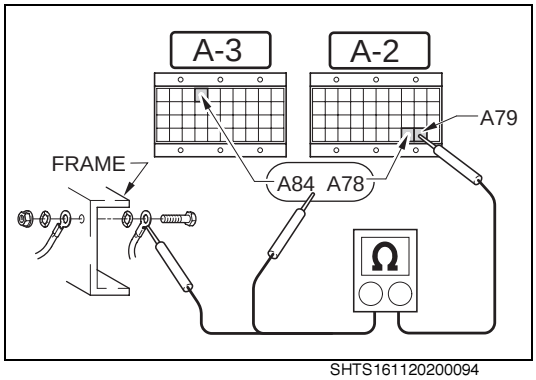
Proceed to 3.



SHTS161120200093

3. CHECK THE CONTINUITY OF HARNESS.

(1) Set the starter switch to the "LOCK" position.
(2) Disconnect the signal check harness connector on the ECU side.
(3) Measure the resistance between A79 terminal of the signal check harness and ACC1 terminal of accelerator sensor (Vehicle harness side).
Standard: 2 Ω or less



SHTS161120200094

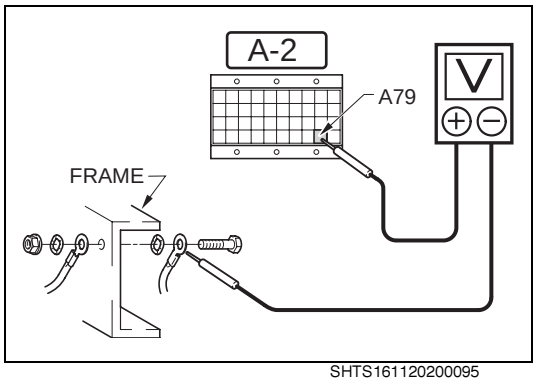
(4) Measure the resistance between terminals of the signal check harness and chassis GND.

Terminals to measure the resistance
A79 ↔ A78
A79 ↔ A84
A79 ↔ Chassis GND

Standard: ∞ Ω

NO → Malfunction of harness

YES



SHTS161120200095

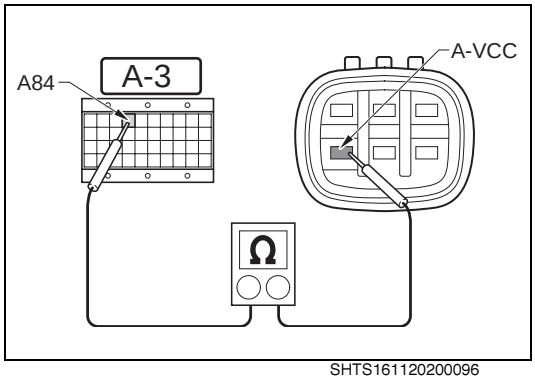
4. CHECK THE VOLTAGE BETWEEN TERMINALS.

(1) Set the starter switch to the "ON" position.
(2) Measure the voltage between A79 terminal of the signal check harness and chassis GND.
Standard: 1V or less

NO → Malfunction of harness

YES

- Malfunction of accelerator sensor
- Malfunction of connectors

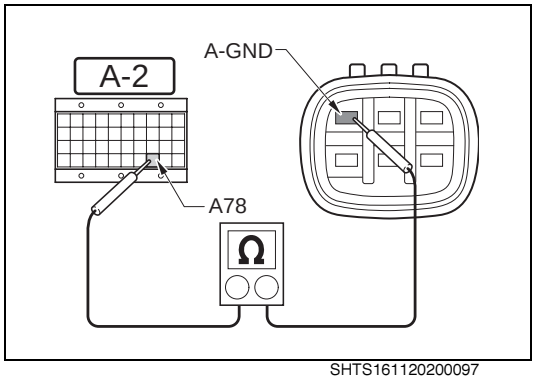


SHTS161120200096

5. CHECK THE CONTINUITY OF HARNESS.

(1) Set the starter switch to the "LOCK" position.
(2) Disconnect the signal check harness connector on the ECU side.
(3) Measure the resistance between A84 terminal of the signal check harness and A-VCC terminal of accelerator sensor (Vehicle harness side).

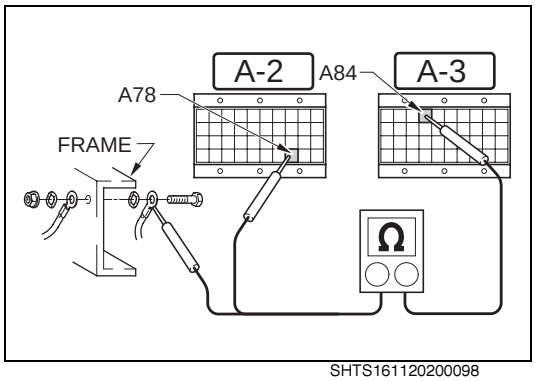
Standard: 2 Ω or less



SHTS161120200097

(4) Measure the resistance between A78 terminal of the signal check harness and A-GND terminal of accelerator sensor (Vehicle harness side).

Standard: 2 Ω or less



SHTS161120200098

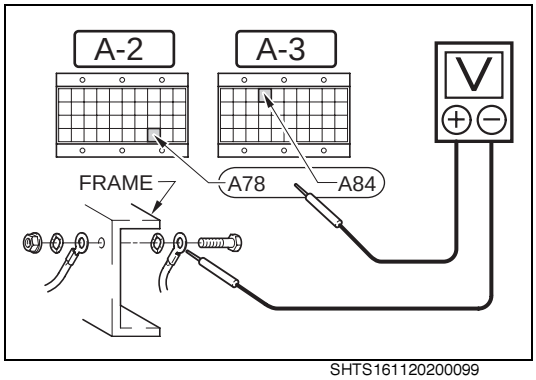
(5) Measure the resistance between terminals of the signal check harness and chassis GND.

Terminals to measure the resistance
A84 ↔ A78
A84 ↔ Chassis GND

Standard: ∞ Ω

NO → Malfunction of harness

YES → Proceed to 6.



SHTS161120200099

6. CHECK THE VOLTAGE BETWEEN TERMINALS.

(1) Set the starter switch to the "ON" position.

(2) Measure the voltage between terminal of the signal check harness and chassis GND.

Terminals to measure the voltage	
+ side	**- side**
A78	Chassis GND
A84	

Standard: 1V or less

NO

Malfunction of harness

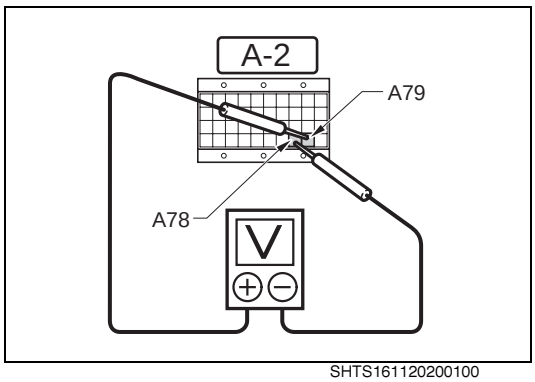
YES

- Malfunction of engine ECU
- Malfunction of ECU connectors

ACCELERATOR SENSOR 1

EN1611202F200032

MC No.	22	DTC No.	P2122	Accelerator sensor 1 malfunction (Input too low)
MC No.	22	DTC No.	P2123	Accelerator sensor 1 malfunction (Input too high)



SHTS161120200100

1. CHECK THE VOLTAGE BETWEEN TERMINALS.

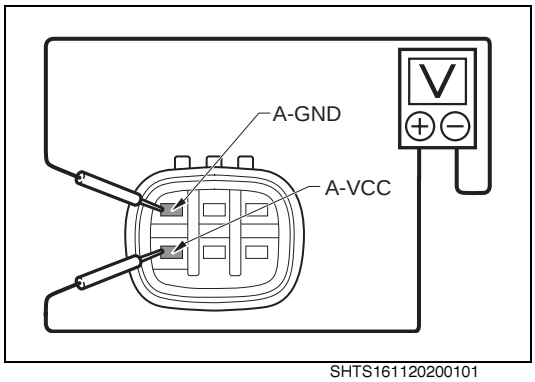
(1) Set the starter switch to the "LOCK" position and connect the signal check harness.
(2) Set the starter switch to the "ON" position.
(3) Measure the voltage between A79 and A78 terminals of the signal check harness.
Standard: 0.60-4.85V: Idle to full throttle

NO

Proceed to 2.

YES

- Malfunction of engine ECU
- Malfunction of ECU connectors



SHTS161120200101

2. CHECK THE VOLTAGE BETWEEN TERMINALS.

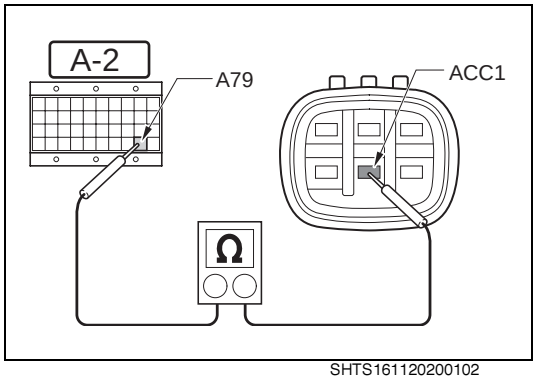
(1) Disconnect the connector of accelerator sensor.
(2) Set the starter switch to the "ON" position.
(3) Measure the voltage between A-VCC and A-GND terminals of accelerator sensor (Vehicle harness side).
Standard: 4.7-5.3V

NO

Proceed to 5.

YES

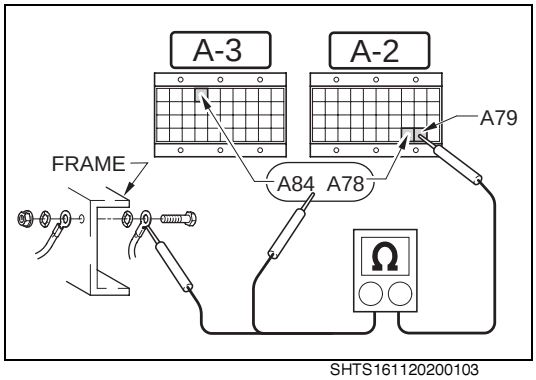
Proceed to 3.



SHTS161120200102

3. CHECK THE CONTINUITY OF HARNESS.

(1) Set the starter switch to the "LOCK" position.
(2) Disconnect the signal check harness connector on the ECU side.
(3) Measure the resistance between A79 terminal of the signal check harness and ACC1 terminal of accelerator sensor (Vehicle harness side).
Standard: 2 Ω or less



SHTS161120200103

(4) Measure the resistance between terminals of the signal check harness and chassis GND.

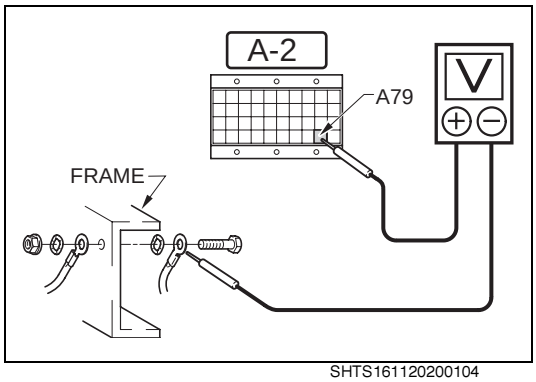
Terminals to measure the resistance
A79 ↔ A78
A79 ↔ A84
A79 ↔ Chassis GND

Standard: ∞ Ω

NO → Malfunction of harness

YES

4. CHECK THE VOLTAGE BETWEEN TERMINALS.



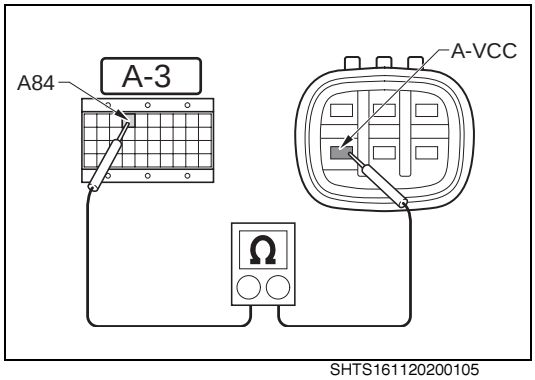
SHTS161120200104

(1) Set the starter switch to the "ON" position.
(2) Measure the voltage between A79 terminal of the signal check harness and chassis GND.
Standard: 1V or less

NO → Malfunction of harness

YES

- Malfunction of accelerator sensor
- Malfunction of connectors

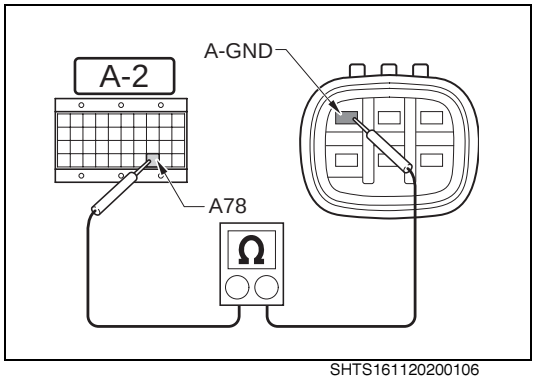


SHTS161120200105

5. CHECK THE CONTINUITY OF HARNESS.

(1) Set the starter switch to the "LOCK" position.
(2) Disconnect the signal check harness connector on the ECU side.
(3) Measure the resistance between A84 terminal of the signal check harness and A-VCC terminal of accelerator sensor (Vehicle harness side).

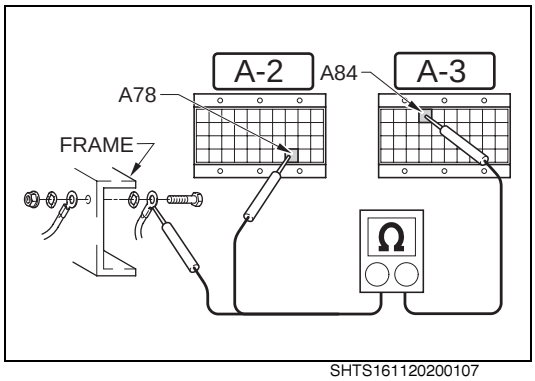
Standard: 2 Ω or less



SHTS161120200106

(4) Measure the resistance between A78 terminal of the signal check harness and A-GND terminal of accelerator sensor (Vehicle harness side).

Standard: 2 Ω or less



SHTS161120200107

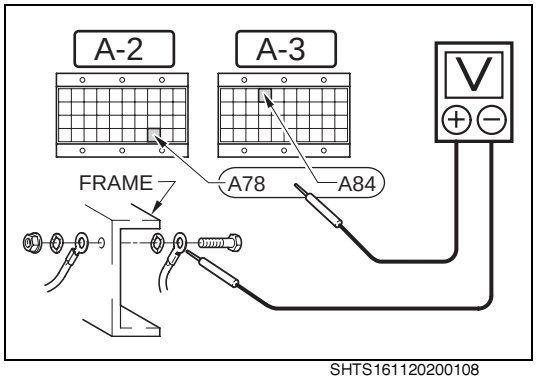
(5) Measure the resistance between terminals of the signal check harness and chassis GND.

Terminals to measure the resistance
A84 ↔ A78
A84 ↔ Chassis GND

Standard: ∞ Ω

NO → Malfunction of harness

YES → Proceed to 6.



SHTS161120200108

6. CHECK THE VOLTAGE BETWEEN TERMINALS.

(1) Set the starter switch to the "ON" position.

(2) Measure the voltage between terminal of the signal check harness and chassis GND.

Terminals to measure the voltage	
+ side	**- side**
A78	Chassis GND
A84	

Standard: 1V or less

NO

Malfunction of harness

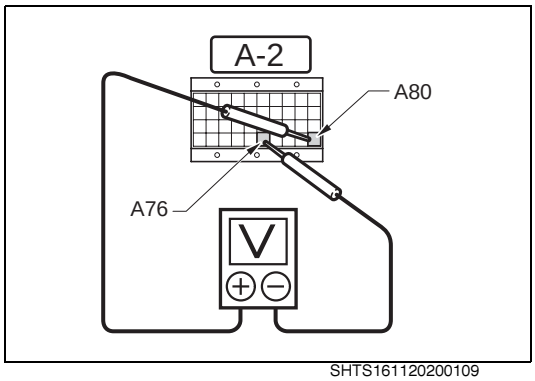
YES

- Malfunction of engine ECU
- Malfunction of ECU connectors

ACCELERATOR SENSOR 2

EN1611202F200033

MC No.	22	DTC No.	P2126	Accelerator sensor 2 abnormal voltage (Stuck close/open)



SHTS161120200109

1. CHECK THE VOLTAGE BETWEEN TERMINALS.

(1) Set the starter switch to the "LOCK" position and connect the signal check harness.
(2) Set the starter switch to the "ON" position.
(3) Measure the voltage between the A80 and A76 terminals of the signal check harness with depress the accelerator pedal.

NOTICE

The standard value at full throttle is based on an actual measurement value.

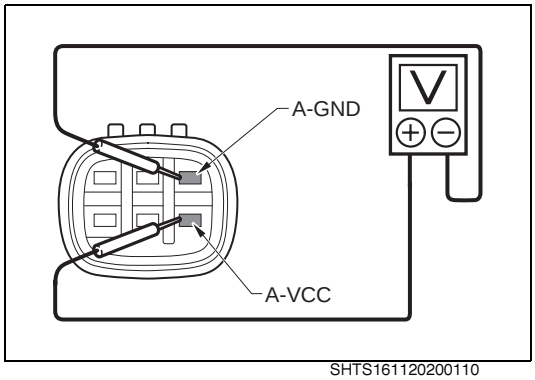
Standard:
0.7-1.0V (Accelerator pedal released)
3.7-4.40V (Full throttle)
A voltage over 1.0V shall change in proportion to an accelerator pedal travel.

NO

Proceed to 2.

YES

- Malfunction of engine ECU
- Malfunction of ECU connectors



SHTS161120200110

2. CHECK THE VOLTAGE BETWEEN TERMINALS.

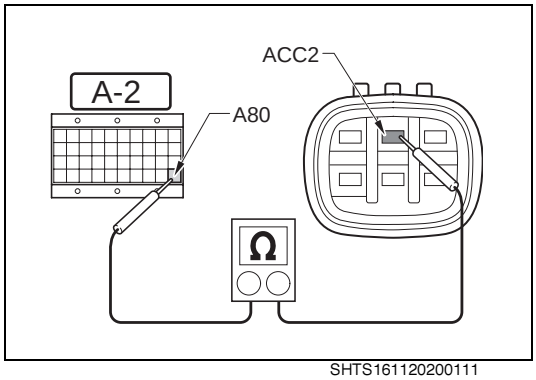
(1) Disconnect the connector of accelerator sensor.
(2) Set the starter switch to the "ON" position.
(3) Measure the voltage between A-VCC and A-GND terminals of accelerator sensor (Vehicle harness side).
Standard: 4.7-5.3V

NO

Proceed to 5.

YES

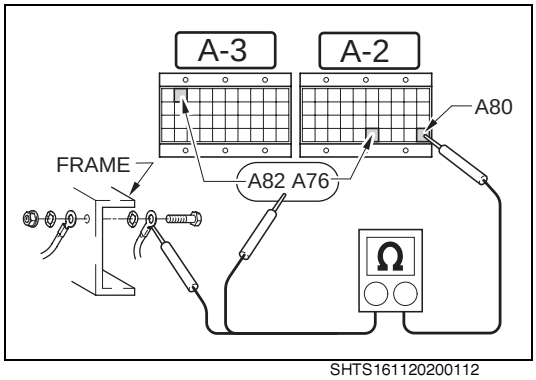
Proceed to 3.



SHTS161120200111

3. CHECK THE CONTINUITY OF HARNESS.

(1) Set the starter switch to the "LOCK" position.
(2) Disconnect the signal check harness connector on the ECU side.
(3) Measure the resistance between A80 terminal of the signal check harness and ACC2 terminal of accelerator sensor (Vehicle harness side).
Standard: 2 Ω or less



SHTS161120200112

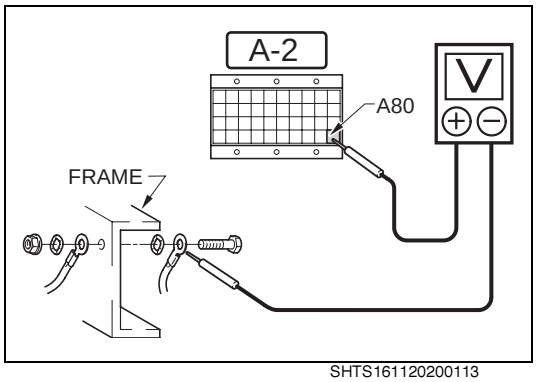
(4) Measure the resistance between terminals of the signal check harness and chassis GND.

Terminals to measure the resistance
A80 ↔ A76
A80 ↔ A82
A80 ↔ Chassis GND

Standard: ∞ Ω

NO → Malfunction of harness

YES



SHTS161120200113

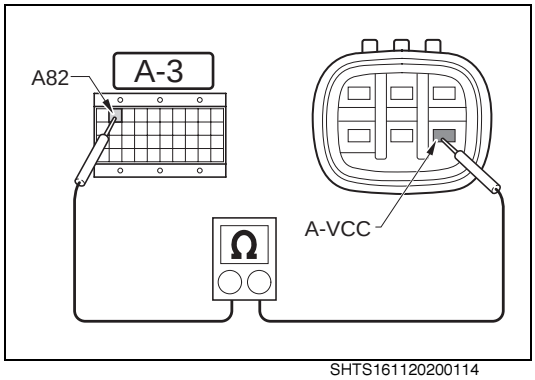
4. CHECK THE VOLTAGE BETWEEN TERMINALS.

(1) Set the starter switch to the "ON" position.
(2) Measure the voltage between A80 terminal of the signal check harness and chassis GND.
Standard: 1V or less

NO → Malfunction of harness

YES

- Malfunction of accelerator sensor
- Malfunction of connectors

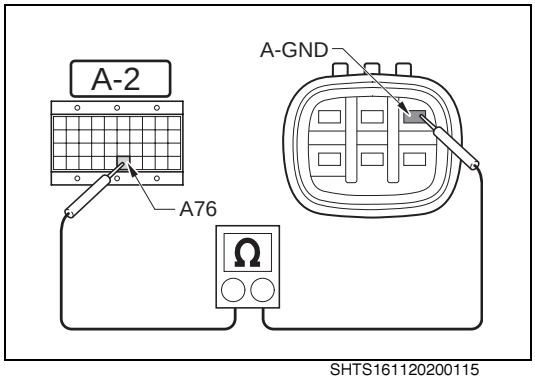


SHTS161120200114

5. CHECK THE CONTINUITY OF HARNESS.

(1) Set the starter switch to the "LOCK" position.
(2) Disconnect the signal check harness connector on the ECU side.
(3) Measure the resistance between A82 terminal of the signal check harness and A-VCC terminal of accelerator sensor (Vehicle harness side).

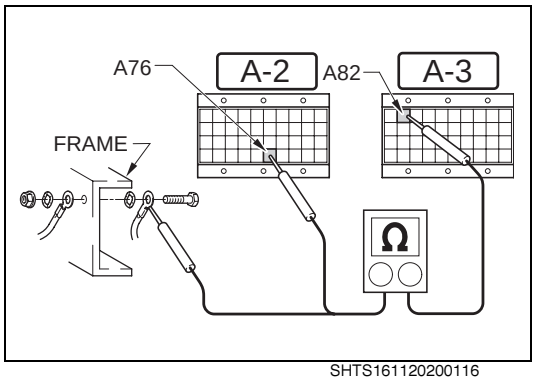
Standard: 2 Ω or less



SHTS161120200115

(4) Measure the resistance between A76 terminal of the signal check harness and A-GND terminal of accelerator sensor (Vehicle harness side).

Standard: 2 Ω or less



SHTS161120200116

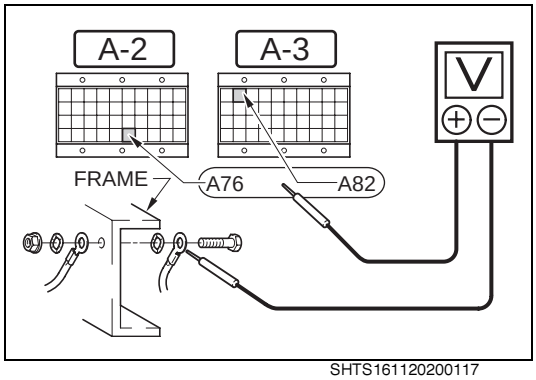
(5) Measure the resistance between terminals of the signal check harness and chassis GND.

Terminals to measure the resistance
A82 ↔ A76
A82 ↔ Chassis GND

Standard: ∞ Ω

NO → Malfunction of harness

YES → Proceed to 6.



SHTS161120200117

6. CHECK THE VOLTAGE BETWEEN TERMINALS.

(1) Set the starter switch to the "ON" position.

(2) Measure the voltage between terminal of the signal check harness and chassis GND.

Terminals to measure the voltage	
+ side	**- side**
A76	Chassis GND
A82	

Standard: 1V or less

NO

Malfunction of harness

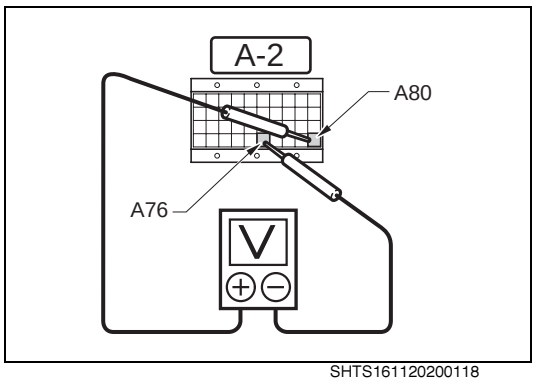
YES

- Malfunction of engine ECU
- Malfunction of ECU connectors

ACCELERATOR SENSOR 2

EN1611202F200034

MC No.	22	DTC No.	P2127	Accelerator sensor 2 malfunction (Input too low)
MC No.	22	DTC No.	P2128	Accelerator sensor 2 malfunction (Input too high)



SHTS161120200118

1. CHECK THE VOLTAGE BETWEEN TERMINALS.

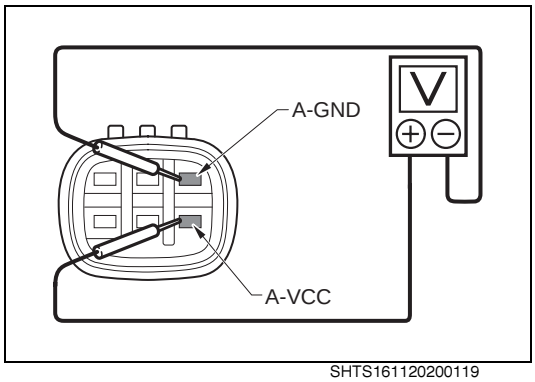
(1) Set the starter switch to the "LOCK" position and connect the signal check harness.
(2) Set the starter switch to the "ON" position.
(3) Measure the voltage between A80 and A76 terminals of the signal check harness.
Standard: 0.60-4.85V: Idle to full throttle

NO

Proceed to 2.

YES

- Malfunction of engine ECU
- Malfunction of ECU connectors



SHTS161120200119

2. CHECK THE VOLTAGE BETWEEN TERMINALS.

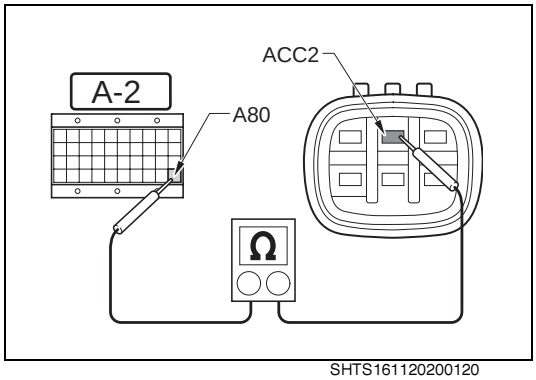
(1) Disconnect the connector of accelerator sensor.
(2) Set the starter switch to the "ON" position.
(3) Measure the voltage between A-VCC and A-GND terminals of accelerator sensor (Vehicle harness side).
Standard: 4.7-5.3V

NO

Proceed to 5.

YES

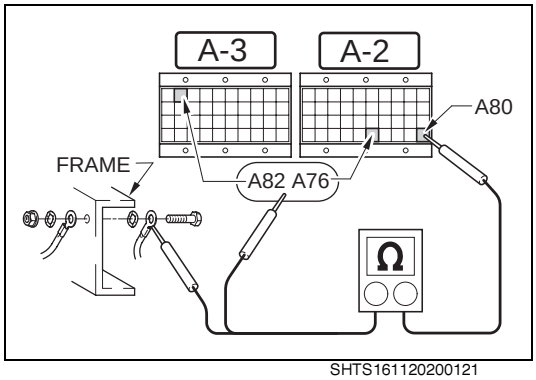
Proceed to 3.



SHTS161120200120

3. CHECK THE CONTINUITY OF HARNESS.

(1) Set the starter switch to the "LOCK" position.
(2) Disconnect the signal check harness connector on the ECU side.
(3) Measure the resistance between A80 terminal of the signal check harness and ACC2 terminal of accelerator sensor (Vehicle harness side).
Standard: 2 Ω or less



SHTS161120200121

(4) Measure the resistance between terminals of the signal check harness and chassis GND.

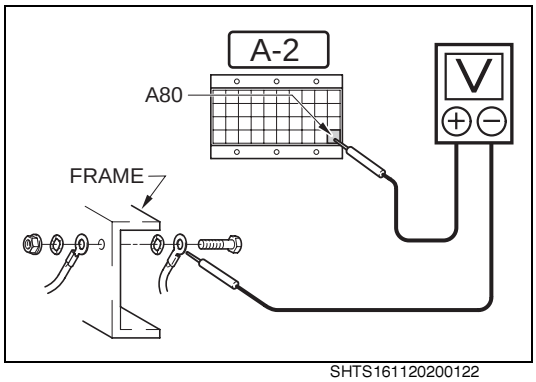
Terminals to measure the resistance
A80 ↔ A76
A80 ↔ A82
A80 ↔ Chassis GND

Standard: ∞ Ω

NO → Malfunction of harness

YES

4. CHECK THE VOLTAGE BETWEEN TERMINALS.



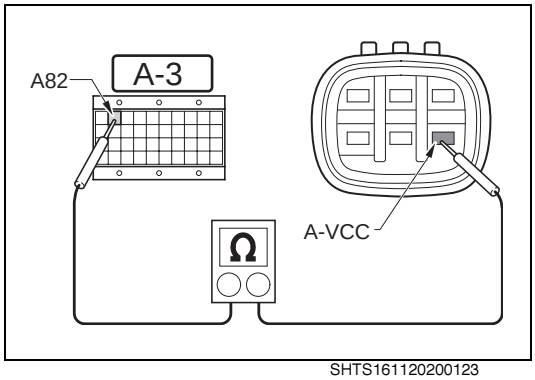
SHTS161120200122

(1) Set the starter switch to the "ON" position.
(2) Measure the voltage between A80 terminal of the signal check harness and chassis GND.
Standard: 1V or less

NO → Malfunction of harness

YES

- Malfunction of accelerator sensor
- Malfunction of connectors

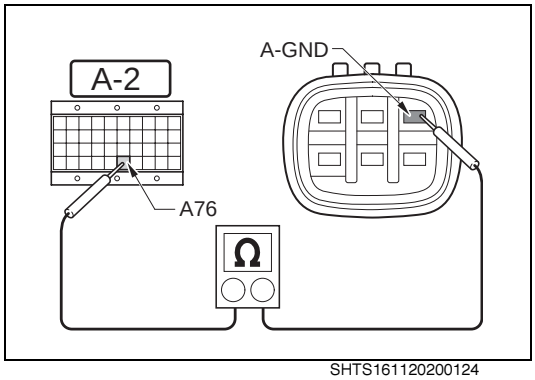


SHTS161120200123

5. CHECK THE CONTINUITY OF HARNESS.

(1) Set the starter switch to the "LOCK" position.
(2) Disconnect the signal check harness connector on the ECU side.
(3) Measure the resistance between A82 terminal of the signal check harness and A-VCC terminal of accelerator sensor (Vehicle harness side).

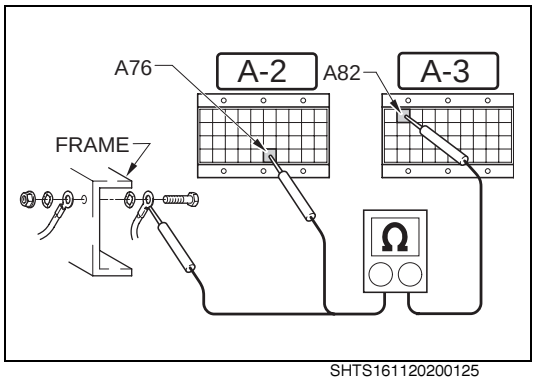
Standard: 2 Ω or less



SHTS161120200124

(4) Measure the resistance between A76 terminal of the signal check harness and A-GND terminal of accelerator sensor (Vehicle harness side).

Standard: 2 Ω or less



SHTS161120200125

(5) Measure the resistance between terminals of the signal check harness and chassis GND.

Terminals to measure the resistance
A82 ↔ A76
A82 ↔ Chassis GND

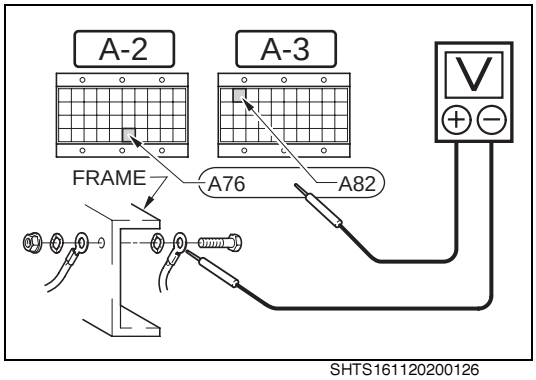
Standard: ∞ Ω

NO

Malfunction of harness

YES

Proceed to 6.



SHTS161120200126

6. CHECK THE VOLTAGE BETWEEN TERMINALS.

(1) Set the starter switch to the "ON" position.

(2) Measure the voltage between terminal of the signal check harness and chassis GND.

Terminals to measure the voltage	
+ side	**- side**
A76	Chassis GND
A82	

Standard: 1V or less

NO

Malfunction of harness

YES

- Malfunction of engine ECU
- Malfunction of ECU connectors

ACCELERATOR SENSOR 1 & 2

EN1611202F200035

MC No.	22	DTC No.	P2120	Accelerator sensor 1 and 2 malfunction

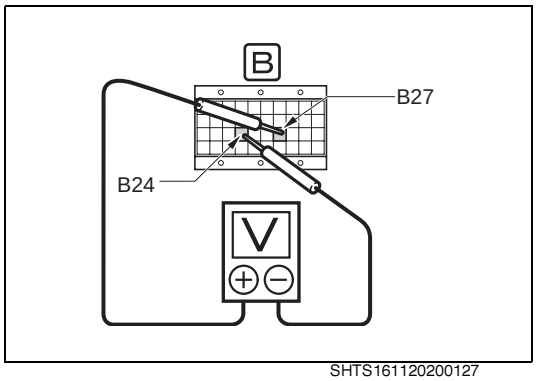
1. INSPECTION ITEM

(1) Make sure to inspect it in accordance with the contents of MC No.22 or DTC No. P2122, P2123, P2127 and P2128.
Refer to the section **"ACCELERATOR SENSOR 1 (DTC No. P2122, P2123/MC No.22)"** .
Refer to the section **"ACCELERATOR SENSOR 2 (DTC No. P2127, P2128/MC No.22)"** .

P.T.O. ACCELERATOR SENSOR

EN1611202F200036

MC No.	23	DTC No.	P1133	P.T.O. accelerator sensor malfunction



SHTS161120200127

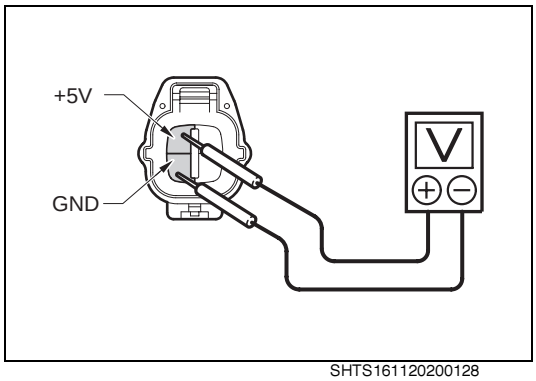
1. CHECK THE VOLTAGE BETWEEN TERMINALS.

(1) Set the starter switch to the "LOCK" position and connect the signal check harness.
(2) Set the starter switch to the "ON" position.
(3) Measure the voltage between B27 and B24 terminals of the signal check harness.
Standard: 4.6V or less

NO → Proceed to 2.

YES →

- Malfunction of engine ECU
- Malfunction of ECU connectors



SHTS161120200128

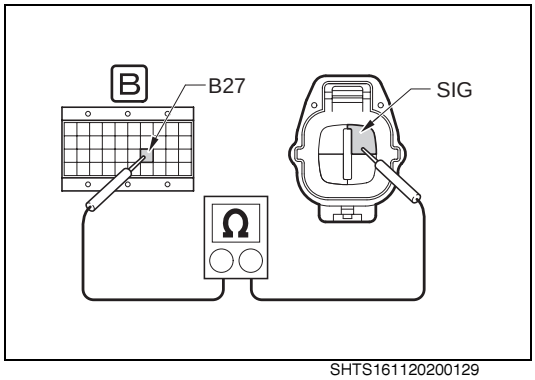
2. CHECK THE VOLTAGE BETWEEN TERMINALS.

(1) Disconnect the connector of the accelerator sensor.
(2) Set the starter switch to the "ON" position.
(3) Measure the voltage between +5V and GND terminals of accelerator sensor (Vehicle harness side).
Standard: 4.5-5.5V

NO → Proceed to 5.

YES →

Proceed to 3.

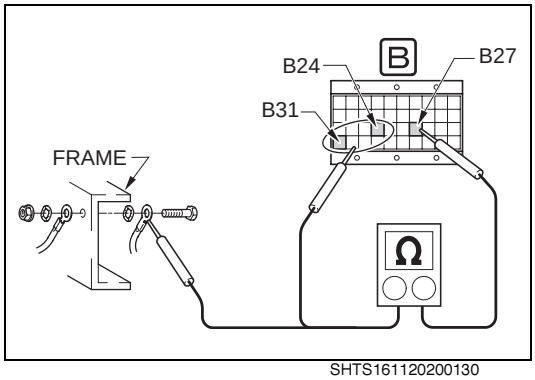


SHTS161120200129

3. CHECK THE CONTINUITY OF HARNESS.

(1) Set the starter switch to the "LOCK" position.
(2) Disconnect the signal check harness connector on the ECU side.
(3) Measure the resistance between B27 terminal of the signal check harness and SIG terminal of accelerator sensor (Vehicle harness side).

Standard: 2 Ω or less



SHTS161120200130

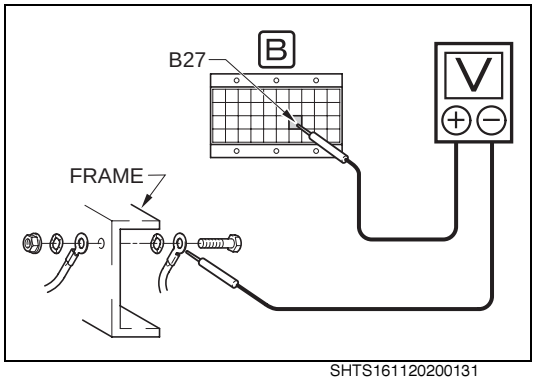
(4) Measure the resistance between terminals of the signal check harness and chassis GND.

Terminals to measure the resistance
B27 ↔ B24
B27 ↔ B31
B27 ↔ Chassis GND

Standard: ∞ Ω

NO → Malfunction of harness

YES



SHTS161120200131

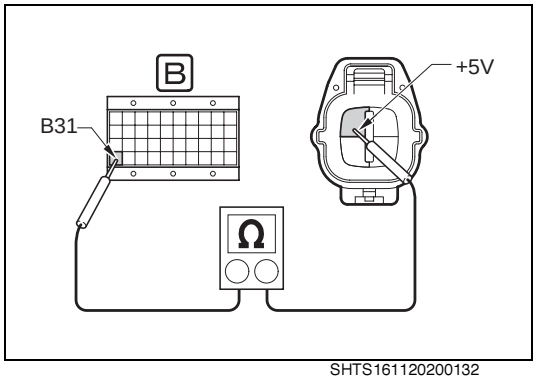
4. CHECK THE VOLTAGE BETWEEN TERMINALS.

(1) Set the starter switch to the "ON" position.
(2) Measure the voltage between B27 terminal of the signal check harness and chassis GND.
Standard: 1V or less

NO → Malfunction of harness

YES

- Malfunction of accelerator sensor
- Malfunction of connectors



SHTS161120200132

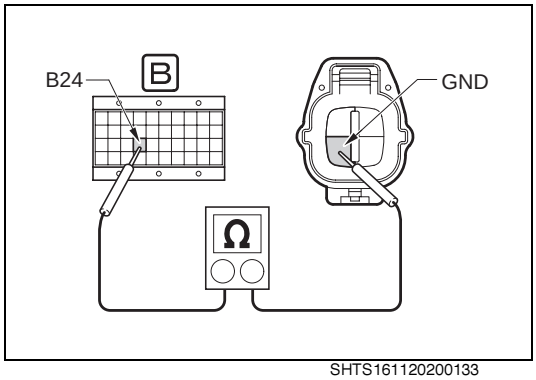
5. CHECK THE CONTINUITY OF HARNESS.

(1) Set the starter switch to the "LOCK" position.

(2) Disconnect the signal check harness connector on the ECU side.

(3) Measure the resistance between B31 terminal of the signal check harness and +5V terminal of accelerator sensor (Vehicle harness side).

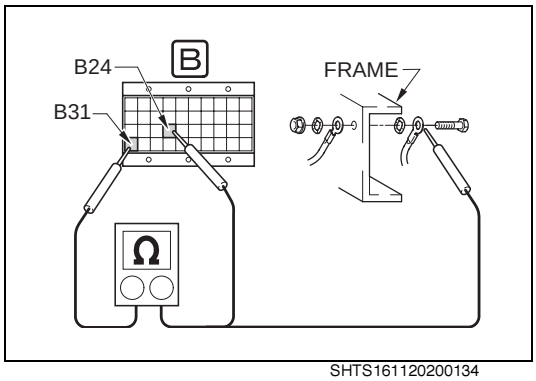
Standard: 2 Ω or less



SHTS161120200133

(4) Measure the resistance between B24 terminal of the signal check harness and GND terminal of accelerator sensor (Vehicle harness side).

Standard: 2 Ω or less



SHTS161120200134

(5) Measure the resistance between terminals of the signal check harness and chassis GND.

Terminals to measure the resistance
B31 ↔ B24
B31 ↔ Chassis GND

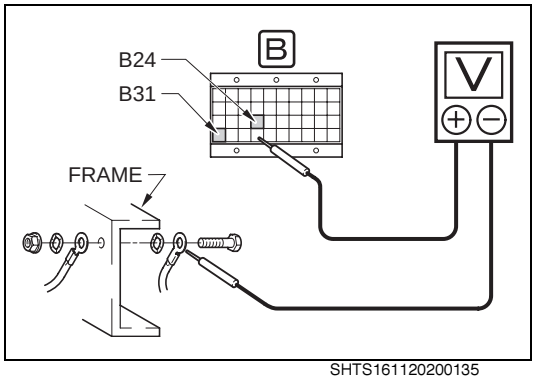
Standard: ∞ Ω

NO

Malfunction of harness

YES

Proceed to 6.



SHTS161120200135

6. CHECK THE VOLTAGE BETWEEN TERMINALS.

(1) Set the starter switch to the "ON" position.

(2) Measure the voltage between terminal of the signal check harness and chassis GND.

Terminals to measure the voltage	
+ side	**- side**
B24	Chassis GND
B31	

Standard: 1V or less

NO

Malfunction of harness

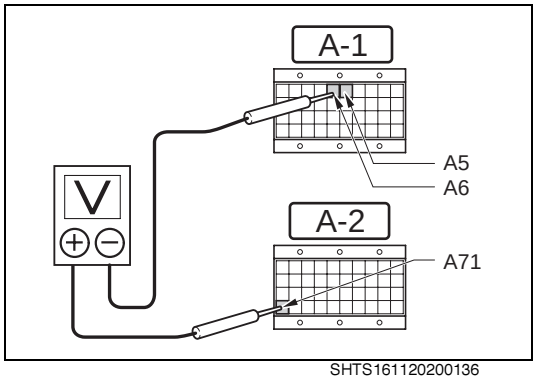
YES

- Malfunction of engine ECU
- Malfunction of ECU connectors

VEHICLE SPEED SENSOR

EN1611202F200037

MC No.	21	DTC No.	P0500	Vehicle speed sensor malfunction (Input too low) (Open/short circuit)
MC No.	21	DTC No.	P0501	Vehicle speed sensor malfunction (Input too high) (Overhigh frequency)



SHTS161120200136

1. CHECK THE VOLTAGE BETWEEN TERMINALS.

(1) Set the starter switch to the "LOCK" position and connect the signal check harness.
(2) Start the engine.
(3) Prepare the voltage measurement between terminals of the signal check harness.
(4) Measure the voltage while the vehicle starts to run at the speed of 10 km/h {6.2 miles/h}.

Terminals to measure the voltage	
+ side	**- side**
A71	A5
	A6

⚠ WARNING
Start the vehicle with caution to surroundings.

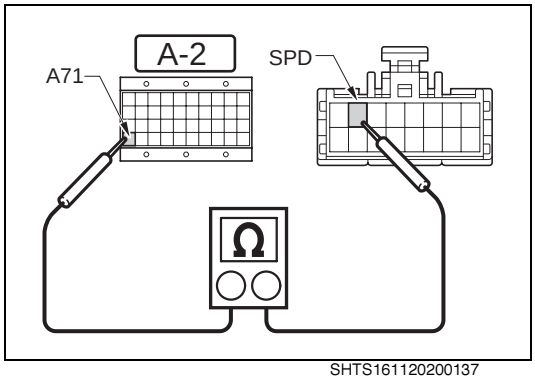
Standard: 4.5V or more ↔ 1.5V or less

(5) Stop the vehicle.

NO → Proceed to 2.

YES →

- Malfunction of engine ECU
- Bad contact of ECU connector



SHTS161120200137

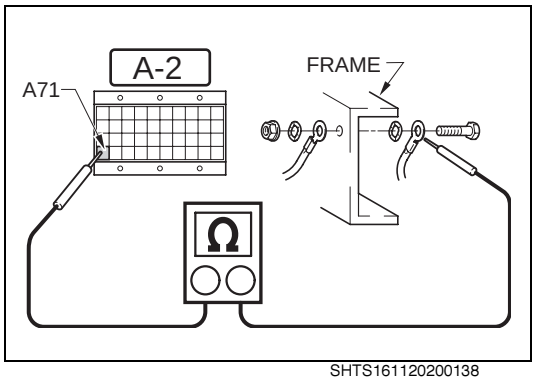
2. CHECK THE RESISTANCE BETWEEN TERMINALS.

(1) Set the starter switch to the "LOCK" position and disconnect the signal check harness connector on the ECU side.
(2) Disconnect the connector of vehicle speed pulse converter.
(3) Measure the resistance between A71 terminal of the signal check harness and SPD terminal of vehicle speed pulse converter (Vehicle harness side).
Standard: 1 Ω or less

NO

Harness disconnection in the vehicle speed sensor circuit

YES



SHTS161120200138

3. CHECK THE INSULATION RESISTANCE BETWEEN TERMINALS.

(1) Measure the insulation resistance between A71 terminal of the signal check harness and chassis GND.
Standard: ∞ Ω

NO

Short circuit to ground in the vehicle speed sensor circuit

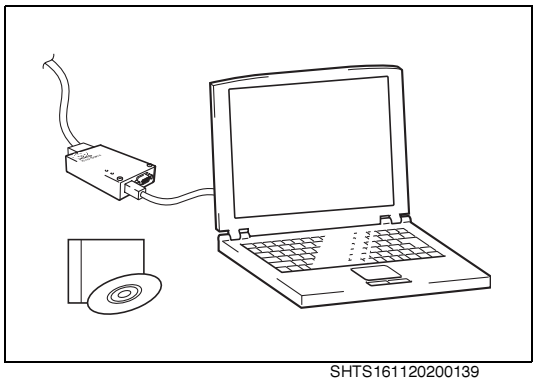
YES

Malfunction of vehicle speed sensor and pulse adjust computer
HINT
Check the vehicle speed sensor itself and the pulse adjust computer. Replace the ECU if the same DTC No. P0500 or P0501 or the MC No. 21 is output again after deleting the past failure and then making a test operation.

ATMOSPHERIC PRESSURE SENSOR

EN1611202F200038

MC No.	15	DTC No.	P2228	Atmospheric pressure sensor malfunction (Input too low)
MC No.	15	DTC No.	P2229	Atmospheric pressure sensor malfunction (Input too high)



SHTS161120200139

1. CHECK THE MC OR DTC.

(1) Connect the PC DIAGNOSIS TOOL (Hino-DX) (Refer to the page DN02-14).

(2) After the starter switch is positioned on the "LOCK" once, it should be turned to the "ON" position again.

(3) After erasing the MC or DTC, check that the same code is displayed again.

Standard: Normal

NO → Malfunction of engine ECU

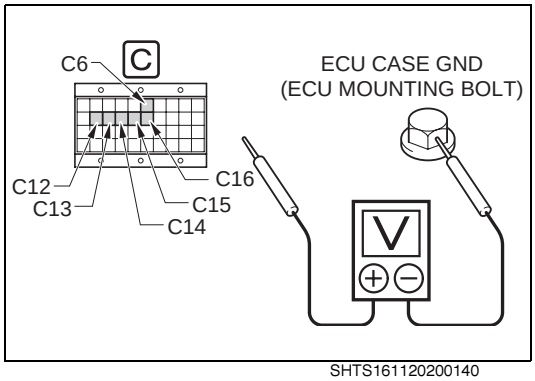
YES

Normal
(Temporary malfunction because of radio interference noise.)

INJECTOR SOLENOID VALVE DRIVE SYSTEM COMMON 1 & 2

EN1611202F200039

MC No.	57	DTC No.	P1211	Injector solenoid valve drive system common 1 malfunction (Short circuit in the "–" side harness)
MC No.	58	DTC No.	P1214	Injector solenoid valve drive system common 2 malfunction (Short circuit in the "–" side harness)



SHTS161120200140

1. CHECK THE VOLTAGE BETWEEN TERMINALS.

(1) Set the starter switch to the "LOCK" position and connect the signal check harness.
(2) Disconnect the signal check harness connector on the ECU side.
(3) Set the starter switch to the "ON" position.
(4) Measure the voltage between the terminals of the signal check harness and ECU case GND.

⚠ WARNING

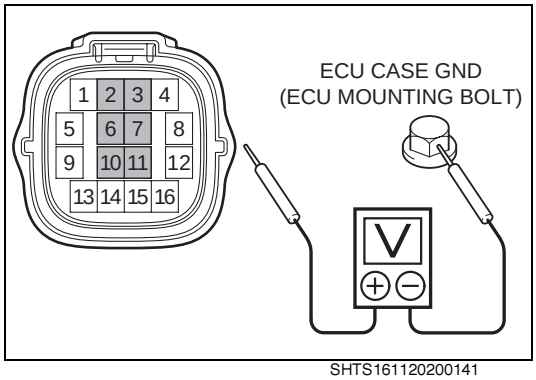
Do not start the engine in this step, or it will cause system malfunctions or electric shocks.

MC No.	DTC No.	Terminals to measure the voltage	
		+ side	- side
57	P1211	C13, C12, C6	ECU case GND
58	P1214	C16, C14, C15	ECU case GND

Standard: 1V or less

NO → Proceed to 2.

YES → Proceed to 3.



SHTS161120200141

2. CHECK THE VOLTAGE BETWEEN TERMINALS.

(1) Set the starter switch to the "LOCK" position.
(2) Disconnect the injector harness collecting connector that is located on the front side of the cylinder.
(3) Set the starter switch to the "ON" position.
(4) Measure the voltage between the terminals of injector harness collecting connector (Vehicle harness side) and ECU case GND.

⚠ WARNING
Do not start the engine in this step, or it will cause system malfunctions or electric shocks.

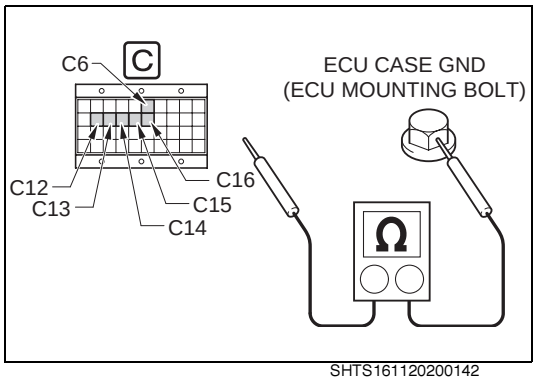
MC No.	DTC No.	Terminals to measure the voltage	
		+ side	- side
57	P1211	11, 2, 6	ECU case GND
58	P1214	3, 7, 10	ECU case GND

Standard: 1V or less

NO → Malfunction of harness (Short circuit)

YES

Malfunction of harness inside head cover (Short circuit)



SHTS161120200142

3. CHECK THE RESISTANCE BETWEEN TERMINALS.

(1) Set the starter switch to the "LOCK" position.
(2) Measure the resistance between the terminals of the signal check harness and ECU case GND.

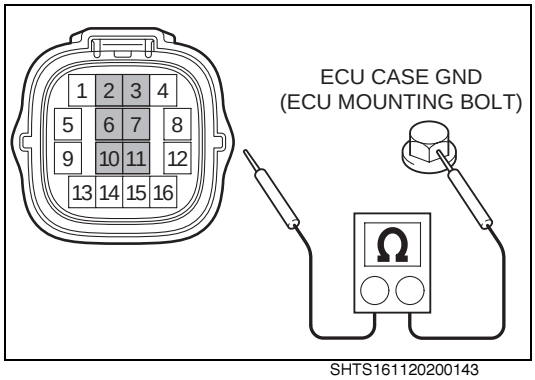
MC No.	DTC No.	Terminals to measure the resistance	
57	P1211	C13, C12, C6	ECU case GND
58	P1214	C16, C14, C15	ECU case GND

Standard: ∞ Ω

NO → Proceed to 4.

YES

Proceed to 5.



SHTS161120200143

4. CHECK THE RESISTANCE BETWEEN TERMINALS.

(1) Set the starter switch to the "LOCK" position.
(2) Disconnect the injector harness collecting connector that is located on the front side of the cylinder.
(3) Measure the resistance between the terminals of injector harness collecting connector (Vehicle harness side) and ECU case GND.

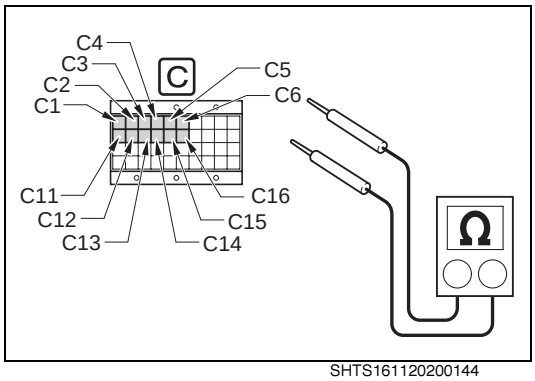
MC No.	DTC No.	Terminals to measure the resistance	
57	P1211	11, 2, 6	ECU case GND
58	P1214	3, 7, 10	ECU case GND

Standard: ∞ Ω

NO → Malfunction of harness (Short circuit)

YES

- Malfunction of harness inside head cover (Short circuit)
- Malfunction of harness of injector (Short circuit)
- Malfunction of injector insulation



SHTS161120200144

5. CHECK THE RESISTANCE BETWEEN TERMINALS.

(1) Set the starter switch to the "LOCK" position.
(2) Disconnect the injector harness collecting connector that is located on the front side of the cylinder.
(3) Measure the resistance between the terminals of the signal check harness.

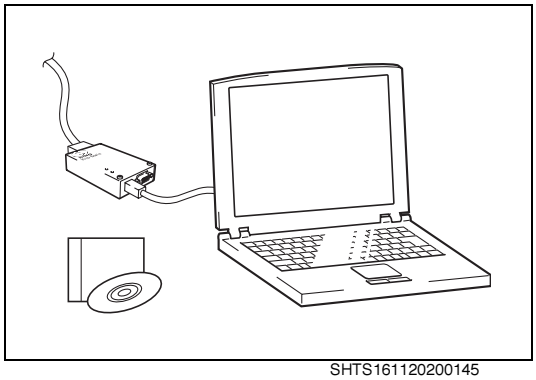
MC No.	DTC No.	Terminals to measure the resistance
57	P1211	C4 ↔ C13, C5 ↔ C12, C11 ↔ C6, C13 ↔ C12, C12 ↔ C6, C13 ↔ C6
58	P1214	C1 ↔ C16, C3 ↔ C14, C2 ↔ C15, C16 ↔ C14, C14 ↔ C15, C16 ↔ C15

Standard: ∞ Ω

NO → Malfunction of harness (Short circuit)

YES

Proceed to 6.



SHTS161120200145

6. CHECK THE MC OR DTC.

(1) Set the starter switch to the "LOCK" position and connect the signal check harness on the ECU side.
(2) Connect the PC DIAGNOSIS TOOL (Hino-DX) (Refer to the page DN02-14).
(3) Start the engine and erase the MC or DTC.
(4) Check the MC or DTC.

Standard: Normal

HINT

If the same code is output after replacing the engine ECU, there may be a layer short in the harness or the injector.

NO

If the same MC or DTC is displayed again, replace engine ECU.

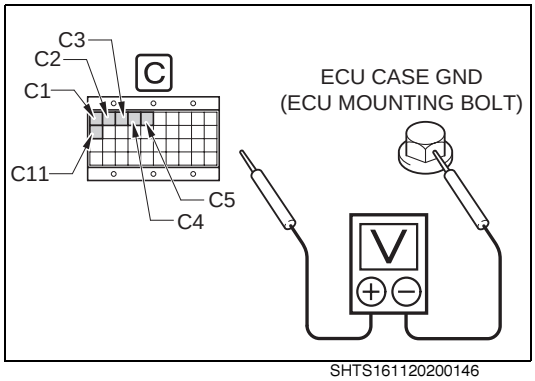
YES

Normal (Temporary malfunction)

INJECTOR SOLENOID VALVE DRIVE SYSTEM COMMON 1 & 2

EN1611202F200040

MC No.	57	DTC No.	P1212	Injector solenoid valve drive system common 1 malfunction (Short circuit in the "+" side harness)
MC No.	58	DTC No.	P1215	Injector solenoid valve drive system common 2 malfunction (Short circuit in the "+" side harness)



SHTS161120200146

1. CHECK THE VOLTAGE BETWEEN TERMINALS AND GND.

(1) Set the starter switch to the "LOCK" position and connect the signal check harness.
(2) Disconnect the signal check harness connector on the ECU side.
(3) Set the starter switch to the "ON" position.
(4) Measure the voltage between the terminals of the signal check harness and ECU case GND.

⚠ WARNING

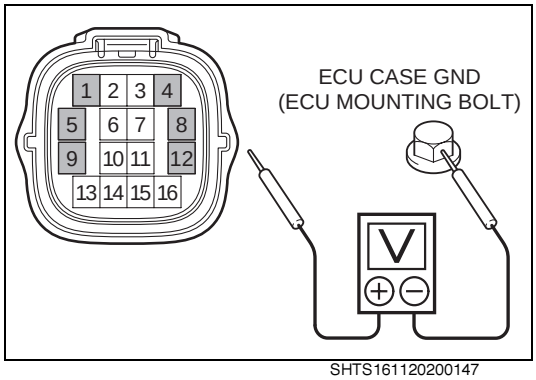
Do not start the engine in this step, or it will cause system malfunctions or electric shocks.

MC No.	DTC No.	Terminals to measure the voltage	
		+ side	- side
57	P1212	C4, C5, C11	ECU case GND
58	P1215	C1, C2, C3	ECU case GND

Standard: 1V or less

NO → Proceed to 2.

YES → Proceed to 3.



SHTS161120200147

2. CHECK THE VOLTAGE BETWEEN TERMINALS.

(1) Set the starter switch to the "LOCK" position.
(2) Disconnect the injector harness collecting connector that is located on the front side of the cylinder.
(3) Set the starter switch to the "ON" position.
(4) Measure the voltage between the terminals of injector harness collecting connector (Vehicle harness side) and ECU case GND.

⚠ WARNING
Do not start the engine in this step, or it will cause system malfunctions or electric shocks.

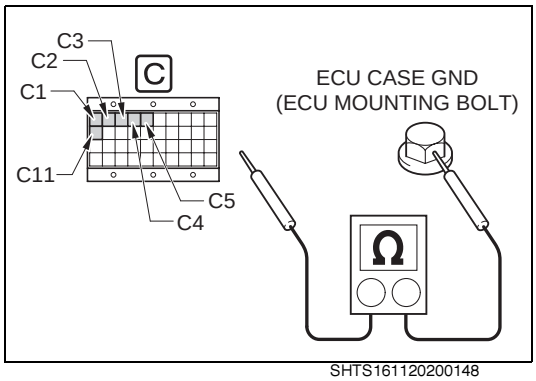
MC No.	DTC No.	Terminals to measure the voltage	
		+ side	- side
57	P1212	12, 1, 5	ECU case GND
58	P1215	4, 8, 9	ECU case GND

Standard: 1V or less

NO → Malfunction of harness (Short circuit)

YES

Malfunction of harness inside head cover (Short circuit)



SHTS161120200148

3. CHECK THE RESISTANCE BETWEEN TERMINALS.

(1) Set the starter switch to the "LOCK" position.
(2) Measure the resistance between the terminals of the signal check harness and ECU case GND.

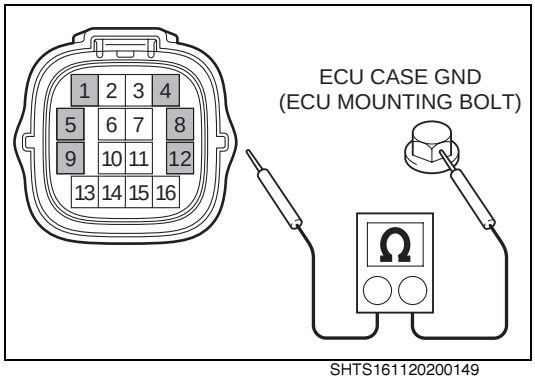
MC No.	DTC No.	Terminals to measure the resistance	
57	P1212	C4, C5, C11	ECU case GND
58	P1215	C1, C2, C3	ECU case GND

Standard: ∞ Ω

NO → Proceed to 4.

YES

Proceed to 5.



SHTS161120200149

4. CHECK THE RESISTANCE BETWEEN TERMINALS.

(1) Set the starter switch to the "LOCK" position.
(2) Disconnect the injector harness collecting connector that is located on the front side of the cylinder.
(3) Measure the resistance between the terminals of injector harness collecting connector (Vehicle harness side) and ECU case GND.

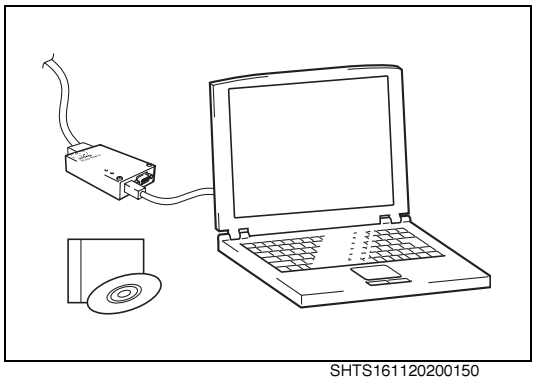
MC No.	DTC No.	Terminals to measure the resistance	
57	P1212	12, 1, 5	ECU case GND
58	P1215	4, 8, 9	ECU case GND

Standard: ∞ Ω

NO → Malfunction of harness (Short circuit)

YES

- Malfunction of harness in the head cover (Short circuit)
- Malfunction of harness of injector (Short circuit)
- Malfunction of injector insulation


SHTS161120200150

5. CHECK THE MC OR DTC.

(1) Set the starter switch to the "LOCK" position and connect the signal check harness on the ECU side.
(2) Connect the PC DIAGNOSIS TOOL (Hino-DX) (Refer to the page DN02-14).
(3) Start the engine and erase the MC or DTC.
(4) Check the MC or DTC.

Standard: Normal

HINT

If the same code is output after replacing the engine ECU, there may be a layer short in the harness or the injector.

NO → If the same MC or DTC is displayed again, replace engine ECU.

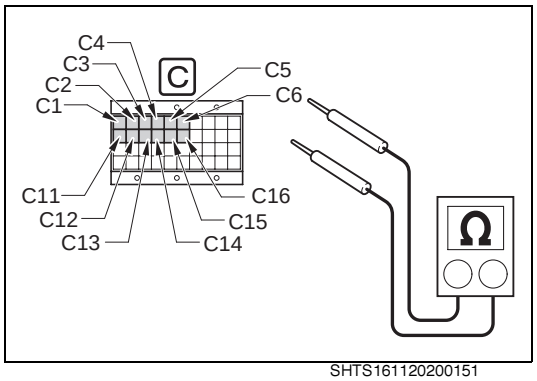
YES

Normal (Temporary malfunction)

INJECTOR SOLENOID VALVE DRIVE SYSTEM

EN1611202F200041

MC No.	51	DTC No.	P0201	Injector 1 solenoid valve drive system malfunction (Wire breaking)
MC No.	52	DTC No.	P0202	Injector 2 solenoid valve drive system malfunction (Wire breaking)
MC No.	53	DTC No.	P0203	Injector 3 solenoid valve drive system malfunction (Wire breaking)
MC No.	54	DTC No.	P0204	Injector 4 solenoid valve drive system malfunction (Wire breaking)
MC No.	55	DTC No.	P0205	Injector 5 solenoid valve drive system malfunction (Wire breaking)
MC No.	56	DTC No.	P0206	Injector 6 solenoid valve drive system malfunction (Wire breaking)



SHTS161120200151

1. CHECK THE RESISTANCE BETWEEN TERMINALS.

(1) Set the starter switch to the "LOCK" position and connect the signal check harness.
(2) Disconnect the signal check harness connector on the ECU side.
(3) Measure the resistance between terminals of the signal check harness.

MC No.	DTC No.	Failure position (Breaking position)	Terminals to measure the resistance
51	P0201	No.1 Injector	C4 ↔ C13
52	P0202	No.2 Injector	C5 ↔ C12
53	P0203	No.3 Injector	C11 ↔ C6
54	P0204	No.4 Injector	C1 ↔ C16
55	P0205	No.5 Injector	C3 ↔ C14
56	P0206	No.6 Injector	C2 ↔ C15

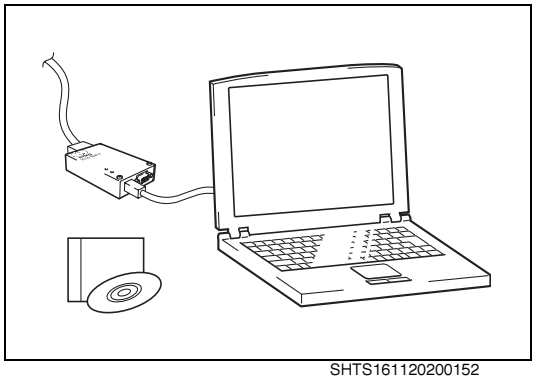
Standard: 2 Ω or less

NO

Proceed to 3.

YES

Proceed to 2.


SHTS161120200152

2. CHECK THE MC OR DTC.

(1) Set the starter switch to the "LOCK" position and connect the signal check harness connector on the ECU side.
(2) Connect the PC DIAGNOSIS TOOL (Hino-DX) (Refer to the page DN02-14).
(3) Start the engine and erase the MC or DTC.
(4) Check the MC or DTC.

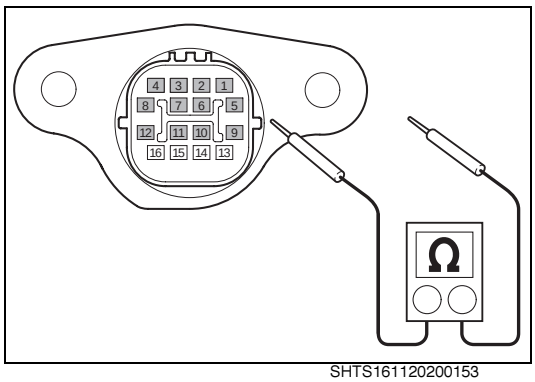
Standard: Normal

NO

If the same MC or DTC is displayed again, replace engine ECU.

YES

Normal (Temporary malfunction)



SHTS161120200153

3. CHECK THE RESISTANCE BETWEEN TERMINALS.

(1) Disconnect the injector harness collecting connector that is located at the front side of the cylinder head.
(2) Measure the resistance between the terminals of the injector harness collecting connector (Cylinder head side).

MC No.	DTC No.	Terminals to measure the resistance
51	P0201	11 ↔ 12
52	P0202	1 ↔ 2
53	P0203	5 ↔ 6
54	P0204	3 ↔ 4
55	P0205	7 ↔ 8
56	P0206	9 ↔ 10

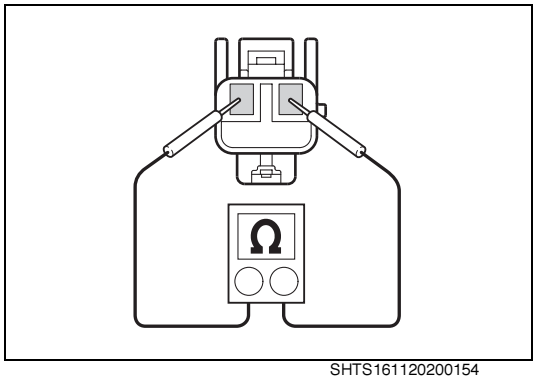
Standard: 2 Ω or less

NO

Proceed to 4.

YES

Malfunction of harness (Vehicle harness side)
(Check the harness between ECU and the injector harness collecting connector.)


SHTS161120200154

4. CHECK THE RESISTANCE BETWEEN TERMINALS.

(1) Dismount the head cover.
Disconnect the injector connector (injector side) of the cylinder displayed by MC or DTC.

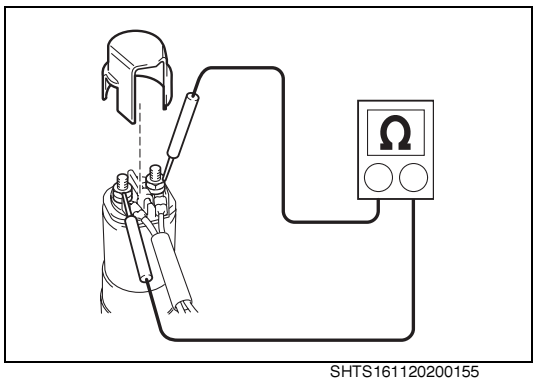
(2) Measure the resistance between No.1 and No.2 terminals of the injector connector.
Standard: 0.15-0.35 Ω

NO

Proceed to 5.

YES

Bad contact of the connector or the harness in the head cover.
(Check the connector or the harness in the head cover.)


SHTS161120200155

5. CHECK THE RESISTANCE BETWEEN TERMINALS.

(1) Remove the injector terminal cap of the cylinder display by MC or DTC.
Measure the insulation resistance between terminal and injector body.
Standard: 0.15-0.35 Ω

NO

Injector coil disconnection.
(Replace the injector assembly.)

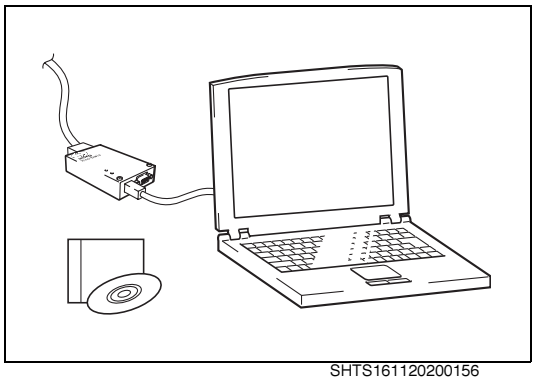
YES

Injection harness disconnections.
(Replace the injector harness.)

CYLINDER CONTRIBUTION/BALANCE

EN1611202F200042

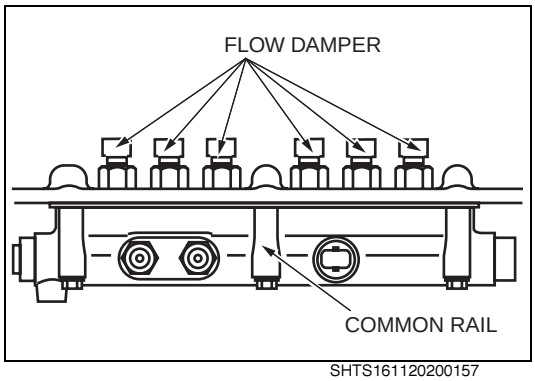
MC No.	61	DTC No.	P0263	Cylinder 1 contribution/balance fault
MC No.	62	DTC No.	P0266	Cylinder 2 contribution/balance fault
MC No.	63	DTC No.	P0269	Cylinder 3 contribution/balance fault
MC No.	64	DTC No.	P0272	Cylinder 4 contribution/balance fault
MC No.	65	DTC No.	P0275	Cylinder 5 contribution/balance fault
MC No.	66	DTC No.	P0278	Cylinder 6 contribution/balance fault



SHTS161120200156

1. CHECK THE FLOW DAMPER.

(1) Connect the PC DIAGNOSIS TOOL (Hino-DX) (Refer to the page DN02-14).
(2) Set the starter switch to the "LOCK" position and stop the engine.
(3) Wait for about 30 seconds and then start the engine.
(4) Perform warm-up until the coolant temperature becomes 60°C {140°F} or more. And erase the MC or DTC.



SHTS161120200157

(5) If the same MC or DTC is displayed again after erasing it, inspect the flow damper of displayed cylinder.

MC No.	DTC No.	Failure position (Flow damper)
61	P0263	No.1
62	P0266	No.2
63	P0269	No.3
64	P0272	No.4
65	P0275	No.5
66	P0278	No.6

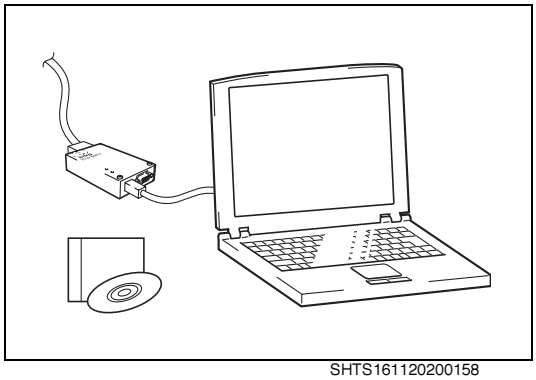
INSPECTION:

After removing the flow damper from the common rail, feed air from one side of the flow damper. Observe whether air flows to the other side and examine whether shutoff takes place.

NOTICE

Take care not to allow dust or water to go into the flow damper when feeding air.

Flow damper active (No air is flowing): Replace the flow damper.
Flow damper inactive (Air is flowing): Proceed to the step "2. RECHECK THE MC OR DTC".


SHTS161120200158

2. RECHECK THE MC OR DTC.

(1) Check that the other MC or DTC is not displayed.
If the other MC or DTC would be displayed, repair the trouble and erase the MC or DTC by PC DIAGNOSIS TOOL (Hino-DX).
If the same MC or DTC would be displayed again, it is possibly from the following problems.

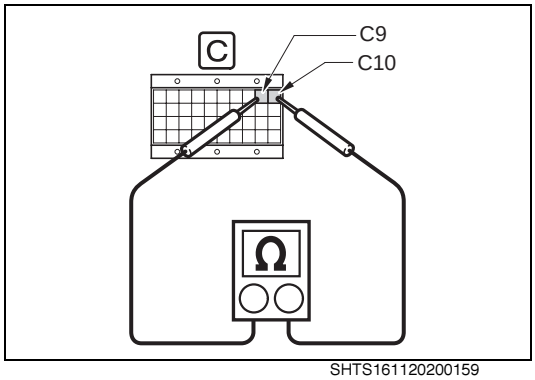
- Excessive fuel flow will cause fuel leakage from injection pipe (Between flow damper and injector) by bending, cracking and pipe connection looseness.
  → Check leakage.
- Excessive or shortage fuel flow would cause an increase in the internal leakage of injector.
  → Check injector leakage using nozzle tester.
- Excessive fuel flow would cause injector seat defection.
  → Check injector nozzle seat using nozzle tester.
- Excessive or shortage fuel flow would cause injector operation malfunction.
  → Check by replacing the injector.

(2) To identify an area where a failure has occurred, conduct a diagnosis while examining the engine data. This diagnosis should be conducted after using the Hino-DX to check the inter-cylinder offset and inactivating a relevant injector.

SUPPLY PUMP METERING-UNIT PROPORTIONAL (MPROP)

EN1611202F200043

MC No.	75	DTC No.	P0628	Supply pump MPROP malfunction (Open circuit, short circuit to ground)

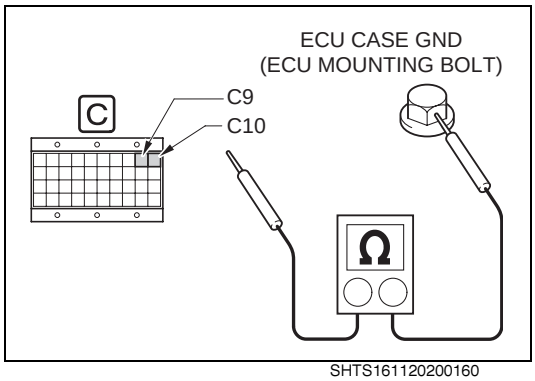


SHTS161120200159

1. CHECK THE RESISTANCE BETWEEN TERMINALS.

(1) Set the starter switch to the "LOCK" position and connect the signal check harness.
(2) Disconnect the signal check harness connector on the ECU side.
(3) Measure the resistance between C9 and C10 terminals of the signal check harness.

Standard: 2.0-3.4 Ω



SHTS161120200160

(4) Measure the resistance between the terminal of the signal check harness and ECU case GND.

Terminals to measure the resistance
C9 ↔ ECU case GND
C10 ↔ ECU case GND

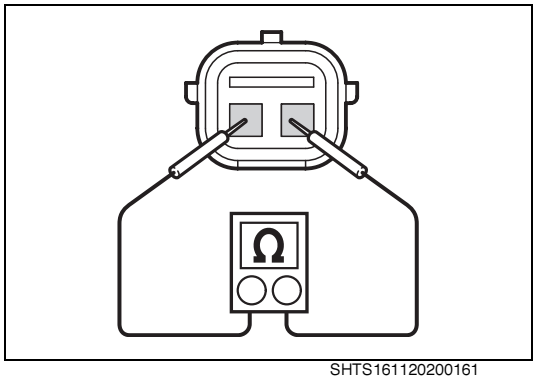
Standard: ∞ Ω

NO

Proceed to 2.

YES

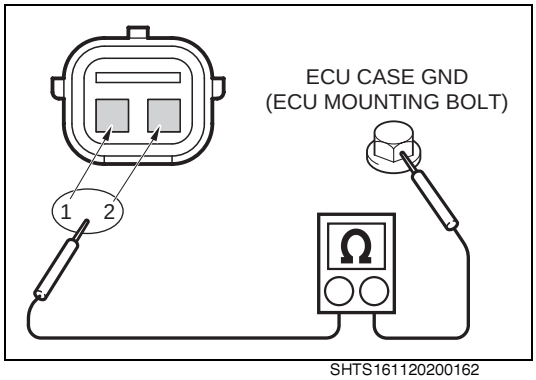
Proceed to 3.


SHTS161120200161

2. CHECK THE SUPPLY PUMP MPROP.

(1) Set the starter switch to the "LOCK" position.
(2) Disconnect the connector of the MPROP.
(3) Measure the resistance between No.1 and No.2 terminals of the MPROP connector.

Standard: 2.0-3.4Ω



SHTS161120200162

(4) Measure the resistance between the terminal of the MPROP connector and ECU case GND.

Terminals to measure the resistance
1 ↔ ECU case GND
2 ↔ ECU case GND

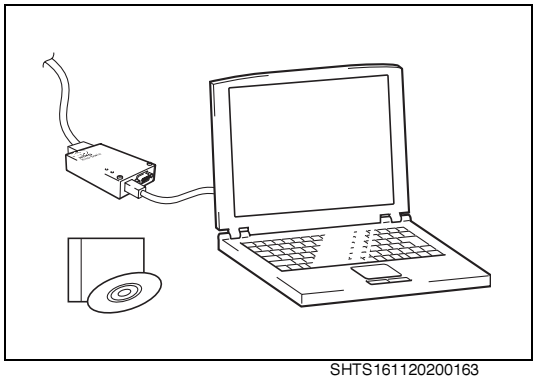
Standard: ∞ Ω

NO

Malfunction of MPROP
(Replace the supply pump)

YES

- Malfunction of harness
- Bad contact of harness connector


SHTS161120200163

3. CHECK THE MC OR DTC.

(1) Set the starter switch to the "LOCK" position and connect the signal check harness connector on the ECU side.
(2) Connect the PC DIAGNOSIS TOOL (Hino-DX) (Refer to the page DN02-14).
(3) Start the engine and erase the MC or DTC.
(4) Check the MC or DTC.

Standard: Normal

NO

If the same MC or DTC is displayed again, replace engine ECU.

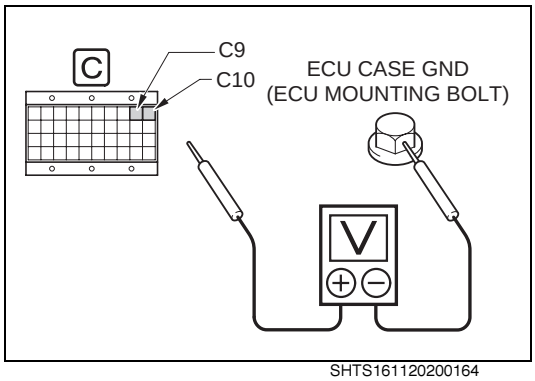
YES

Normal (Temporary malfunction)

SUPPLY PUMP METERING-UNIT PROPORTIONAL (MPROP)

EN1611202F200044

MC No.	74	DTC No.	P0629	Supply pump MPROP malfunction (Short circuit to battery)



SHTS161120200164

1. CHECK THE VOLTAGE BETWEEN TERMINALS.

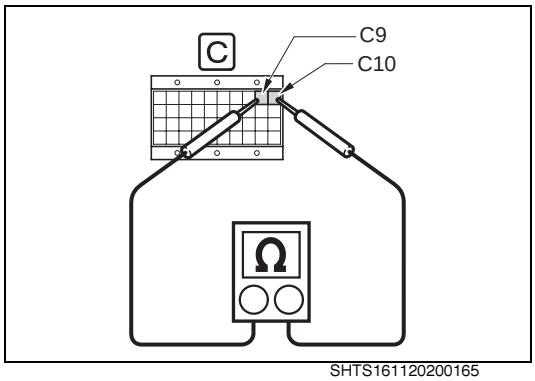
(1) Set the starter switch to the "LOCK" position and connect the signal check harness.
(2) Disconnect the signal check harness connector on the ECU side.
(3) Set the starter switch to the "ON" position.
(4) Measure the voltage between the terminal of the signal check harness and ECU case GND.

Terminals to measure the voltage	
+ side	**- side**
C9	ECU case GND
C10	ECU case GND

Standard: 1V or less

NO → Malfunction of harness (Short circuit)

YES



SHTS161120200165

2. CHECK THE RESISTANCE BETWEEN TERMINALS.

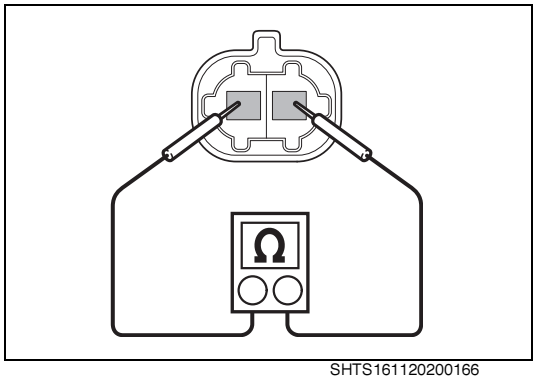
(1) Set the starter switch to the "LOCK" position.
(2) Disconnect the connector of the MPROP.
(3) Measure the resistance between C9 and C10 terminals of the signal check harness.

Standard: ∞ Ω

NO → Malfunction of harness (Short circuit)

YES

Proceed to 3.


SHTS161120200166

3. CHECK THE MPROP.

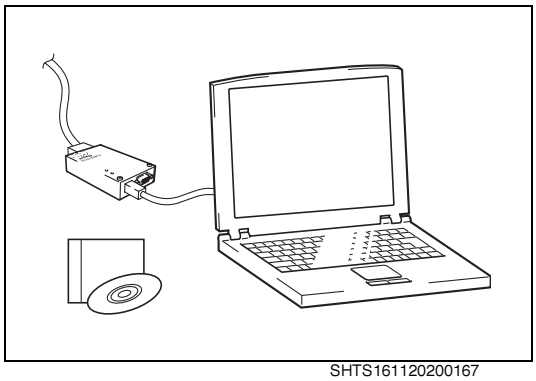
(1) Measure the resistance between No.1 and No.2 terminals of the MPROP connector.

Standard: 2.0-3.4 Ω

NO

YES

Malfunction of MPROP
(Replace the supply pump)


SHTS161120200167

4. CHECK THE MC OR DTC.

(1) Set the starter switch to the "LOCK" position.
(2) Connect the signal check harness connector on the ECU side and the MPROP connector.
(3) Connect the PC DIAGNOSIS TOOL (Hino-DX) (Refer to the page DN02-14).
(4) Start the engine and erase the MC or DTC.
(5) Check the MC or DTC.

Standard: Normal

NO

YES

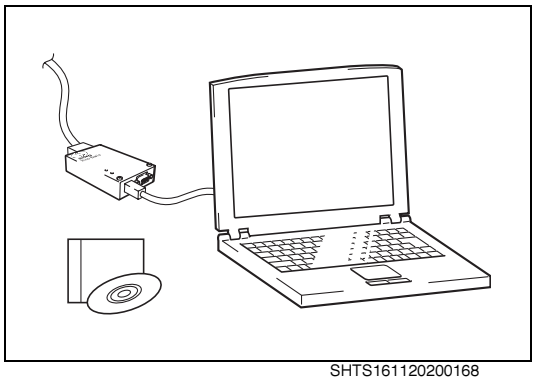
If the same MC or DTC is displayed again, replace engine ECU.

Normal (Temporary malfunction)

SUPPLY PUMP

EN1611202F200045

MC No.	77	DTC No.	P1266	Supply pump malfunction (Force feed)



SHTS161120200168

1. INSPECTION ITEM

(1) When no failures are found with the DTC No. P0628, P0629, P0088, P0191, P0192 and P0193/MC No. 74, 75, 68, 69, 76 and 67 but an actual common rail pressure falls below the target pressure by 15 MPa or greater for a certain duration of time at the engine speed of 450 r/min or more, the diagnosis will determine such phenomenon as a trouble.
If this failure code is output, there may be troubles such as:

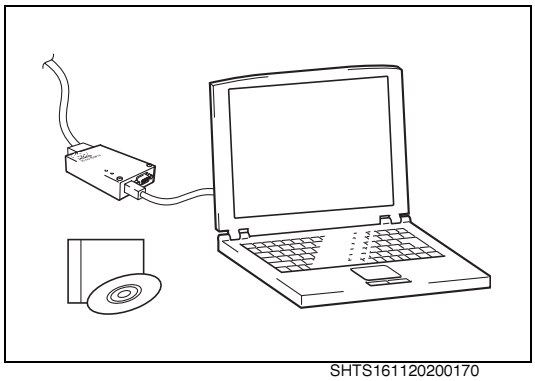
- insufficient fuel flow due to clogging in fuel supply system,
- malfunction of supply pump,
- malfunction of common rail pressure sensor, and
- fuel leakage from high-pressure piping system.

(2) More detailed diagnosis should be done by PC DIAGNOSIS TOOL (Hino-DX).

EGR ACTUATOR

EN1611202F200046

MC No.	81	DTC No.	P1458	EGR actuator 1 malfunction (Major fault)
MC No.	81	DTC No.	P1459	EGR actuator 2 malfunction (Minor fault)



SHTS161120200170

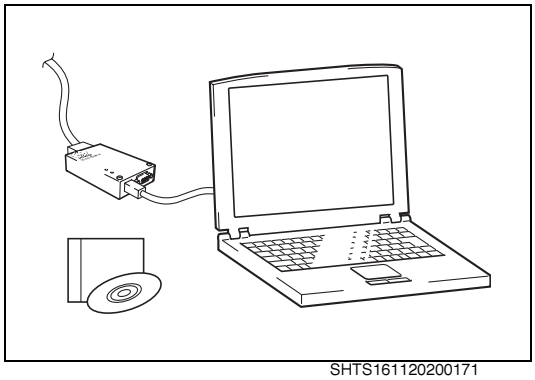
1. CHECK THE EGR.

(1) Connect the PC DIAGNOSIS TOOL (Hino-DX) (Refer to the page DN02-14).
(2) Select the "EGR" menu and check the EGR.

VNT (VARIABLE NOZZLE TURBINE) ACTUATOR

EN1611202F200047

MC No.	35	DTC No.	P0045	VNT controller malfunction (Major fault)
MC No.	36	DTC No.	P0045	VNT controller malfunction (Minor fault)



SHTS161120200171

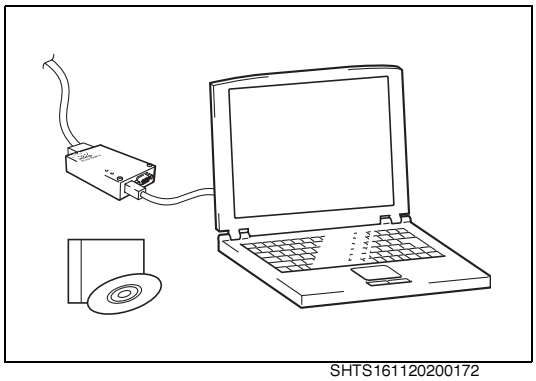
1. CHECK THE VNT.

(1) Connect the PC DIAGNOSIS TOOL (Hino-DX) (Refer to the page DN02-14).
(2) Select the "VNT" menu and check the VNT.

EGR COOLER OVERHEAT

EN1611202F200048

MC No.	85	DTC No.	P1416	EGR cooler overheat



SHTS161120200172

1. INSPECTION ITEM

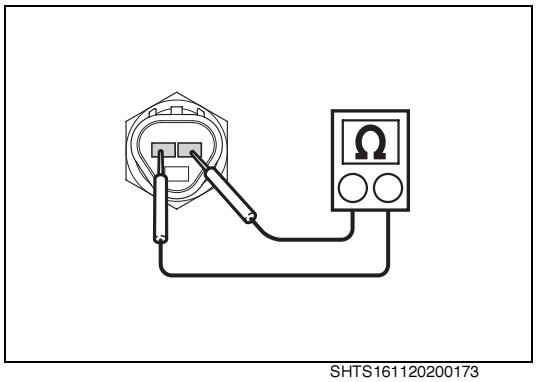
(1) Connect the PC DIAGNOSIS TOOL (Hino-DX) (Refer to the page DN02-14).
(2) Confirm not to find the engine overheat (DTC No. P0217/MC No.6).

Standard: Not to find the engine overheat.

NO

YES

- Overheating because of abnormal cooling system
- Check the cooling system.
  (Presence of coolant, coolant leak.)



SHTS161120200173

2. CHECK THE RESISTANCE BETWEEN TERMINALS.

(1) Set the starter switch to the "LOCK" position.
(2) Disconnect the connector of the EGR cooler coolant temperature sensor.
(3) Measure the resistance between No.1 and No.2 terminals of the EGR cooler coolant temperature sensor.

HINT
Measure the resistance under any of the following conditions.

Standard:

Coolant temperature	Resistance
20°C {68°F}	**2.45 kΩ**
40°C {104°F}	**1.15 kΩ**
60°C {140°F}	**584 Ω**
80°C {176°F}	**318 Ω**

HINT
This code would be displayed when the EGR cooler coolant temperature sensor is properly functioning and detects the EGR cooler coolant temperature of 105°C {221°F} or more.

NO

YES

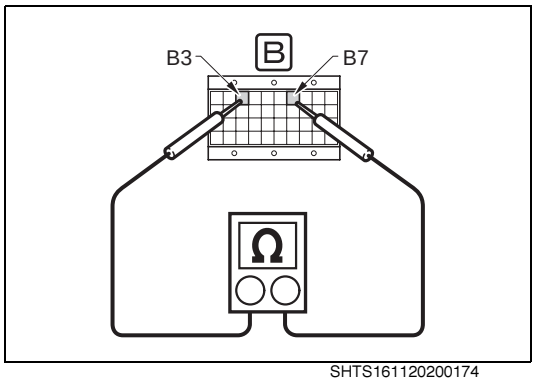
Malfunction of EGR cooler coolant temperature sensor

Malfunction of EGR cooler

ENGINE RETARDER

EN1611202F200049

MC No.	26	DTC No.	P1462	Engine retarder 1 open circuit, short circuit to ground
MC No.	26	DTC No.	P1463	Engine retarder 1 short circuit to battery



SHTS161120200174

1. CHECK THE RESISTANCE BETWEEN TERMINALS.

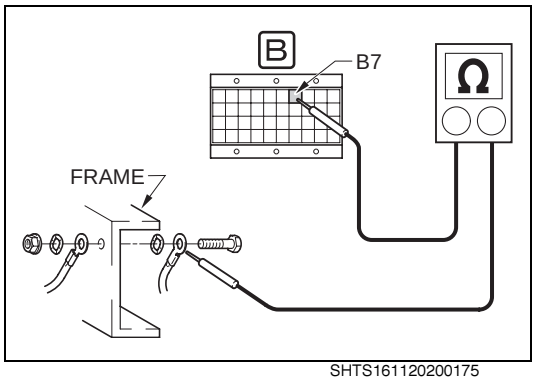
(1) Set the starter switch to the "LOCK" position and connect the signal check harness.
(2) Disconnect the signal check harness connector on the ECU side.
(3) Measure the resistance between B3 and B7 terminals of the signal check harness.

Standard: 34-44 Ω

NO

Proceed to 3.

YES



SHTS161120200175

2. CHECK THE CONTINUITY OF HARNESS.

(1) Measure the resistance between B7 terminal of the signal check harness and chassis GND.

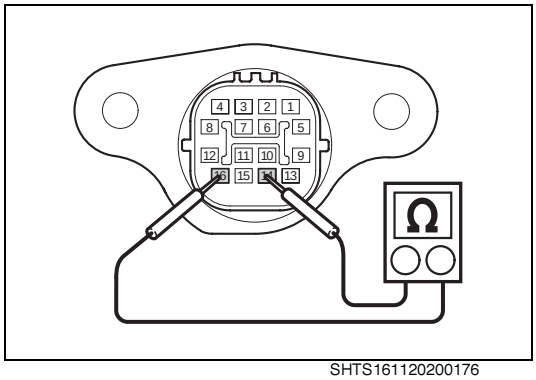
Standard: ∞ Ω

NO

Proceed to 4.

YES

Proceed to 5.



SHTS161120200176

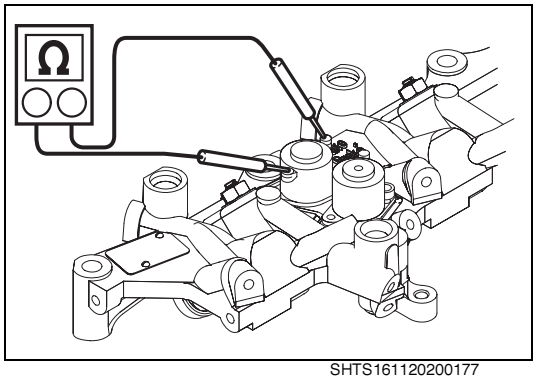
3. CHECK THE RESISTANCE BETWEEN TERMINALS.

(1) Set the starter switch to the "LOCK" position.

(2) Disconnect the injector harness collecting connector that is located on the front side of the cylinder.

(3) Measure the resistance between the No.14 and No.16 terminals of the injector harness collecting connector (Cylinder head side).

Standard: 34-44 Ω



SHTS161120200177

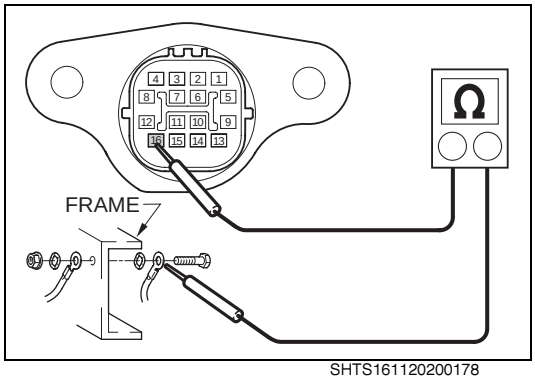
(4) If the above check shows abnormality, remove the cylinder head, remove the engine retarder valve harness and measure the resistance between terminals (Engine retarder solenoid valve side).

Standard: APPROX. 34-44 Ω

NO → Malfunction of engine retarder solenoid valve

YES

- Malfunction of harness
- Malfunction of connector



SHTS161120200178

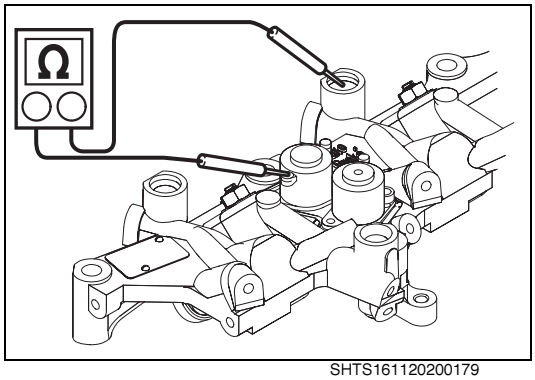
4. CHECK THE ENGINE RETARDER SOLENOID VALVE.

(1) Set the starter switch to the "LOCK" position.

(2) Disconnect the injector harness collecting connector that is located on the front side of the cylinder.

(3) Measure the resistance between No.16 terminal of the injector harness collecting connector (cylinder head side) and chassis GND.

Standard: ∞ Ω


SHTS161120200179

(4) If the above check would show abnormality, remove the cylinder head, remove the engine retarder solenoid valve harness and measure the resistance between terminals and chassis GND.

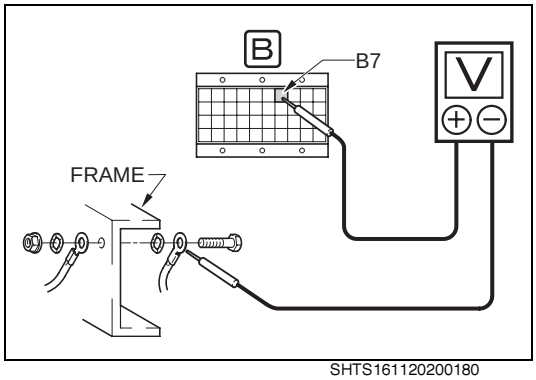
Standard: ∞ Ω

NO

Malfunction of engine retarder solenoid valve

YES

- Malfunction of harness
- Malfunction of connector



SHTS161120200180

5. CHECK THE VOLTAGE BETWEEN TERMINALS.

(1) Set the starter switch to the "ON" position.

(2) Measure the voltage between B7 terminal of the signal check harness and chassis GND.

Standard: 1V or less

NO

- Malfunction of harness
- Malfunction of connector

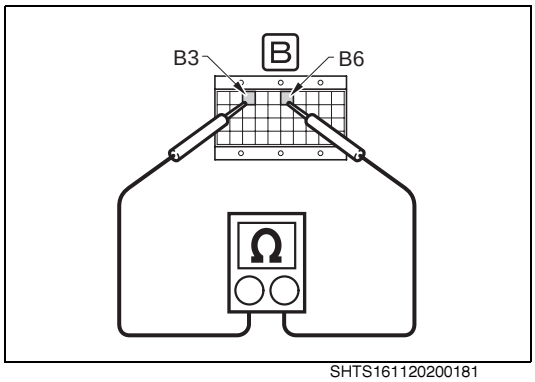
YES

- Malfunction of engine ECU
- Bad contact of ECU connector

ENGINE RETARDER

EN1611202F200050

MC No.	27	DTC No.	P1467	Engine retarder 2 open circuit, short circuit to ground
MC No.	27	DTC No.	P1468	Engine retarder 2 short circuit to battery



SHTS161120200181

1. CHECK THE RESISTANCE BETWEEN TERMINALS.

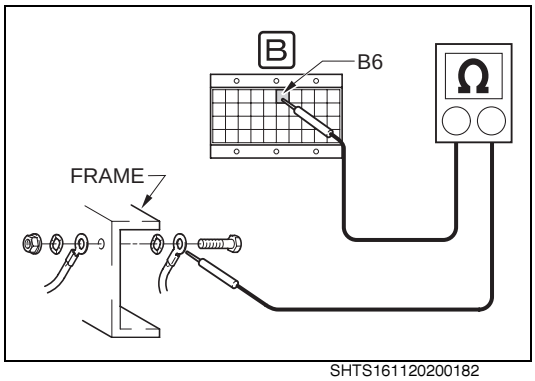
(1) Set the starter switch to the "LOCK" position and connect the signal check harness.
(2) Disconnect the signal check harness connector on the ECU side.
(3) Measure the resistance between B3 and B6 terminals of the signal check harness.

Standard: 34-44 Ω

NO

Proceed to 3.

YES



SHTS161120200182

2. CHECK THE CONTINUITY OF HARNESS.

(1) Measure the resistance between B6 terminal of the signal check harness and chassis GND.

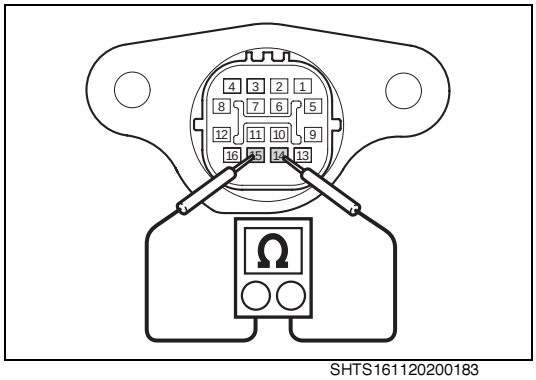
Standard: ∞ Ω

NO

Proceed to 4.

YES

Proceed to 5.



SHTS161120200183

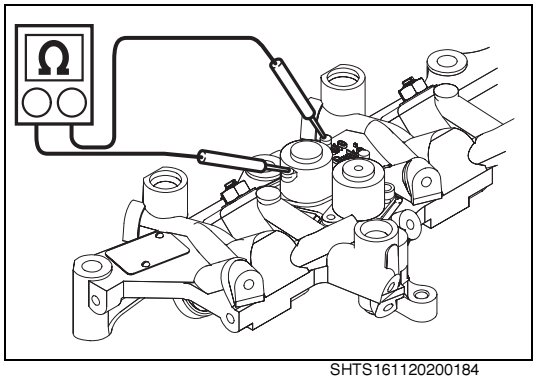
3. CHECK THE RESISTANCE BETWEEN TERMINALS.

(1) Set the starter switch to the "LOCK" position.

(2) Disconnect the injector harness collecting connector that is located on the front side of the cylinder.

(3) Measure the resistance between No.14 and No.15 terminals of the injector harness collecting connector (Cylinder head side).

Standard: 34-44 Ω



SHTS161120200184

(4) If the above check would show abnormality, remove the cylinder head, remove the engine retarder solenoid valve harness and measure the resistance between terminals (Engine retarder solenoid valve side).

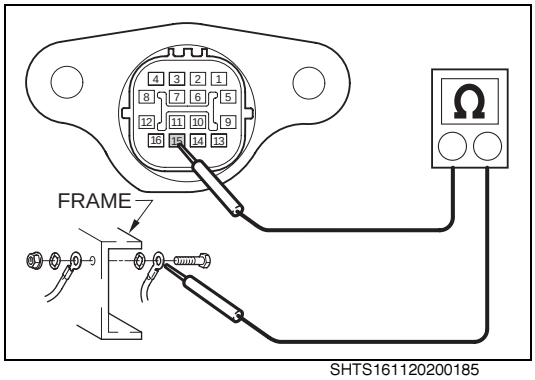
Standard: APPROX. 34-44 Ω

NO

Malfunction of engine retarder solenoid valve

YES

- Malfunction of harness
- Malfunction of connector



SHTS161120200185

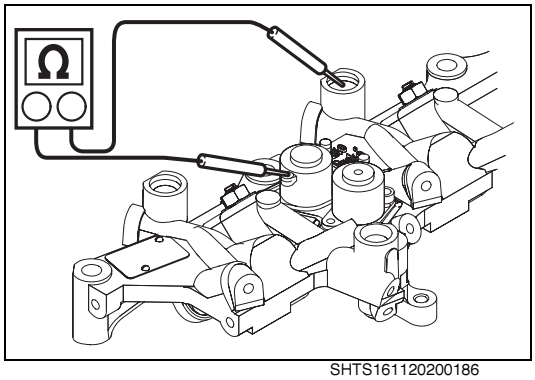
4. CHECK THE ENGINE RETARDER SOLENOID VALVE.

(1) Set the starter switch to the "LOCK" position.

(2) Disconnect the injector harness collecting connector that is located on the front side of the cylinder.

(3) Measure the resistance between No.15 terminal of the injector harness collecting connector (cylinder head side) and chassis GND.

Standard: ∞ Ω


SHTS161120200186

(4) If the above check would show abnormality, remove the cylinder head, remove the engine retarder solenoid valve harness and measure the resistance between terminals and chassis GND.

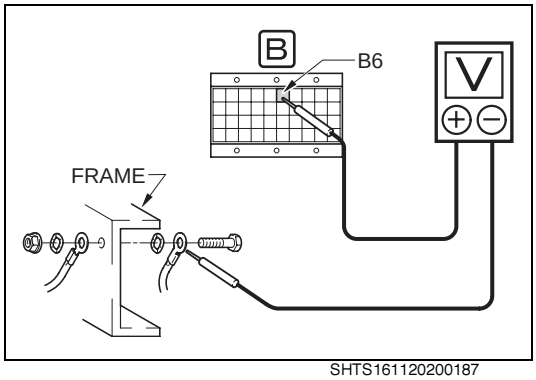
Standard: ∞ Ω

NO

Malfunction of engine retarder solenoid valve

YES

- Malfunction of harness
- Malfunction of connector



SHTS161120200187

5. CHECK THE VOLTAGE BETWEEN TERMINALS.

(1) Set the starter switch to the "ON" position.

(2) Measure the voltage between B6 terminal of the signal check harness and chassis GND.

Standard: 1V or less

NO

- Malfunction of harness
- Malfunction of connector

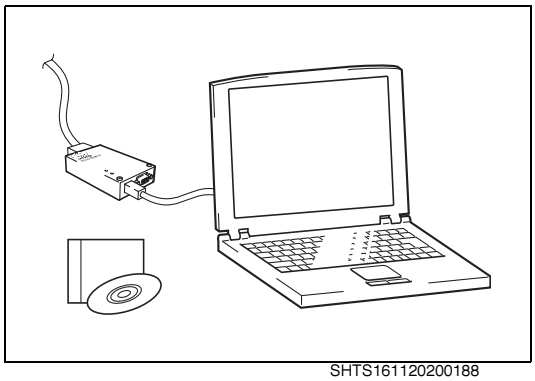
YES

- Malfunction of engine ECU
- Bad contact of ECU connector

INJECTOR CORRECTION DATA

EN1611202F200051

MC No.	2	DTC No.	P1601	Injector correction data conforming error



SHTS161120200188

1. CHECK THE QR CODE.

(1) Connect the PC DIAGNOSIS TOOL (Hino-DX). (Refer to the page DN02-14.)
Select the "Injector Calibration" menu and read the QR codes.
Standard: Same as the installed injector or service record.

NO → Re-input the QR codes.

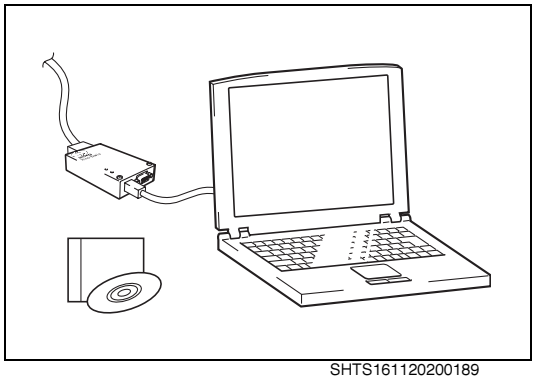
YES

Replace the engine ECU.

ECU

EN1611202F200052

MC No.	3	DTC No.	P0606	ECU malfunction (Hard detection)
MC No.	3	DTC No.	P0607	ECU malfunction (Monitoring IC malfunction in ECU)



SHTS161120200189

1. CHECK THE MC OR DTC.

(1) Connect the PC DIAGNOSIS TOOL (Hino-DX). (Refer to the page DN02-14.)
(2) After the starter switch is positioned on the "LOCK" once, it should be turned to the "ON" position again.
(3) After erasing the MC or DTC, check that the same code (DTC No. P0606, P0607/MC No.3) is displayed again.
Standard: Normal

NO → Malfunction of engine ECU

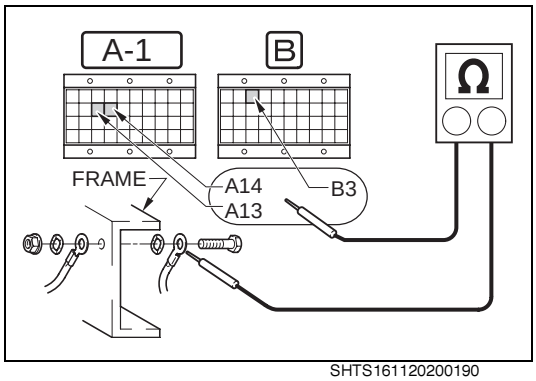
YES

Normal
(Temporary malfunction because of radio interference noise.)

MAIN RELAY

EN1611202F200053

MC No.	5	DTC No.	P0686	Main relay malfunction



SHTS161120200190

1. CHECK THE CONTINUITY OF HARNESS.

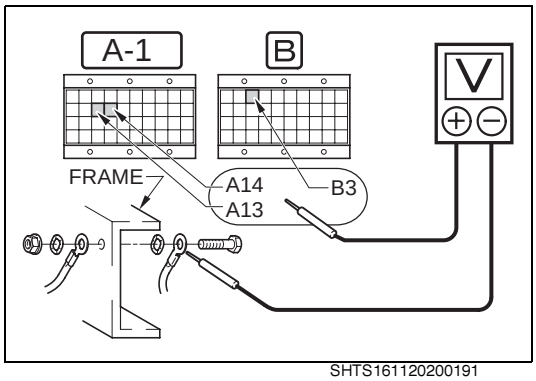
(1) Set the starter switch to the "LOCK" position and connect the signal check harness.
(2) Disconnect the signal check harness connector on the ECU side.
(3) Measure the resistance between terminal of the signal check harness and chassis GND.

Terminals to measure the resistance
A13 ↔ chassis GND
A14 ↔ chassis GND
B3 ↔ chassis GND

Standard: ∞ Ω

NO → Malfunction of harness

YES



SHTS161120200191

2. CHECK THE VOLTAGE BETWEEN TERMINALS.

(1) Set the starter switch to the "ON" position.
(2) Measure the voltage between terminal of the signal check harness and chassis GND.

Terminals to measure the voltage	
+ side	**- side**
A13	chassis GND
A14	
B3	

Standard: 1V or less

NO → Malfunction of harness

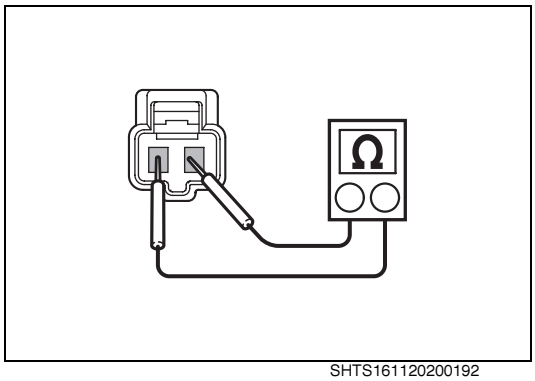
YES

- Malfunction of engine ECU
- Bad contact of ECU connector

IDLE SWITCH

EN1611202F200054

MC No.	42	DTC No.	P0510	Idle switch malfunction



SHTS161120200192

1. CHECK THE RESISTANCE BETWEEN TERMINALS.

(1) Set the starter switch to the "LOCK" position.
(2) Disconnect connector of the idle switch.
(3) Measure the resistance between No.1 and No.2 terminals of idle switch connector (Switch side).

Standard:
2 Ω or less (Accelerator pedal released)
∞ Ω (With full throttle)

NO → Malfunction of accelerator switch

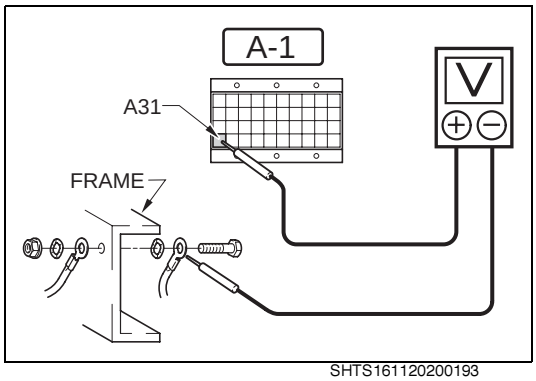
YES

- Malfunction of harness
- Malfunction of connector
- Malfunction of vehicle control ECU

STARTER SWITCH

EN1611202F200055

MC No.	45	DTC No.	P0617	Starter switch malfunction



SHTS161120200193

1. CHECK THE VOLTAGE BETWEEN TERMINALS.

(1) Set the starter switch to the "LOCK" position and connect the signal check harness.
(2) Disconnect the signal check harness connector on the ECU side.
(3) Set the starter switch to the "ON" position.
(4) Measure the voltage between A31 terminal of the signal check harness and chassis GND.

NOTICE

Make sure that transmission is in neutral position.

Standard:
1V or less (Starter switch "LOCK")
8V or more (Starter switch "START")

NO

- Malfunction of harness
- Malfunction of starter switch

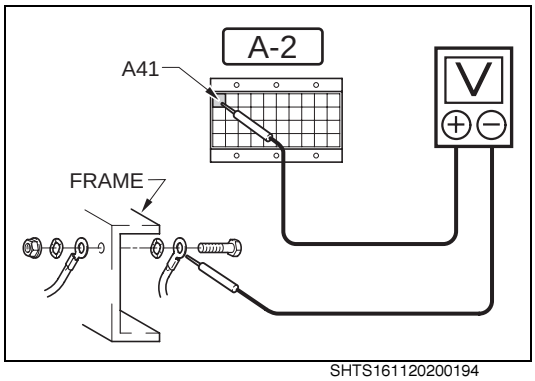
YES

- Malfunction of engine ECU
- Malfunction of ECU connectors

NEUTRAL SWITCH

EN1611202F200056

MC No.	47	DTC No.	P0850	Neutral switch malfunction



SHTS161120200194

1. CHECK THE VOLTAGE BETWEEN TERMINAL AND GND.

(1) Set the starter switch to the "LOCK" position and connect the signal check harness.
(2) Disconnect the signal check harness connector on the ECU side.
(3) Set the starter switch to the "ON" position.
(4) Measure the voltage between A41 terminal of the signal check harness and chassis GND.

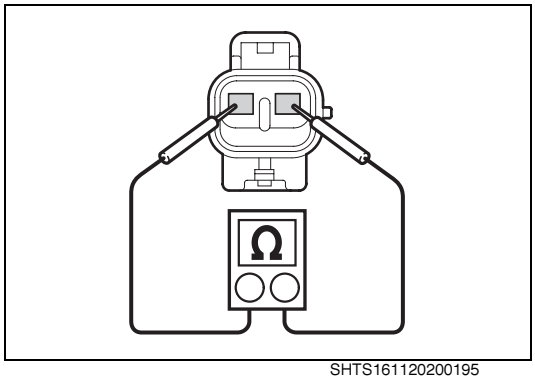
Standard:
8V or more (Transmission: Neutral position)
1V or less (Transmission: Not neutral position)

NO

Proceed to 2.

YES

- Malfunction of engine ECU
- Malfunction of ECU connectors



SHTS161120200195

2. CHECK THE RESISTANCE BETWEEN TERMINALS.

(1) Set the starter switch to the "LOCK" position.
(2) Disconnect the connector of neutral switch.
(3) Measure the resistance between No.1 and No.2 terminals of neutral switch connector (Neutral switch side).
Standard:
1 Ω or less (Neutral switch pressed)
∞ Ω (Neutral switch not pressed)

NO

Malfunction of neutral switch

YES

- Malfunction of harness
- Malfunction of connectors
- Malfunction of neutral relay

CAN COMMUNICATION ERROR (TRANSMISSION)

EN1611202F200057

MC No.	9	DTC No.	U0101	CAN communication error (Transmission)

1. INSPECTION ITEM

(1) Use the Hino-DX to check whether communication blackout (Vehicle control ECU) (DTC No. U110A/MC No. 8) is output.
If the communication blackout (Vehicle control ECU) code is output, fix such failure. Then check again whether the DTC No. U0101/MC No. 9 is output.
Refer to the section **"CAN COMMUNICATION ERROR (VEHICLE CONTROL ECU) (DTC No. U110A/MC No. 8)"** .

(2) Check the CAN communication line.
Refer to the chapter **"OTHERS (CAN COMMUNICATION)"** in the **"WORKSHOP MANUAL (CHASSIS)"** .

CAN COMMUNICATION ERROR (CRUISE)

EN1611202F200058

MC No.	9	DTC No.	U0104	CAN communication error (Cruise)

1. INSPECTION ITEM

(1) Use the Hino-DX to check whether communication blackout (Vehicle control ECU) (DTC No. U110A/MC No. 8) is output.
If the communication blackout (Vehicle control ECU) code is output, fix such failure. Then check again whether the DTC No. U0104/MC No. 9 is output.
Refer to the section **"CAN COMMUNICATION ERROR (VEHICLE CONTROL ECU) (DTC No. U110A/MC No. 8)"** .

(2) Check the CAN communication line.
Refer to the chapter **"OTHERS (CAN COMMUNICATION)"** in the **"WORKSHOP MANUAL (CHASSIS)"** .

CAN COMMUNICATION ERROR (ABS/AIR SUSPENSION)

EN1611202F200059

MC No.	9	DTC No.	U0121	CAN communication error (ABS)
MC No.	9	DTC No.	U0132	CAN communication error (Air suspension)

1. INSPECTION ITEM

(1) Check the CAN communication line.
Refer to the chapter **"OTHERS (CAN COMMUNICATION)"** in the **"WORKSHOP MANUAL (CHASSIS)"** .

CAN COMMUNICATION ERROR (METER)

EN1611202F200060

MC No.	9	DTC No.	U0155	CAN communication error (Meter)

1. INSPECTION ITEM

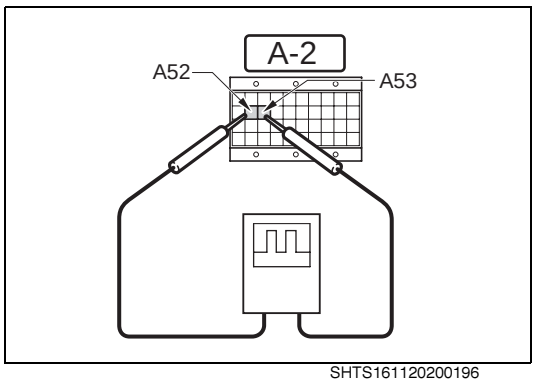
(1) Use the Hino-DX to check whether communication blackout (Vehicle control ECU) (DTC No. U110A/MC No. 8) is output.
If the communication blackout (Vehicle control ECU) code is output, fix such failure. Then check again whether the DTC No. U0155/MC No. 9 is output.
Refer to the section **"CAN COMMUNICATION ERROR (VEHICLE CONTROL ECU) (DTC No. U110A/MC No. 8)"** .

(2) Check the CAN communication line.
Refer to the chapter **"OTHERS (CAN COMMUNICATION)"** in the **"WORKSHOP MANUAL (CHASSIS)"** .

CAN COMMUNICATION ERROR (VEHICLE CONTROL ECU)

EN1611202F200061

MC No.	8	DTC No.	U110A	CAN communication error (Vehicle control ECU)



SHTS161120200196

1. CHECK THE VOLTAGE BETWEEN TERMINALS.

(1) Set the starter switch to the "LOCK" position and connect the signal check harness.

(2) Set the starter switch to the "ON" position.

(3) Measure the voltage between A53 and A52 terminals of the signal check harness.

Standard: Pulse wave-shape by 0 ↔ 5V

NO

- Malfunction of harness
- Malfunction of connectors

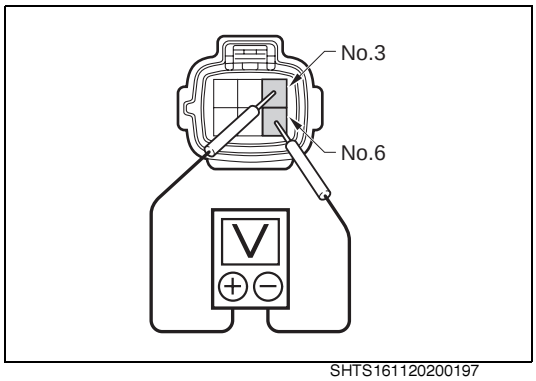
YES

- Malfunction of vehicle control ECU

CAN COMMUNICATION ERROR (EGR)

EN1611202F200062

MC No.	8	DTC No.	U1122	CAN communication error (EGR)



SHTS161120200197

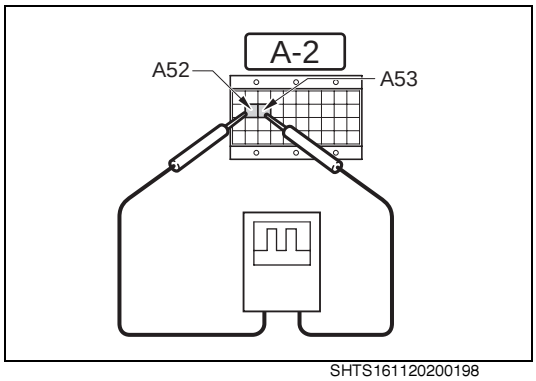
1. CHECK THE VOLTAGE BETWEEN TERMINALS.

(1) Set the starter switch to the "LOCK" position.
(2) Disconnect the connectors of EGR actuator.
(3) Set the starter switch to the "ON" position.
(4) Measure the voltage between No.3 and No.6 terminals of EGR actuator (Vehicle harness side).

Standard: 19V or more

NO → Malfunction of harness

YES



SHTS161120200198

2. CHECK THE VOLTAGE BETWEEN TERMINALS.

(1) Set the starter switch to the "LOCK" position and connect the signal check harness.
(2) Connect the connector of the EGR actuator.
(3) Set the starter switch to the "ON" position.
Measure the voltage between A53 and A52 terminals of the signal check harness.

Standard: Pulse wave-shape by 0 ↔ 5V

NO →
- Malfunction of harness
- Malfunction of connectors

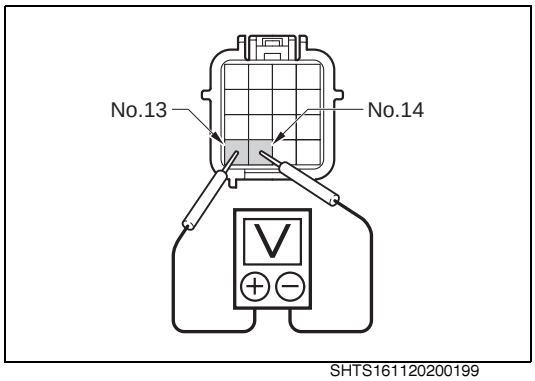
YES

Malfunction of EGR actuator

CAN COMMUNICATION ERROR (VNT)

EN1611202F200063

MC No.	8	DTC No.	U1123	CAN communication error (VNT)



SHTS161120200199

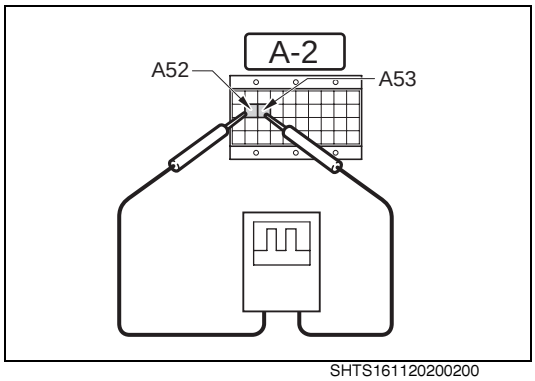
1. CHECK THE VOLTAGE BETWEEN TERMINALS.

(1) Set the starter switch to the "LOCK" position.
(2) Disconnect the connectors of VNT actuator.
(3) Set the starter switch to the "ON" position.
(4) Measure the voltage between No.13 and No.14 terminals of VNT actuator (Vehicle harness side).

Standard: 19V or more

NO → Malfunction of harness

YES



SHTS161120200200

2. CHECK THE VOLTAGE BETWEEN TERMINALS.

(1) Set the starter switch to the "LOCK" position and connect the signal check harness.
(2) Connect the connector of the VNT actuator.
(3) Set the starter switch to the "ON" position.
Measure the voltage between A53 and A52 terminals of the signal check harness.

Standard: Pulse wave-shape by 0 ↔ 5V

NO →
- Malfunction of harness
- Malfunction of connectors

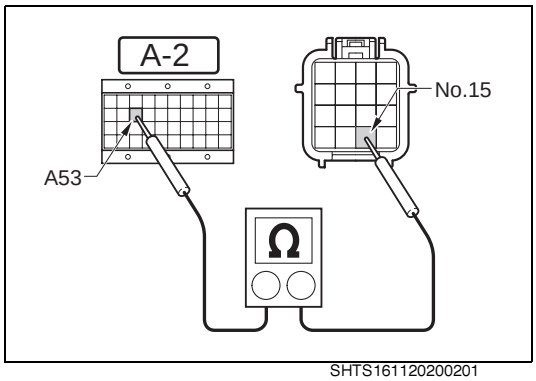
YES

Malfunction of VNT actuator

CAN MALFUNCTION (ENGINE)

EN1611202F200064

MC No.	8	DTC No.	U0073	CAN malfunction (Engine)



SHTS161120200201

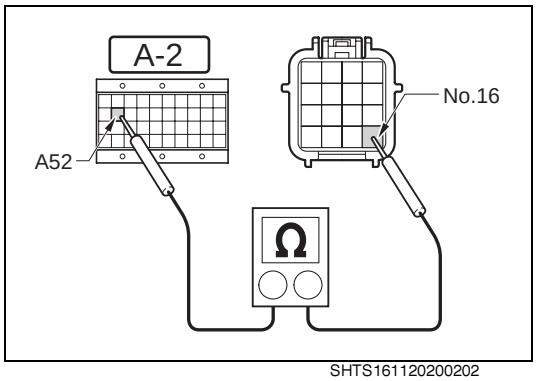
1. CHECK THE CONTINUITY BETWEEN CANH TERMINALS.

(1) Set the starter switch to the "LOCK" position and connect the signal check harness.
(2) Disconnect the connector of the VNT actuator.
(3) Disconnect the signal check harness connector on the ECU side.
(4) Check the continuity between A53 terminal of the signal check harness and No.15 terminal of VNT actuator (Vehicle harness side).

Standard: Continuity

NO → Malfunction of harness

YES



SHTS161120200202

2. CHECK THE CONTINUITY BETWEEN CANL TERMINALS.

(1) Check the continuity between A52 terminal of the signal check harness and No.16 terminal of VNT actuator (Vehicle harness side).

Standard: Continuity

NO → Malfunction of harness

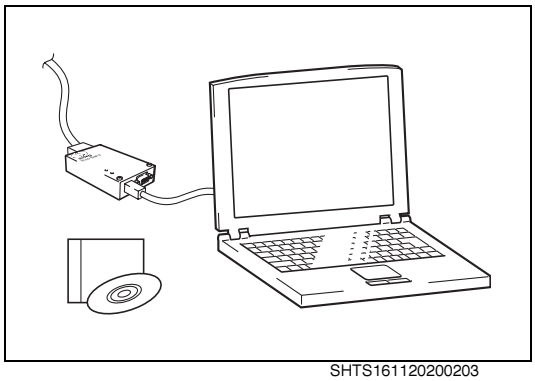
YES

- Malfunction of engine ECU
- Malfunction of ECU connectors

NO VEHICLE INFORMATION RECORDED

EN1611202F200065

MC No.	8	DTC No.	P0610	No vehicle information recorded



SHTS161120200203

1. CHECK THE MC OR DTC.

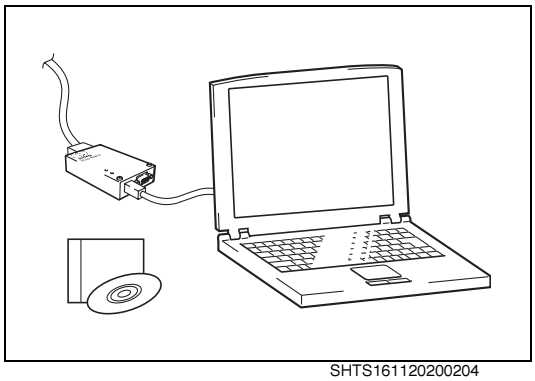
(1) Connect the PC DIAGNOSIS TOOL (Hino-DX). (Refer to the page DN02-14.)
(2) After the starter switch is positioned on the "LOCK" once, wait for about 30 seconds, it should be turned to the "ON" position again.
(3) Use the Hino-DX to delete the past failure records and check whether the same code (DTC No.P0610/MC No.8) is output again.
Standard: Normal

NO

Proceed to 2.

YES

No information has been recorded in the EEPROM between receipt of new vehicle information and ECU power off. Finish this step after observing normal recovery.



SHTS161120200204

2. CHECK THE CAN COMMUNICATION ERROR (VEHICLE CONTROL ECU).

(1) Use the Hino-DX to check whether the CAN communication error (Vehicle control ECU) (DTC No.U110A/MC No.8) is output.

Standard:
Not to find the CAN communication error (Vehicle control ECU).

NO

Vehicle information unreceived due to CAN communication error (Vehicle control ECU)

Take the procedures for DTC No.U110A/MC No.8.
Refer to the section **"CAN COMMUNICATION ERROR (VEHICLE CONTROL ECU) (DTC No. U110A/MC No. 8)"** .

YES

- Malfunction of engine ECU
- Malfunction of vehicle control ECU

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