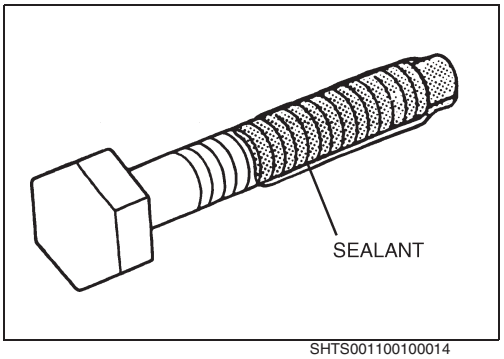
HINO

HINO E13C ENGINE WORKSHOP MANUAL



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2. PRE-COATED BOLT

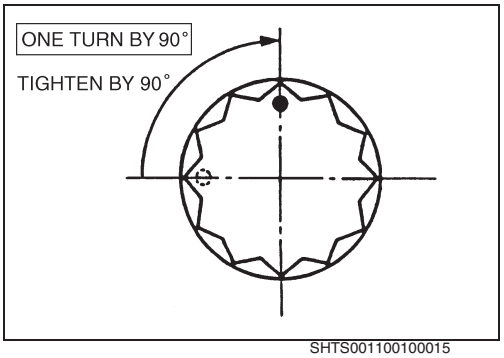
A pre-coated bolt is a bolt having a thread coated with sealant.

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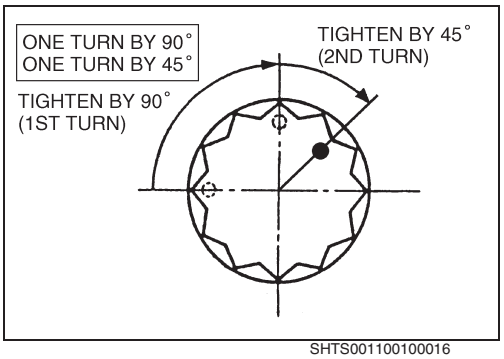
3. TENSION CONTROL WITH ANGULAR TORQUING METHOD IN PLASTIC REGION OF MATERIAL

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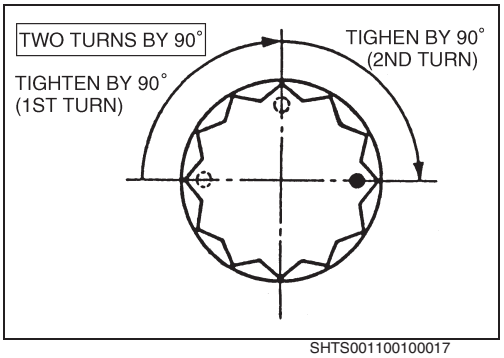
(2) Target region
Cylinder head bolt, crankshaft main bearing cap bolt, connecting rod bearing, cap bolt and so on.

⚠ 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°).

ENGINE INTRODUCTION (E13C)

EN01-001

ENGINE ASSEMBLY

DATA AND SPECIFICATIONS

EN0111001I200001

Model		E13C-TI
Type		Diesel, 4 cycle, vertical, 6 cylinder, in-line overhead camshaft, water-cooled, direct injection
Aspiration		Turbocharged with intercooler
Bore and stroke		137x146 mm {5.394x5.748 in.}
Piston displacement		12.913 L {788.0 cu.in.}
Compression ratio		17.5: 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 (no load)		2,100 or 2,400 r/min
Idling revolution		500 r/min
Dry weight		1,250 kg {2,756 lbf}
Valve seat angle	Intake	30°
	Exhaust	45°
Valve face angle	Intake	30°
	Exhaust	45°
Valve timing (flywheel travel)	Intake opens	12.5° before top dead center
	Intake closes	60° after bottom dead center
	Exhaust opens	56° before bottom dead center
	Exhaust closes	19° after top dead center
Valve clearance (when cold)	Intake	0.28 mm {0.0110 in.}
	Exhaust	0.49 mm {0.0193 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	160 MPa {1,630 kgf/cm^2, 23,200 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

EN0111001F300001

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.

Excessive oil consumption

Symptom	Possible cause	Remedy/Prevention
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 breaking in of piston rings	Replace piston rings and cylinder liner.
	Unsuitable oil (viscosity too low)	Change oil as required and replace piston rings and cylinder liners.
	Incorrectly fitted piston rings (upside down)	Replace piston rings.
	Gaps of piston rings in cell with each other	Reassemble piston rings.
Excessive oil consumption (Valve and valve guides)	Worn valve stem	Replace valve and valve guide.
	Worn valve guide	Replace 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 (Excess oil feed)	Defective oil level gauge	Replace oil level gauge.
	Oil level too high	Drain excess oil.
Excessive oil consumption (Oil leakage from miscellaneous parts)	Oil leakage from oil seal	Replace oil seal.
	Cracks or blowhole in cylinder block	Replace cylinder block.
	Oil leakage from connections of oil lines	Tighten connections of oil lines.
	Oil leakage from oil cooler	Replace oil cooler.
	Oil leakage from oil pan gasket	Replace oil pan gasket.
	Oil leakage from O-ring	Replace O-ring.
Excessive oil consumption (Other problems)	Overcooled engine (low temperature wear)	Warm up engine before moving vehicle. Check cooling system.

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.**

Piston seizure

Symptom	Possible cause	Remedy/Prevention
Piston seizure (Pistons, cylinder liners and piston rings)	Incorrect clearance between piston and cylinder liner	Replace piston, piston rings and cylinder liner.
	Unsatisfactory installation of piston pin	Replace piston, piston rings, cylinder liner and piston pin as required.
	Broken piston ring	Replace piston, piston rings and cylinder liner.
	Difference in expansion due to use of wrong piston	Replace piston, piston rings and cylinder liner.
Piston seizure (Coolant)	Reduction in capacity of coolant pump (due to vane corrosion)	Replace the coolant pump.
	Leakage of coolant	Repair.
	Insufficient coolant	Add coolant.
	Dirty coolant	Clean and replace coolant.
	Defective radiator (coolant leakage, clogging)	Repair or replace the radiator.
	Defective rubber hose (leakage)	Replace rubber hose.
	Defective thermostat	Replace the thermostat.
	Leakage of exhaust into cooling system	Repair.
Piston seizure (Operation)	Abrupt stoppage of engine after running at high speed	Operate engine properly.
	Hill climbing using unsuitable gear	Select suitable gear.
Piston seizure (Oil)	Insufficient oil	Add oil.
	Dirty oil	Change oil.
	Poor quality oil	Replace with proper engine oil.
	High oil temperature	Repair.
	Low oil pressure	Repair.
	Defective oil pump	Repair oil pump.
	Reduced performance due to worn oil pump	Replace oil pump.
	Suction strainer sucking air	Add oil and/or repair strainer.
Piston seizure (Abnormal combustion)	Use of defective fuel	Change fuel.
	Engine overheating	See Symptom: "Engine overheating".
	Breakdown of injector	Replace the injector.

NOTICE
If piston seizure occurs, the problems above will occur. Complaints from the customer are often related to these problems.

1. **White smoke is emitted.**
2. **Lack of power**
3. **Excessive blow-by gas**

Lack of power

Symptom	Possible cause	Remedy/Prevention
Lack of power (Supply pump)	Damaged suction control valve	Replace the supply pump.
Lack of power (Intake)	Clogged air cleaner	Clean element or replace element.
Lack of power (Overheating)		See Symptom: "Engine overheating".
Lack of power (Fuel and 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.
	Breakdown of injector	Replace the injector.
Lack of power (Pistons, cylinder liners and piston rings)	Seized or wear of piston	Replace the piston, piston rings and liner.
	Worn or broken piston rings, piston and cylinder liner	Replace piston rings, piston and liner.
Lack of power (Other problems)	Exhaust brake butterfly valve stuck in half-open position	Replace or repair exhaust brake.
	Connecting rod bent	Replace or repair connecting rod.
	Exhaust pipe or muffler crushed (increased back-pressure)	Replace exhaust pipe or muffler.
	Breakage of turbine or blower	Replace turbocharger.

Leakage of exhaust

Symptom	Possible cause	Remedy/Prevention
Leakage of exhaust (Head gasket)	Fatigued gasket (aging)	Replace gasket.
	Damage	Replace gasket.
	Improper installation	Replace gasket.
Leakage of exhaust (Head bolts)	Loose bolts	Tighten bolts.
	Elongated bolts	Replace bolts.
	Improper tightening torque or tightening sequence	Tighten properly.
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 block.
Leakage of exhaust (Cylinder head)	Cracking	Replace cylinder head.
	Surface distortion	Repair or replace.
Leakage of exhaust (Cylinder liners)	Cracking	Replace cylinder liner.
	Corrosion	Replace cylinder liner.
	Insufficient projection of cylinder liner	Replace cylinder liner.

NOTICE

If leakage of the exhaust occurs, the problems above will occur. Complaints from the customer are often related to these problems.

1. **Lack of power.**
2. **The engine overheats.**
3. **The coolant is discolored.**

Difficulty starting engine

Symptom	Possible cause	Remedy/Prevention
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
	Broken glow plug	Replace.
Difficulty starting engine (Supply pump)	Defective supply pump	Replace the supply pump.
Difficulty starting engine (Air cleaner)	Clogged element	Replace the element.
Difficulty starting engine (Fuel system)	No fuel in tank	Supply fuel.
	Clogged fuel line	Clean fuel line.
	Air sucked into fuel system through fuel line connections	Tighten fuel line connections.
	Clogged fuel filter	Replace element.
	Loose connection in high-pressure line	Tighten sleeve nut of high-pressure line.
	Water in fuel	Drain and clean fuel system.
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.
	Improperly adjusted or broken	Adjust.

Rough idling

Symptom	Possible cause	Remedy/Prevention
Rough idling (Supply pump)	Damaged suction control valve	Replace the supply pump.
Rough idling (Injector)	Breakdown of injector	Replace the injector.
Rough idling (Engine proper)	Improper valve clearance	Adjust valve clearance.
	Improper contact of valve seat	Replace or repair valve and valve seat.
	Idling speed too low	Adjust idling speed.
	Coolant temperature too low	Warm up engine.
	Compression pressure of cylinders markedly different from one another	Overhaul engine.
Rough idling (Other problems)	Clogged high pressure injection line	Replace line.
	Leakage due to improper tightening of high pressure fuel line	Tighten sleeve nut.
	Engine seizure	Replace pistons, piston rings and liners.
	Incorrect valve timing	Replace camshaft.

Diesel knock

Symptom	Possible cause	Remedy/Prevention
Diesel knock (Supply pump)	Damaged suction control valve	Replace the supply pump.
Diesel knock (Injector)	Breakdown of injector	Replace the injector.
Diesel knock (Fuel system)	Use of poor fuel	Use good quality fuel.
Diesel knock (Other problems)	Excessively cooled or heated engine	Warm up or cool engine.
	Insufficient air intake	Correct.
	Insufficient compression pressure	Repair.
	Compression pressure leaks at cylinder head gasket	Replace head gasket.
	Improper valve clearance or valve sticking	Adjust or repair.
	Tappet sticking	Replace tappet and camshaft.

Unusual engine noise

Symptom	Possible cause	Remedy/Prevention
Unusual engine noise (Piston)	Wear of piston pin boss or piston pin	Replace piston and/or piston pin.
	Seized, damaged, or worn piston pin bushing	Replace piston pin bushing.
	Worn pistons or cylinder liners	Replace piston or cylinder liner.
	Damaged or seized piston	Replace piston and cylinder liner.
	Foreign matter on top surface of the piston	Remove foreign matter and repair or replace piston, cylinder liner, and/or cylinder head.
Unusual engine noise (Valve mechanism)	Incorrect valve clearance	Adjust valve clearance.
	Valve cotter out of place	Replace valve cotter.
	Seized valve stem	Replace valve and valve guide.
	Broken valve	Replace valve.
	Damaged rocker arm support	Replace rocker arm support.
	Broken valve spring	Replace valve spring.
Unusual engine noise (Bearings seizure)	Insufficient lubricating oil	Add oil.
	Excessive or insufficient tightening of bearing housings	Retighten to specified torque.
	Pits and scratches on bearing surface	Replace bearing and crankshaft.
	Oil film formed on back of bearing	Replace bearing.
	Improper installation of bearing	Replace bearing.
	Reduction of spread dimension of bearing	Replace bearing.
	Distorted bearing housing	Replace or correct bearing housing.
	Excessive oil clearance	Replace bearing.
Unusual engine noise (Various other parts)	Exhaust gas leakage from exhaust pipe joints	Retighten joints.
	Loosen or missing intake manifold flange gasket	Retighten or replace.
	Intake valve seating is not concentric	Replace or correct the valve and valve seat.
	Intake gas leakage	Retighten.

Symptom	Possible cause	Remedy/Prevention
Unusual engine noise (Other problems)	Loose cooling fan mounting bolts or fan pulley nut	Tighten the fan and crankshaft pulley.
	Lack of lubricating oil (coolant pump, valves, etc.)	Lubricate.
	Worn timing gear	Replace the timing gear.
	Breakage of turbine or blower	Replace turbocharger.

NOTICE
The items on this page concern unusual engine noise which is due to causes other than those given for diesel knock.

TROUBLESHOOTING (COMMON RAIL SYSTEM)

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Engine does not start

Symptom	Possible cause	Remedy/Prevention
Engine does not start (Fuel not reaching supply pump)	Fuel lines clogged or damaged	Clean or replace fuel lines.
	Fuel filter clogged	Clean or replace the filter element.
	Air in fuel caused by improper connections of fuel line between fuel tank and feed pump	Repair connections.
	Filter incorporated in inlet side of feed pump clogged	Remove foreign material.
	Breakdown feed pump	Replace the supply pump.
Engine does not start (Fuel reaching supply pump)	Leakage due to improper tightening of high pressure fuel line	Tighten sleeve nut.
	Breakdown ECU	Replace the ECU.
Engine does not start (Injector faulty)	Injector broken	Replace the injector.
Engine does not start (Electrical system)	Defective sensors or circuits	Refer to FUEL CONTROL.
Engine starts and stops	Fuel lines clogged	Clean or replace fuel lines.
	Air in fuel caused by damaged fuel lines or improper connection of fuel lines	Repair fuel lines or replace fuel lines and gaskets.
Engine has low power (Injector faulty)	Injector broken	Replace the injector.
Engine has low power (Electrical system)	Defective sensors or circuits	Refer to FUEL CONTROL.

Excessive smoke (Black smoke)

Symptom	Possible cause	Remedy/Prevention
Excessive smoke (Black smoke)	Defective sensors or circuits	Refer to FUEL CONTROL.
	Defective injector	Replace the injector.
Excessive smoke (White smoke)	Water in fuel	Check and clean fuel lines.
	Glow plug not operating	Check glow plug circuit.

Low idle speed irregular

Symptom	Possible cause	Remedy/Prevention
Low idle speed irregular	Defective sensors or circuits	Refer to FUEL CONTROL.
	Defective injector	Replace the injector.

ENGINE TUNEUP

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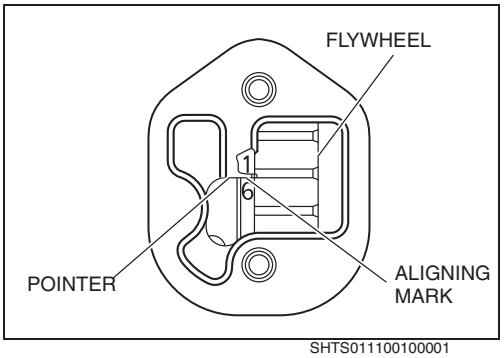
VALVE CLEARANCE CHECKING AND ADJUSTING PROCEDURES

NOTICE

Valve clearance adjustment is performed only when the checking result is not within the specified value.



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1. PREPARATION OF CHECKING AND ADJUSTMENT

(1) Positioning the No.1 or No.6 cylinder at Top Dead Center of the compression stroke.

a. Turn the crankshaft counterclockwise (viewed from the flywheel side) to align mark 1/6 on the outer periphery of the flywheel with the pointer of the flywheel housing.

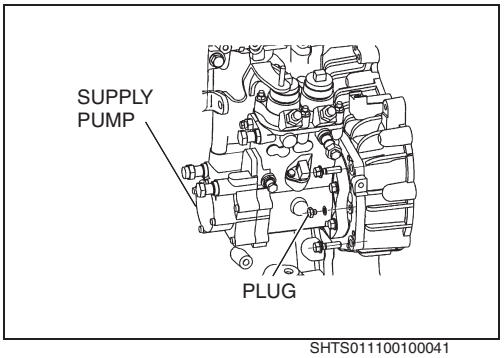
NOTICE

- **Always turn the crankshaft counterclockwise (viewed from the flywheel side).**
- **In this position, the No.1 or No.6 cylinder is at the Top Dead Center of the compression stroke.**

b. Confirm whether No.1 or No.6 cylinder is at the Top Dead Center of the compression stroke by the following two steps.

- When the end-face of special tool and the surface of coupling plate are contacted by inserting special tool into coupling plate, No. 1 cylinder is set at Top Dead Center of the compression stroke.

  SST: Supply pump tool (09512-2530)



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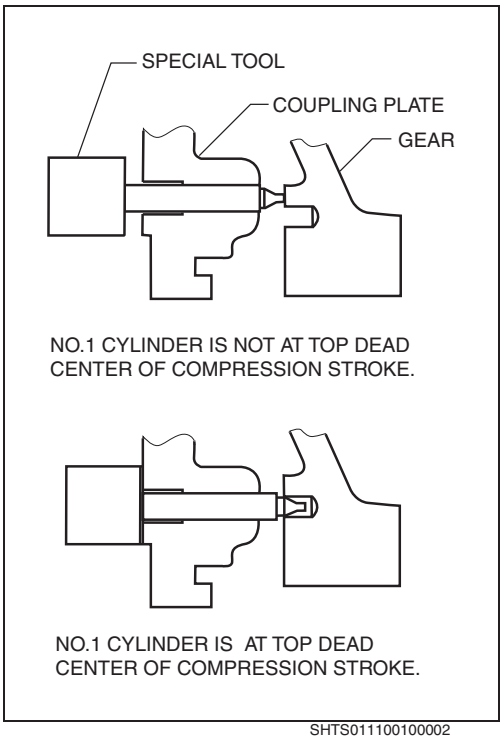
NOTICE

When the end-face of special tool and the surface of coupling plate are not contacted, No. 6 cylinder is set at Top Dead Center of the compression stroke. Rotating crankshaft once, reconfirm it with special tool.



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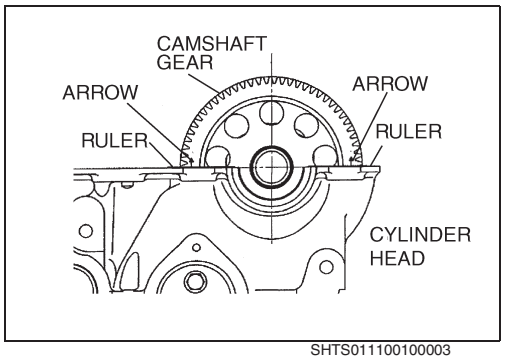

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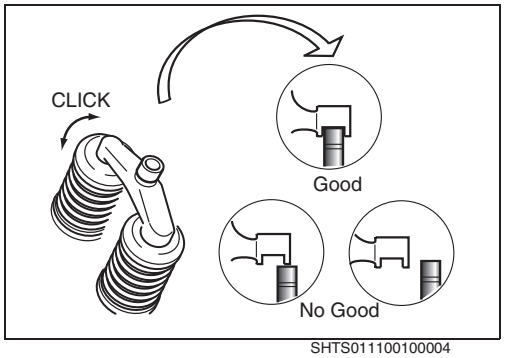
- If the arrows engraved on the both side of the camshaft gear points up (↑), the No.1 cylinder is at the Top Dead Center of the compression stroke.

NOTICE
If the arrows are pointing down (↓), the No.6 cylinder is at the Top Dead Center of the compression stroke.



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(2) Make sure that the valve stem is correctly inserted in the cross head.

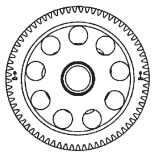
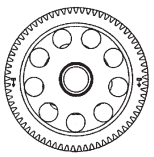
NOTICE
Move the cross head with fingers right and left to confirm the valve stem is correctly inserted in the cross head by listening to the clicking sound.

(3) Confirm that there is no foreign particles or dust between the cross head and the valve stem.

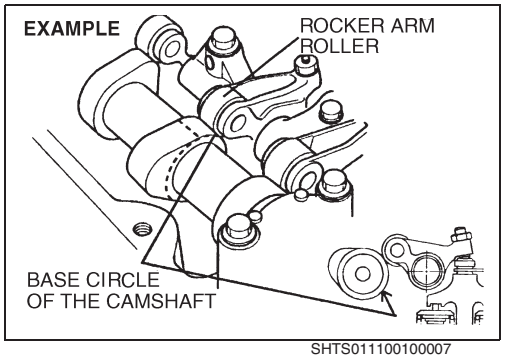
2. VALVE CLEARANCE CHECKING

NOTICE
Before beginning the checking, you must perform "1. PREPARATION OF CHECKING AND ADJUSTMENT".

(1) You can understand which valve to adjust when No.1 or No.6 cylinder is at the Top Dead Center of the compression stroke by the following chart).

	Cylinder			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	Camshaft gear condition		Arrow points up and underline is horizontal. #1	○	○		○	○			○	○			
With No.6 cylinder at T.D.C. on compression stroke			Arrow points down and underline is horizontal. #1			○			○	○			○	○	○

- **#1= View from rear side of cylinder head**
- **○Mark: Possible to check valve clearance**
- **Firing order: 1-4-2-6-3-5**
- **T.D.C.: Top Dead Center**



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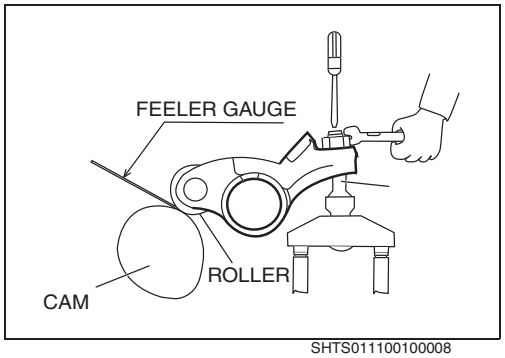
(2) Before checking the valve clearance, make sure that the roller is on the base circle of the camshaft.



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(3) Insert a feeler gauge of the specified thickness as below between the roller of the rocker arm and the cam to check the valve clearance.

VALVE CLEARANCE (when cold)

Intake valve	**0.28 mm {0.0110 in.}**
Exhaust valve	**0.49 mm {0.0193 in.}**

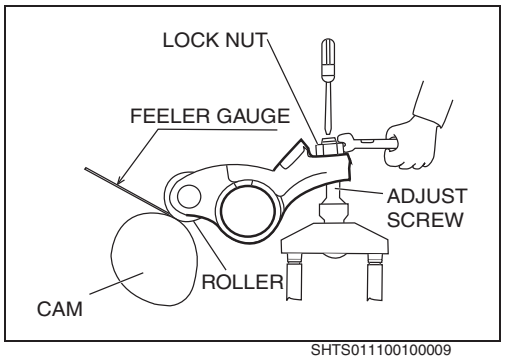
NOTICE
Valve clearance adjustment is performed only when the checking result is outside the specified value.

3. VALVE CLEARANCE ADJUSTMENT

NOTICE
Valve clearance adjustment is performed only when the checking result is outside the specified value.

NOTICE

- **Before beginning the adjustment you must perform "1. PREPARATION OF CHECKING AND ADJUSTMENT".**
- **As for the valve which can adjust the valve clearance refer to "2. VALVE CLEARANCE CHECKING".**
- **Make sure that the cylinder head bolt, rocker arm support bolt, injector clamp bolt and cam bearing cap bolt are tightened to the specified torque.**



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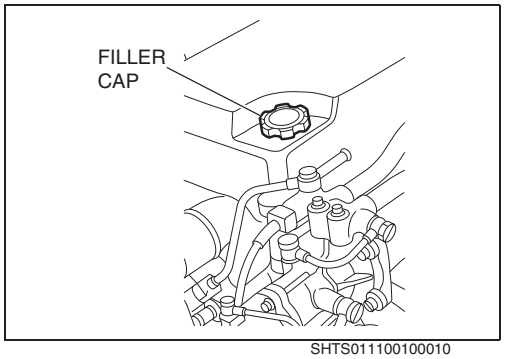
(1) Loosen the adjusting screw lock nut of the rocker arm fully.
(2) Insert a feeler gauge of the specified thickness shown below between the roller of the rocker arm and the cam, and adjust the valve clearance with the adjust screw of the rocker arm.

VALVE CLEARANCE (when cold)

Intake valve	**0.28 mm {0.0110 in.}**
Exhaust valve	**0.49 mm {0.0193 in.}**

(3) After completion of the adjustment, tighten the lock nut securely with the specified tightening torque.
Tightening Torque:
69 N·m {700 kgf·cm, 51 lbf·ft}

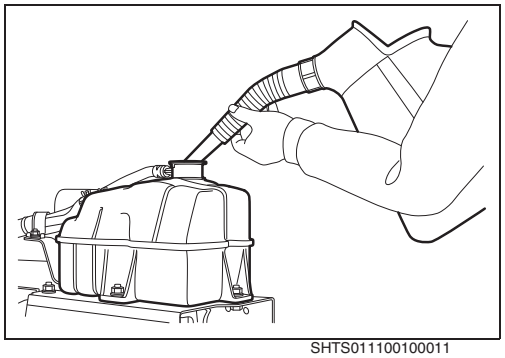


SHTS011100100010

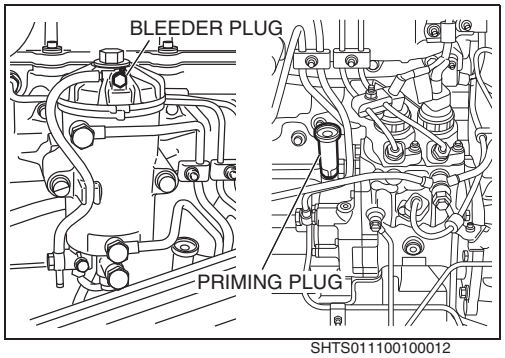
START THE ENGINE

⚠ CAUTION
Do not leave tools on or around the engine. Contact of tools with moving parts may result in personal injury or damage to equipment.

1. PREPARATION
(1) Supply engine oil.


SHTS011100100011

(2) Supply cooling water and bleed air from it.



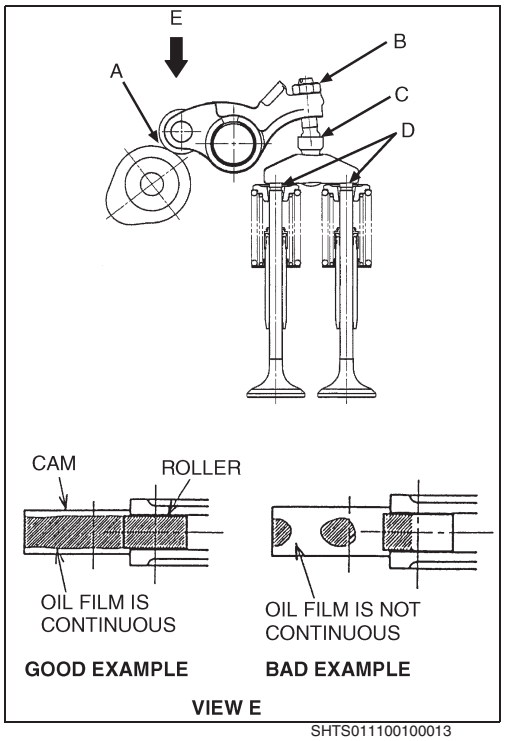
SHTS011100100012

(3) Bleed air from the fuel system.

(4) Check connection to the alternator.

⚠ CAUTION
Start the engine without wiring in place may burn out the alternator.

(5) Check the engine stopping performance.



SHTS011100100013

LUBRICATION

1. CHECK THE ROCKER ARM.

(1) Remove the head cover.
(2) Set the engine revolution to the specified idling revolution.
(3) After the engine starts, check that oil is supplied to the following locations of all rocker arms within approximately 10 seconds.
   a. Roller and cam face A
   b. Cross head top C and spring upper seat top face D through adjusting screw B

NOTICE

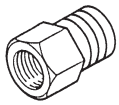
If the supply of oil is delayed or not happening, hydraulic pressure may be low or the oil gallery may be clogged. Insufficient supply of oil may lead to seizure, abnormal wear or abnormal noise. Recheck the assembly.

OVERHAUL CRITERIA

SPECIAL TOOL

EN0111001K100001

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

Illustration	Part number	Tool name	Remarks
	09508-1060	COMPRESSION GAUGE ADAPTER (A)	For Overhaul criteria
	09552-1030 09552-1060	COMPRESSION GAUGE ADAPTER (B)	
—	9851-20143	O-RING	

OVERHAUL CRITERIA

EN0111001H300002

FACTORS TO DETERMINE THE ENGINE OVERHAUL

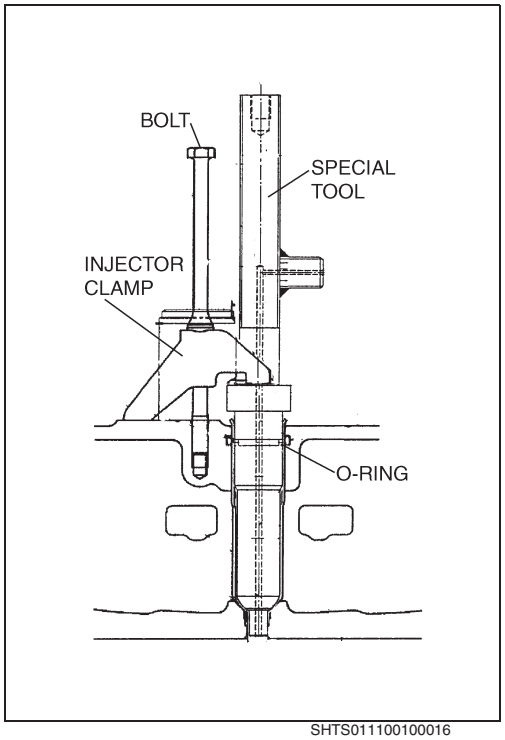
1. LOW COMPRESSION PRESSURE

(1) Before measurement
   a. Charge the battery completely.
   b. Set the valve clearance to the correct value.
   c. Idle the engine (Coolant temperature at 80°C {176°F}).
   d. Remove the air cleaner.
   e. Remove all injectors.

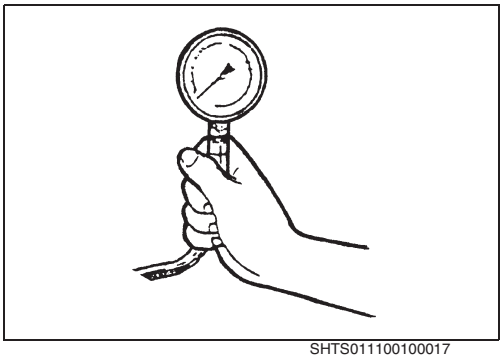
(2) Measurement
   a. Install the O-ring to the groove of the pressure gauge adapter (A).
   SST:
   Compression gauge adaptor (A) (09508-1060)
   O-ring (9851-20143)

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

   d. Connect the pressure gauge using the compression gauge adapter (B).
   SST:
   Compression gauge adaptor (B) (09552-1030)
   Compression gauge adaptor (B) (09552-1060)



SHTS011100100016


SHTS011100100017

e. Run the engine with the starter and measure the compression pressure.

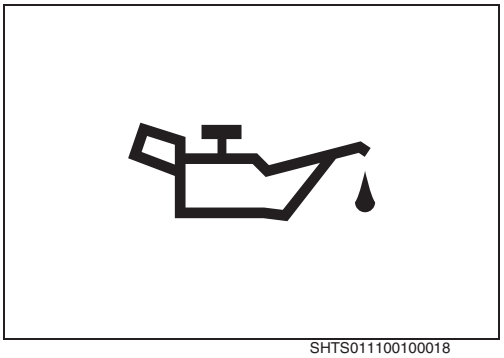
Standard	Limit
3.3 MPa {34 kgf·cm^2, 479 lbf/in^2}	**3.0 MPa {31 kgf·cm^2, 435 lbf/in^2}**
Engine revolution 200r/min	

NOTICE
Do not operate the starter for more than 15 seconds.

f. Measure the compression pressure of each cylinder.

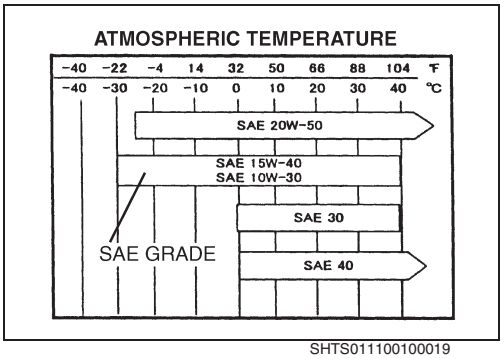
NOTICE
Do not allow gas leakage from the seal face.

(3) Reassemble the removed parts.


SHTS011100100018

2. ENGINE OIL PRESSURE

(1) Check the oil pressure warning lamp when the oil and coolant temperature is hot [about 80°C {176°F}].
a. If the warning lamp is lit, check the oil level.
b. Check oil deterioration.
If oil quality is poor, replace with a suitable grade oil.
c. Remove the oil pressure switch and install the oil pressure gauge.



SHTS011100100019

d. Measure the oil pressure at a coolant temperature of 80°C {176°F} or more.

Oil pressure

Standard	Limit
49-490 kPa {0.5-5.0 kg/cm^2, 7.11-71.10 lbf/in.^{2}}	**Less than 49kPa {0.5 kg/cm^2, 7.11 lbf/in.^{2}}**

3. OTHER FACTORS

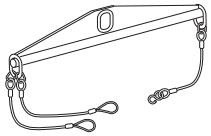
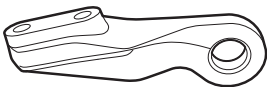
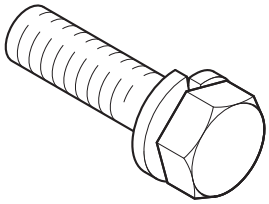
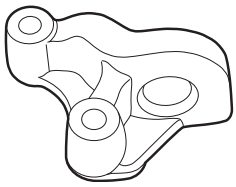
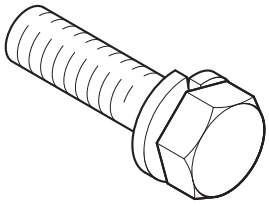
(1) Increase of blowby gas
(2) Defective engine start
(3) Decrease of engine output
(4) Increase of fuel consumption
(5) Increase of engine noise
(6) Increase of oil consumption

DISMOUNTING AND MOUNTING

SPECIAL TOOL

EN0111001K100002

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

Illustration	Part number	Tool name	Remarks
	09405-1190	ENGINE HANGER	
	12281-2201	ENGINE HANGER	
	9409-14104	BOLT	
	12281-2211	ENGINE HANGER	
	9409-14108	BOLT	

DISMOUNTING AND MOUNTING

EN0111001H100001

IMPORTANT POINT - DISMOUNTING

1. DISMOUNT THE ENGINE ASSEMBLY.

(1) Park the vehicle on level ground and then block the wheels.
(2) Tilt the cab.
(3) Disconnect the battery cable from negative (–) pole of the batterry.
(4) Drain coolant from the radiator and cylinder block, and 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.

(5) Remove the rear cab mounting.

NOTICE
Refer to CHAPTER "CAB" for details.

(6) Remove the radiator.

NOTICE
Refer to CHAPTER "COOLING SYSTEM" for details.

(7) Disconnect the electric lines, fuel lines and air lines.

NOTICE
Cover open ends of pipes and hoses to prevent entry of dirt.

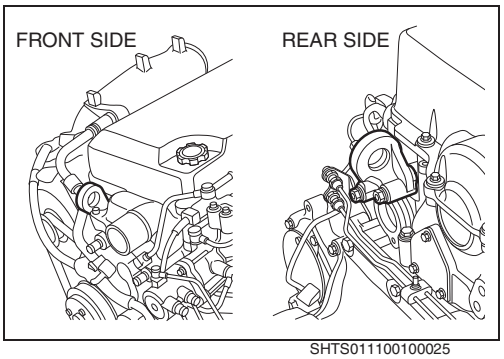
(8) Remove the mad guard.
(9) Remove the noise insulator cover.
(10) Remove the exhaust pipe, intake hose and intercooler hose.
(11) Remove the cooling fan and fan shroud ring bracket.
(12) Disconnect the propeller shaft.

NOTICE
Refer to CHAPTER "PROPELLER SHAFT" for details.

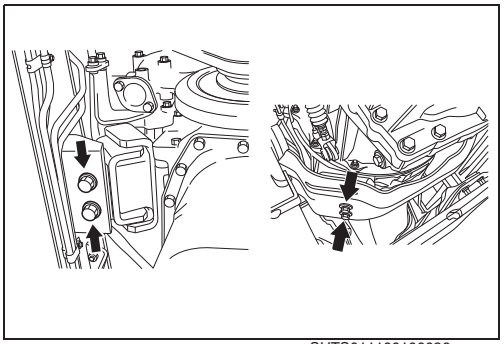
(13) Dismount the transmission.

NOTICE
Refer to CHAPTER "TRANSMISSION MAIN UNIT" and "TRANSMISSION/TRANSFER CONTROL" for details.

(14) Dismount the engine assembly.
a. Install the engine hanger to the front and rear of the engine.
SST:
Engine hanger (12281-2201) (Front side)
Bolt (9401-14101) (2 pieces)
Engine hanger (12281-2211) (Rear side)
Bolt (9401-14108) (2 pieces)

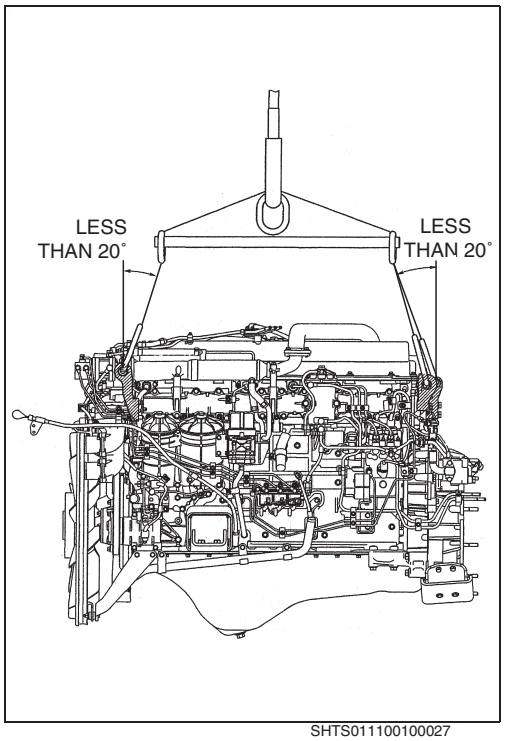


SHTS011100100025


SHTS011100100026

(15) Connect a cable from the engine hanger to the hanger (1 point) on the front of the engine, and to the hanger (1 point) on the rear of the engine. Using a hoist, raise the hanger until there is a bit of slack in the cables.
Engine weight: **Refer to section "DATA AND SPECIFICATIONS".**
SST: Engine hanger (09405-1190)

(16) Remove the engine mounting fitting nuts (front and rear, both sides).



SHTS011100100027

(17) 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.

IMPORTANT POINTS - MOUNTING

1. MOUNT THE ENGINE ASSEMBLY.

(1) Mount the engine assembly in the reverse order of dismounting.
Tightening Torque:
170-230 N·m {1,735-2,345kgf·cm, 126-169 lbf·ft (Front side)} (Engine mounting fitting bolts)

Tightening Torque:
87-129 N·m {885-1,305kgf·cm, 64-94 lbf·ft (Rear side)} (Engine mounting fitting bolts)

NOTICE
Check to see that there are no oil leaks, fuel leaks, coolant leaks, or air leaks.

LIQUID GASKET AND APPLICATION POINTS

EN0111001H200001

- Following liquid gaskets are used for the E13C series engine.

Liquid gasket specification:
Three Bond TB1207B: Black
Liquid gasket specification:
Three Bond TB1207C: Red brown
Liquid gasket specification:
Three Bond TB1211: White

1. LIQUID GASKET APPLICATION AND PART ASSEMBLY PROCEDURE.

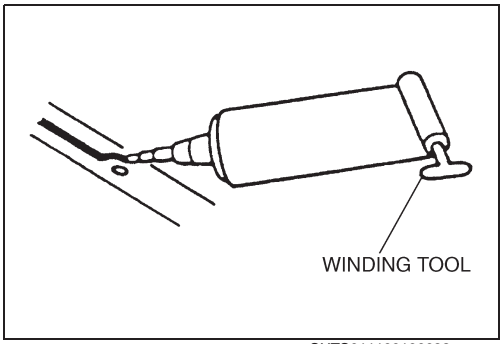
(1) Remove old liquid gasket from each part and matching parts and wipe off oil, moisture or dirt with a rag.
(2) Overlap the liquid gasket at the start and end of application.
(3) Be careful of misalignment when assembling parts with liquid gasket. If they are misaligned, reapply the liquid gasket.
(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.

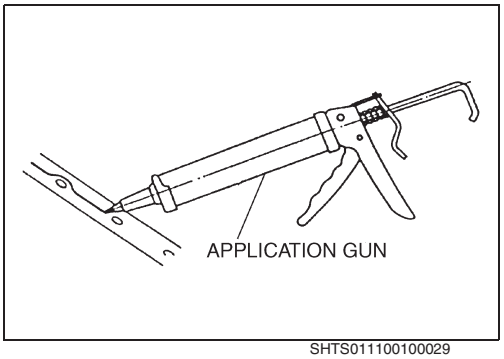
3. OTHERS

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



SHTS011100100028

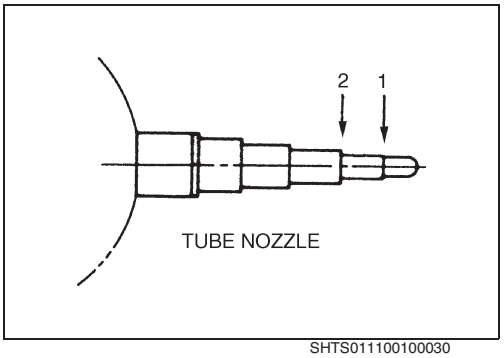
(2) For cartridge-type gasket, use an application gun.



SHTS011100100029

(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

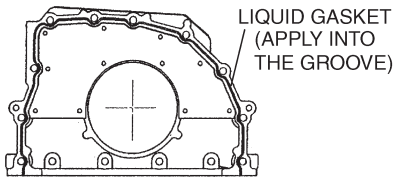
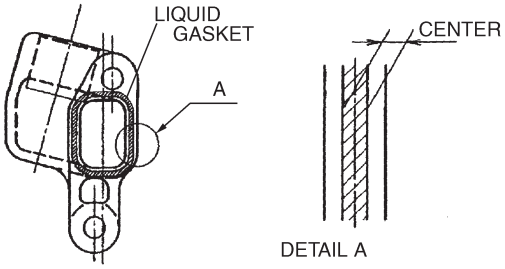
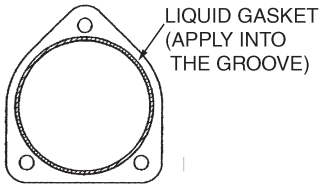


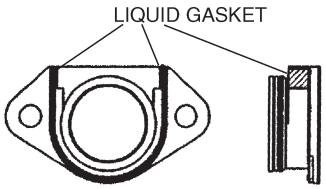
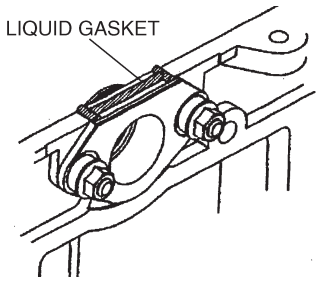
SHTS011100100030

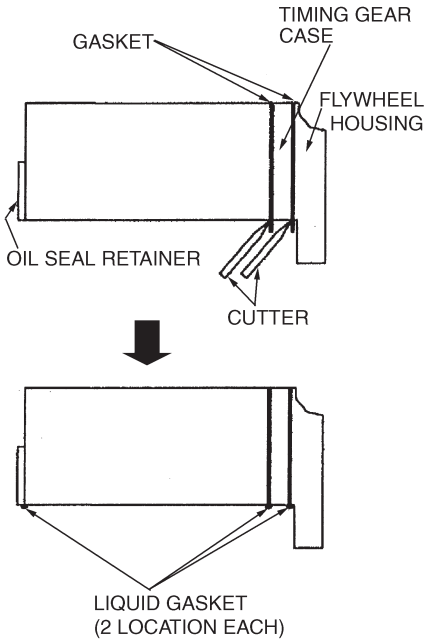
4. PARTS AND POSITIONS FOR LIQUID GASKET

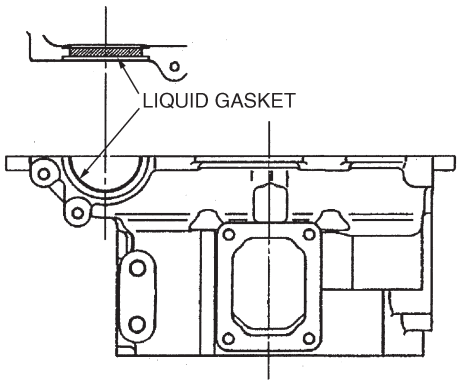
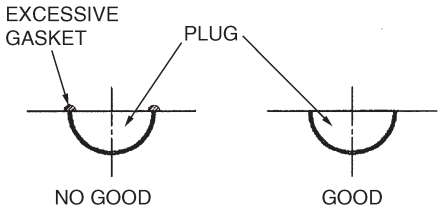
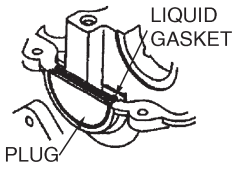
(1) Apply liquid gasket to positions and types of gasket according to the table shown below.
Follow the application pattern at each position shown in the figures.

Unit: mm {in.}

No.	Part name	Application position and pattern	Application width	Gasket to be used	Remarks
1	**Oil seal retainer**	**Matching flange face with the block** 	**3-4 {0.1182-0.1574}**	**Red brown**	
2	**Breather pipe**	**Matching flange face with the oil seal retainer** 	**3-4 {0.1182-0.1574}**	**Red brown**	
3	**Cylinder head plate**	**Matching plate face with the cylinder head rear end** 	**3-4 {0.1182-0.1574}**	**Red brown**	

No.	Part name	Application position and pattern	Application width	Gasket to be used	Remarks
4	Pressure sensor seal	1. Matching faces with cylinder head and side face, upper face of seal 2. Matching parts of cylinder head, seal, cylinder head cover and gasket  NOTICE • Application area of liquid gasket is side face of seal. Never apply it to the upper face of seal. • Remove the excessive gasket completely. • When the cylinder head cover is assembled, reapply the liquid gasket. (Assembly must be done within 20 minutes.) 	3-4 {0.1182-0.1574}	Black	

No.	Part name	Application position and pattern	Application width	Gasket to be used	Remarks
5	Front and rear ends of lower face of block	**Matching parts of oil seal retainer and block lower face front end** **Matching parts of block lower rear end, gasket, timing gear case and flywheel housing**  **NOTICE** **Cut the rear end plate gasket with a craft knife flush with the block upper face.**	3-4 {0.1182-0.1574}	Red brown	

No.	Part name	Application position and pattern	Application width	Gasket to be used	Remarks
6	Cylinder head	1. Matching faces with cylinder head and plug 2. Matching parts of cylinder head, plug, cylinder head cover and gasket  NOTICE • Application area of liquid gasket is half circle of cylinder head. Never apply it to the upper cylinder head of the plug. • Remove the excessive gasket completely.  • When the cylinder head cover is assembled, reapply the liquid gasket. (Assembly must be done within 20 minutes.) 	3-4 {0.1182-0.1574}	Black	2 locations at front and rear ends of cylinder head
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.					

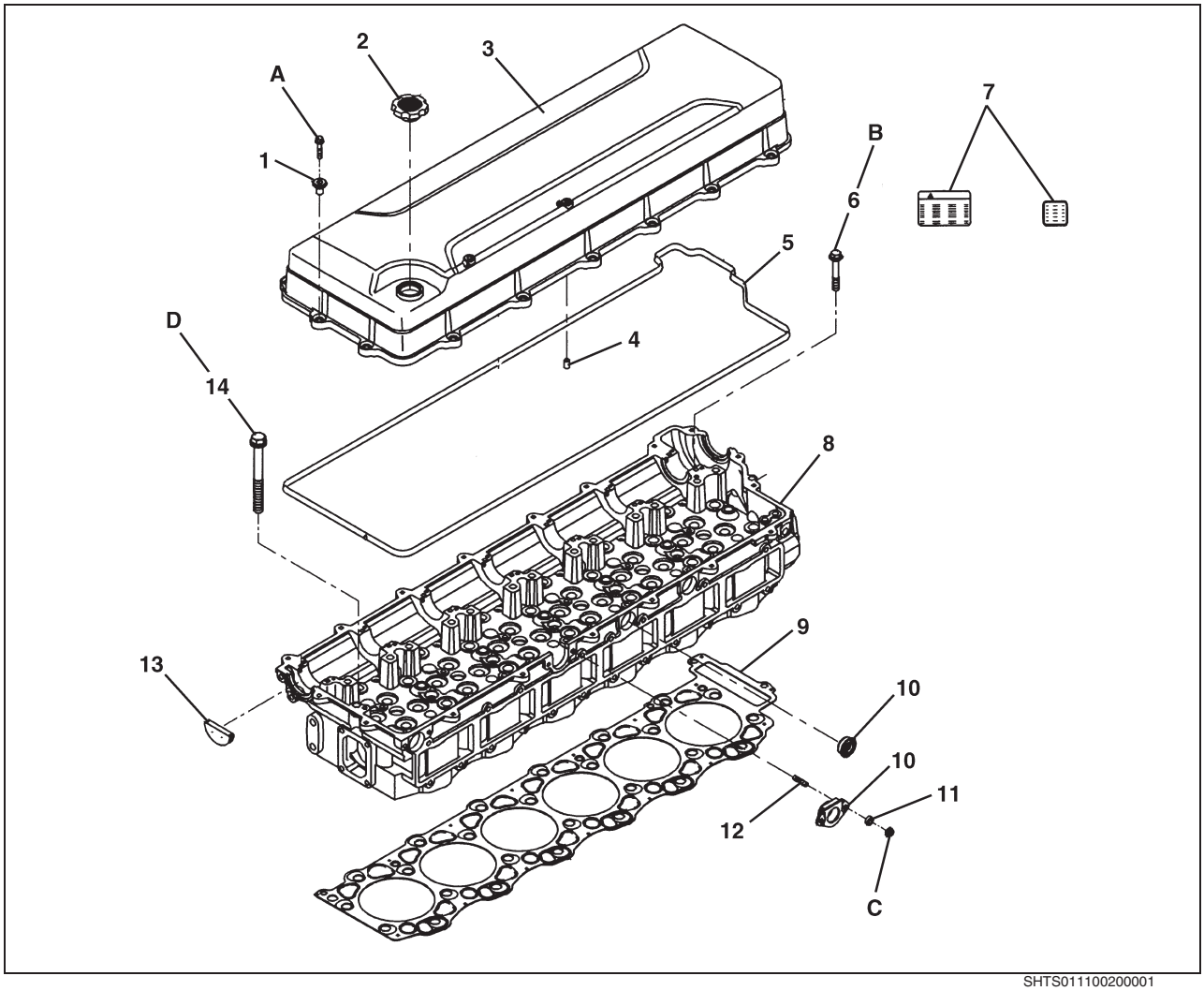
ENGINE MECHANICAL (E13C)

EN02-001

CYLINDER HEAD

COMPONENT LOCATOR

EN0111002D100001



SHTS011100200001

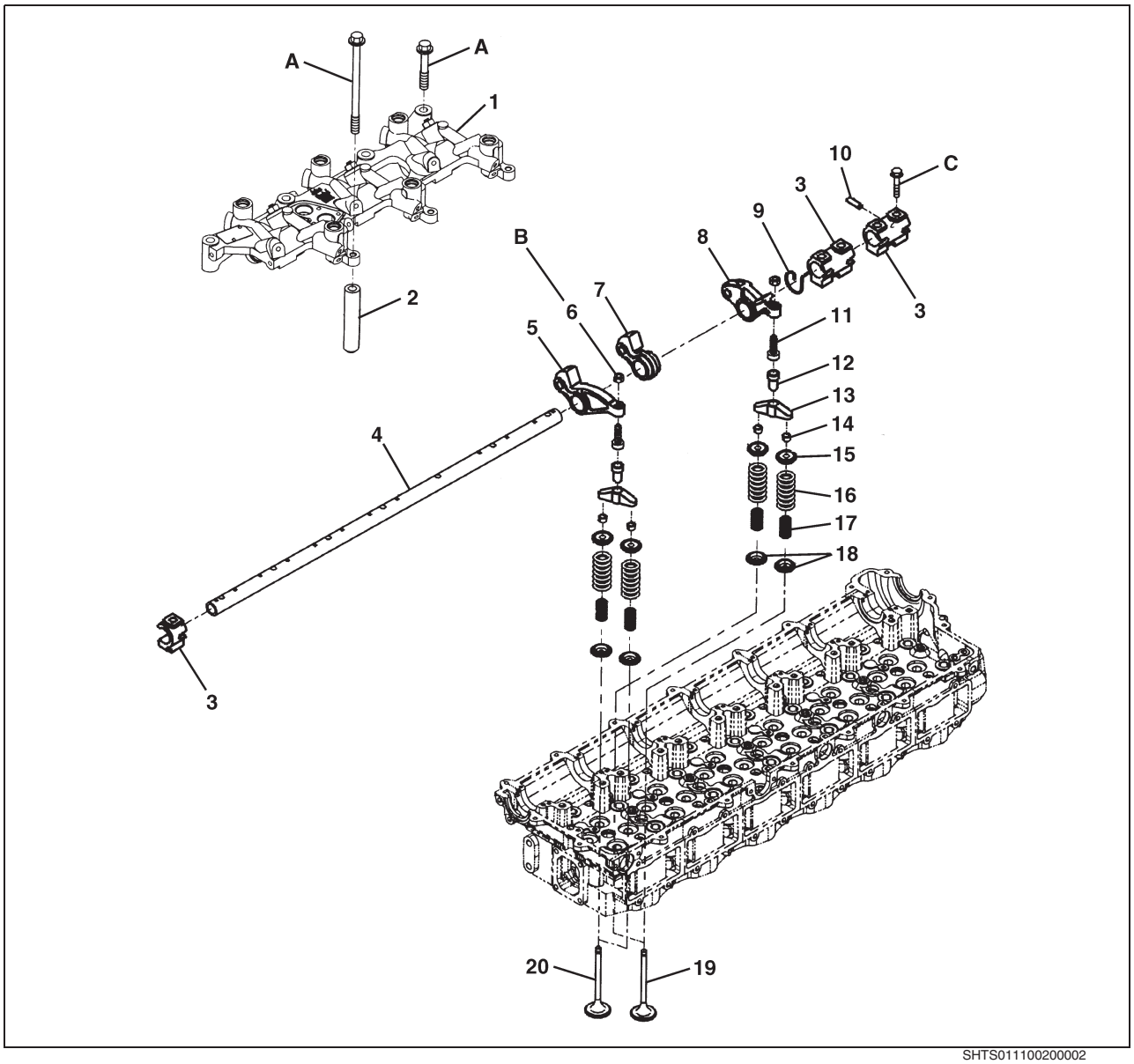
1	Silent block	8	Cylinder head
2	Oil filler cap	9	Cylinder head gasket
3	Cylinder head cover	10	Injection pipe oil seal
4	Helisert	11	Spacer
5	Cylinder head cover gasket	12	Stud
6	Additional bolt	13	Cylinder head plug
7	Caution plate	14	Head bolt

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

A	25 {250, 18}	C	25 {250, 18}
B	108 {1,100,80}	D	118 {1,200, 87}+90°+90°#

#=Apply oil to the threads and seat surfaces before tightening.

-



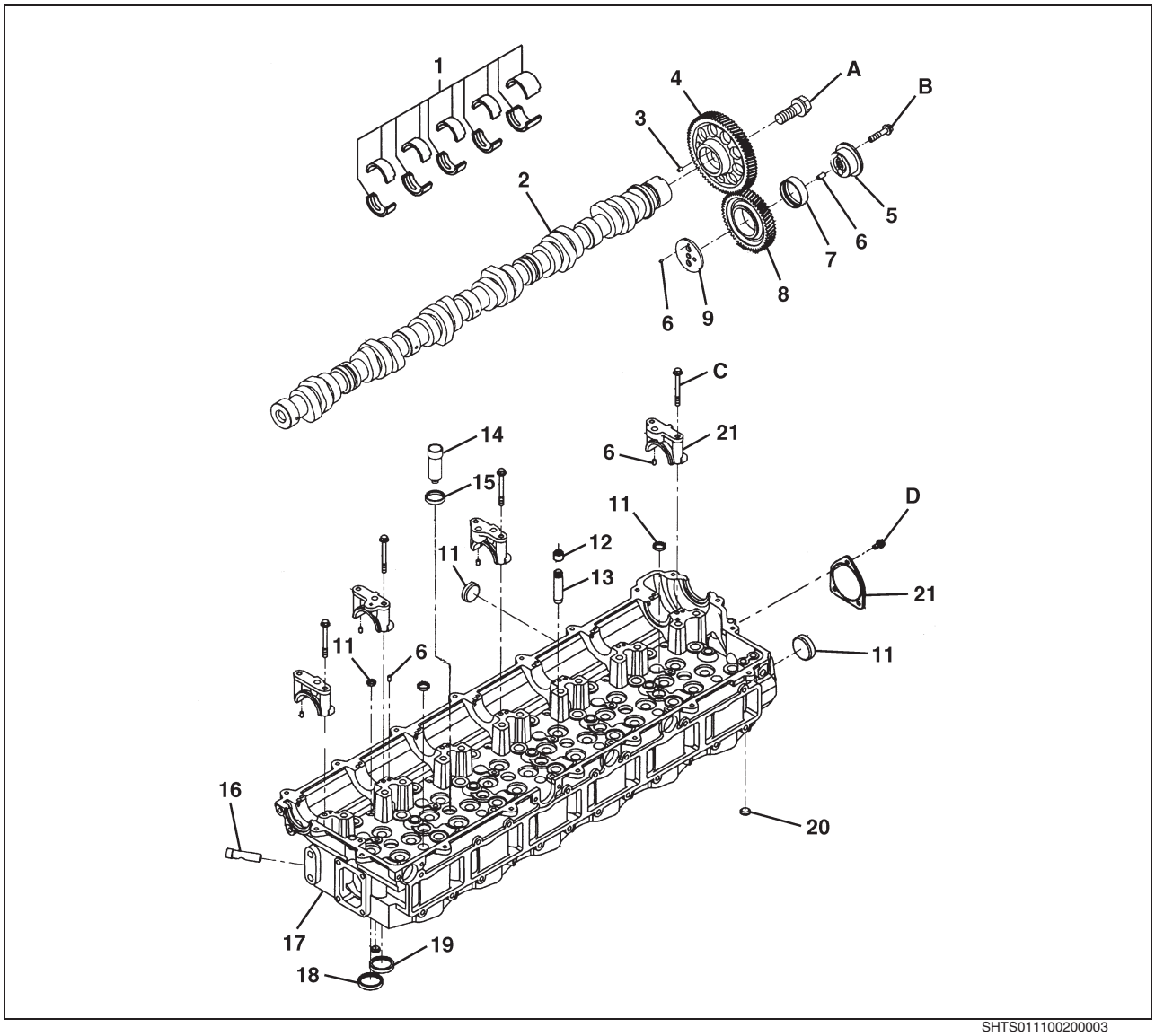
SHTS011100200002

1	Engine retarder assembly	11	Adjusting screw
2	Retarder housing support	12	Push rod
3	Rocker support	13	Cross head
4	Rocker shaft	14	Valve spring retainer
5	Rocker arm (Intake)	15	Valve spring seat (Upper)
6	Lock nut	16	Valve spring (Outer)
7	Rocker arm (Retarder)	17	Valve spring (Inner)
8	Rocker arm (exhaust)	18	Valve spring seat (Lower)
9	Torsion spring	19	Exhaust valve
10	Stopper pin	20	Intake valve

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

A	100 {1,020, 74}#	C	59 {600, 44}+120°#
B	69 {700, 51}		

#=Apply oil to the threads and seat surfaces before tightening.



SHTS011100200003

1	Camshaft bearing	12	Valve stem oil seal
2	Camshaft	13	Valve guide
3	Pin	14	Nozzle seat
4	Camshaft gear	15	O-ring
5	Idle gear shaft	16	Water pipe
6	Straight pin	17	Cylinder head
7	Bushing	18	Valve seat (Intake)
8	Cam idle gear	19	Valve seat (Exhaust)
9	Thrust plate	20	Expansion plug
10	Cam shaft cap	21	Cylinder head plate
11	Sealing plug		

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

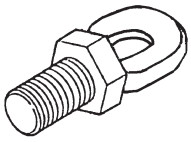
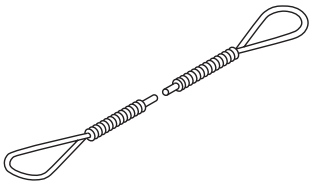
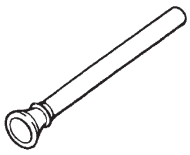
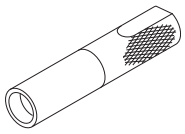
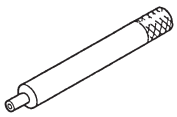
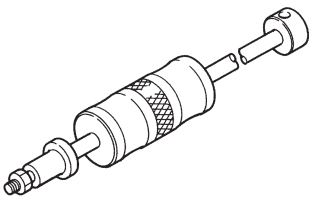
A	422 {4,300, 311}#	C	39 {400, 29}#
B	59 {600, 44}#	D	28.5 {290, 21}

#=Apply oil to the threads and seats surfaces before tightening.

SPECIAL TOOL

EN0111002K100001

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

Illustration	Part number	Tool name	Remarks
	09433-1061	EYE BOLT	M12 x 1.75
	09491-1030	WIRE	
	09470-1120	VALVE SPRING PRESS	
	09431-1010	VALVE LAPPING TOOL	
	09472-2190	VALVE STEM OIL SEAL PRESS	
	09472-1210	BAR	For Nozzle sleeve seat
	9800-06100	STEEL BALL	Used with 09472-1210
	09420-1442	SLIDING HAMMER	For Cam idle gear shaft

OVERHAUL

EN0111002H200001

IMPORTANT POINTS - DISASSEMBLY

1. DISASSEMBLE THE CYLINDER HEAD.

(1) Clean parts around the cylinder head and fuel system connections.

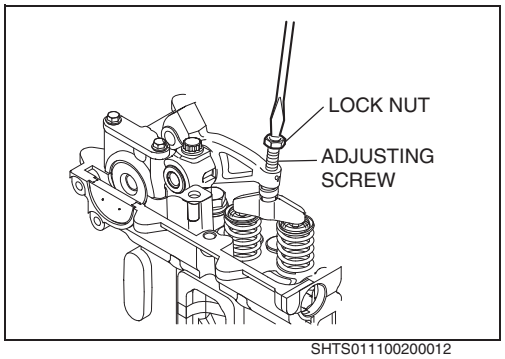
NOTICE

Entry of foreign particles into the combustion chamber may result in engine trouble.

(2) Remove the cylinder head cover.
(3) Remove the engine retarder.
Refer to the CHAPTER “ENGINE RETARDER”.
(4) Remove the injector and common rail.
Refer to the CHAPTER “FUEL SYSTEM”.
(5) Remove the rocker arm assembly.
a. Loosen the lock nut at the end of the rocker arm and turn the adjusting screw counterclockwise completely.

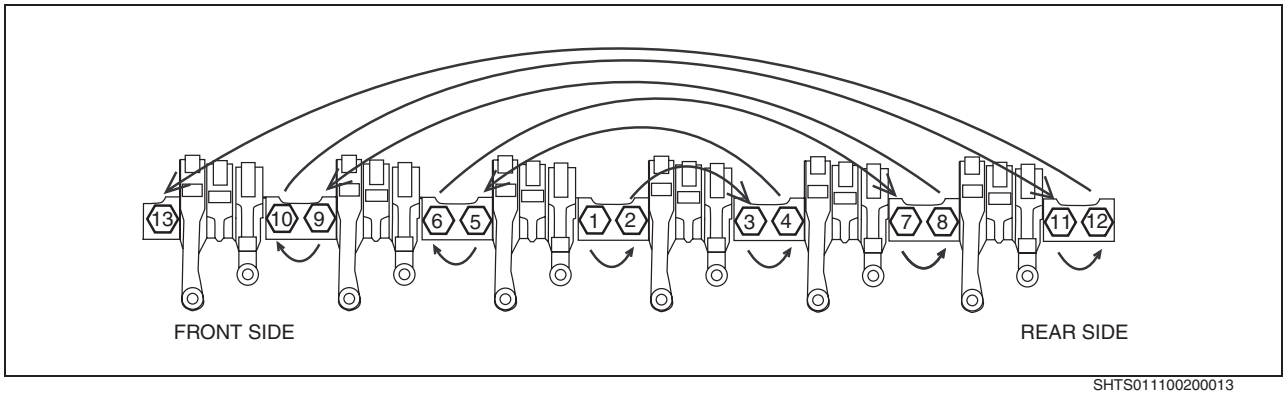
NOTICE

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



SHTS011100200012

b. Gradually loosen the rocker arm support bolt three times in the order shown in the figure.



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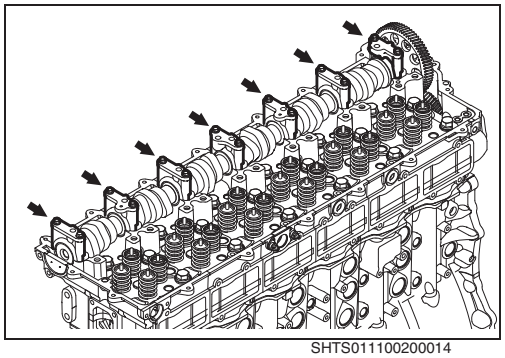
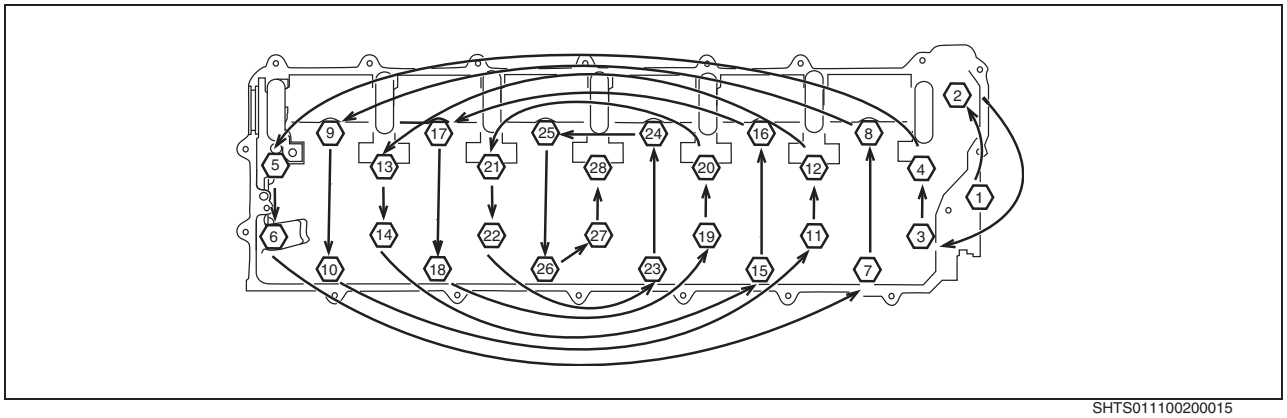
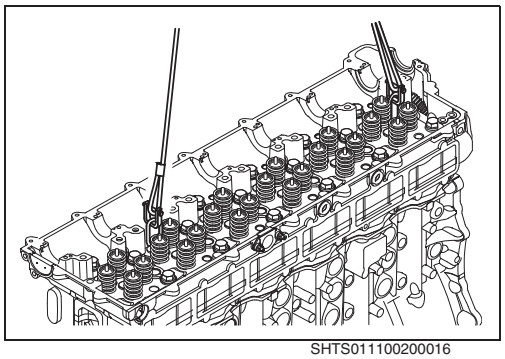
(6) Remove the camshaft.
a. Remove the camshaft cap.
b. Remove the camshaft.


SHTS011100200014

(7) Remove the cylinder head bolts.
a. Gradually loosen bolts three times in the order shown in the figure.



SHTS011100200015


SHTS011100200016

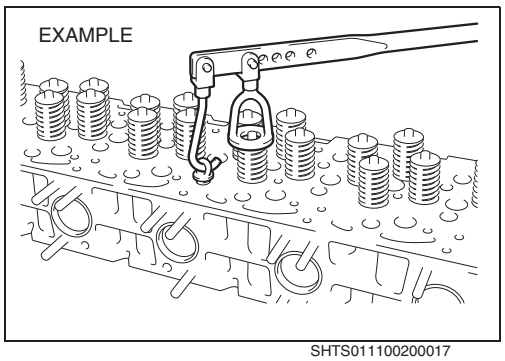
(8) Lift and remove the cylinder head using the special tool and hoist.
SST:
Eye bolt (09433-1061)
Wire (09491-1030)

NOTICE

- **Do not damage the cylinder head lower surface or cylinder block upper surface during removal of the cylinder head.**
- **If it is difficult to lift off the cylinder head, pry with a chisel between the cylinder head and cylinder block.**

2. DISASSEMBLE THE VALVE SYSTEM.

(1) Remove the valve spring retainer using the special tool.
SST: Valve spring press (09470-1120)

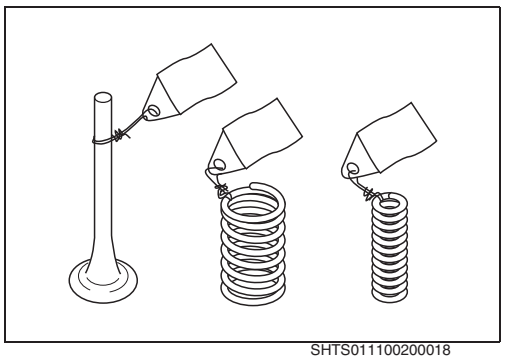


SHTS011100200017

(2) Remove the valve springs, intake and exhaust valves.

NOTICE

Attaching tags to the valves (giving corresponding cylinder Nos.) will eliminate time required for lapping the valve seats on reassembly.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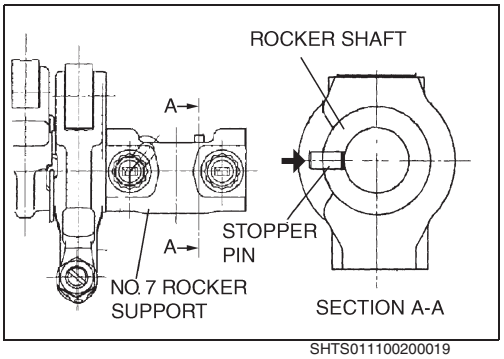
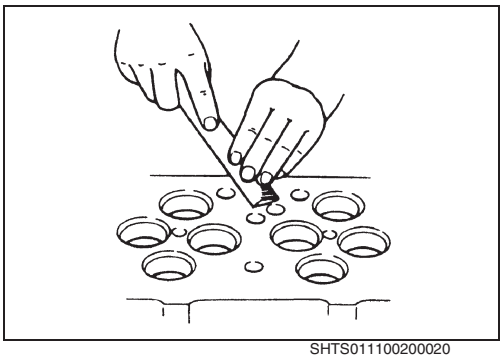


SHTS011100200019

3. DISASSEMBLE THE ROCKER ARM ASSEMBLY.

(1) Remove the rocker support, rocker arm (intake), rocker arm (retarder), torsion spring and rocker arm (exhaust).
(2) Drive the stopper pin into the hole of the rocker shaft.
(3) Disassemble the rocker shaft and No. 7 rocker support.


SHTS011100200020

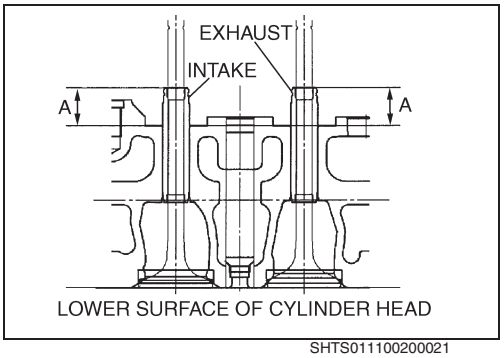
4. CLEAN THE CYLINDER HEAD.

(1) Clean the cylinder head and remove carbon deposits or foreign particles.

NOTICE

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

IMPORTANT POINTS - REPLACEMENT



SHTS011100200021

1. REPLACE THE VALVE GUIDE.

(1) Remove the valve stem seal.
(2) For removal, strike the valve guide with a brass bar and hammer.

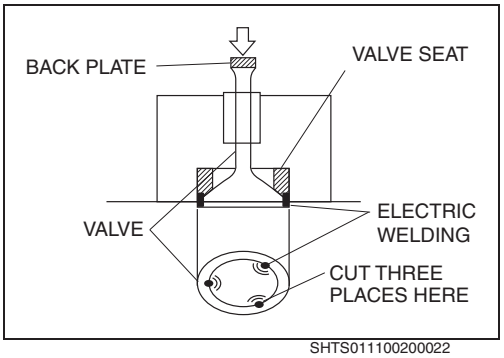
⚠ WARNING

Striking the valve guide during removal may cause metal chips to fly up. Be sure to wear protective goggles.

(3) When installing a new valve guide, do not twist the end. Press fit the valve guide.
Assembly standard (A): 24-24.3mm {0.945-0.956 in.}

NOTICE

- **Be careful not to damage the valve stem at the upper or lower end of the guide during press-fitting.**
- **Be sure to apply engine oil around the valve guide during press-fitting.**



SHTS011100200022

2. REPLACE 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.

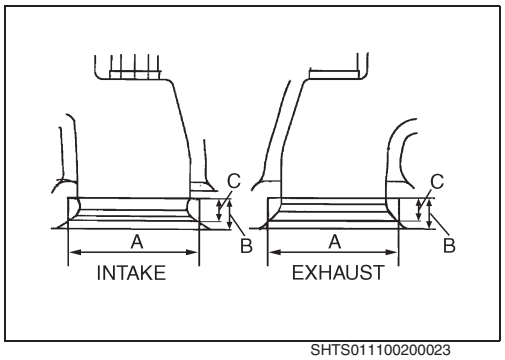
NOTICE

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.

⚠ WARNING

Striking the valve seat for removal may cause metal chips to fly up. Be sure to wear protective goggles.

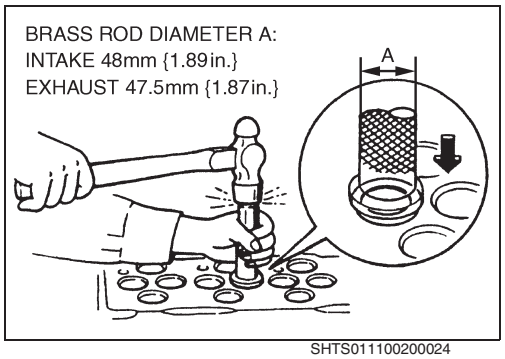


SHTS011100200023

(3) Machine the valve according to the valve seat dimensions.

Unit: mm {in.}

		Intake	Exhaust
Cylinder head side	**A**	**48-48.016 {1.8898-1.8903}**	**47.5-47.516 {1.8701-1.8707}**
	B	**11.2-11.4 {0.4410-0.4488}**	**11.1-11.3 {0.4371-0.4448}**
Valve seat side	**A**	**48.085-48.1 {1.8932-1.8937}**	**47.596-47.606 {1.8740-1.8742}**
	C	**8.0-8.2 {0.3150-0.3228}**	**8.0-8.2 {0.3150-0.3228}**

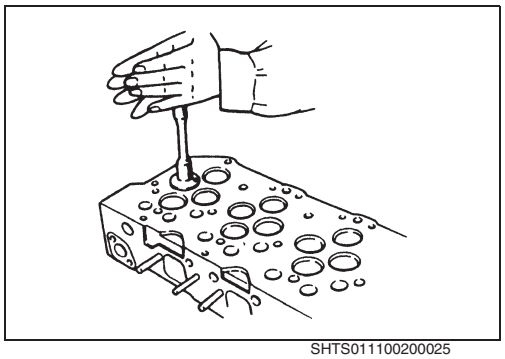


SHTS011100200024

(4) 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.

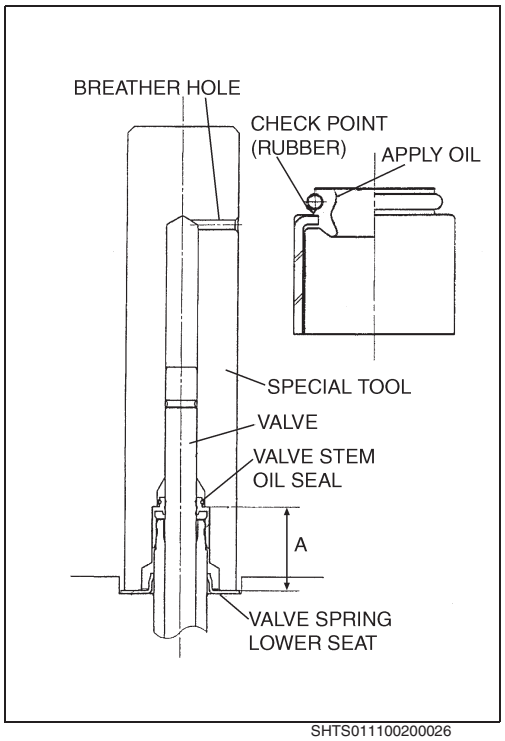
⚠ WARNING

Striking the valve seat during installation may cause metal chips to fly up. Be sure to wear protective goggles.


SHTS011100200025

(5) Apply a small amount of lapping compound to the contact surfaces of the valve and valve seat. Turn the valve using the special tool and tap it lightly to lap.

SST: Valve lapping tool (09431-1010)



SHTS011100200026

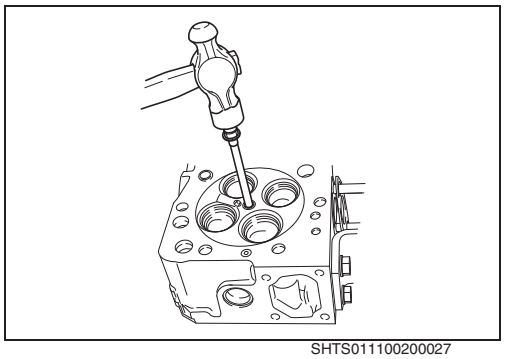
3. REPLACE THE VALVE STEM OIL SEAL.

(1) After removing the valve stem oil seal, install the valve spring lower seat.
(2) Install the valve.
(3) Apply engine oil to the oil seal lip.
(4) Punch the oil seal into the valve guide using the special tool.
SST: Valve stem seal press (09472-2190)

Assembly standard (A): 27.3 mm {1.075 in.}

⚠ WARNING
Punching the valve stem seal during installation may cause metal chips to fly up. Be sure to wear protective goggles.

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

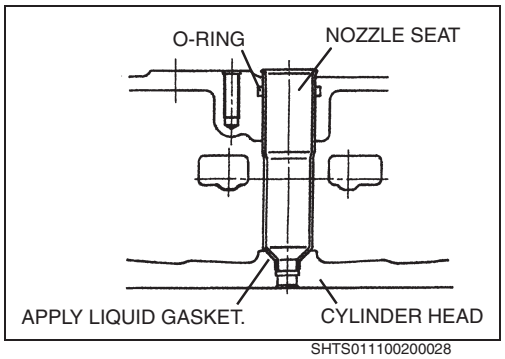

SHTS011100200027

4. REPLACE THE NOZZLE SEAT.

(1) Tap the nozzle seat from the cylinder head lower surface.
Then, screw in a suitable bolt and strike the bolt head with a hammer to remove the nozzle seat from the cylinder head.

⚠ WARNING
Punching the nozzle seat during installation may cause metal chips to fly up. Be sure to wear protective goggles.

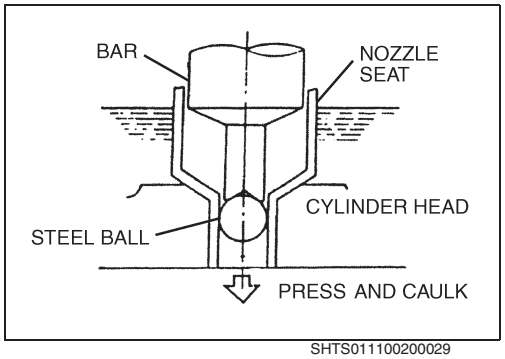
NOTICE
After removed the nozzle seat, removed the rest of liquid gasket or the adhesion such as dust completely.



SHTS011100200028

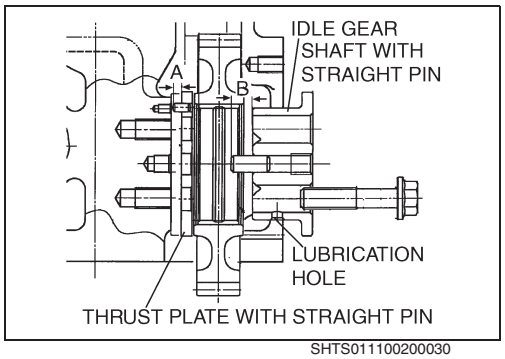
(2) After inserting the O-ring into the nozzle seat insertion hole of the cylinder head, apply liquid gasket (ThreeBond TB1211 or equivalent) to the lower part of the new nozzle seat and assemble it onto the cylinder head.

NOTICE
Be sure to replace the O-ring with a new one. Reuse of the O-ring may cause water or gas leakage, resulting in overheating or cracking of the cylinder head.



SHTS011100200029

(3) Caulk the nozzle seat with the special tools.
SST:
Bar (09472-1210)
Steel ball (9800-06100)

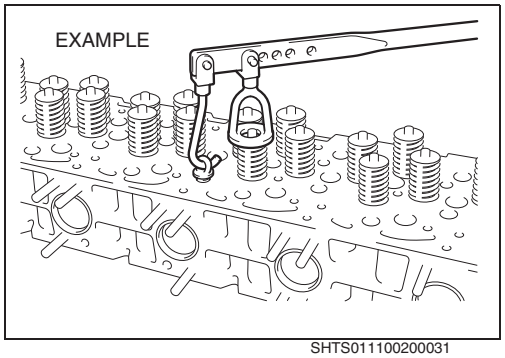


SHTS011100200030

5. REPLACE THE CAM IDLE GEAR.
(1) Remove the idle gear shaft using the special tool.
SST: Sliding hammer (09420-1442)

(2) Install the cam idle gear.
Assembly standard (A): 3.5-4.5 mm {0.1378-0.1771 in.}
Assembly standard (B): 9.5-10.5 mm {0.3741-0.4133 in.}

NOTICE
- **Install the cam idle gear shaft as shown in the figure so that the lubrication hole is downward.**
- **Apply clean engine oil to the bolt seat and bolt threads.**

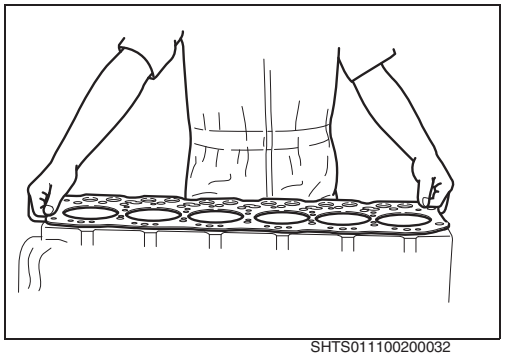


SHTS011100200031

IMPORTANT POINTS - ASSEMBLY

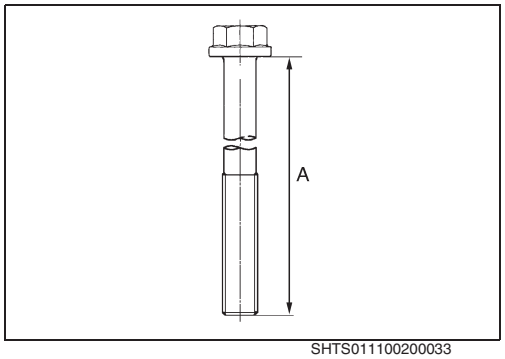
1. ASSEMBLE THE VALVE AND VALVE SPRING.
(1) Install the valve spring retainer at the valve spring upper seat using the special tool.
SST: Valve spring press (09470-1120)

NOTICE
- **Be sure to apply engine oil to the contact surface of each part before assembly.**
- **Be sure to place each valve in its original position.**
- **When the valve spring is compressed, be careful of damage to the valve stem oil seal due to contact of the upper seat.**
- **Since this valve spring is evenly pitched, it can be installed either end up.**


SHTS011100200032

2. INSTALL THE CYLINDER HEAD GASKET.

NOTICE
- **When installing the cylinder head, install the new gasket after removing dirt, moisture and oil on the cylinder head and cylinder block surface.**
- **Never reuse the gasket as it may cause engine damage.**
- **Make sure that the seal rings are not loose or damaged.**

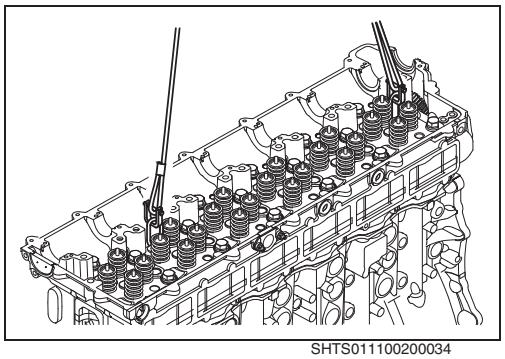


SHTS011100200033

3. MEASURE THE CYLINDER HEAD BOLT.

(1) Measure the length of the head bolts, if the length is A or more, replace with new bolts.

Dimension A	160 mm {6.299 in.}

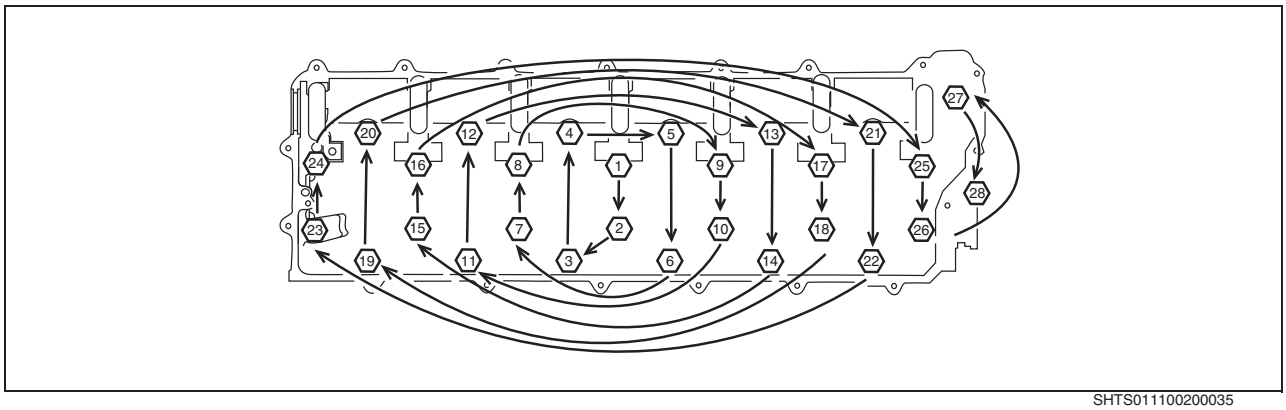

SHTS011100200034

4. INSTALL THE CYLINDER HEAD.

(1) Using the special tool and hoist, put the cylinder head on the cylinder block.
SST:
Eye bolt (09433-1061)
Wire (09491-1030)

NOTICE
When put the cylinder head, attention to cam idle gear (cylinder head side) and cam idle gear (cylinder block side) engagement.

(2) Apply clean engine oil to the bolt seats surface and bolt threads of the head bolts.
(3) Clean the bolt seats completely on the cylinder head upper surface.
(4) Tighten No. 1 - No. 26 head bolts in the order shown in the figure to the specified torque.
Tightening Torque:
118 N·m {1,200 kgf·cm, 87 lbf·ft}



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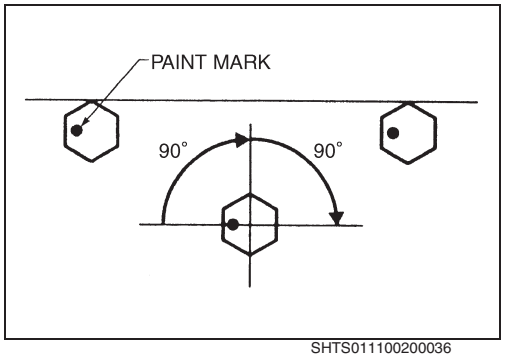
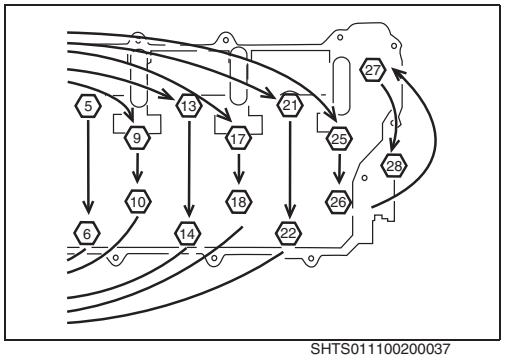


SHTS011100200036

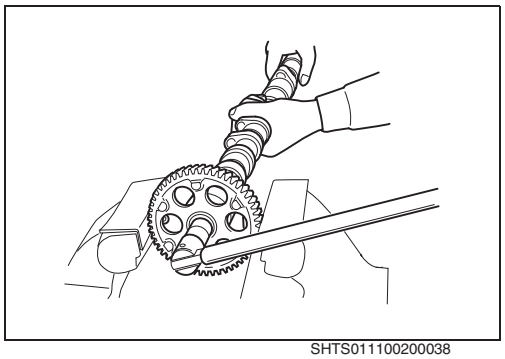
(5) Mark the head bolts with paint to indicate the same directions as shown in the figure.
(6) Turn No. 1 - No. 26 head bolts 90° (1/4 turn) in the same order as in (4).
(7) Retighten them 90° (1/4 turn) as step (6).
(8) Make sure that all paint marks face the same direction.

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

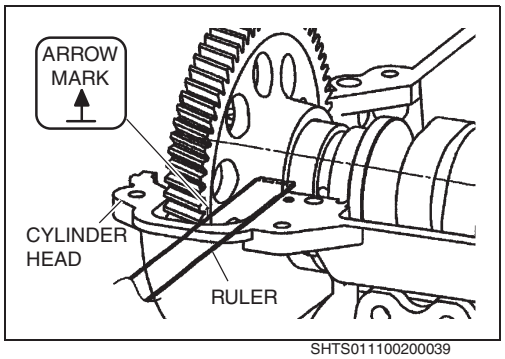


SHTS011100200037

(9) Tighten No. 27 - No. 28 additional bolts in the order shown in the figure to the specified torque below.
Tightening Torque:
108 N·m {1,100 kgf·cm, 80 lbf·ft}

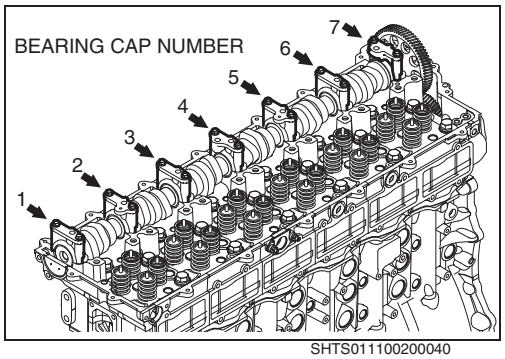

SHTS011100200038

5. ASSEMBLE THE CAMSHAFT GEAR.
(1) Make sure that there is neither damage to the camshaft gear or camshaft nor dirt on them.
(2) Apply clean engine oil to the bolt seat surface and bolt threads and tighten them to the specified torque.
Tightening Torque:
422 N·m {4,300 kgf·cm, 311 lbf·ft}



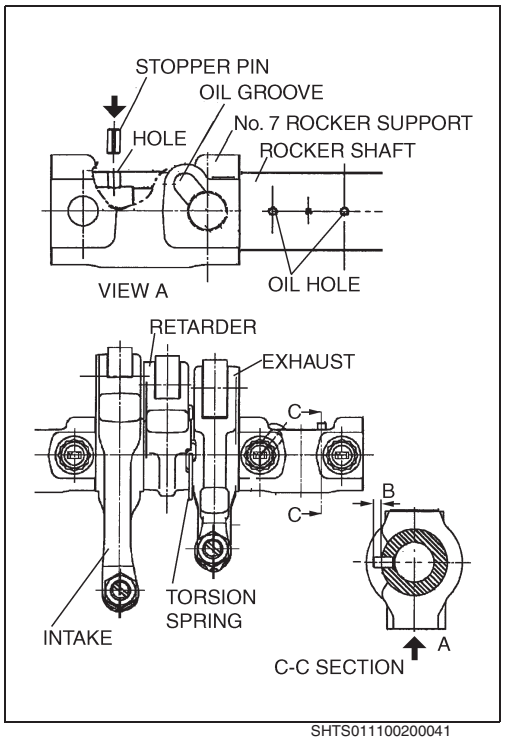
SHTS011100200039

6. INSTALL THE CAMSHAFT.
(1) Align the mark 1/6 on the flywheel with the flywheel housing pointer.
(2) Install the camshaft on the cylinder head.
NOTICE
The arrow engaged on the front of the camshaft gear must face upward and the line must be level.



SHTS011100200040

(3) Install the camshaft bearing cap, and tighten the bolts.
NOTICE
Check the number engraved on the camshaft bearing cap.

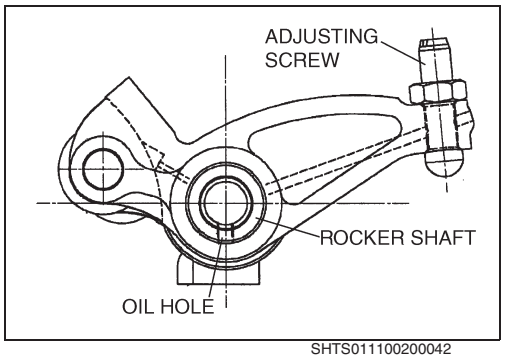


SHTS011100200041

7. ASSEMBLE THE ROCKER ARM.

(1) Assemble the rocker shaft and No. 7 rocker support.
   a. Insert the rocker shaft into the No. 7 rocker shaft.
   b. Install the stopper pin into the hole.
      Assembly standard (B): 4mm {0.1575 in.}

(2) Install the rocker arm (exhaust), torsion spring, rocker arm (retarder) and rocker arm (intake) to the rocker shaft.

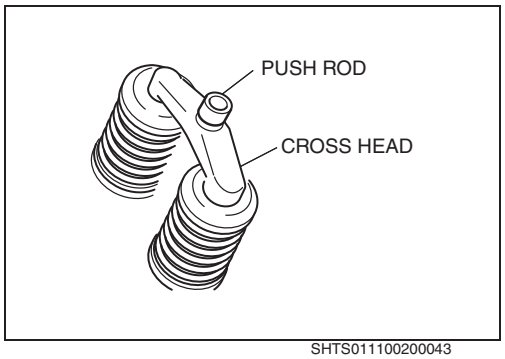


SHTS011100200042

(3) Turn the adjusting screw counterclockwise completely.

NOTICE

- **Not untightening the adjusting screw may result in a bent rocker shaft.**
- **Make sure the oil hole of the rocker shaft is placed below.**



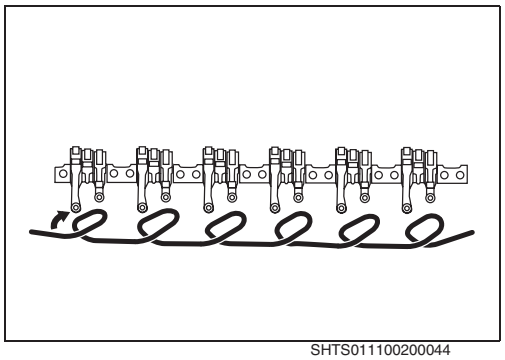
SHTS011100200043

8. INSTALL THE ROCKER ARM ASSEMBLY.

(1) Make sure that the cross head and push rod are on each valves.

NOTICE

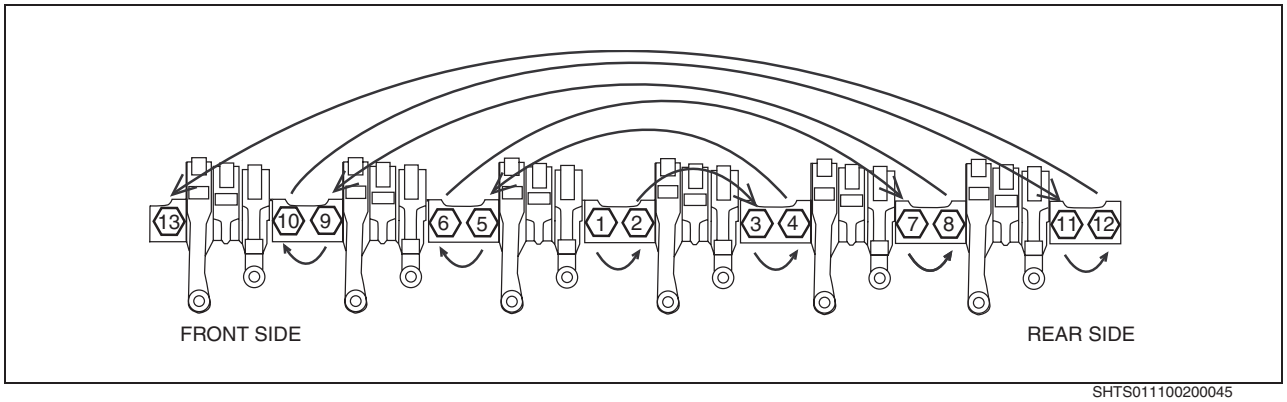
If the cross head is assembled whilst off the valve, the upper seat will be pressed, resulting in a loose valve.


SHTS011100200044

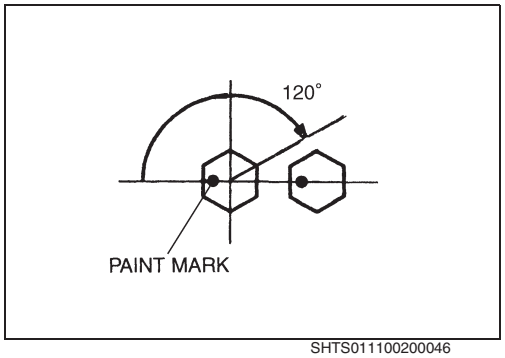
(2) Apply clean engine oil to the bolt seat surface and bolt threads of the rocker support bolts.
(3) Clean the rocker support seats surface and the cylinder head upper surface.
(4) Set the rocker arm assembly on the cylinder head.

HINT
When assembling the rocker arm assembly, fix the arms with string as shown in the figure to facilitate installation.

(5) Tighten the rocker support bolts in the order shown in the figure to the specified torque.
Tightening Torque:
59 N·m {600 kgf·cm, 43 lbf·ft}



SHTS011100200045



SHTS011100200046

(6) Mark the bolts with paint to indicate the same directions as shown in the figure.
(7) Turn the bolts 120° (1/3 turn) in the same order as in (6).
(8) Make sure that all paint marks face the same direction.

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

9. ADJUST THE VALVE CLEARANCE.
(1) Refer to the CHAPTER “ENGINE TUNEUP”.

10. INSTALL THE INJECTOR AND COMMON-RAIL.
(1) Refer to the CHAPTER “FUEL SYSTEM”.

11. INSTALL THE ENGINE RETARDER.
(1) Refer to the CHAPTER “ENGINE RETARDER”.

12. INSTALL THE HEAD COVER.

(1) Remove the cylinder head plugs at the front and rear ends of the cylinder head.

NOTICE

Do not remove the plug except there is no oil leakage from plug.

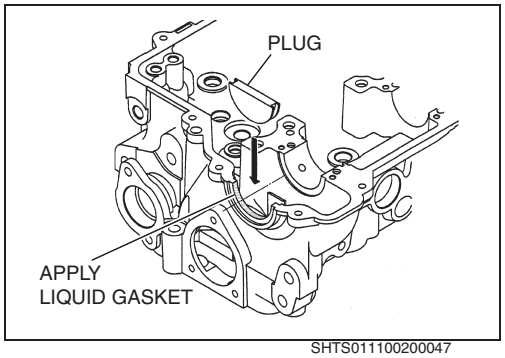
(2) Remove the liquid gasket from cylinder head plugs and cylinder head completely.

(3) Apply liquid gasket (ThreeBond TB1207B or equivalent) to the front and rear half circles of the cylinder head.

(4) Install the cylinder head plug to cylinder head.

NOTICE

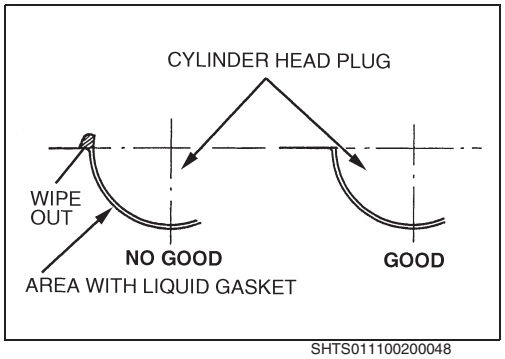
Make sure that plug installed with no tilt.



SHTS011100200047

NOTICE

Wipe out excess liquid gasket completely.



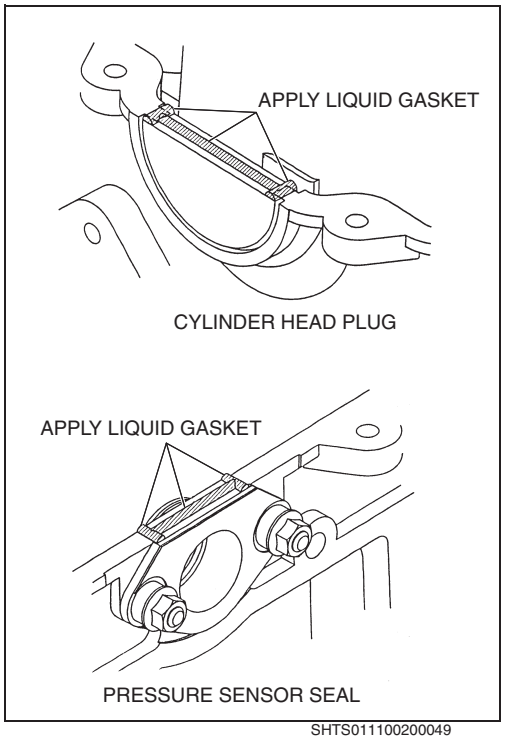
SHTS011100200048

(5) Install the cylinder head cover gasket into the gasket groove at the head cover lower surface.

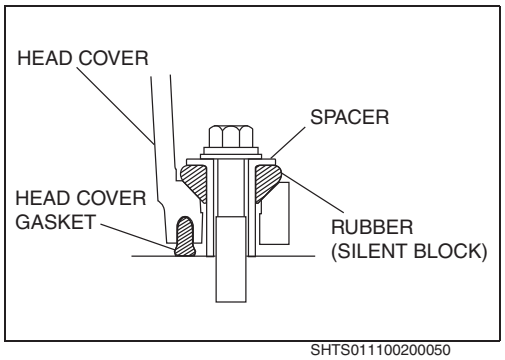
NOTICE

Make sure that there are no foreign particles (including liquid gasket), or oil on the gasket grooves of the head cover, gasket or cylinder head upper surface nor damage to them.

(6) Apply liquid gasket (ThreeBond TB1207B or equivalent) to the plug corner at the front and rear ends of the cylinder head and the pressure sensor seal before installing the head cover.



SHTS011100200049



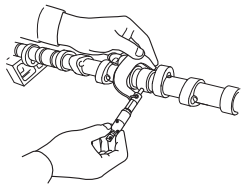
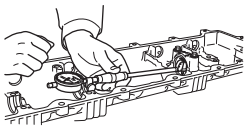
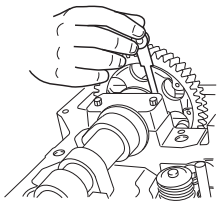
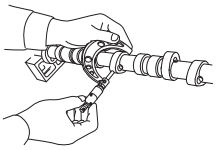
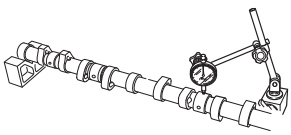
SHTS011100200050

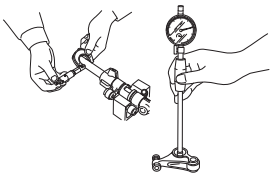
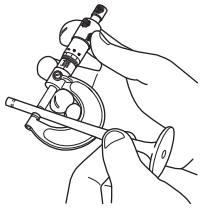
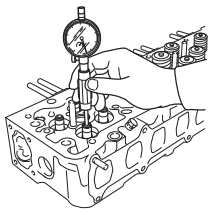
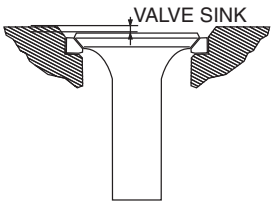
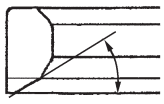
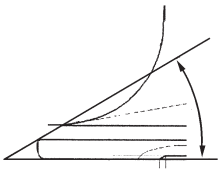
(7) Install the cylinder head cover on the cylinder head.
(8) Insert the silent block from the head cover upper surface.
(9) Tighten the bolt through the silent block to the specified torque below.
Tightening Torque:
25 N·m {250 kgf·cm, 18 lbf·ft}

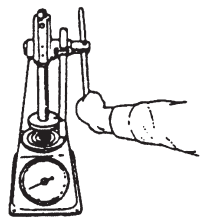
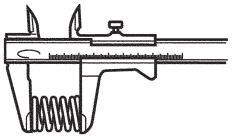
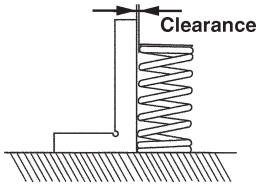
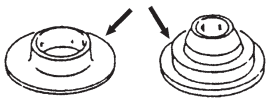
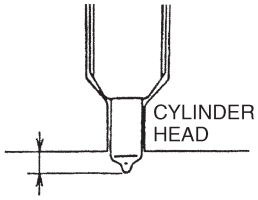
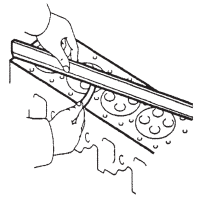
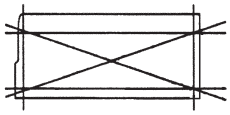
INSPECTION AND REPAIR

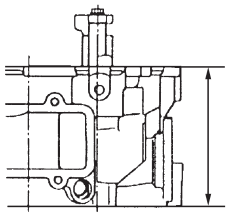
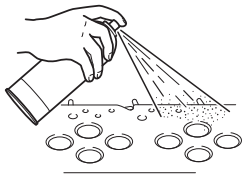
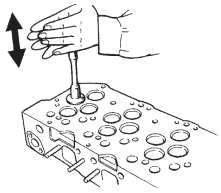
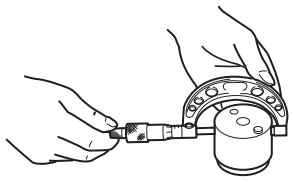
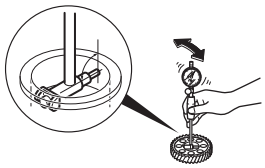
EN0111002H300001

Unit: mm {in.}

Inspection item		Standard	Limit	Remedy	Inspection procedure
Camshaft journal outside diameter		54.0 {2.1260}	—	Replace camshaft.	Measure (EXAMPLE) 
Camshaft bearing inside diameter		54.0 {2.1260}	—	Replace cam bearing.	
Clearance between camshaft journal and camshaft bearing		0.025-0.072 (0.0010-0.0028)	0.3 {0.0118}	Replace camshaft and/or cam bearing.	
Camshaft end play at No. 7 journal		0.10-0.31 (0.0040-0.0122)	0.5 {0.0197}	Replace camshaft.	Measure (EXAMPLE) 
Cam height	IN	68.418 {2.6936}	67.618 {2.6621}	Replace camshaft.	Measure (EXAMPLE) 
	EX	71.512 {2.8154}	70.712 {2.7840}		
	RETARDER	76.945 {3.0293}	76.145 {2.9978}		
Camshaft deflection		0.05 {0.0020}	—	Replace camshaft.	Measure (EXAMPLE) 

Inspection item		Standard	Limit	Remedy	Inspection procedure
Rocker arm bushing inside diameter		31.5 {1.2402}	31.58 {1.2433}	Replace rocker arm.	Measure (EXAMPLE) 
Rocker shaft outside diameter		31.5 {1.2402}	31.42 {1.2370}	Replace rocker shaft.	
Clearance between rocker shaft and rocker arm bushing		0.044-0.120 {0.0018-0.0047}	0.15 {0.0059}	Replace rocker arm and/or rocker shaft.	
Intake valve	Stem outside diameter	10 {0.3937}	9.85 {0.3878}	Replace the valve.	Measure 
	Guide inside diameter	10 {0.3937}	—	—	
	Clearance	0.040-0.077 {0.0016-0.0030}	0.3 {0.0118}	Replace the valve and/or valve guide.	
Exhaust valve	Stem outside diameter	10 {0.3937}	9.8 {0.3858}	Replace the valve.	
	Guide inside diameter	10 {0.3937}	—	Replace the valve guide.	
	Clearance	0.057-0.094 {0.0023-0.0037}	0.35 {0.0138}	Replace the valve and/or valve guide.	
Valve sink	IN	-0.05-0.35 {-0.0020-0.0137}	0.7 {0.0276}	Replace the valve and valve seat.	Measure 
	EX	-0.05-0.35 {-0.0020-0.0137}	0.7 {0.0276}	Replace the valve and valve seat.	
Valve seat angle	IN	30°	—	Resurface the valve and/or valve seat.	Measure  VALVE SEAT
	EX	45°	—		
Valve face angle	IN	30°	—		 VALVE
	EX	45°	—		

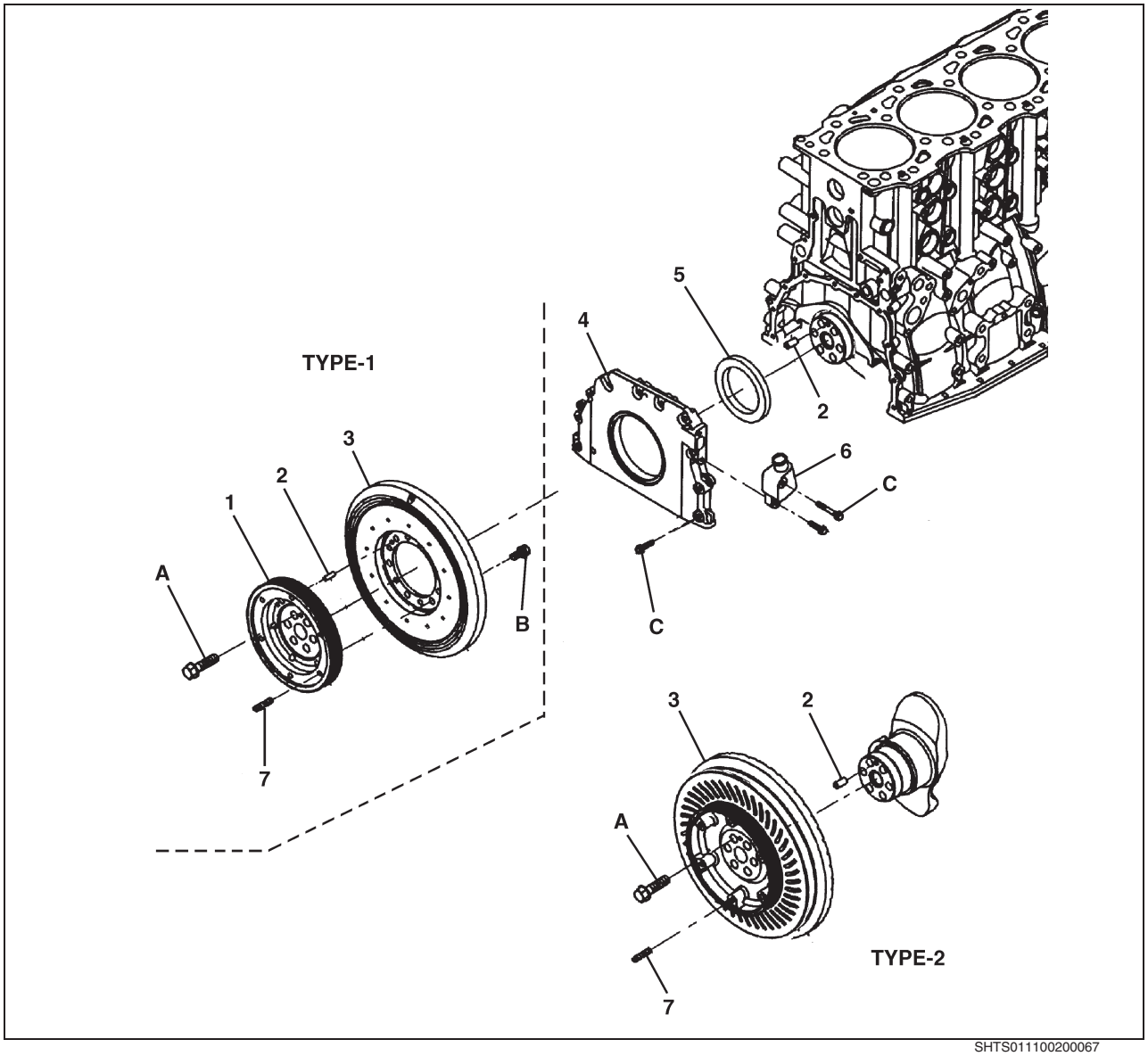
Inspection item		Standard	Limit	Remedy	Inspection procedure
Outer valve spring	Setting load	519.8 N {53.0 kgf, 116.9 lbf} at 60.0 {2.362}	477.7 N {48.7 kgf, 107.4 lbf}	Replace.	Measure  Setting road
	Free length (reference value)	89.3 {3.516}	—	—	
	Squareness	less than 3.1 {0.1220} (2.0°)	3.9 {0.1535} (2.5°)	Replace.	
Inner valve spring	Setting load	123.6 N {12.6 kgf, 27.8 lbf} at 57.0 {2.244}	113.6 N {11.6 kgf, 25.5 lbf}	Replace.	 Free length
	Free length (reference value)	82.9 {3.264}	—	—	
	Squareness	less than 2.9 {0.1142} (2.0°)	3.6 {0.1417} (2.5°)	Replace.	 Squareness
Wear and damage of valve spring seat upper and lower		—	—	Replace.	Visual check 
Nozzle protrusion		2.65-3.15 {0.1044-0.1240}	—	Replace nozzle seat.	Measure 
Cylinder head lower surface flatness		0.075 or less {0.0030 or less}	0.20 {0.0078}	Regrind.	Measure  

Inspection item	Standard	Limit	Remedy	Inspection procedure
Cylinder head thickness	167.7-168 {6.6024-6.6141 in.}	—	—	Measure 
Cracks of damage to cylinder head (Dye penetrant check)	—	—	Replace.	Visual check 
Contact of valve (Use of Red lead marking compound)	Entire periphery of valve head evenly in contact	—	Matches valve.	Visual check 
Cam idle gear shaft outside diameter	72 {2.8346}	—	—	Measure 
Cam idle gear shaft bushing inside diameter	72 {2.8346}	—	—	
Clearance between cam idle gear shaft and cam idle gear bushing	0.030-0.090 {0.0012-0.0035}	0.2 {0.0078}	Replace idle gear shaft and/or idle gear.	
Cam idle gear end play	0.090-0.145 {0.0036-0.0057}	0.3 {0.0118}	Replace thrust plate idle gear shaft and/or idle gear.	Measure

CRANKSHAFT FRONT END

COMPONENT LOCATOR

EN0111002D100002



SHTS011100200067

1	Crankshaft pulley	5	Crankshaft oil seal
2	Straight pin	6	Vent pipe
3	Crankshaft damper	7	Stud
4	Oil seal retainer		

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

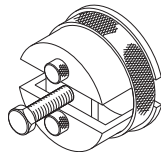
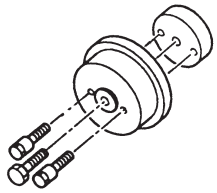
A	78 {800, 58}+90°#	C	28.5 {290, 21}
B	98-118 {1,000-1,200, 73-86}		

#=Apply oil to the threads and seat surfaces before tightening.

SPECIAL TOOL

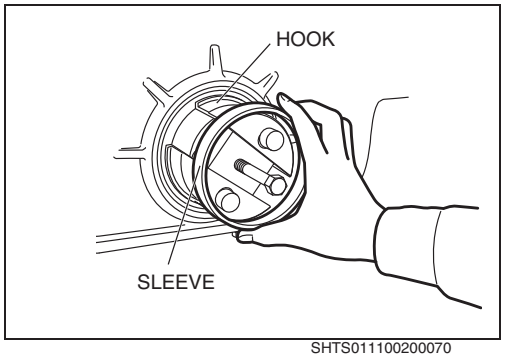
EN0111002K100002

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

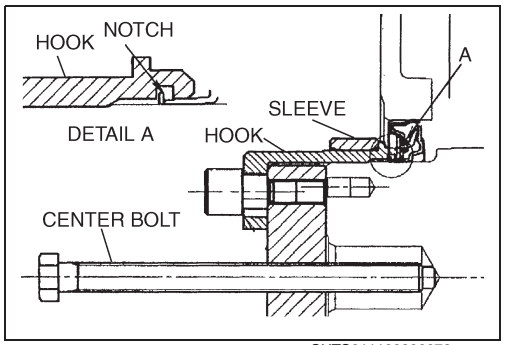
Illustration	Part number	Tool name	Remarks
	09420-2060	OIL SEAL PULLER	
	09407-1200	OIL SEAL PRESS	

OVERHAUL

EN0111002H200002



SHTS011100200070



SHTS011100200072

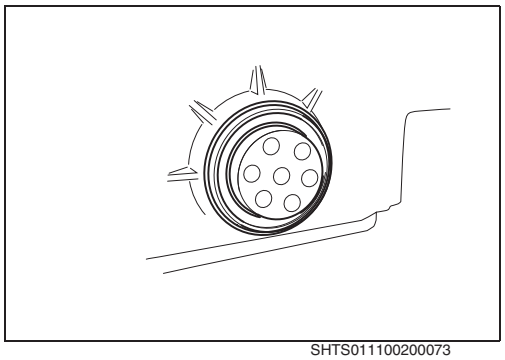
IMPORTANT POINTS - REPLACEMENT

1. REMOVE THE CRANKSHAFT FRONT OIL SEAL.
SST: Oil seal puller (09420-2060)

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

(2) Place the sleeve on the hook.

(3) Install the center bolt and tighten it to remove the oil seal.

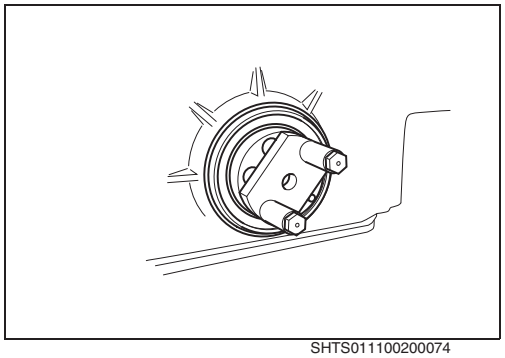


SHTS011100200073

2. INSTALL THE CRANKSHAFT FRONT OIL SEAL.
SST: Oil seal press (09407-1200)

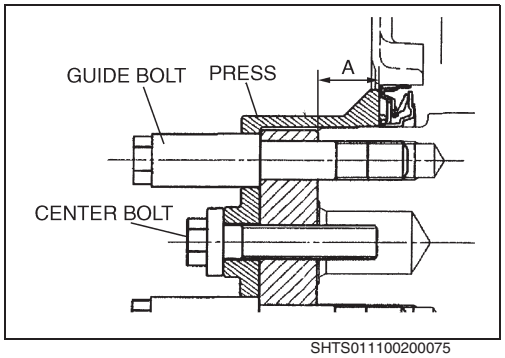
(1) Apply a little engine oil to the new oil seal inner and outer ring surfaces.
(2) Making sure it is properly oriented, insert the new oil seal by hand until it stops against the crankshaft.

NOTICE
Install the oil seal so that the felt surface faces outward and the surface with the slinger (steel plate) faces in forward the engine.



SHTS011100200074

(3) Install the plate on the crankshaft end using the guide bolts.

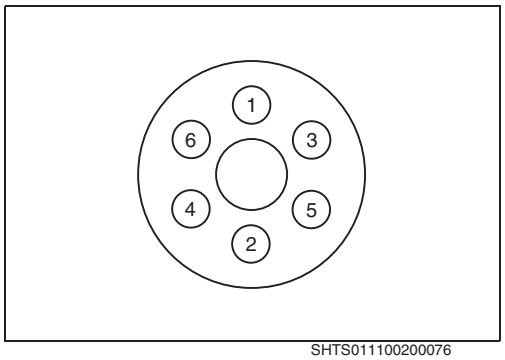


SHTS011100200075

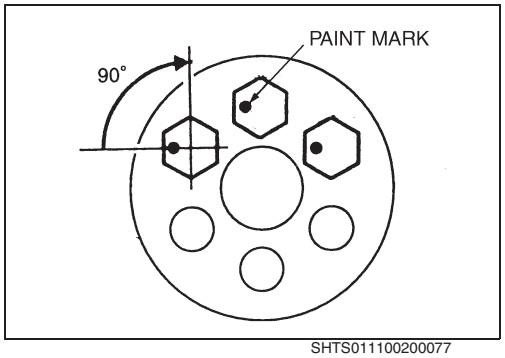
(4) Fit the press over the guide bolts, fix it in place by tightening the center bolt, and then press-fit the oil seal.

NOTICE
Make sure the press is set so that pressure will be applied evenly around the entire circumference of the oil seal

(5) Tighten the press until it contacts the crankshaft end, and then confirm that the oil seal is uniformly press-fitted.
Assembly standard (A): 25.7-26.3mm {1.0119-1.0354 in.}



SHTS011100200076



SHTS011100200077

IMPORTANT POINTS - ASSEMBLY

1. INSTALL THE CRANKSHAFT DAMPER.

(1) Apply clean engine oil to the bolt seat surface and bolt threads.

(2) Install the crankshaft damper to the crankshaft, then tighten the bolts in the order shown in the figure to the specified torque.
Tightening Torque:
78 N·m {800 kgf·cm, 58 lbf·ft}

(3) Mark the bolts with paint to indicate the same direction as shown in the figure.

(4) Turn the bolts 90° (1/4 turn) in the same order as in (3).

(5) Make sure that all paint marks face the same direction.

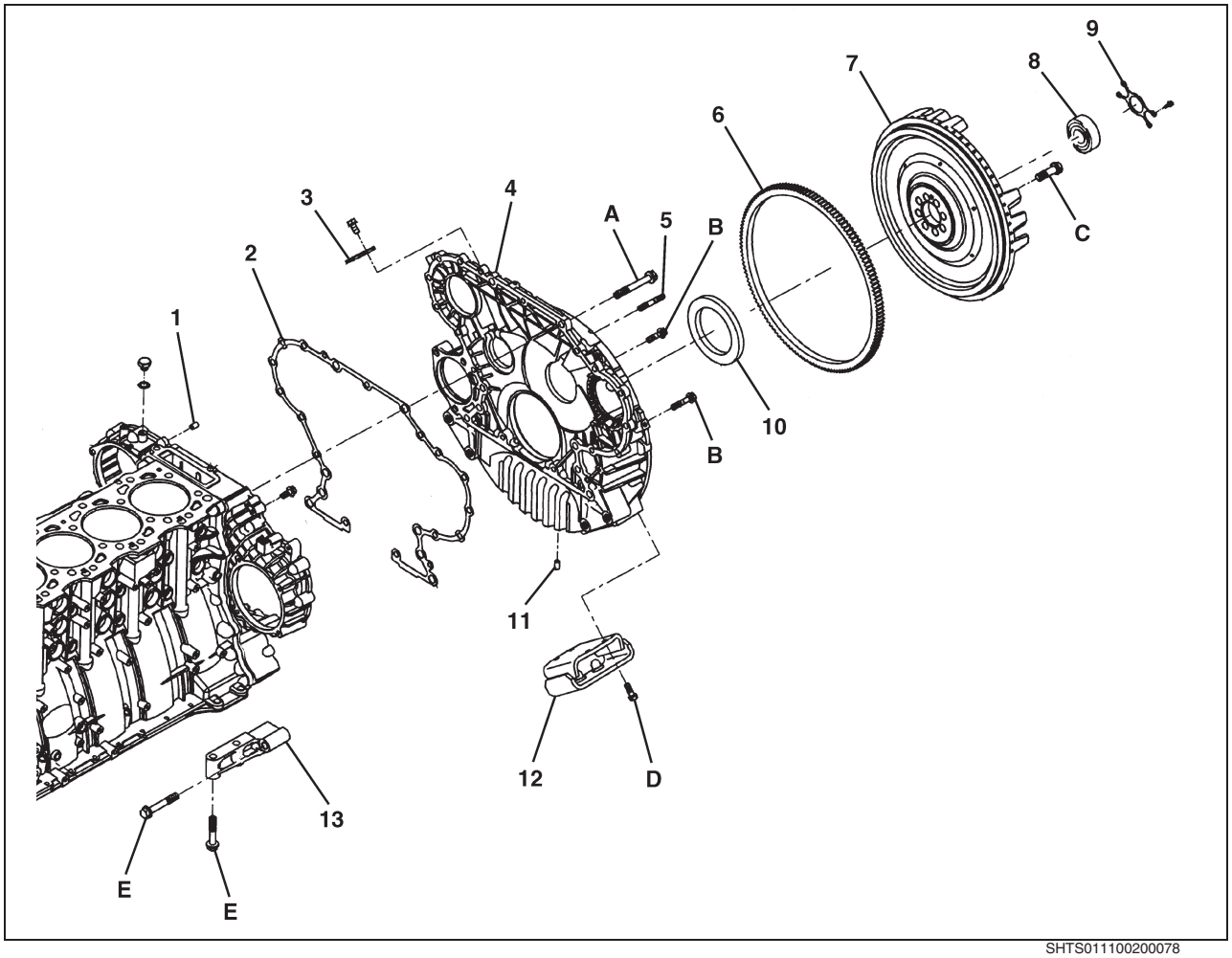
NOTICE

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

FLYWHEEL AND FLYWHEEL HOUSING

COMPONENT LOCATOR

EN0111002D100003



SHTS011100200078

1	Pin	8	Ball bearing
2	Flywheel housing gasket	9	Bearing stopper
3	Dust cover	10	Rear oil seal
4	Flywheel housing	11	Helisert
5	Stud	12	Engine mounting (Rear)
6	Ring gear	13	Flywheel housing stay
7	Flywheel (Representative)		

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

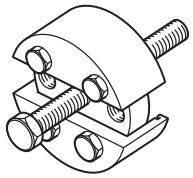
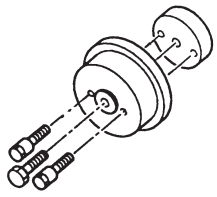
A	M16: 225 {2,300, 166}	D	200 {2,000, 147}
B	M12: 125 {1,275, 92}	E	225 {2,300, 166}
C	345 {3,500, 254}#		

#=Apply oil to the threads and seat surface before tightening.

SPECIAL TOOL

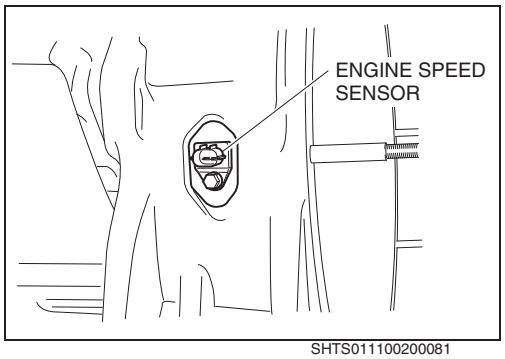
EN0111002K100003

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

Illustration	Part number	Tool name	Remarks
	09420-1780	REAR OIL SEAL PULLER	
	09407-1210	OIL SEAL PRESS	

OVERHAUL

EN0111002H200003



SHTS011100200081

IMPORTANT POINT - DISASSEMBLY

1. REMOVE THE FLYWHEEL.

(1) Remove the engine speed sensor.

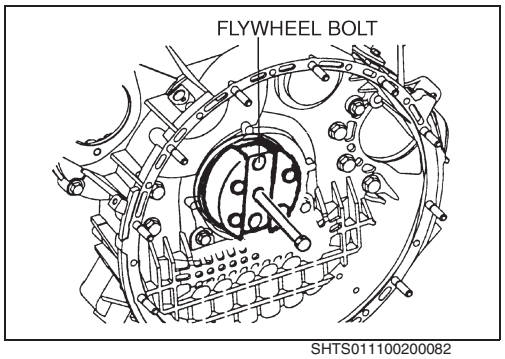
NOTICE

When removing the flywheel, remove the engine speed sensor.

(2) Remove the flywheel.

⚠ WARNING

The flywheel is too heavy. When removing, be careful not to drop it on your feet.



SHTS011100200082

IMPORTANT POINTS - REPLACEMENT

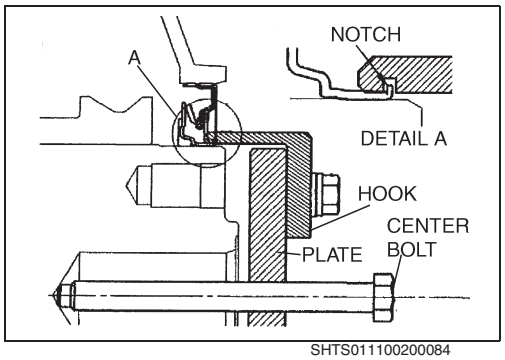
1. REPLACE THE CRANKSHAFT REAR OIL SEAL.

(1) Place the plate at the crankshaft end using the flywheel bolts.

NOTICE

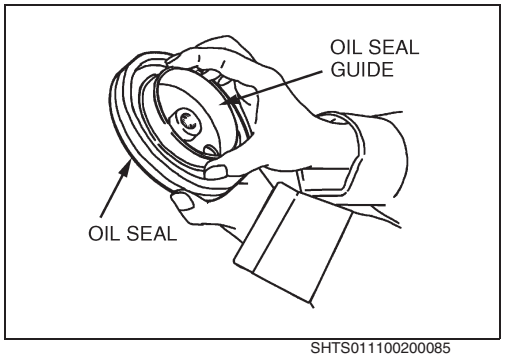
Tighten the flywheel bolts only finger-tight.

SST: Oil seal puller (09420-1742)



SHTS011100200084

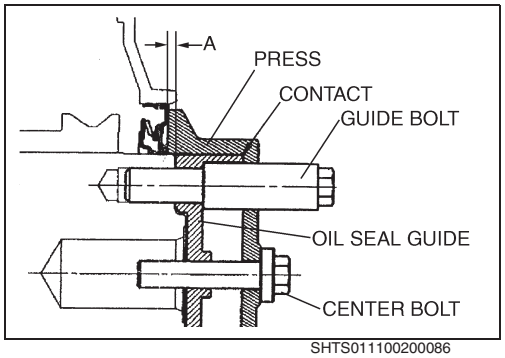
(2) Engage the hook with the oil seal notch and install the hook using the bolt supplied.
(3) Remove the installed flywheel bolts in step (1).
(4) Install the center bolt and tighten it to remove the oil seal.



SHTS011100200085

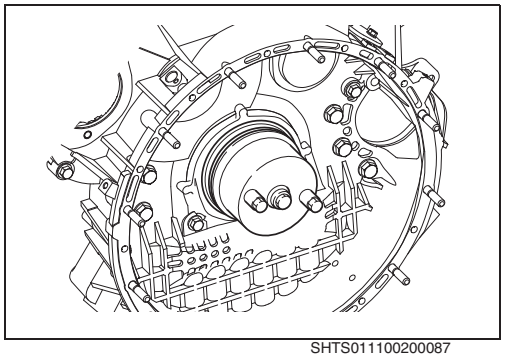
(5) Clean the edges and surface of the crankshaft and the special tools.
SST: Oil seal press (09407-1210)
(6) Apply a little engine oil to the new oil seal inner and outer ring surface.
(7) Making sure it is properly oriented, insert the new oil seal into the oil seal guide.

NOTICE
Install the oil seal so that the felt surface faces outward and the surface with the slinger (steel plate) faces in toward the engine.



SHTS011100200086

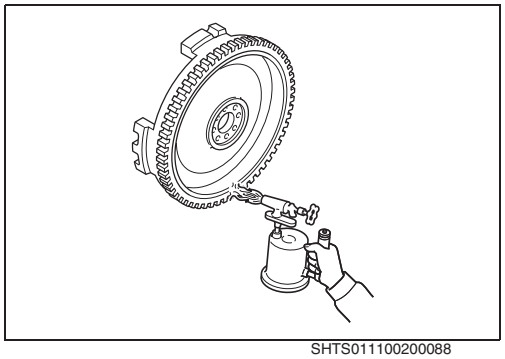
(8) Install the oil seal guide on the crankshaft end using the guide bolts.


SHTS011100200087

(9) Fit the press over the guide bolts, fix it in place by tightening the center bolt, and then press-fit the oil seal.

NOTICE
Make sure the press is set so that pressure will be applied evenly around the entire circumference of the oil seal.

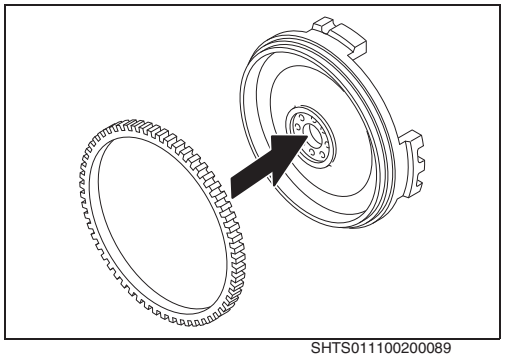
(10) Tighten the press until it contacts the oil seal guide, and then confirm that the oil seal is uniformly press-fitted.
Assembly standard (A): 3.7-4.3mm {0.1457-0.1692 in.}


SHTS011100200088

2. REPLACE THE FLYWHEEL RING GEAR.

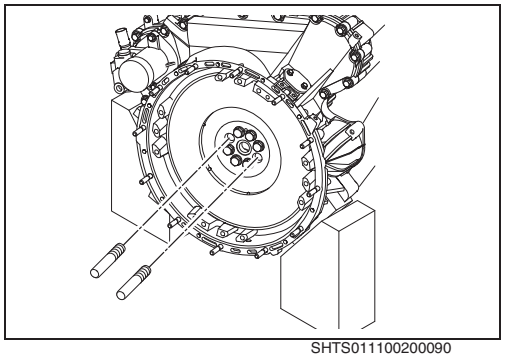
(1) Heat the ring gear evenly to about 200°C {392°F} with a torch. Tap the ring gear periphery lightly using a cushion bar to remove the gear.

⚠ WARNING
Never touch the heated ring gear or flywheel with your bare hand. This can result in personal injury.


SHTS011100200089

(2) Heat the ring gear evenly to about 200°C {392°F} with a torch. Insert the ring gear into the flywheel so that the chamfered side is upward.

⚠ WARNING
Never touch the heated ring gear or flywheel with your bare hand. This can result in personal injury.


SHTS011100200090

IMPORTANT POINT - ASSEMBLY

1. INSTALL THE FLYWHEEL.

(1) Make sure that there are no burns or dirt on the contact surface or in the threaded holes of the crankshaft or flywheel. Install a suitable guide bar onto the crankshaft.

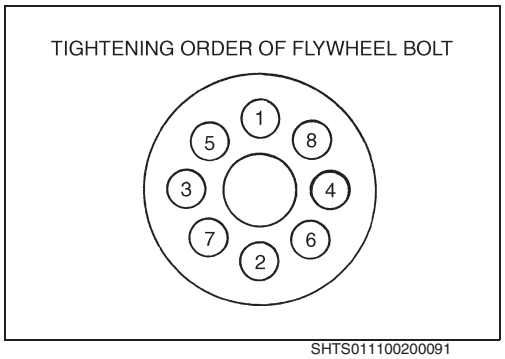
(2) Insert the flywheel slowly until it contacts the straight pin to prevent impact on the guide bar. Adjust the position, then insert the flywheel completely.

⚠ WARNING
The flywheel is too heavy. When installing, be careful not to drop it on your feet.

(3) Apply clean engine oil to the threads of the flywheel bolt and the flywheel bolt seat. Be sure to tighten the flywheel bolts (6 pieces) with a low-torque impact wrench.

(4) Pull out the guide bar and tighten the remaining two flywheel bolts provisionally as in step (3).

(5) Tighten the flywheel in the order shown in the figure to the specified torque below.
Tightening Torque:
345 N·m {3,500 kgf·cm, 254 lbf·ft}

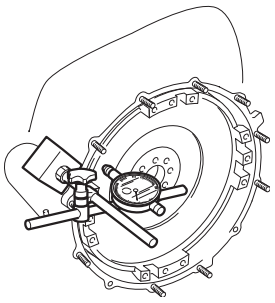
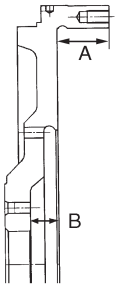
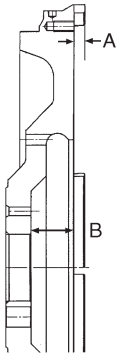


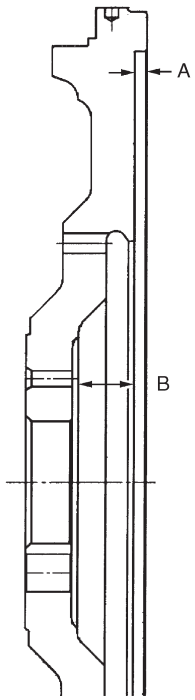
SHTS011100200091

INSPECTION AND REPAIR

EN0111002H300002

Unit: mm {in.}

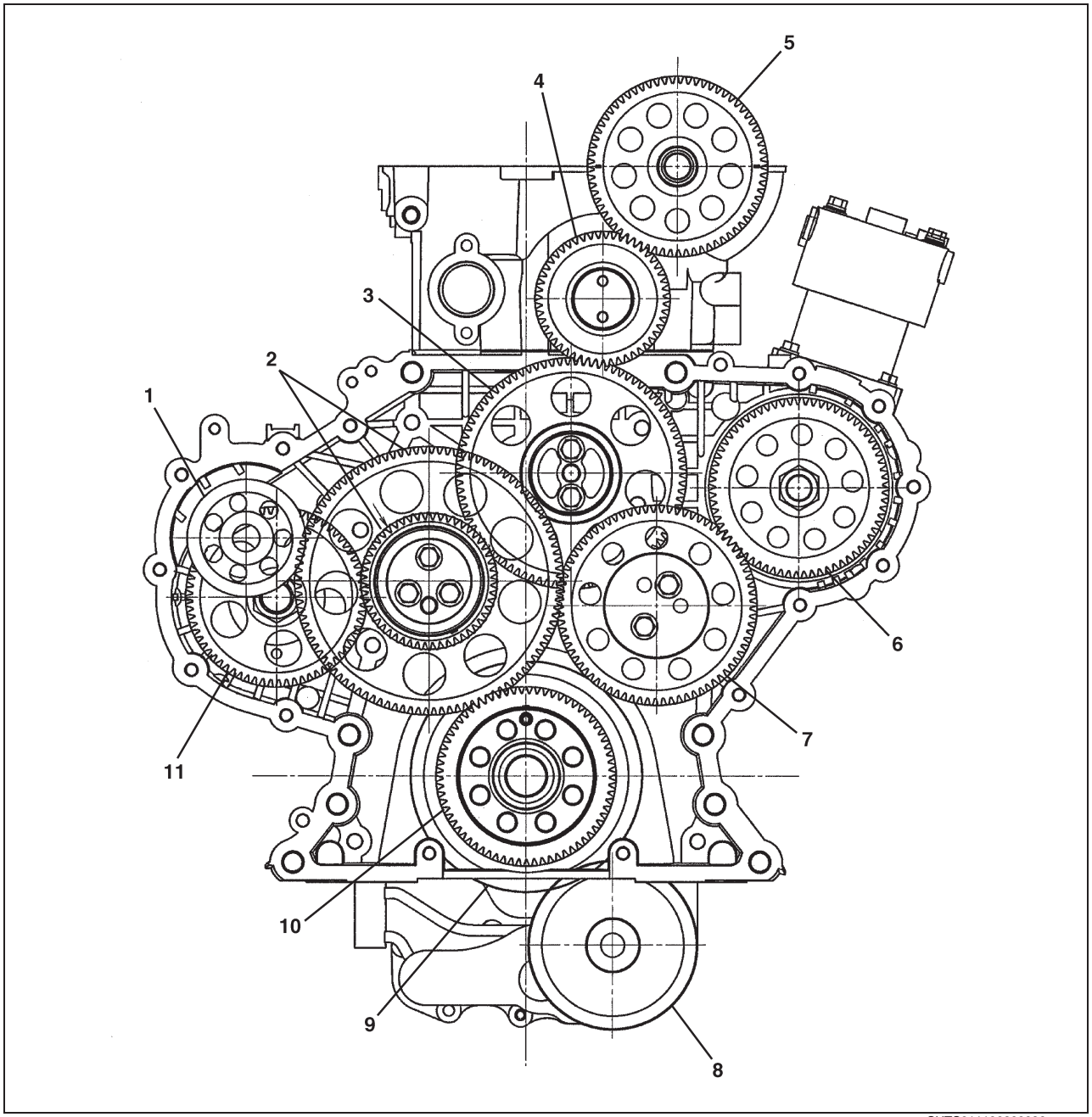
Inspection item		Standard	Limit	Remedy	Inspection procedure
Flywheel surface deflection		—	0.2 {0.0079}	Regrind and/or replace.	Measure 
Flywheel flange depth (Dimension A)	DSP-430 (Pull) series (Diameter 430 mm {17 in.})	48 {1.890}	48 {1.890}	Repair.	Measure 
Flywheel thickness (Dimension B)		26 {1.024}	25 {0.985}	Replace.	
Flywheel flange depth (Dimension A)	DSP-430 (SACHS) series (Diameter 430 mm {17 in.})	10 {0.394}	—	—	Measure 
Flywheel thickness (Dimension B)		40 {1.575}	39 {1.536}	Replace.	

Inspection item		Standard	Limit	Remedy	Inspection procedure
Flywheel flange depth (Dimension A)	CLF-3802 (TWIN PLATE) series (Diameter 380 mm {15 in.})	4.5 {0.177}	—	—	Measure 
Flywheel thickness (Dimension B)		32.8 {1.291}	31.8 {1.252}	Replace.	
Flywheel flange depth (Dimension A)	F & S-380 (TWIN PLATE) series (Diameter 380 mm {15 in.})	6 {0.236}	—	—	
Flywheel thickness (Dimension B)		31.3 {1.232}	30.3 {1.193}	Replace.	
Flywheel surface crack or heat spot		—	—	Regrind and/or replace.	Visual check

TIMING GEAR

DESCRIPTION

EN0111002D100004

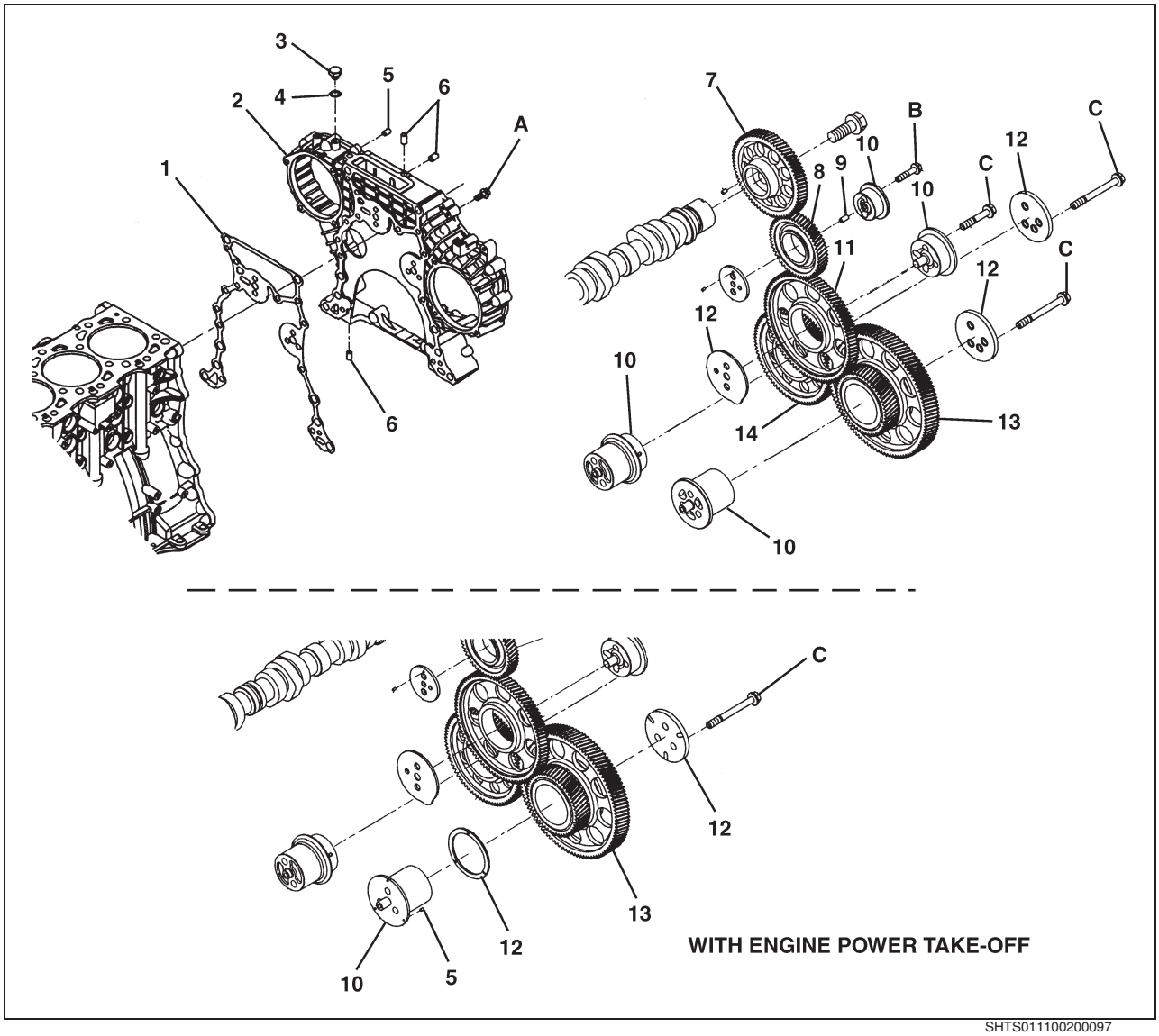


SHTS011100200096

1	Power steering pump drive gear	7	Air compressor idle gear
2	Idle gear	8	Oil pump driven gear
3	Cam idle gear (cylinder block side)	9	Oil pump drive gear
4	Cam idle gear (cylinder head side)	10	Crankshaft gear
5	Camshaft gear	11	Supply pump drive gear
6	Air compressor drive gear		

COMPONENT LOCATOR

EN0111002D100005



SHTS011100200097

1	Timing gear case gasket	8	Cam idle gear (cylinder head side)
2	Timing gear case	9	Straight pin
3	Plug	10	Idle gear shaft
4	Gasket	11	Cam idle gear (cylinder head side)
5	Pin	12	Thrust plate
6	Helisert	13	Main idle gear
7	Camshaft gear	14	Air compressor idle gear

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

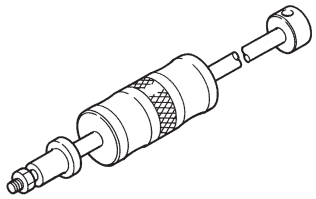
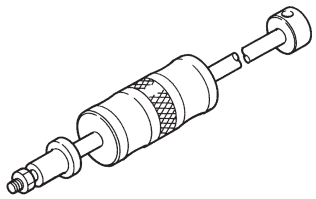
A	125 {1,275, 92}	C	108 {1,100, 80}#
B	59 {600, 44}#		

#=Apply oil to the threads and seat surfaces before tightening.

SPECIAL TOOL

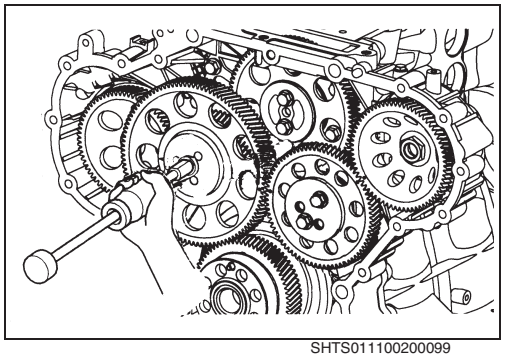
EN0111002K100004

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

Illustration	Part number	Tool name	Remarks
	09420-1510	SLIDING HAMMER	For Main idle gear, cam idle gear (cylinder block) and air compressor idle gear
	09420-1442	SLIDING HAMMER	For Cam idle gear (cylinder head)

OVERHAUL

EN0111002H200004



SHTS011100200099

IMPORTANT POINT - DISASSEMBLY

1. REMOVE THE MAIN IDLE GEAR, AIR COMPRESSOR IDLE GEAR AND CAM IDLE GEAR (CYLINDER BLOCK).

(1) Remove the idle gear attaching bolts.

(2) Remove the idle gear shaft using the special tool.

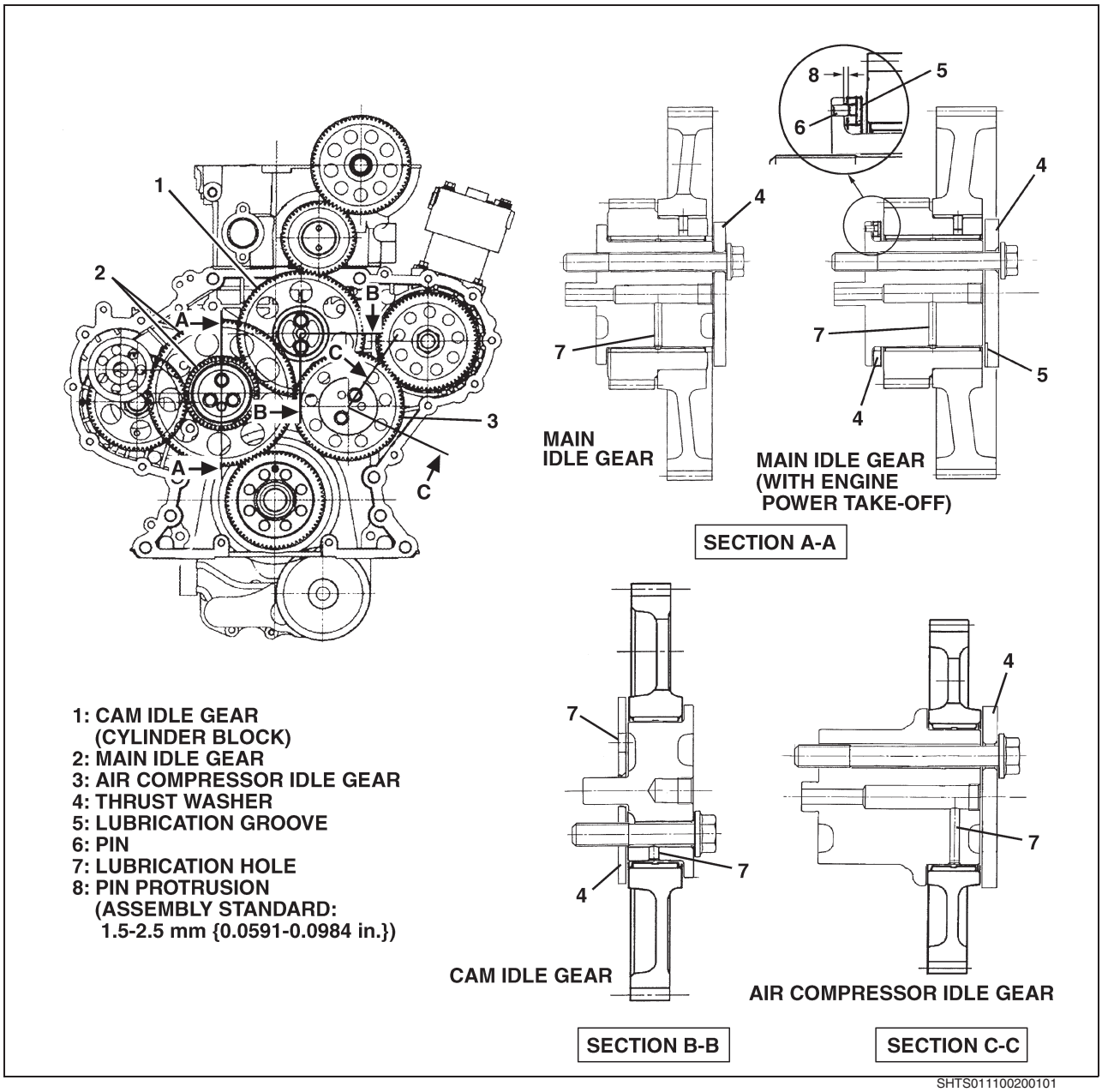
SST:

Sliding hammer (09420-1510)

Sliding hammer (for cam idle gear) (09420-1442)

IMPORTANT POINTS - ASSEMBLY

1. INSTALL THE REAR END PLATE.



1: CAM IDLE GEAR (CYLINDER BLOCK)
2: MAIN IDLE GEAR
3: AIR COMPRESSOR IDLE GEAR
4: THRUST WASHER
5: LUBRICATION GROOVE
6: PIN
7: LUBRICATION HOLE
8: PIN PROTRUSION (ASSEMBLY STANDARD: 1.5-2.5 mm {0.0591-0.0984 in.})

SHTS011100200101

NOTICE
Install each idle gear shaft as shown in the figure so that the lubrication hole is downward.

2. CHECK THE BACKLASH AND THE END PLAY.

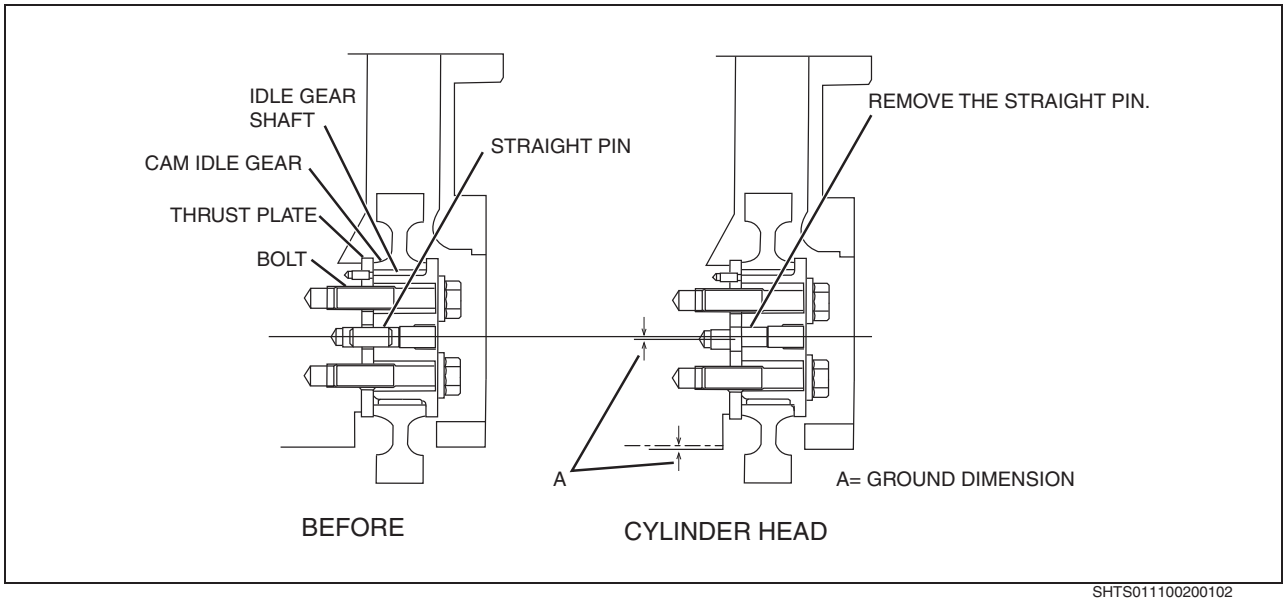
(1) Measure the backlash between the gears with a dial gauge. (Refer to the table of INSPECTION AND REPAIR.)
(2) Measure the end play between the gear and thrust plate with a feeler gauge. (Refer to the table of INSPECTION AND REPAIR.)

NOTICE
After measurement of the backlash, apply engine oil to each gear surface.

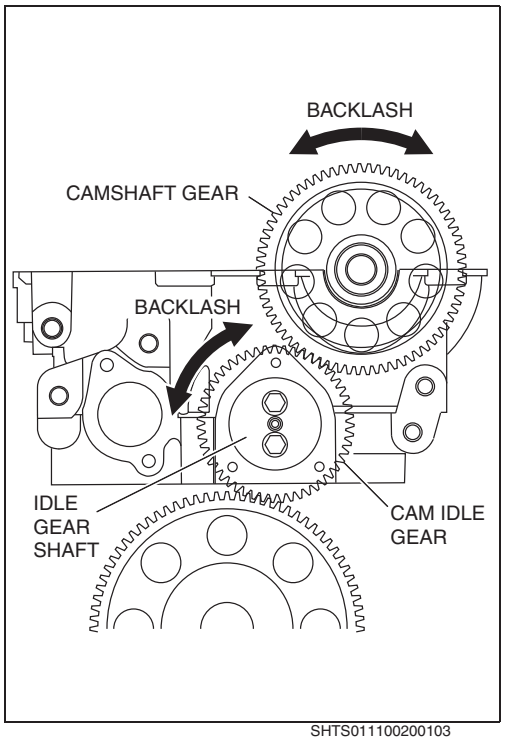
3. WHEN THE LOWER SURFACE OF CYLINDER HEAD IS GROUND, ADJUST BACKLASH BETWEEN CAM IDLE GEAR (CYLINDER HEAD SIDE), CAM IDLE GEAR (CYLINDER BLOCK SIDE) AND CAM SHAFT GEAR.

NOTICE

Once the lower surface of cylinder head is ground, installing dimension between cylinder head and straight pin becomes shorten by ground dimension. As a result, backlash adjustment is needed since backlash value between the cam idle gears (cylinder head side and cylinder block one) becomes smaller.



SHTS011100200102



SHTS011100200103

(1) Remove out straight pin of idle gear shaft.

NOTICE

By removing straight pin, installing position of gear shaft can be changed by the clearance between the bolt hole and the bolt of the Idle gear shaft.

(2) Tighten temporally cam idle gear on the ground cylinder head.

(3) Mount cylinder head on cylinder block.

NOTICE

Refer to the CHAPTER “CYLINDER HEAD”.

(4) Install cam shaft on cylinder head.

NOTICE

Refer to the CHAPTER “CYLINDER HEAD”.

(5) By moving little by little the installing position of cam idle gear, adjust backlash between cam idle gears (cylinder head side and cylinder block one) and between cam idle gear (cylinder head side) and camshaft gear to the standard value.

(6) Tighten the bolt for installing cam idle gear.
Tightening Torque:
59 N·m {600 kgf·cm, 44 lbf·ft}

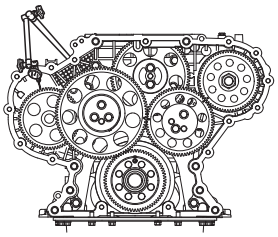
NOTICE

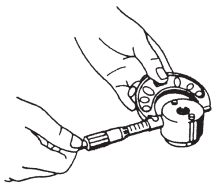
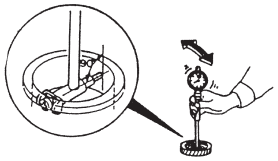
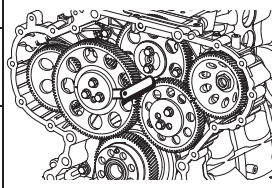
Apply engine oil to the bolt seat surfaces and bolt threads before tightening.

INSPECTION AND REPAIR

EN0111002H300003

Unit: mm {in.}

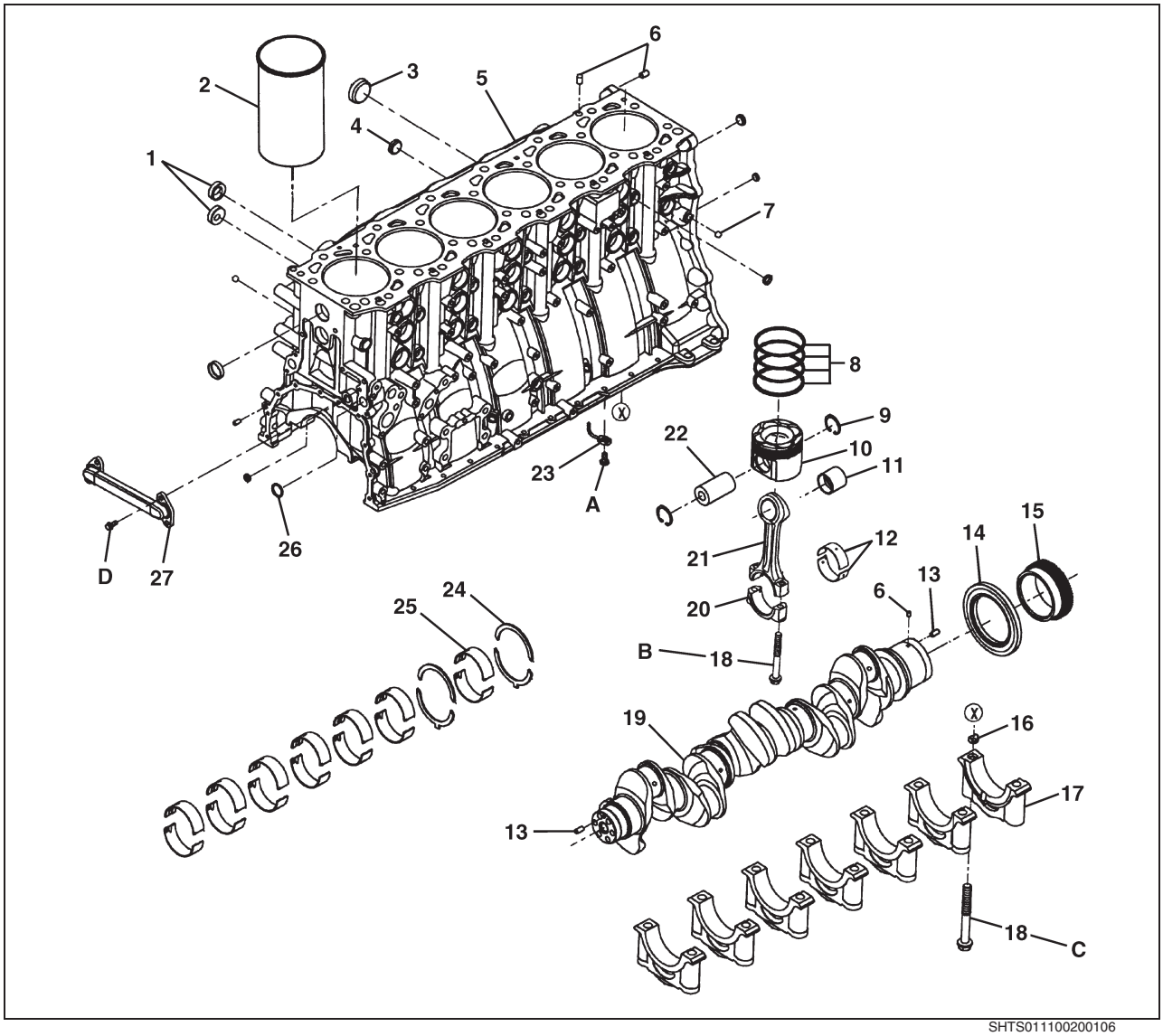
Inspection item		Standard	Limit	Remedy	Inspection procedure
Timing gear backlash	Crankshaft gear-Main idle gear	0.039-0.135 {0.0016-0.0053}	0.40 {0.0157}	Replace gear.	Measure 
	Main idle gear-Air compressor idle gear	0.046-0.142 {0.0019-0.0055}	0.40 {0.0157}		
	Main idle gear-Power steering pump drive gear	0.043-0.199 {0.0017-0.0078}	0.40 {0.0157}		
	Main idle gear -Cam idle gear (Block)	0.040-0.136 {0.0016-0.0053}	0.40 {0.0157}		
	Main idle gear-Supply pump drive gear	0.043-0.177 {0.0017-0.0069}	0.40 {0.0157}		
	Air compressor idle gear Air compressor drive gear	0.035-0.204 {0.0014-0.0080}	0.40 {0.0157}		
	Cam idle gear (Block)-Cam idle gear (Head)	0.038-0.356 {0.0015-0.0140}	0.40 {0.0157}		
	Cam idle gear (Head)-Camshaft gear	0.038-0.139 {0.0015-0.0053}	0.40 {0.0157}		
	Oil pump drive gear-Oil pump driven gear	0.034-0.261 {0.0014-0.0102}	0.40 {0.0157}		

Inspection item		Standard	Limit	Remedy	Inspection procedure
Main idle gear	Shaft outside diameter	72 {2.853}	—	—	Measure  Outside diameter  Inside diameter  End play
	Bushing inside diameter	72 {2.853}	—	—	
	Clearance	0.030-0.090 {0.0012-0.0035}	0.20 {0.0079}	Replace gear and/or shaft.	
	End play	0.090-0.145 {0.0036-0.0057}	0.3 {0.0118}	Replace gear, thrust plate and/or shaft.	
Air compressor idle gear	Shaft outside diameter	72 {2.853}	—	—	
	Bushing inside diameter	72 {2.853}	—	—	
	Clearance	0.030-0.090 {0.0012-0.0035}	0.20 {0.0079}	Replace gear and/or shaft.	
	End play	0.090-0.145 {0.0036-0.0057}	0.3 {0.0118}	Replace gear, thrust plate and/or shaft.	
Cam idle gear (Block)	Shaft outside diameter	72 {2.853}	—	—	
	Bushing inside diameter	72 {2.853}	—	—	
	Clearance	0.030-0.090 {0.0012-0.0035}	0.20 {0.0079}	Replace gear and/or shaft.	
	End play	0.090-0.145 {0.0036-0.0057}	0.3 {0.0118}	Replace gear, thrust plate and/or shaft.	

MAIN MOVING PARTS AND CYLINDER BLOCK

COMPONENT LOCATOR

EN0111002D100006



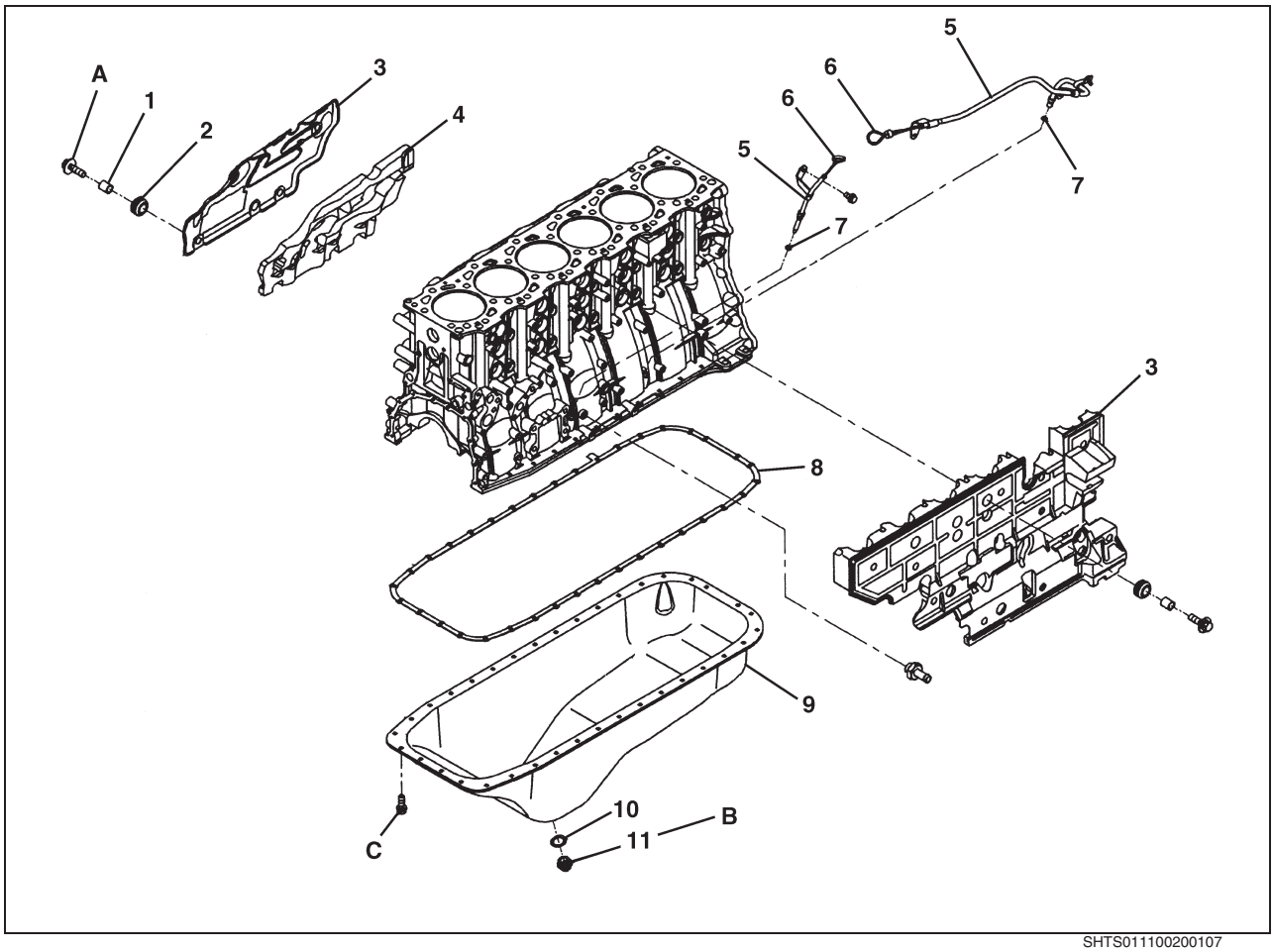
SHTS011100200106

1	Cooling water insert	15	Crankshaft gear
2	Cylinder liner	16	Collar
3	Expansion plug	17	Main bearing cap
4	Sealing plug	18	Bearing cap bolt
5	Cylinder block	19	Crankshaft
6	Pin	20	Connecting rod cap
7	Steel ball	21	Connecting rod
8	Piston ring	22	Piston pin
9	Retainer ring	23	Piston cooling jet
10	Piston	24	Crankshaft thrust bearing
11	Connecting rod bushing	25	Crankshaft main bearing
12	Connecting rod bearing	26	O-ring
13	Straight pin	27	Oil pipe
14	Oil pump drive gear		

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

A	23 {235, 17}	C	127 {1,300, 94}+90°+45°#
B	60 {610, 44}+110°#	D	28.5 {290, 21}

#=Apply oil to the threads and seat surfaces before tightening.



SHTS011100200107

1	Spacer	7	O-ring
2	Silent block	8	Oil pan gasket
3	Enclosure cover (If so equipped)	9	Oil pan
4	Sound insulator (If so equipped)	10	Soft washer
5	Oil level gauge guide	11	Drain plug
6	Oil level gauge		

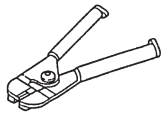
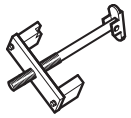
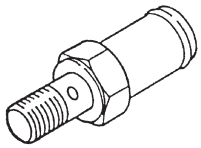
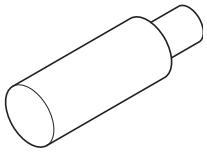
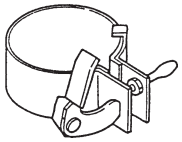
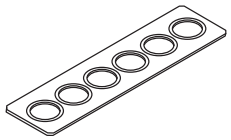
Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

A	25 {255, 18}	C	59 {600, 44}
B	44 {450, 32}		

SPECIAL TOOL

EN0111002K100005

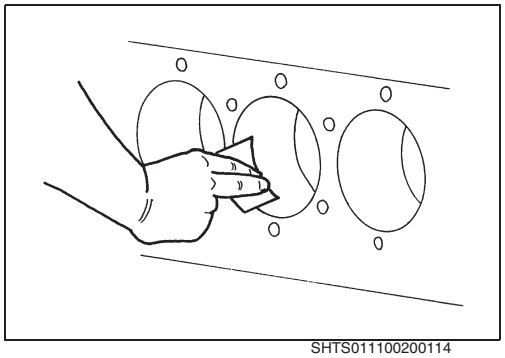
Prior to starting an engine overhaul, it is necessary to have these special tools.

Illustration	Part number	Tool name	Remarks
	09442-1131	PISTON RING EXPANDER	For Piston ring
	09420-2080	PULLER	For Cylinder liner
	9001-24265	CONNECTOR BOLT	For Piston cooling jet
	09482-1380	PISTON PIN PRESS	
	09441-1011	PISTON RING HOLDER	
	09444-1770	GAUGE	

OVERHAUL

EN0111002H200005

IMPORTANT POINTS - DISASSEMBLY



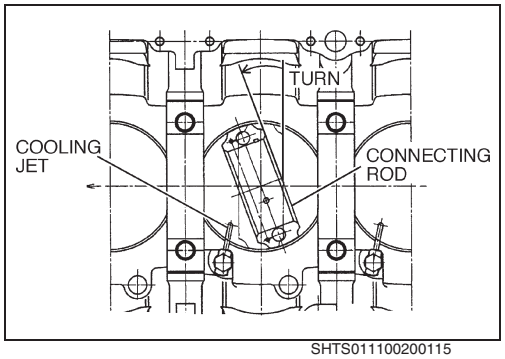
SHTS011100200114

1. REMOVE THE PISTON WITH CONNECTING ROD.

(1) Remove the piston and connecting rod from the cylinder block upper side.

NOTICE

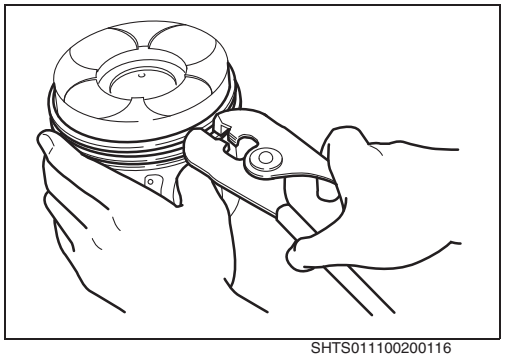
- **Remove carbon deposits from the end inside the cylinder liner with a scraper or emery paper (recommended: No. 150) in a circular direction.**



SHTS011100200115

NOTICE

- **When removing the piston, be careful that the cooling jet is not struck by the connecting rod.**
- **Arrange the removed pistons and connecting rod caps in the order of cylinder numbers. Be careful not to change the combination of the connecting rod and cap.**



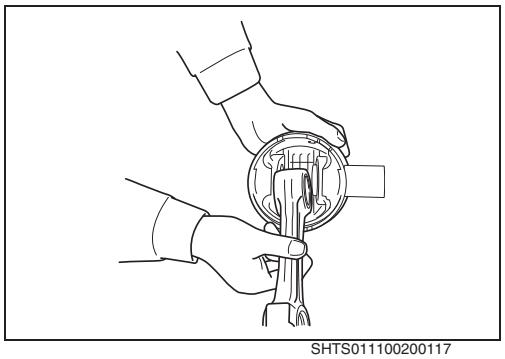
SHTS011100200116

2. REMOVE THE PISTON RINGS.

(1) Remove the piston ring using the special tool.
SST: Piston ring expander (09442-1131)

NOTICE

- **Handle the piston rings carefully because they are made of a special casting which is easily broken.**
- **Keep the piston rings for each cylinder separately.**



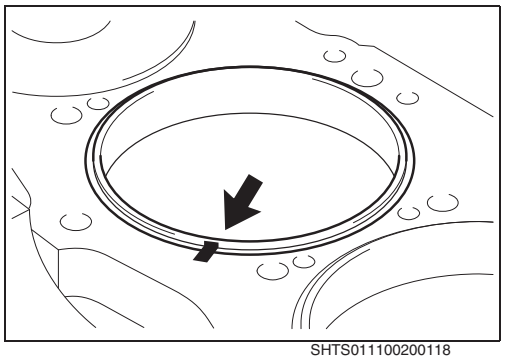
SHTS011100200117

3. DISASSEMBLE THE PISTON AND THE CONNECTING ROD.

(1) Remove the retainer rings.

(2) Remove the piston pin using the special tool.
SST: Piston pin press (09482-1380)

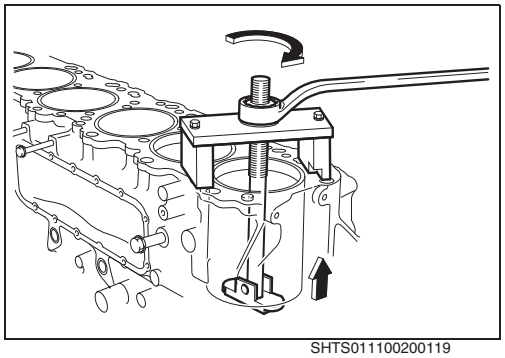
(3) Disassemble the piston and the connecting rod.


SHTS011100200118

4. REMOVE THE CYLINDER LINER.

(1) Before removing the cylinder liner, put alignment marks on the cylinder block and liner flange.

NOTICE
Do not make alignment marks with a punch.


SHTS011100200119

(2) Pull the cylinder liner from the cylinder block using the special tool.
SST: Puller (09420-2080)

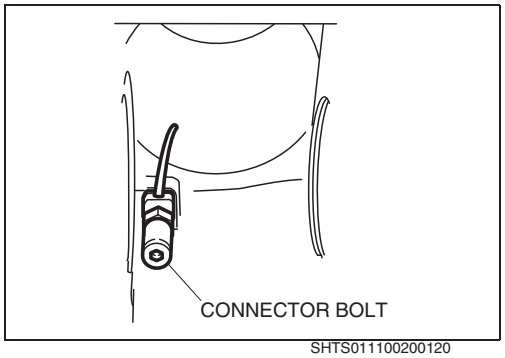
NOTICE

- **Carefully set the special tool to prevent touching to the piston cooling jet.**
- **After removing the cylinder liners, arrange them in the order of cylinder numbers.**

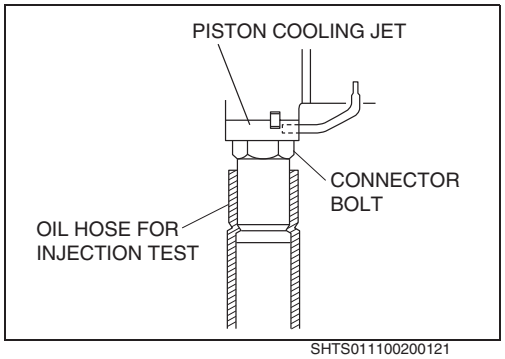
IMPORTANT POINTS - ASSEMBLY

1. INSPECT THE PISTON COOLING JET.

(1) Install the piston cooling jet on the cylinder block using the special tool.
SST: Connector bolt (9001-24265)



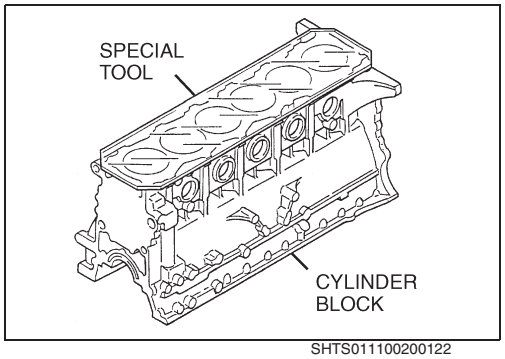
SHTS011100200120



SHTS011100200121

(2) For the jet test, connect the oil hose to the connector bolt from the cylinder block lower side.

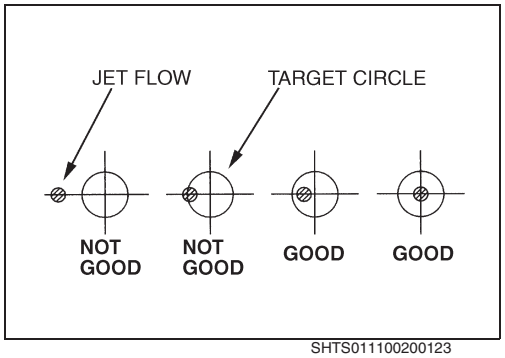
NOTICE
Use clean engine oil for jet flow.



SHTS011100200122

(3) Set the special tool on the cylinder block upper surface against the dowel pin.
SST: Gauge (09444-1770)

(4) Test jet oil flow from the piston cooling jet nozzle at a hydraulic pressure of 196 kPa {2 kgf/cm^2, 28 lbf/in^2}.

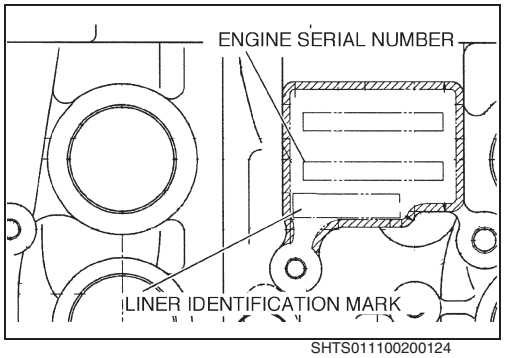


SHTS011100200123

(5) If the center of the jet flow is within the target circle, the test is acceptable.

⚠ CAUTION
- **Fire may occur due to splattered oil during the jet flow test. Do not use naked lights near the test area.**
- **Engine oil is flammable. Carry out this test in a well ventilated room and do not use naked lights in the room.**

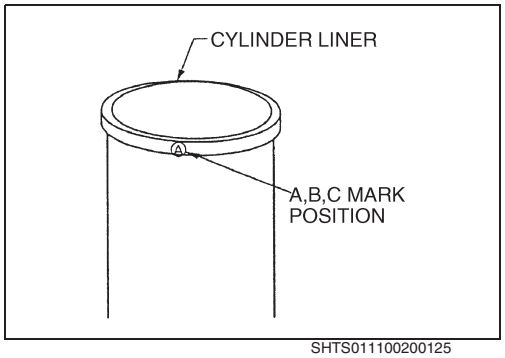
(6) If the center of the jet flow is out of the target circle, install the new piston cooling jet and test jet oil flow.



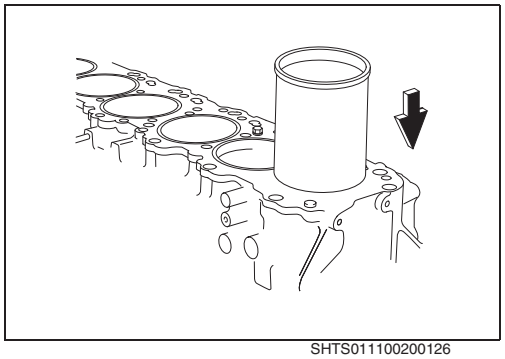
SHTS011100200124

2. INSTALL THE CYLINDER LINER.

NOTICE
- **When assembling the cylinder liner with the cylinder block, clearance can be set to three levels.**
- **The upper surface and side surface of the cylinder block are engraved A, B or C depending on the inside diameter. Insert a matching cylinder liner having the same symbol.**



SHTS011100200125

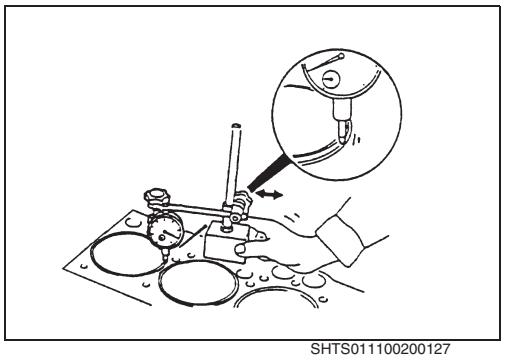


SHTS011100200126

(1) Apply engine oil to the inner surface of the block bore and insert the cylinder liner.

NOTICE

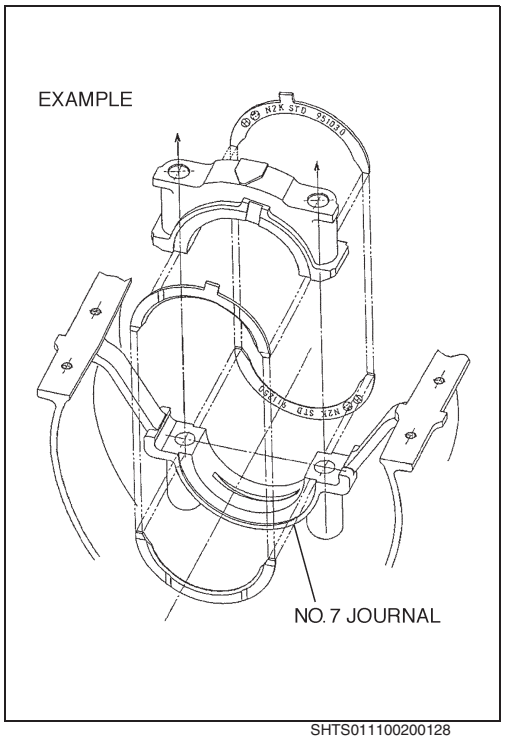
Handle the cylinder liner carefully because it is thin.
(If it falls on the floor, it cannot be used.)



SHTS011100200127

3. MEASURE THE PROTRUSION AT THE CYLINDER LINER FLANGE.

Standard	**0.050-0.120 mm {0.0020-0.0047 in.}**



SHTS011100200128

4. INSTALL THE CRANKSHAFT.

(1) Install the main bearing onto the bearing caps and the cylinder block.

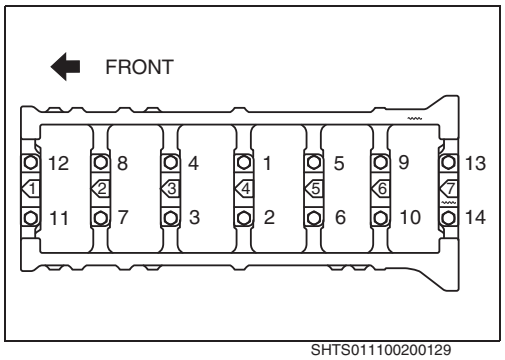
NOTICE

- **Install the bearing with the oil hole on the block side and the bearing without the oil hole on the cap side.**
- **Apply clean engine oil to inner surfaces of the bearings.**

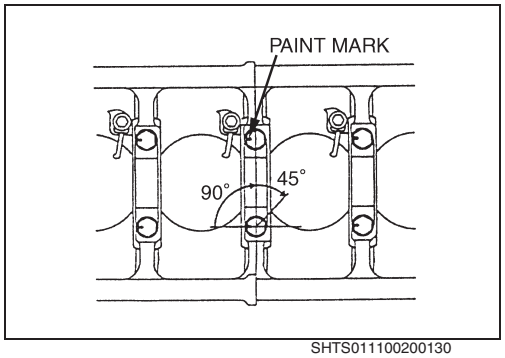
(2) Install the crankshaft onto the cylinder block.
(3) Install the thrust bearing with the groove side (front) toward the crank arm and with the part No. stamp (back) toward the main bearing cap or cylinder block.

HINT

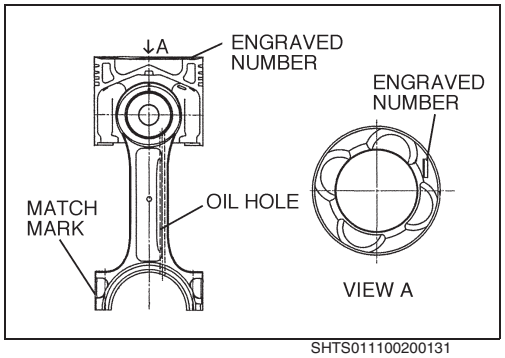
Apply engine oil or grease to the back of the thrust bearing to prevent loosening during installation.



SHTS011100200129



SHTS011100200130



SHTS011100200131

5. INSTALL THE MAIN BEARING CAP.

(1) Install the main bearing cap onto the cylinder block.

NOTICE

Check the number stamped on the cap.

(2) Apply clean engine oil to the bolt seat surface and bolt threads.

(3) Tighten the bolts in the order shown in the figure to the specified torque.

Tightening Torque:
127 N·m {1,300 kgf·cm, 94 lbf·ft}

(4) Loosen all bolts, tap the front and back ends of the crankshaft using a plastic hammer.

(5) Tighten the bolts as in step (4).

(6) Mark the bolt heads with paint to indicate the same directions as shown in the figure.

(7) Tighten the bolts 90° (1/4 turn) in the same order as in step (4).

(8) Retighten the bolts 45° (1/8 turn) as in step (8).

(9) Make sure that all paint marks face the same direction.

NOTICE

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

(10) After tightening, tap the front and back ends of the crankshaft using a plastic hammer to allow complete fit.

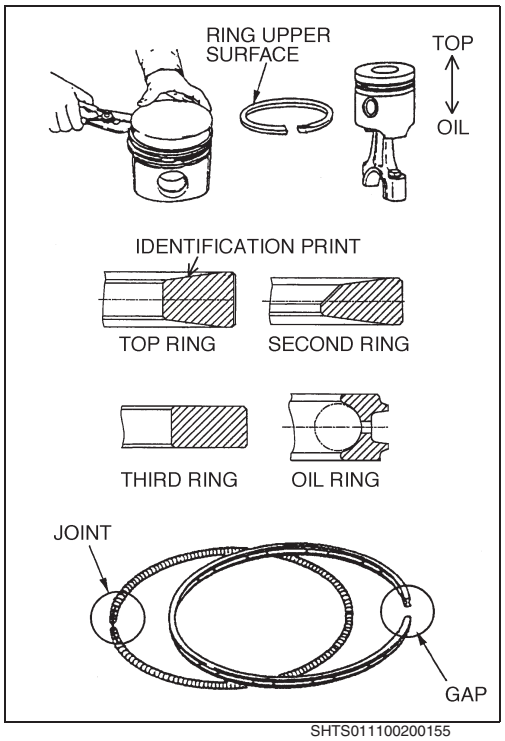
6. ASSEMBLE THE PISTON AND CONNECTING ROD.

(1) Heat the piston to more than 50°C {122°F} in hot water.

(2) Assemble the engraved number on the piston to be opposite to the connecting rod match mark.

NOTICE

Replace the retainer ring with a new one.



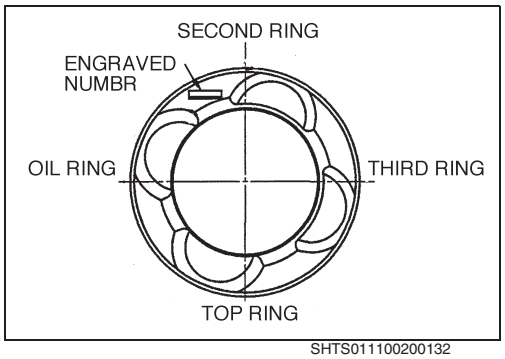
SHTS011100200155

7. ASSEMBLE THE PISTON RING.

(1) Install in the order of oil ring, third ring, second ring and top ring using the special tool.
SST: Piston ring expander (09442-1131)

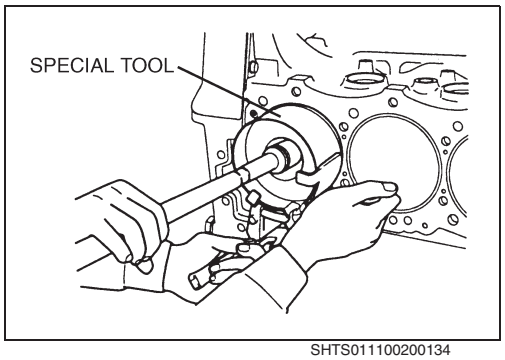
NOTICE
Install the top ring, second ring and third ring that turn the identification print on the piston ring to upper surface.

(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.



SHTS011100200132

(3) Position the matching points of the piston ring at a even distance as shown in the figure.

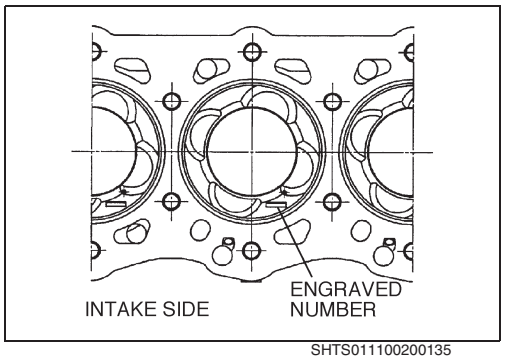


SHTS011100200134

8. INSTALL THE PISTON WITH CONNECTING ROD.

(1) Install the connecting rod bearing onto the connecting rod and the connecting rod cap.

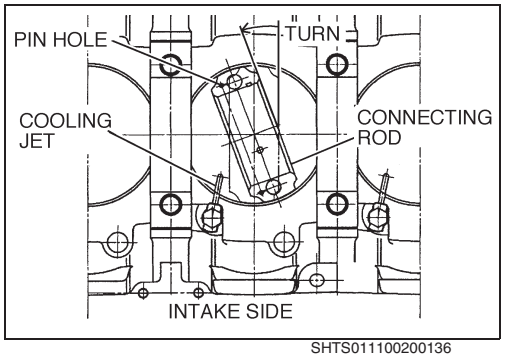
NOTICE
Install the bearing with the oil hole on the connecting rod and the bearing without the oil hole on the cap side.



SHTS011100200135

(2) Apply engine oil to the piston, cylinder liner and connecting rod bearing, then compress the piston ring using the special tool.
SST: Piston ring holder (09441-1011)

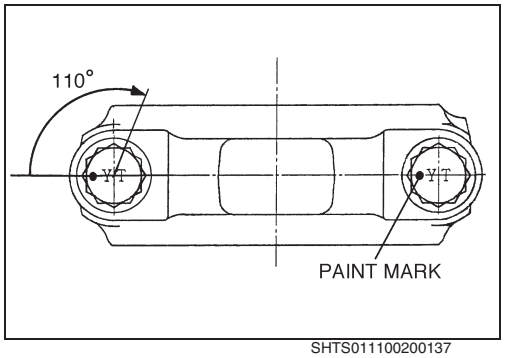
NOTICE
Make sure that engraved number on the piston is at the intake side.



SHTS011100200136

(3) Insert the piston into the cylinder liner.

NOTICE
When inserting the piston, be careful that the cooling jet is not struck by the connecting rod.



SHTS011100200137

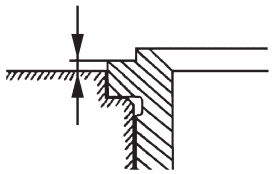
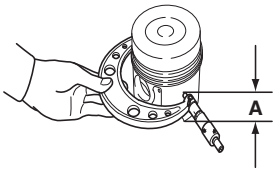
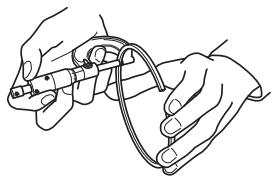
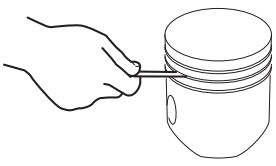
(4) Align the pin and pin hole, install the connecting rod cap on the connecting rod.
(5) Apply clean engine oil to the bolt seat surfaces and bolt threads.
(6) Tighten the connecting rod bolt to the specified torque.
Tightening Torque:
60 N·m {610 kgf·cm, 44 lbf·ft}
(7) Mark the bolt head in the same direction with paint.
(8) Tighten the connecting rod bolt 110°.
(9) Make sure that the paint marks face the same direction.

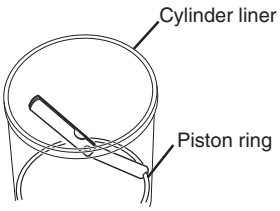
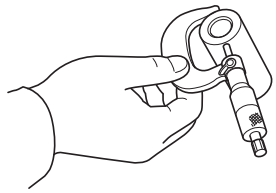
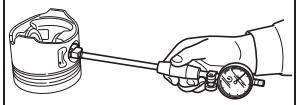
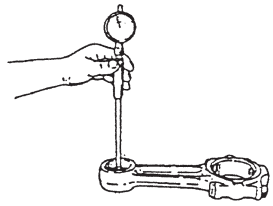
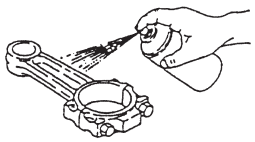
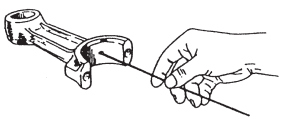
NOTICE
When adding torque, never untighten the bolts, even if they have been overtightened.

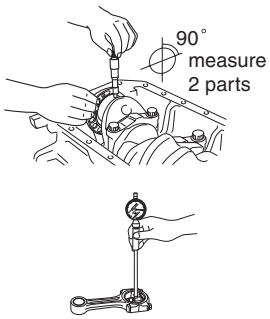
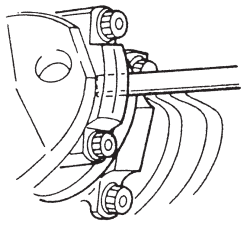
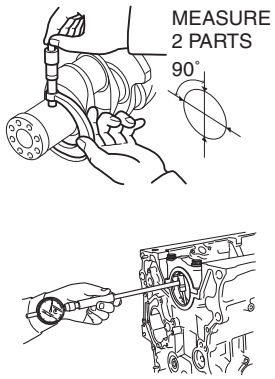
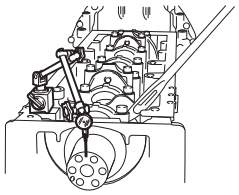
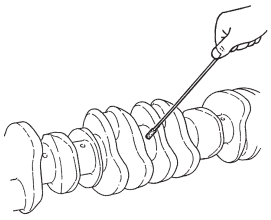
INSPECTION AND REPAIR

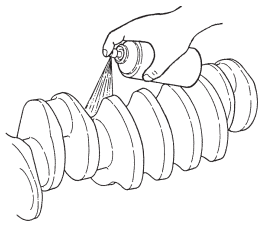
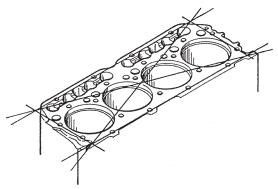
EN0111002H300004

Unit: mm {in.}

Inspection item		Standard	Limit	Remedy	Inspection procedure
Cylinder block flange depth		5{0.1969}	—	—	Measure 
Cylinder liner thickness		5{0.1969}	—	—	
Cylinder liner protrusion		0.050-0.120 {0.0020-0.0074}	—	—	
Block inside diameter	A	142 {5.5906}	—	—	Reference only
	B				
	C				
Liner outside diameter	A	142 {5.5906}	—	—	Reference only
	B				
	C				
Clearance between block and liner	A	0.0120-0.0285 {0.0005-0.0011}	—	—	Reference only
	B	0.0115-0.0285 {0.0005-0.0011}			
	C	0.0115-0.0280 {0.0005-0.0011}			
Piston outside diameter at A:25{0.9843}		136.92 {5.3906}	—	Replace piston and/ or liner.	Measure  
Liner inside diameter (Apply the value obtained at the most worn point to the cylinder liner inside diameter.)		137 {5.3937}	137.2 {5.4016}		
Clearance between piston and cylinder liner		0.068-0.092 {0.0027-0.0036}	—		
Piston ring width	Top	3.306 {0.1302}	3.056 {0.1203}	Replace ring.	Measure 
	Second	2.806 {0.1105}	2.556 {0.1006}		
	Third	2.5 {0.0984}	2.25 {0.0886}		
	Oil	4.0 {0.1575}	3.75 {0.1476}		
Piston groove width	Third	2.5 {0.0984}	2.75 {0.1083}	Replace piston.	Measure 
	Oil	4.0 {0.1575}	4.25 {0.1637}		

Inspection item		Standard	Limit	Remedy	Inspection procedure
Clearance between piston ring and piston ring groove	Third	0.065-0.105 {0.0026-0.0041}	—	—	—
	Oil	0.025-0.065 {0.0010-0.0025}			
Gap between ends of piston ring	Top	0.45-0.60 {0.0178-0.0236}	1.5 {0.0591}	Replace piston ring.	Measure 
	Second	0.65-0.80 {0.0256-0.0314}	1.5 {0.0591}		
	Third	0.48-0.63 {0.0189-0.0248}	1.5 {0.0591}		
	Oil	0.40-0.55 {0.0158-0.0216}	1.0 {0.0394}		
Piston pin outside diameter		55 {2.1654}	54.99 {2.1650}	Replace piston pin.	Measure 
Piston pin bore inside diameter		55 {2.1654}	—	—	
Clearance between piston pin and piston pin bore		0.011-0.029 {0.0005-0.0011}	0.05 {0.0020}	Replace piston and/or piston pin.	
Connecting rod bushing inside diameter		55 {2.1654}	—	—	Measure 
Clearance between piston pin and connecting rod bushing		0.030-0.048 {0.0012-0.0018}	0.1 {0.0039}	Replace piston pin and/or connecting rod.	
Wear or damage of connecting rod *Dye penetrant check (Color check)		—	—	Replace.	Visual check 
Clogging of connecting rod oil hole		—	—	Replace.	Visual check 

Inspection item	Standard	Limit	Remedy	Inspection procedure
Crank pin outside diameter	90 {3.543}	89.8 {3.5354}	Replace crankshaft.	Measure 
Clearance between connecting rod bearing and crank pin	0.049-0.100 {0.0020-0.0039}	0.3 {0.0118}	Replace connecting rod bearing.	
Connecting rod large end width	48 {1.890}	—	—	Measure 
Crank pin width	48 {1.890}	—	—	
Connecting rod end play	0.15-0.32 {0.0060-0.0125}	0.6 {0.0236}	Replace connecting rod and/or crankshaft.	
Crank journal outside diameter	108 {4.252}	107.8 {4.2441}	Replace crankshaft.	Measure 
Clearance between crank journal and main bearing	0.054-0.110 {0.0022-0.0043}	0.3 {0.0118}	Replace main bearing and/or crankshaft.	
No.7 journal width	48 {1.890}	—	—	Measure 
Thrust bearing thickness	4.0 {0.1575}	—	—	
Crankshaft end play	0.110-0.274 {0.0044-0.0107}	0.5 {0.0197}	Replace thrust bearing and/or crankshaft.	
Clogging of crankshaft oil hole	—	—	Clean.	Visual check 

Inspection item	Standard	Limit	Remedy	Inspection procedure
Crack and wear of crankshaft *Dye penetrant check (Color check)	**—**	**—**	**Replace.**	**Visual check** 
Cylinder block upper surface flatness	**0.05 {0.0019} or less**	**0.15 {0.0059}**	**Regrind. NOTICE If necessary, regrind the upper surface of timing gear case.**	**Measure** 

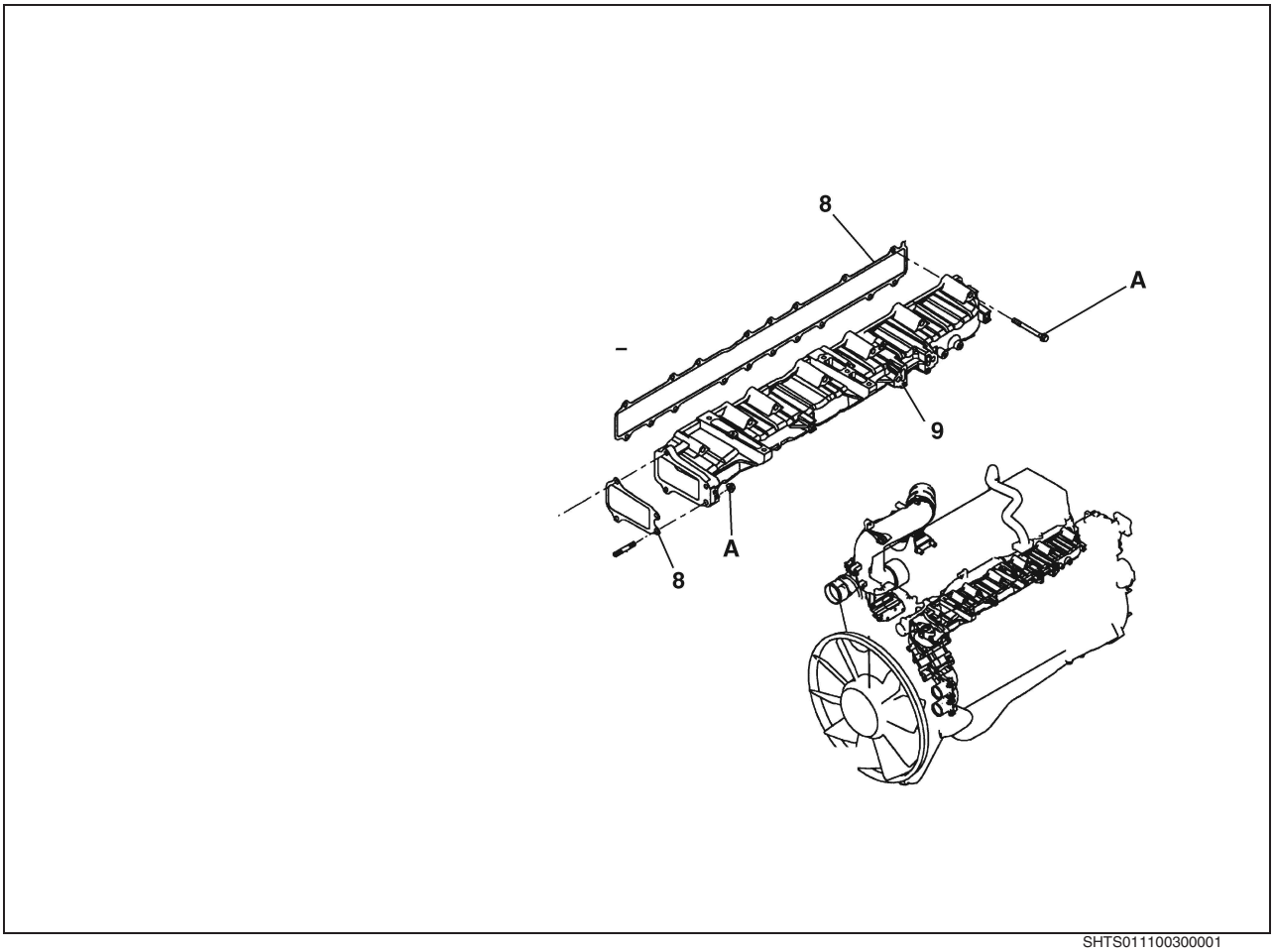
AIR INTAKE SYSTEM (E13C)

EN03-001

INTAKE MANIFOLD AND AIR PIPE

COMPONENT LOCATOR

EN0111003D100001



SHTS011100300001

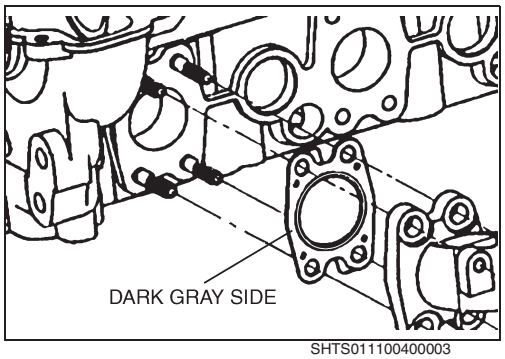
1	Intake pipe	6	Air hose
2	Clamp	7	Boost compensator pipe
3	Air hose	8	Intake manifold gasket
4	Intake pipe bracket	9	Intake manifold
5	Clip	10	Intake pipe or air intake heater

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

A	55 {560, 41}	B	28.5 {290, 21}

OVERHAUL

EN0111004H200001



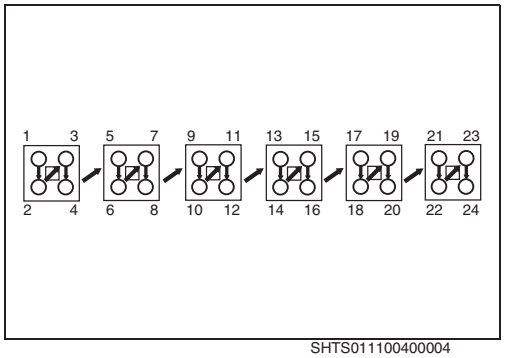
SHTS011100400003

IMPORTANT POINTS - MOUNTING

1. INSTALL THE EXHAUST MANIFOLD GASKET.

NOTICE

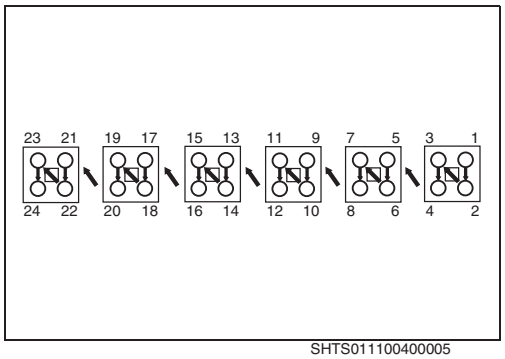
Since the exhaust manifold gasket must be installed in one way, install the gasket with the dark gray side facing toward the exhaust manifold.



SHTS011100400004

2. INSTALL THE EXHAUST MANIFOLD.

(1) Install the exhaust manifold onto the cylinder head and tighten the nut in the order shown in the figure to the specified torque.
Tightening Torque:
44 N·m {450 kgf·cm, 32 lbf·ft}

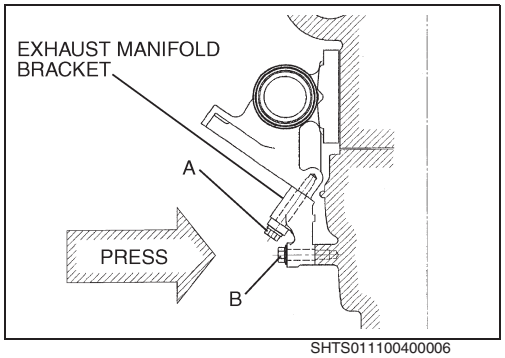


SHTS011100400005

(2) Tighten nut in the order shown in the figure to the specified torque.
Tightening Torque:
59 N·m {600 kgf·cm, 44 lbf·ft}

NOTICE

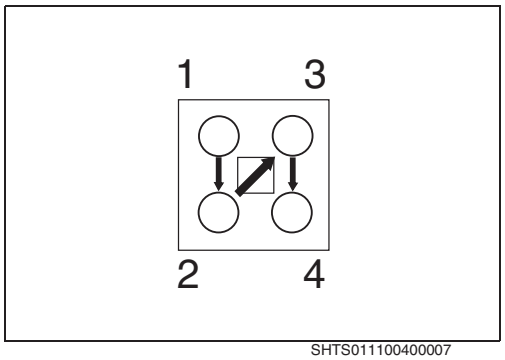
Be sure to carry out the procedure.



SHTS011100400006

3. INSTALL THE EXHAUST MANIFOLD BRACKET.

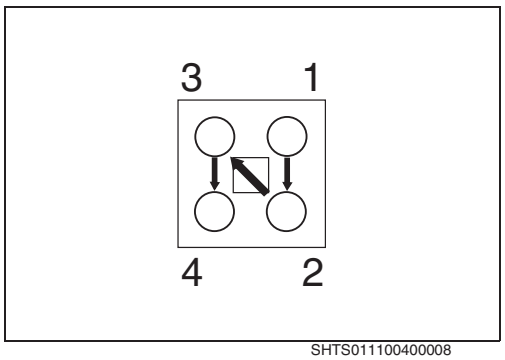
(1) Install the bracket and temporarily secure with bolts.
(2) Press the bracket and tighten the bolt (A) to the specified torque.
(3) Tighten the bolt (B) to the specified torque.



SHTS011100400007

4. INSTALL THE TURBOCHARGER AND THE EXHAUST MANIFOLD CONNECTOR.

(1) Tighten the nut in the order shown in the figure to the specified torque.
Tightening Torque:
M10: 44 N·m {450 kgf·cm, 32 lbf·ft}
M12: 81 N·m {825 kgf·cm, 59 lbf·ft}



SHTS011100400008

(2) Tighten the nut in the order shown in the figure to the specified torque.
Tightening Torque:
M10: 59 N·m {600 kgf·cm, 44 lbf·ft}
M12: 108 N·m {1,100 kgf·cm, 80 lbf·ft}

NOTICE
Be sure to carry out the procedure.

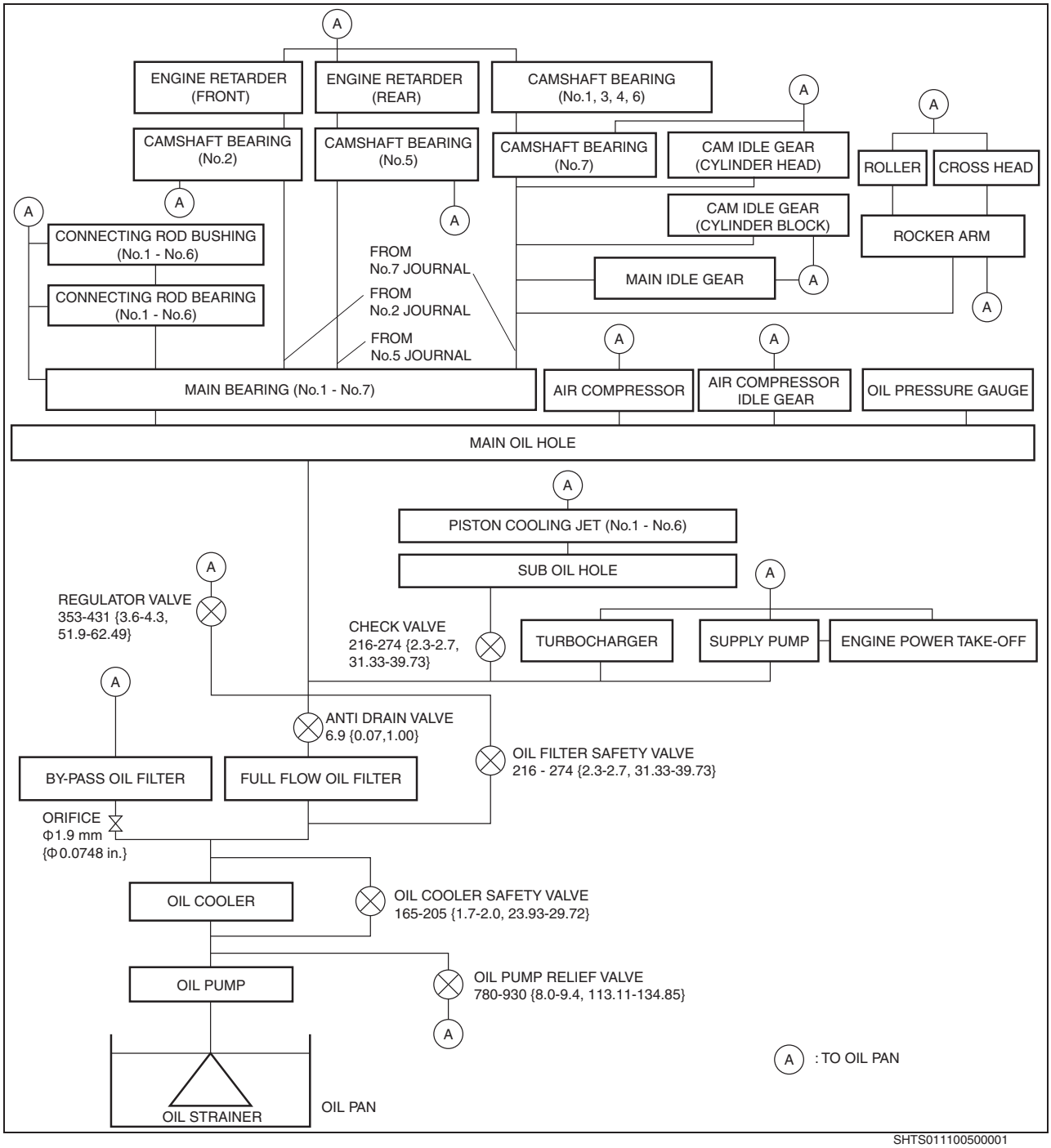
LUBRICATING SYSTEM (E13C)

EN05-001

LUBRICATING SYSTEM

DIAGRAM

EN0111005J100001



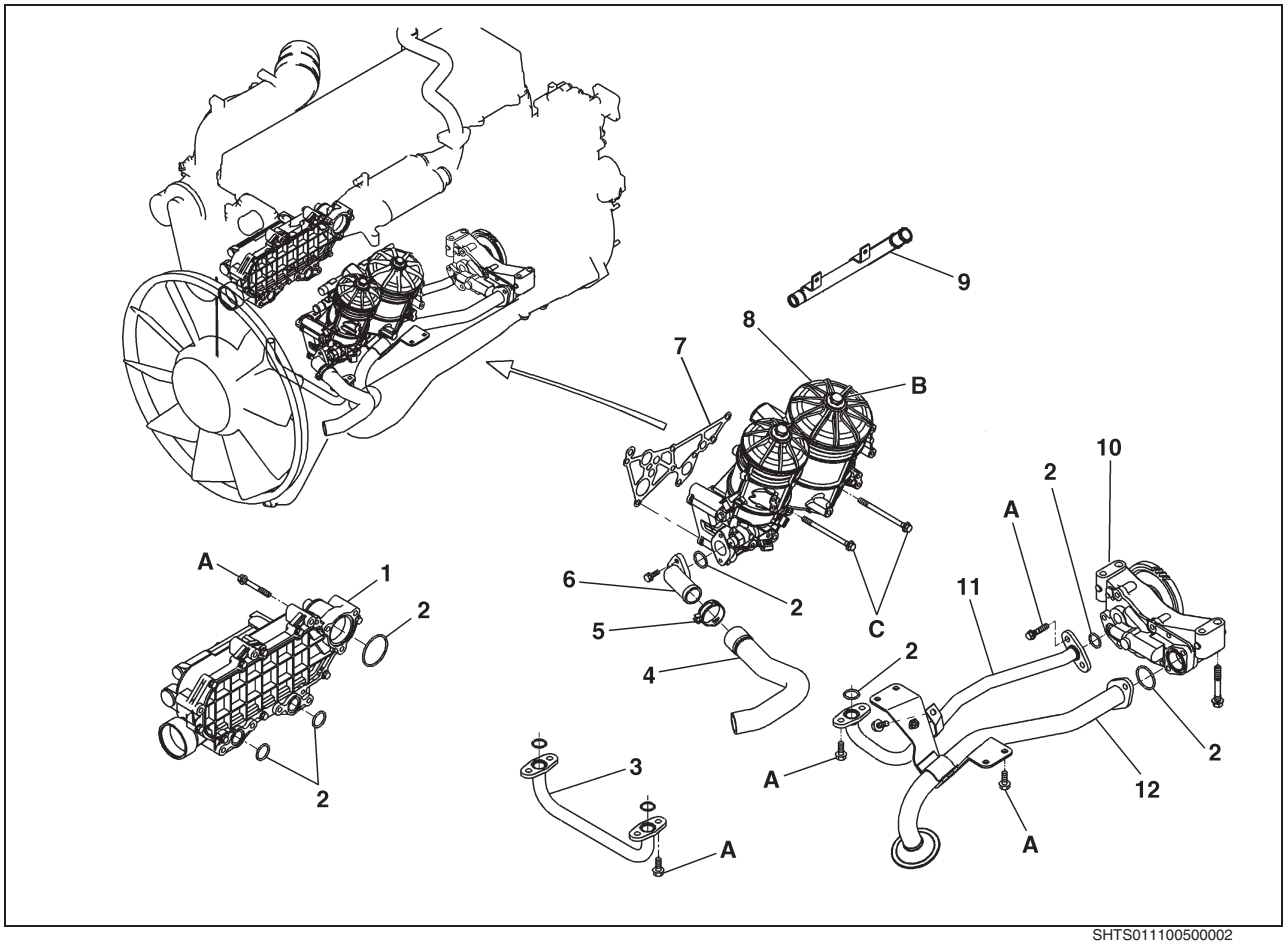
SHTS011100500001

Unit: kPa {kgf/cm^2, lbf/in.^{2}}.

LUBRICATION SYSTEM

COMPONENT LOCATOR

EN0111005D100001



SHTS011100500002

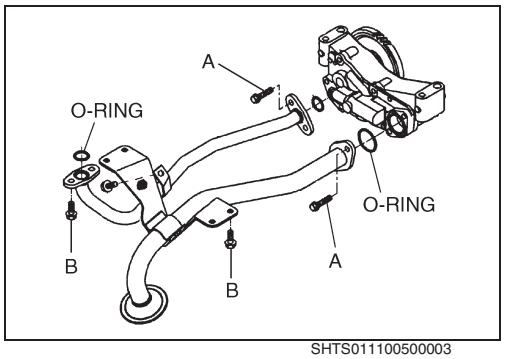
1	Oil cooler assembly	7	Oil filter gasket
2	O-ring	8	Oil filter assembly
3	Oil filter inlet pipe	9	Vent pipe
4	Oil hose	10	Oil pump assembly
5	Band	11	Oil pump outlet pipe
6	Oil filter pipe	12	Oil pump inlet pipe

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

A	55 {560, 41}	C	68.5 {700, 51}
B	53.9 {550, 40}		

OVERHAUL

EN0111005H200001

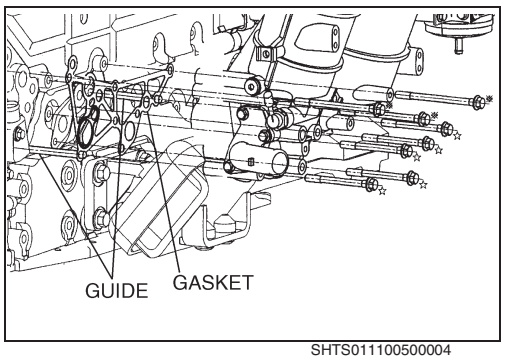


SHTS011100500003

IMPORTANT POINTS - ASSEMBLY

1. INSTALL THE OIL PUMP OUTLET PIPE AND THE OIL PUMP INLET PIPE.

(1) Install the oil pump outlet pipe and inlet pipe.
(2) Temporarily secure with bolts.
(3) Tighten the bolts (A) to the specified torque.
(4) Tighten the bolts (B) to the specified torque.



SHTS011100500004

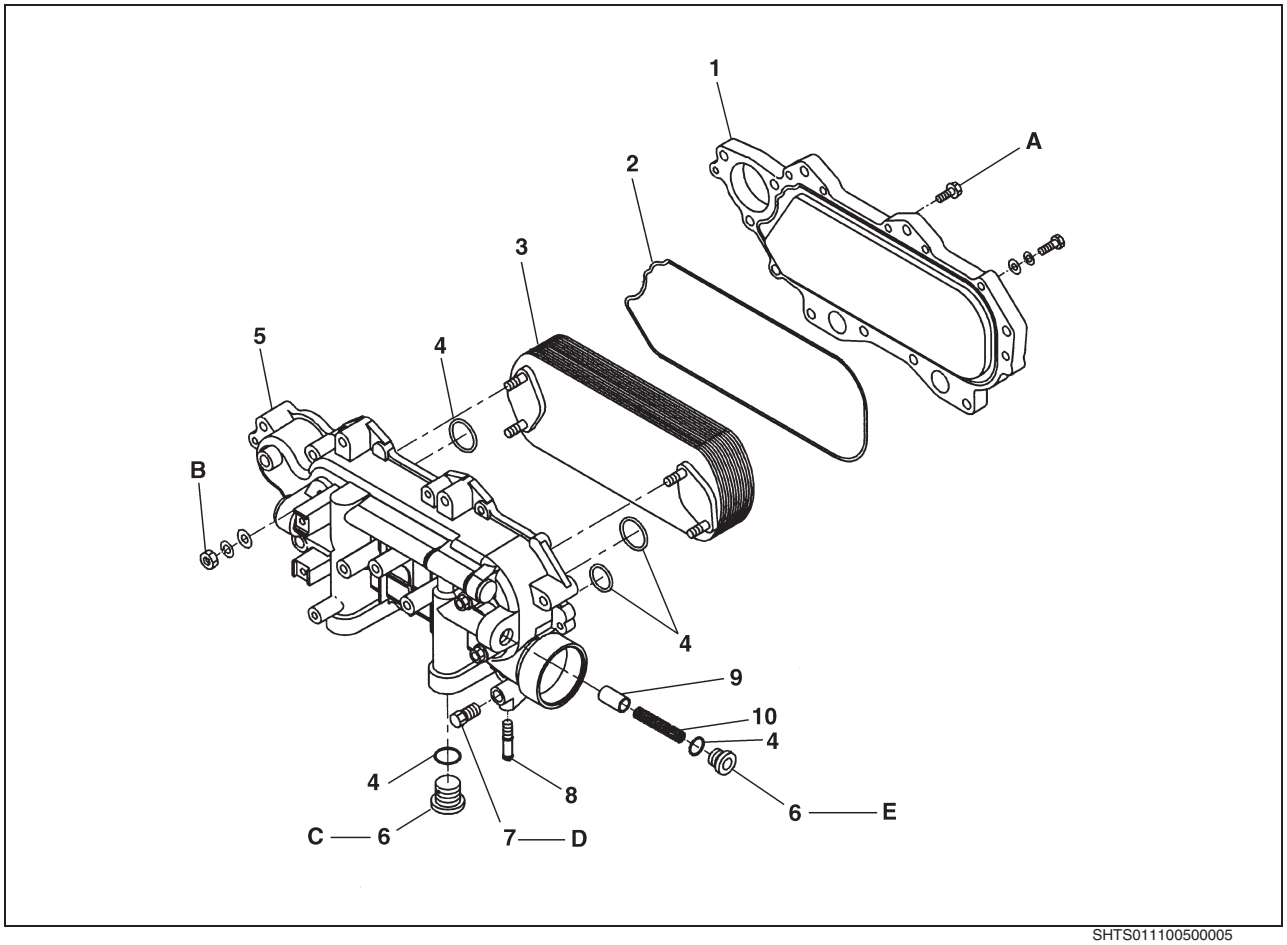
2. INSTALL THE OIL FILTER CASE.

(1) Install the guides (Length 105 mm {4.134 in.}, M10 x 1.5).
(2) Install the oil filter gasket and oil filter case.
(3) Install the bolts, then remove the guides.
(4) Tighten the bolts to the specified torque.

OIL COOLER

COMPONENT LOCATOR

EN0111005D100002



SHTS011100500005

1	Oil cooler cover	6	Valve spring plug
2	Case gasket	7	Drain plug
3	Oil cooler element	8	Drain pipe
4	O-ring	9	Safety valve
5	Oil cooler case	10	Valve spring

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

A	14.7-19.7 {150-200, 11-14}	D	12.8-22.6 {130-230, 10-16}
B	19.6-29.4 {200-300, 15-21}	E	24.5-34.3 {250-350, 19-25}
C	29.4-39.2 {300-400, 22-28}		

INSPECTION AND REPAIR

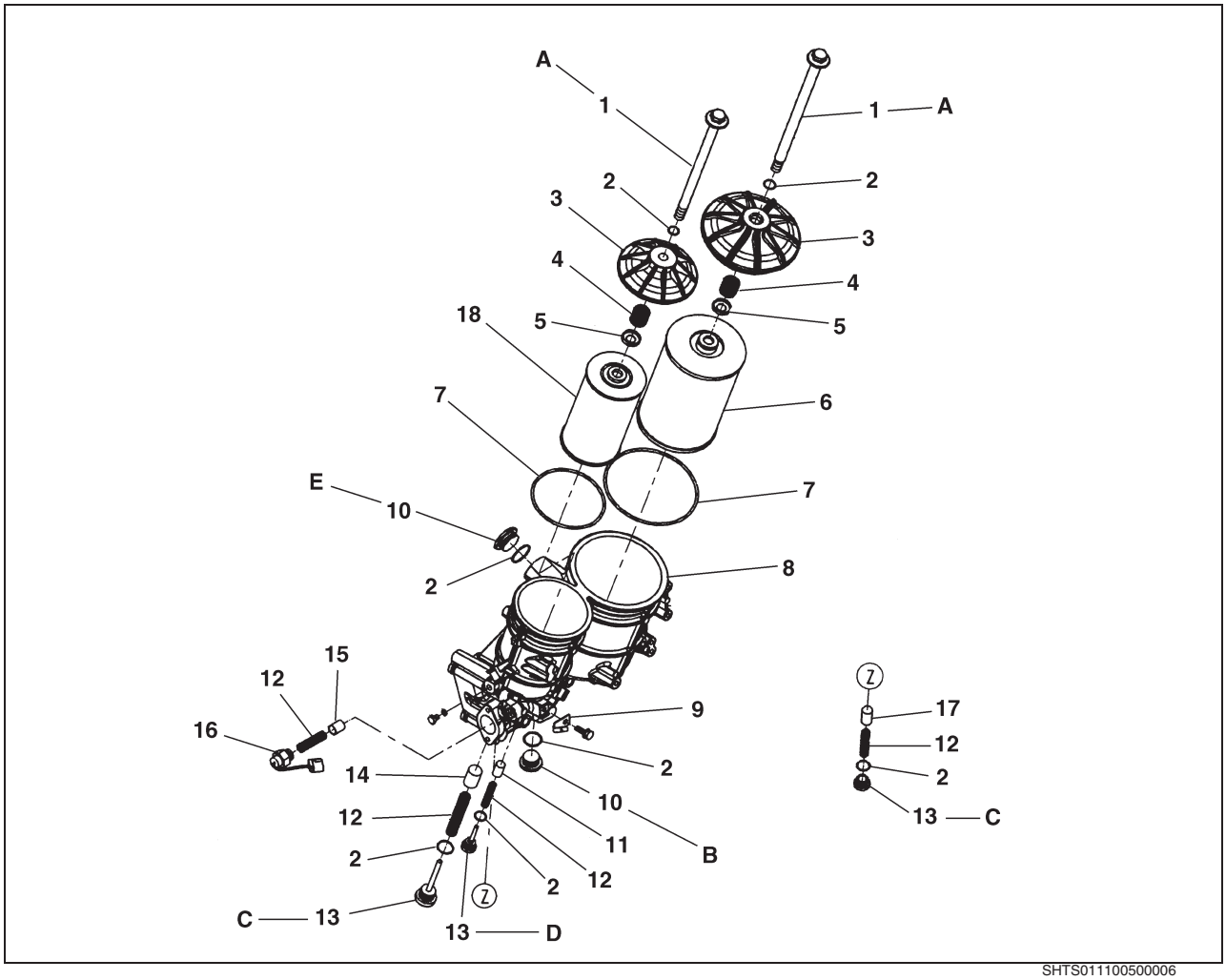
EN0111005H300001

Inspection item	Standard	Limit	Remedy	Inspection procedure
Oil cooler air leakage Air pressure: 588 kPa {6 kgf/cm^2, 85 lbf/in.^{2}}	0 mL	—	Replace, if necessary.	Visual check
Valve spring and valve wear or damage	—	—	Replace, if necessary.	1. Damage to sliding face of valve 2. Valve movement (smoothness)

OIL FILTER

COMPONENT LOCATOR

EN0111005D100003



SHTS011100500006

1	Bolt	10	Plug
2	O-ring	11	Check valve
3	Oil filter cap	12	Valve spring
4	Element support spring	13	Valve spring plug
5	Holder	14	Anti drain Valve
6	Element (By-pass)	15	Oil filter safety valve
7	Gasket	16	Oil pressure switch
8	Oil filter case	17	Regulator valve
9	Bracket	18	Element (Full flow)

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

A	49-58.8 {500-600, 37-43}	D	19.6-29.4 {200-300, 15-21}
B	29.4-39.2 {300-400, 22-28}	E	34.3-44.1 {350-450, 26-32}
C	24.5-34.3 {250-350, 19-25}		

INSPECTION AND REPAIR

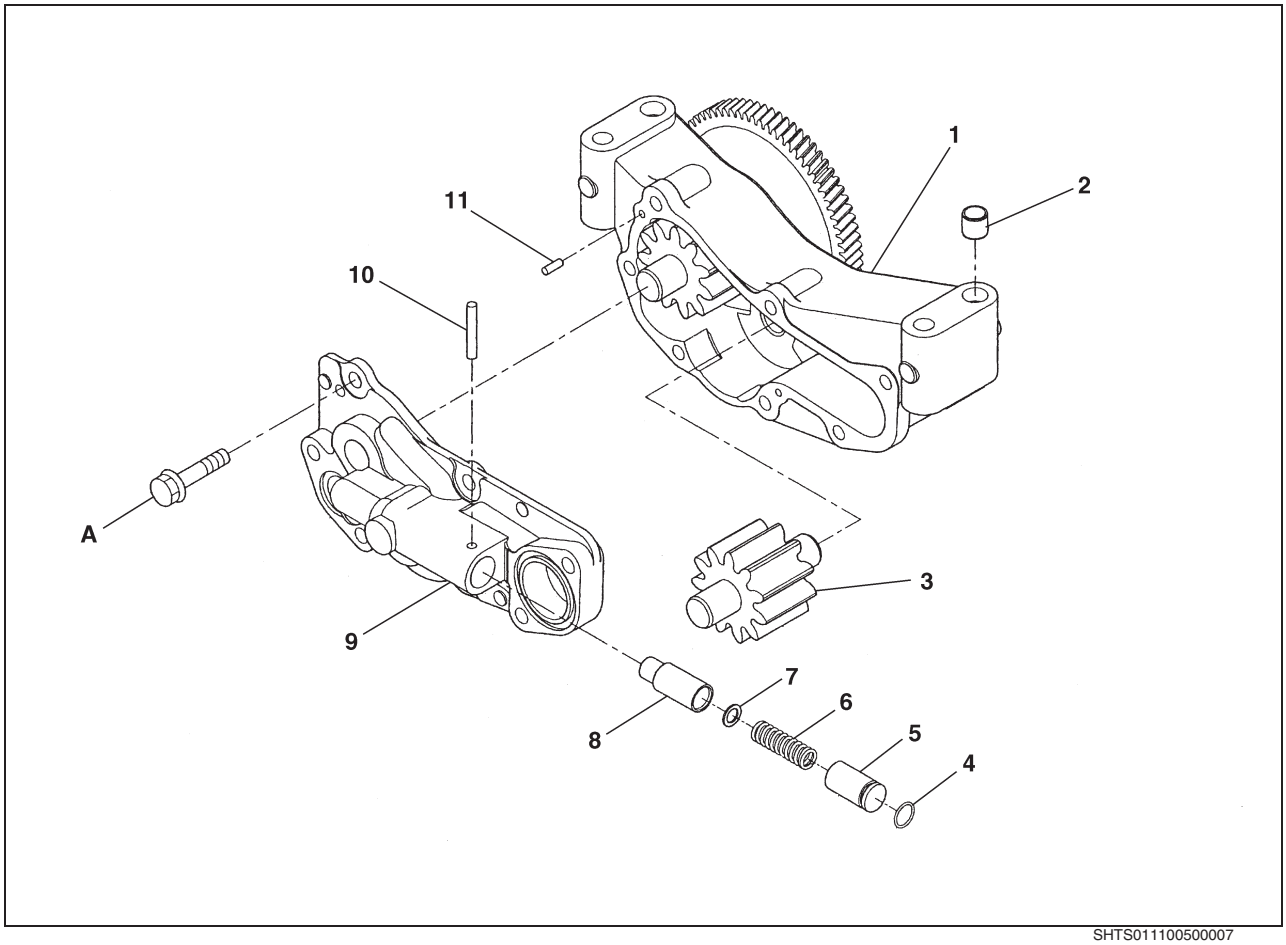
EN0111005H300002

Inspection item	Standard	Limit	Remedy	Inspection procedure
Valve spring and valve wear or damage	—	—	Replace, if necessary.	1. Damage to sliding face of valve 2. Valve movement (smoothness)

OIL PUMP

COMPONENT LOCATOR

EN0111005D100004



SHTS011100500007

1	Oil pump body	7	Shim
2	Collar	8	Relief valve
3	Driven gear	9	Oil pump cover
4	O-ring	10	Cotter pin
5	Spring seat	11	Straight pin
6	Relief valve spring		

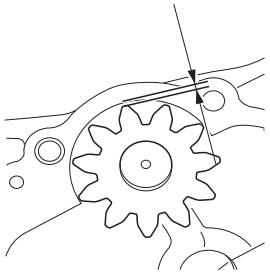
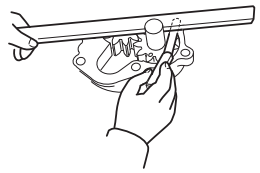
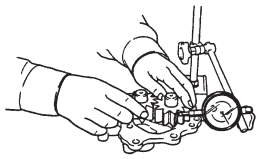
Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

A	43.1-56.8 {440-580, 32-41}	

INSPECTION AND REPAIR

EN0111005H300003

Unit: mm {in.}

Inspection item		Standard	Limit	Remedy	Inspection procedure
Tip clearance		0.095-0.150 {0.0038-0.0059}	0.18 {0.0071}	Replace gear and/or pump body	Measure 
Gear width		45 {1.772}	—	—	Measure 
Oil pump body inside depth		45 {1.772}	—	—	
End play		0.060-0.105 {0.0024-0.0041}	0.15 {0.0059}	Replace gear and/or pump.	
Drive gear	Shaft outside diameter	20 {0.787}	—	—	
	pump body and pump cover inside diameter	20 {0.787}	—	—	
	Clearance	0.043-0.077 {0.0017-0.0030}	0.19 {0.0075}	Replace oil pump	
Gear backlash		0.034-0.261 {0.0014-0.0102}	0.4 {0.0157}	Replace oil pump.	Measure 
Valve spring and valve wear or damage		—	—	Replace.	1. Damage to sliding face of valve 2. Valve movement (smoothness)

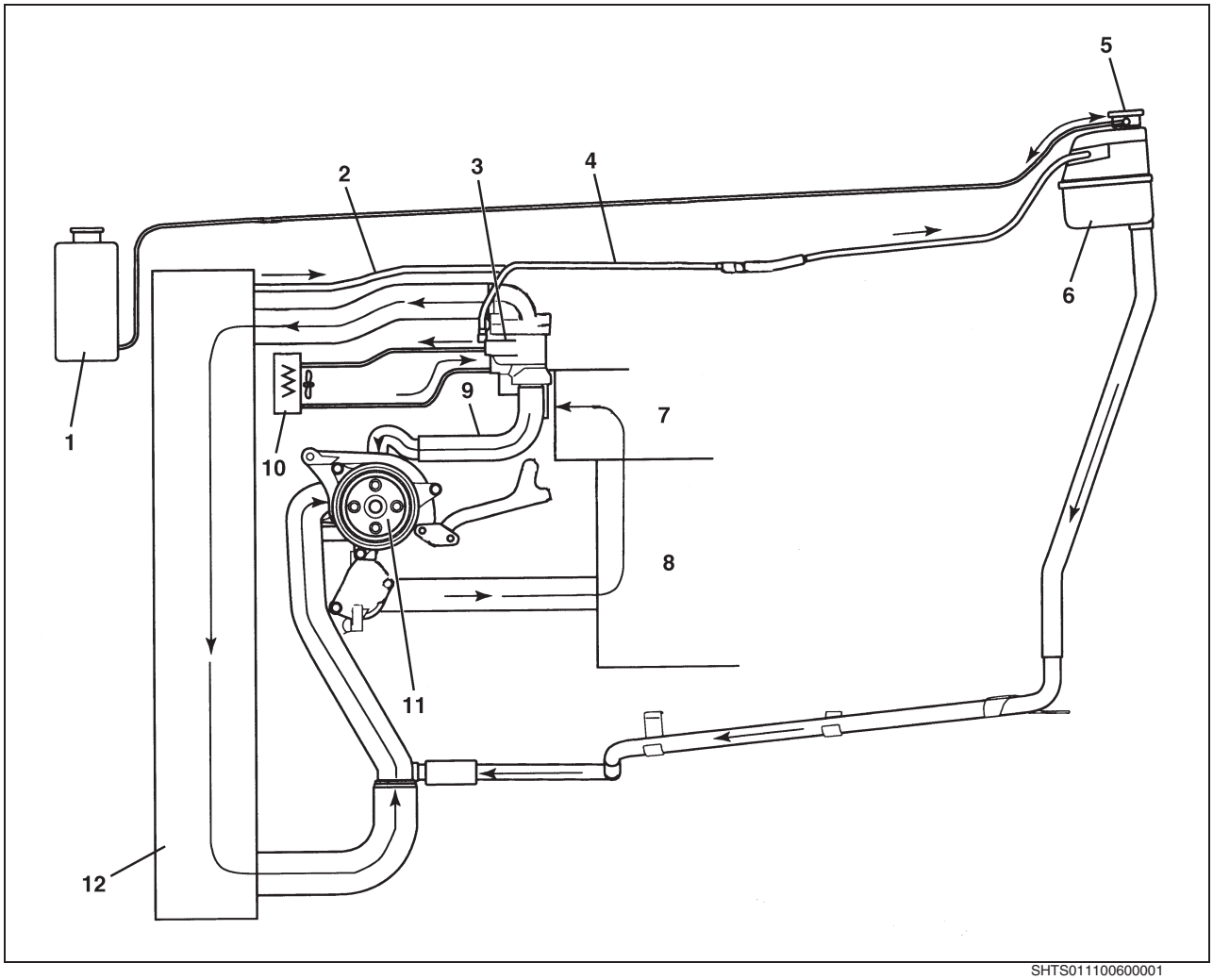
COOLING SYSTEM (E13C)

EN06-001

COOLING SYSTEM

DIAGRAM

EN0111006J100001



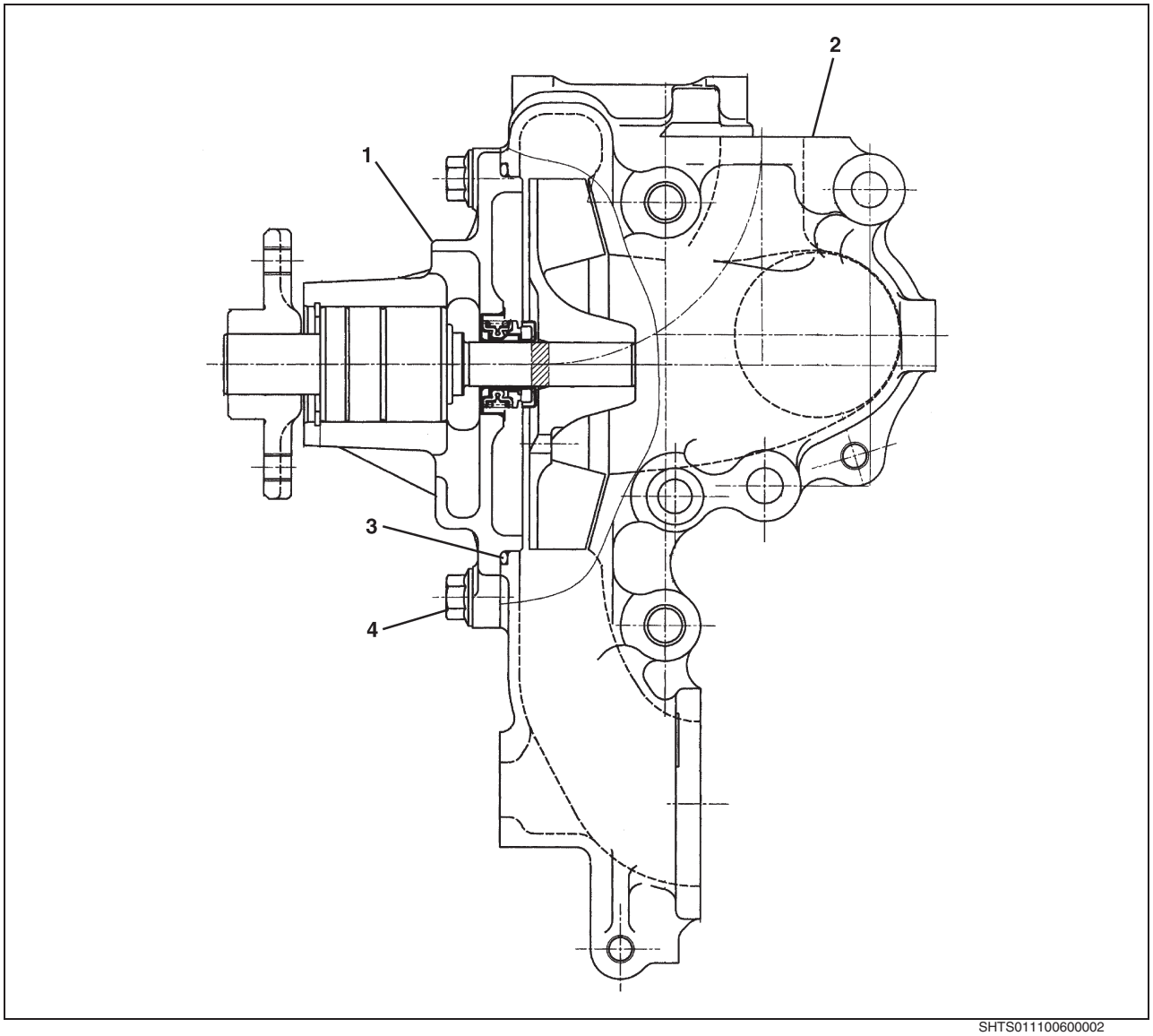
SHTS011100600001

1	Reservoir tank	7	Cylinder head
2	Radiator air escape pipe	8	Cylinder block
3	Thermostat case	9	By-pass hose
4	Engine air escape pipe	10	Car heater (If so equipped)
5	Radiator cap	11	Coolant pump
6	Header tank	12	Radiator

COOLANT PUMP

DESCRIPTION

EN0111006C100001

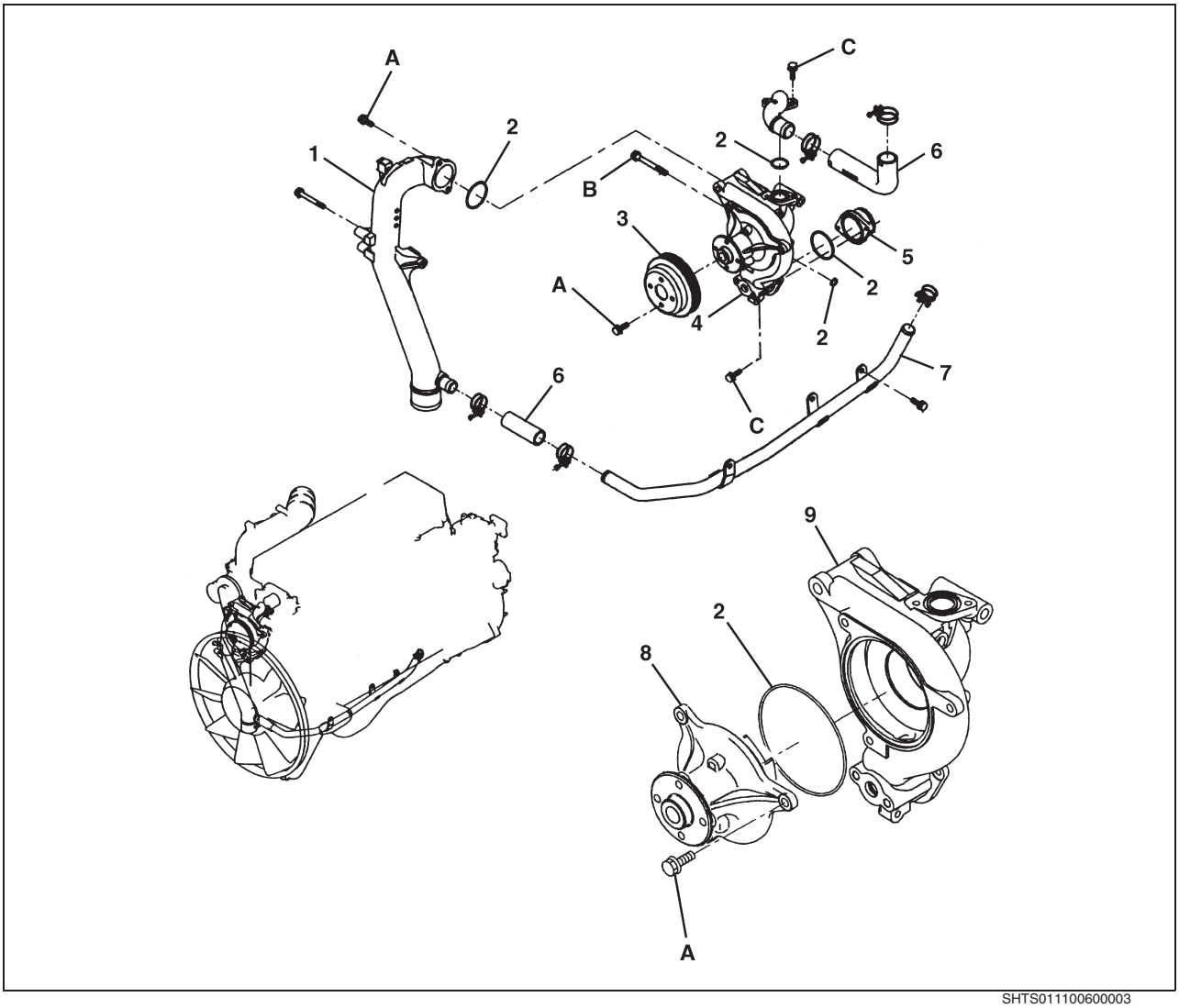


SHTS011100600002

1	Coolant pump case sub assembly	3	O-ring
2	Coolant pump cover	4	Flange bolt

COMPONENT LOCATOR

EN0111006D100001



SHTS011100600003

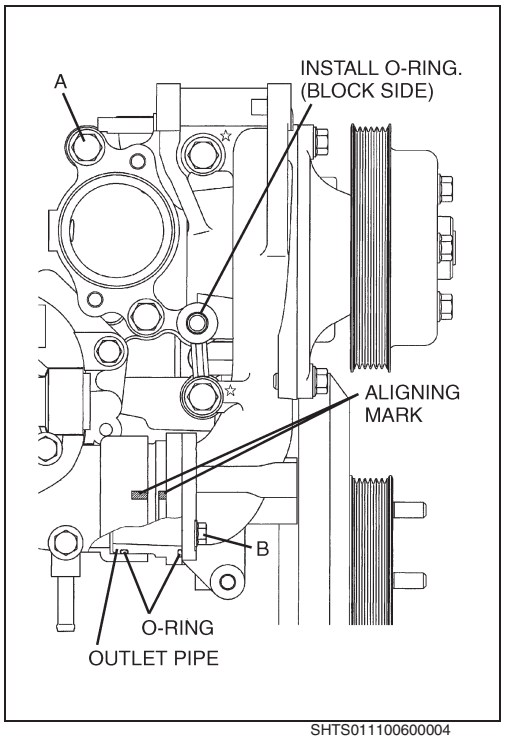
1	Suction pipe	6	Coolant hose
2	O-ring	7	By-pass pipe
3	Coolant pump pulley	8	Coolant pump case sub assembly
4	Coolant pump assembly	9	Coolant pump cover
5	Outlet pipe		

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

A	55 {560, 41}	C	28.5 {290, 21}
B	97 {990, 72}		

OVERHAUL

EN0111006H200001



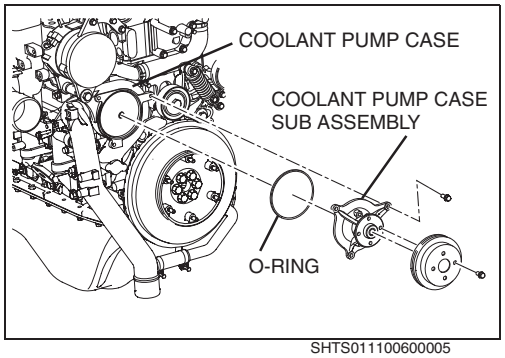
SHTS011100600004

IMPORTANT POINTS - MOUNTING

1. INSTALL THE OUTLET PIPE.
(1) Install the O-ring to the outlet pipe.
(2) Align the marks, install the outlet pipe to the oil cooler.

2. INSTALL THE COOLANT PUMP.
(1) Align the collar of the coolant pump and the installation hole of cylinder block (☆ Mark).
(2) Install the coolant pump.

3. TIGHTEN THE INSTALLATION BOLTS.
(1) Temporarily tighten the 4 bolts (A) and 2 bolts (B) and securely contact the fitting surface, then tighten the bolts to the specified torque.



SHTS011100600005

IMPORTANT POINTS - REPLACEMENT

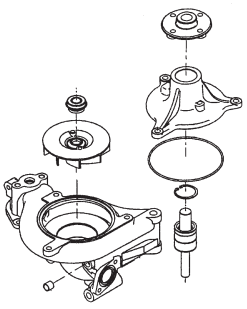
1. REMOVE THE COOLANT PUMP CASE SUB ASSEMBLY FROM THE COOLANT PUMP CASE.

NOTICE
If the coolant pump case sub assembly is damaged, replace it by assembly.

2. INSTALL THE COOLANT PUMP CASE SUB ASSEMBLY.
(1) Install the new O-ring and the coolant pump case sub assembly.
(2) After assembly, turn the coolant pump shaft by hand and make sure that there is no noise, catching or movement in the shaft direction and that it rotates smoothly.

INSPECTION AND REPAIR

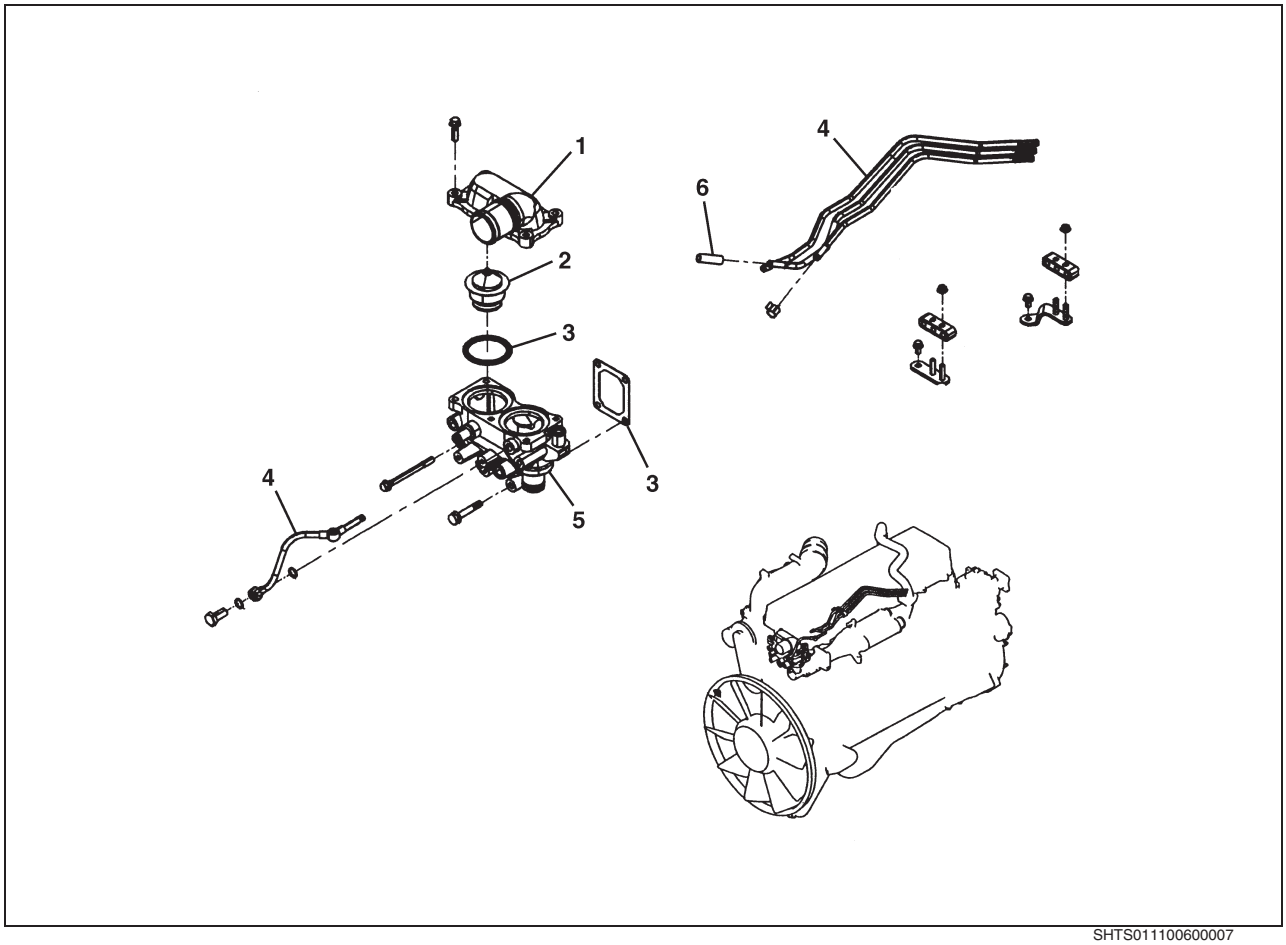
EN0111006H300001

Inspection item	Standard	LImit	Remedy	Inspection procedure
Coolant pump vane, case: Wear, damage and corrosion	—	—	**Replace parts.**	**Visual check** 

THERMOSTAT

COMPONENT LOCATOR

EN0111006D100002

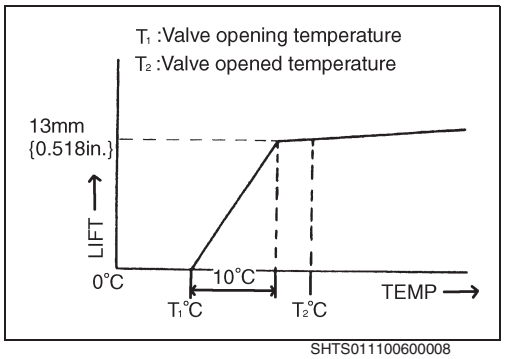


SHTS011100600007

1	Thermostat case cover	4	Air escape pipe
2	Thermostat	5	Thermostat case
3	Gasket	6	Coolant hose

OVERHAUL

EN0111006H200002



SHTS011100600008

IMPORTANT POINT - INSPECTION AND REPAIR

1. INSPECT THE THERMOSTAT FUNCTION.

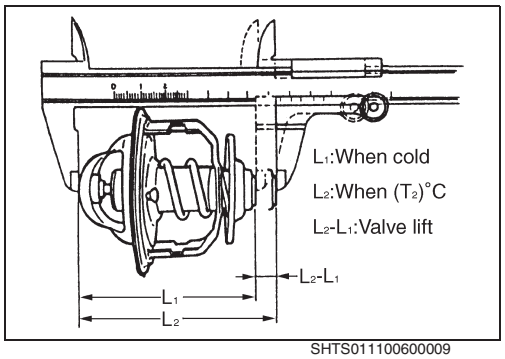
(1) Place the thermostat in hot water and check the valve opening temperature and the valve lift.

Thermostat valve opening temperature:

Thermostat valve opening temperture. (T_1)	Service standard
82°C {180°F}	80-84°C {176-183°F}

NOTICE

Check that the thermostat valve opening temperature (T_1) is engraved on the thermostat seat.

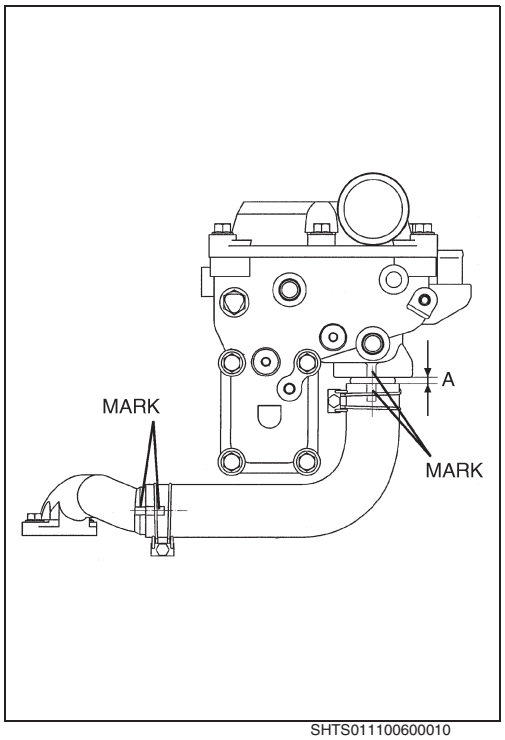


SHTS011100600009

Thermostat valve lift:

Thermostat valve opening temp. (T_1)	Measuring temp. (T_2)	Valve lift (L_2-L_1)
82°C {180°F}	95°C {203°F}	10 mm {0.394 in.} or more

(2) Immerse the opened thermostat in water at normal temperature. If it completely closes within 5 minutes, it is satisfactory. If it remains slightly open, it is defective and must be replaced.



SHTS011100600010

IMPORTANT POINT - MOUNTING

1. INSTALL THE COOLANT HOSE.

(1) Align the marks and insert the hose as shown in the figure.
Assembly standard (A): APRROX. 6mm {0.236 in.}

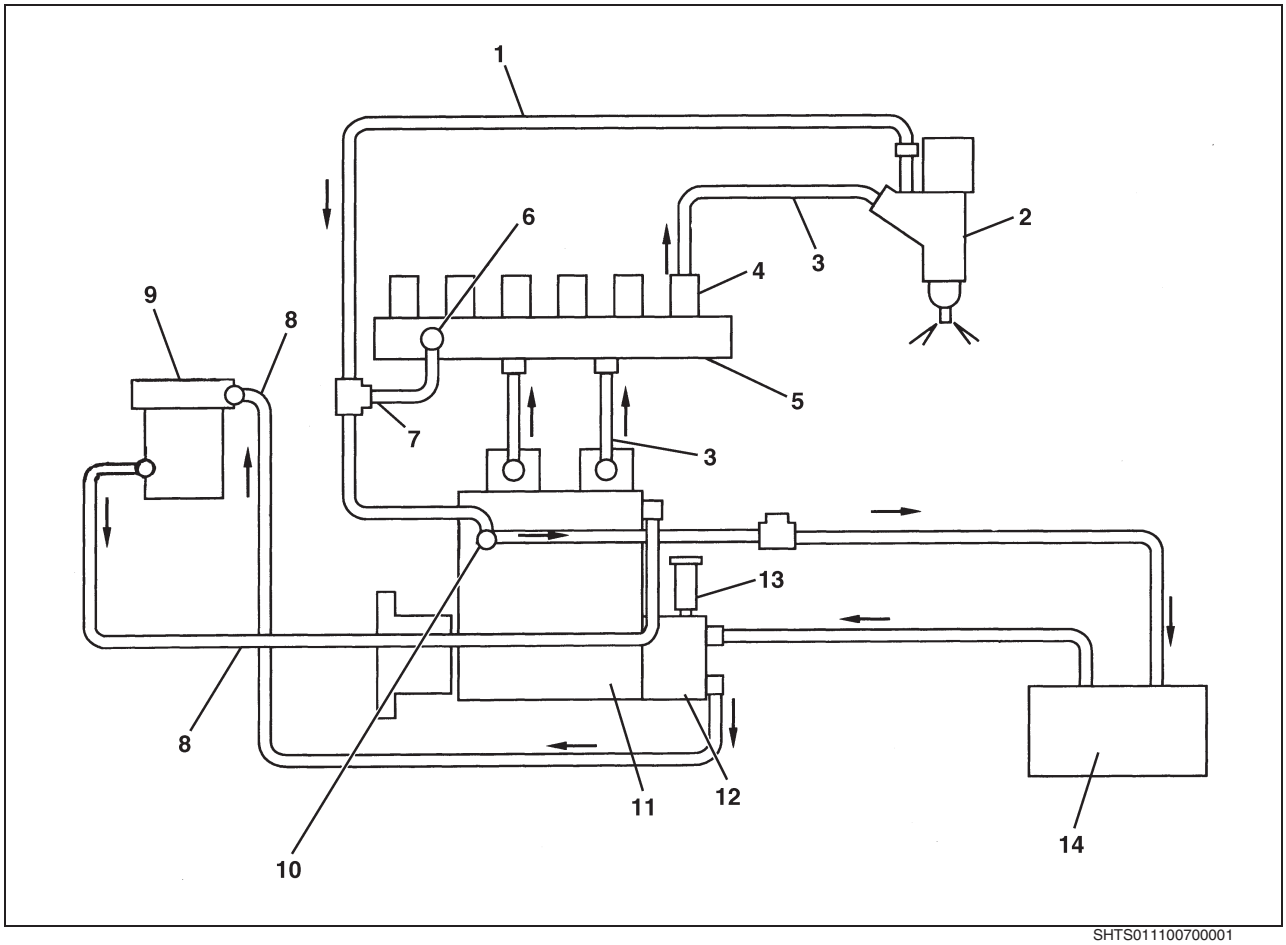
FUEL SYSTEM (E13C)

EN07-001

FUEL SYSTEM

DIAGRAM

EN0111007J100001

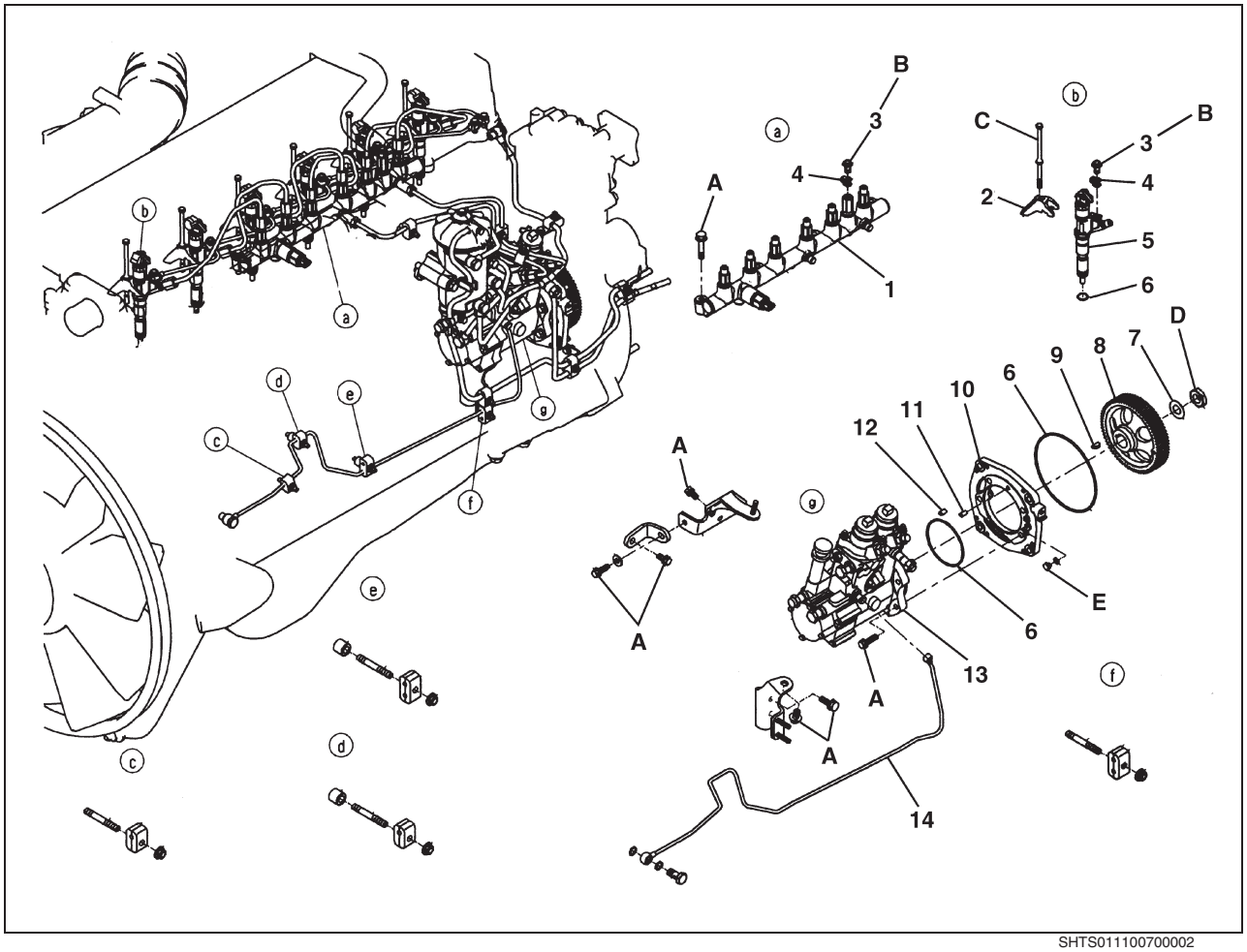


SHTS011100700001

1	Leakage pipe	8	Feed pipe
2	Injector	9	Fuel filter
3	Injection pipe	10	Over flow valve
4	Flow damper	11	Supply pump
5	Common rail	12	Feed pump
6	Pressure limiter	13	Priming pump
7	Through feed pipe	14	Fuel tank

COMPONENT LOCATOR

EN0111007C100001



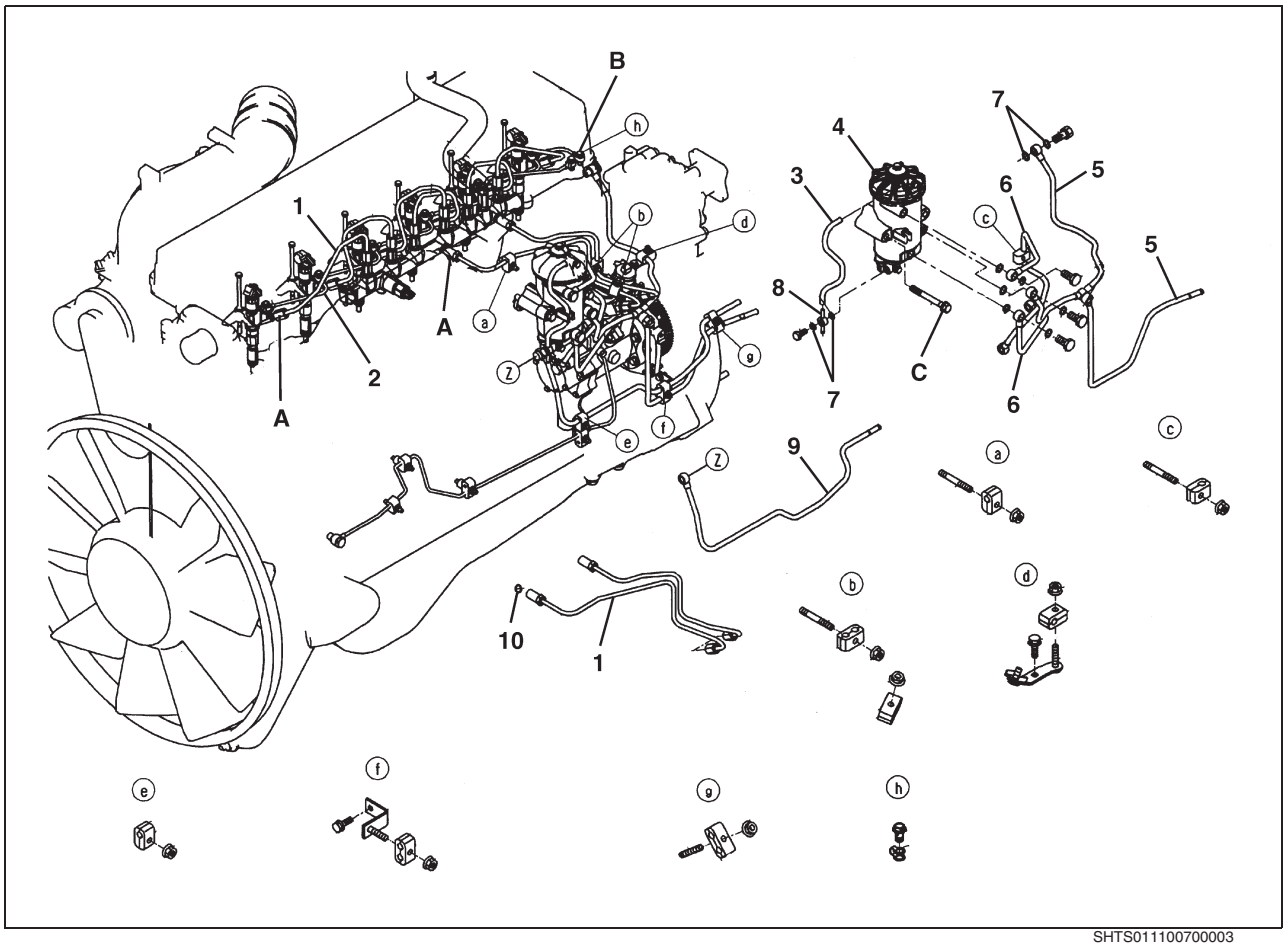
SHTS011100700002

1	Common rail assembly	8	Supply pump drive gear
2	Injector clamp	9	Key
3	Joint bolt	10	Coupling plate
4	Soft washer	11	Straight pin
5	Injector unit	12	Helisert
6	O-ring	13	Supply pump
7	Collar	14	Oil pipe

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

A	55 {560, 41}	D	246 {2,500, 181} #
B	20 {200, 15}	E	13 {135, 10}
C	34 {350, 25}		

#: Apply oil to the threads and seat surfaces before tightening.



SHTS011100700003

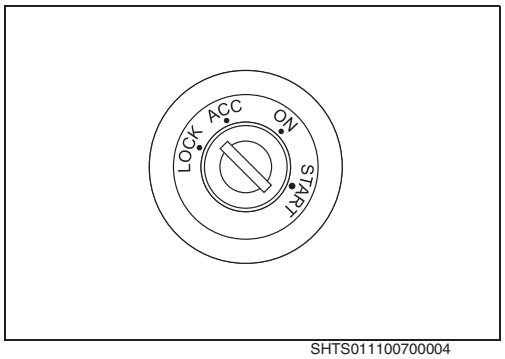
1	Injection pipe	6	Fuel feed pipe
2	Leakage pipe	7	Soft washer
3	Tube	8	Drain pipe
4	Fuel filter assembly	9	Fuel pipe
5	Through feed pipe	10	O-ring

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

A	44 {450, 32}	C	97 {990, 72}
B	20 {200, 15}		

OVERHAUL

EN0111007H200001

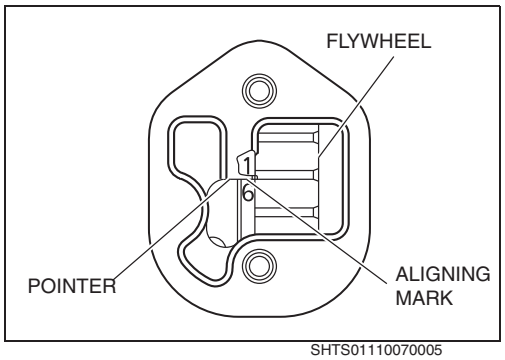


SHTS011100700004

IMPORTANT POINTS - DISMOUNTING

1. TURN THE STARTER SWITCH TO THE LOCK POSITION.

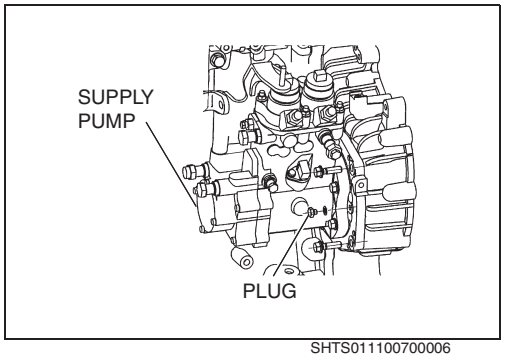
⚠ WARNING
The fuel in the common rail may have a high temperature (approx. 100°C {212°F}) immediately after driving. Perform the operation after the engine cools off because there is a danger of fire or burning.



SHTS01110070005

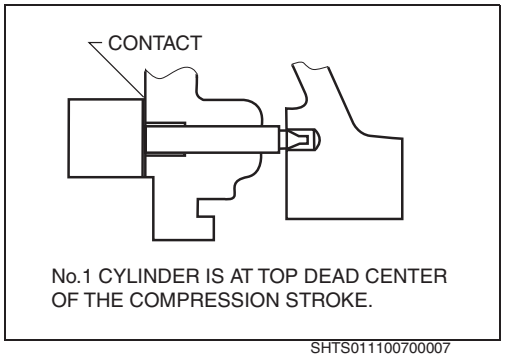
2. REMOVE THE FUEL SUPPLY PUMP.
(1) Disconnect the fuel lines, oil lines and harness coupler.
(2) Turn the crankshaft counterclockwise (viewed from the flywheel side) to align mark 1/6 on the outer periphery of the flywheel with the pointer of the flywheel housing.

NOTICE
Refer to the SECTION "ENGINE TUNEUP" of the CHAPTER "ENGINE INTRODUCTION".

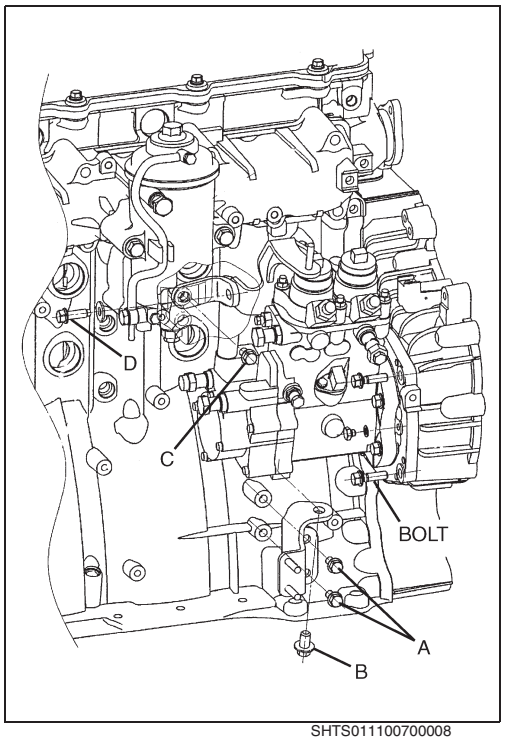


SHTS011100700006

(3) When the No.1 cylinder is at Top Dead Center of the compression stroke, the end-face of special tool and the surface of coupling plate are contacted by inserting special tool into the coupling plate plug opening.
Once certain that the end-face of special tool and the surface of coupling plate are contacted, proceed to the removal of the supply pump assembly.
SST: Supply pump tool (09512-2530)



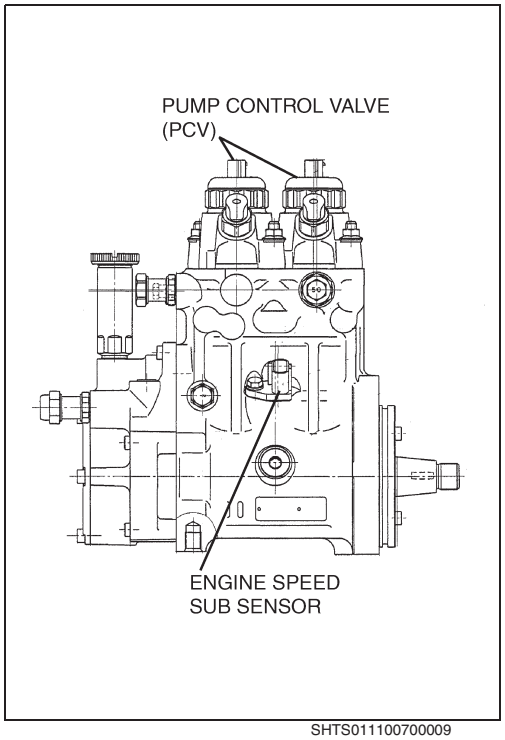
SHTS011100700007



SHTS011100700008

(4) Remove the bolts (A, B, C, D) on the bracket of the supply pump.
(5) Remove the four bolts of the coupling plate.
(6) Remove the supply pump with the coupling plate from the timing gear case.
(7) Remove the supply pump drive gear using a suitable puller.
(8) Remove the 4 bolts, remove the coupling plate.

NOTICE
After dismounting the pump, cover the pump and high pressure pipe to prevent entry of dirt.



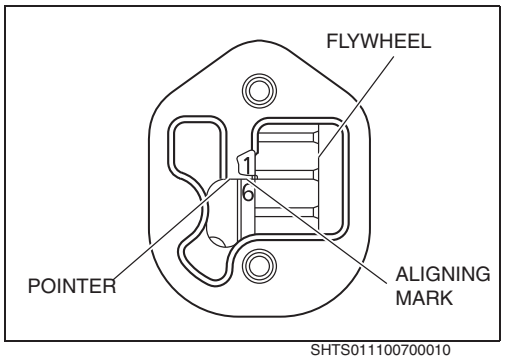
SHTS011100700009

IMPORTANT POINT - ON VEHICLE INSPECTION

1. INSPECT THE PUMP CONTROL VALVE (PCV) AND ENGINE SPEED SUB SENSOR.

(1) Measure the resistance between terminals.
If not standard value, replace supply pump assembly.
Standard:
Pump control valve (PCV): 2.9-3.5 Ω
Engine speed sub sensor: 4.5-5.5 kΩ at 20°C {68°F}

NOTICE
If pump control valve (PCV) and engine speed sub sensor need replacements, they should be serviced by Denso service dealer.



SHTS011100700010

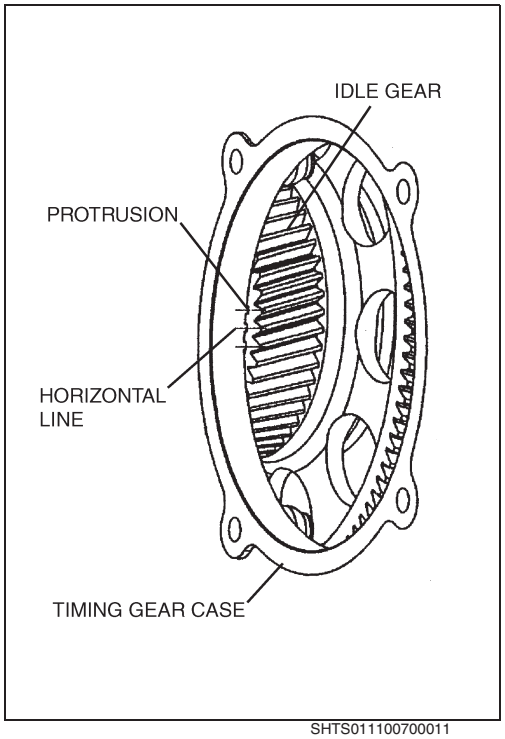
IMPORTANT POINTS - MOUNTING

1. INSTALL THE SUPPLY PUMP.

(1) Turn the crankshaft counterclockwise (viewed from the flywheel side) to align mark 1/6 on the outer periphery of the flywheel with the pointer of the flywheel housing.

NOTICE

- **Refer to the SECTION "ENGINE TUNEUP" of the CHAPTER "ENGINE INTRODUCTION".**
- **Make sure that the No.1 cylinder is positioned at the top dead center of the compression stroke.**

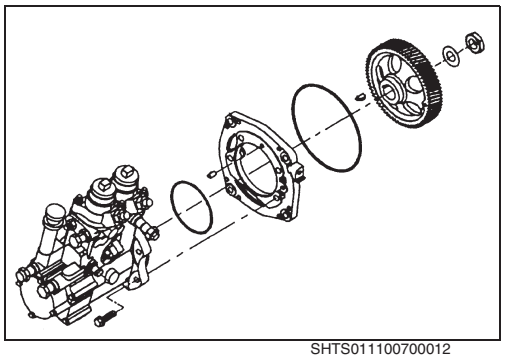


SHTS011100700011

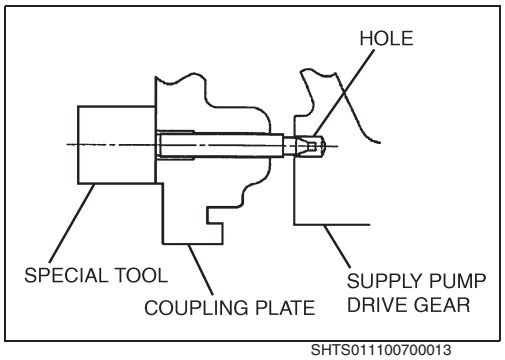
HINT

Confirmation of No.1 cylinder top dead center of the compression stroke

1. **Align the aligning mark 1/6 on the outer periphery of the flywheel with pointer of the flywheel housing.**
2. **If the 3 protrusion points of timing gear case and top gear of 3 gear teeth are aligned, No.1 cylinder is top dead center of the compression stroke.**

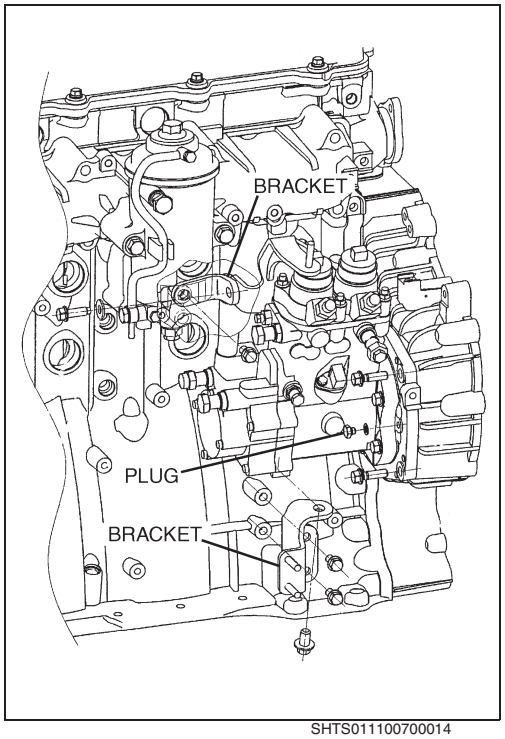

SHTS011100700012

(2) Install the O-ring to the supply pump and install the coupling plate.
(3) Install the key and supply pump drive gear to the supply pump shaft, then tighten the nut.



SHTS011100700013

(4) Insert the special tool through the plug hole of the coupling plate as shown in the figure and fix the direction of the supply pump drive gear by matching the special tool with the hole of the drive gear.
SST: Supply pump tool (09512-2530)



SHTS011100700014

(5) Install the O-ring to the coupling plate.
(6) Install the supply pump to the timing gear case.
a. Tighten the four bolts of the coupling plate.
Tightening Torque:
55 N·m {560 kgf·cm, 41 lbf·ft}

b. Install the brackets.

NOTICE
Once the bolts have been tightened to a point where the bracket is in contact with both the surface of the cylinder block and the surface of the supply pump, tighten fully by alternating between the bolts on either surface.

(7) Remove the special tool and install the plug.

(8) Connect the fuel lines, air lines and harness connectors.

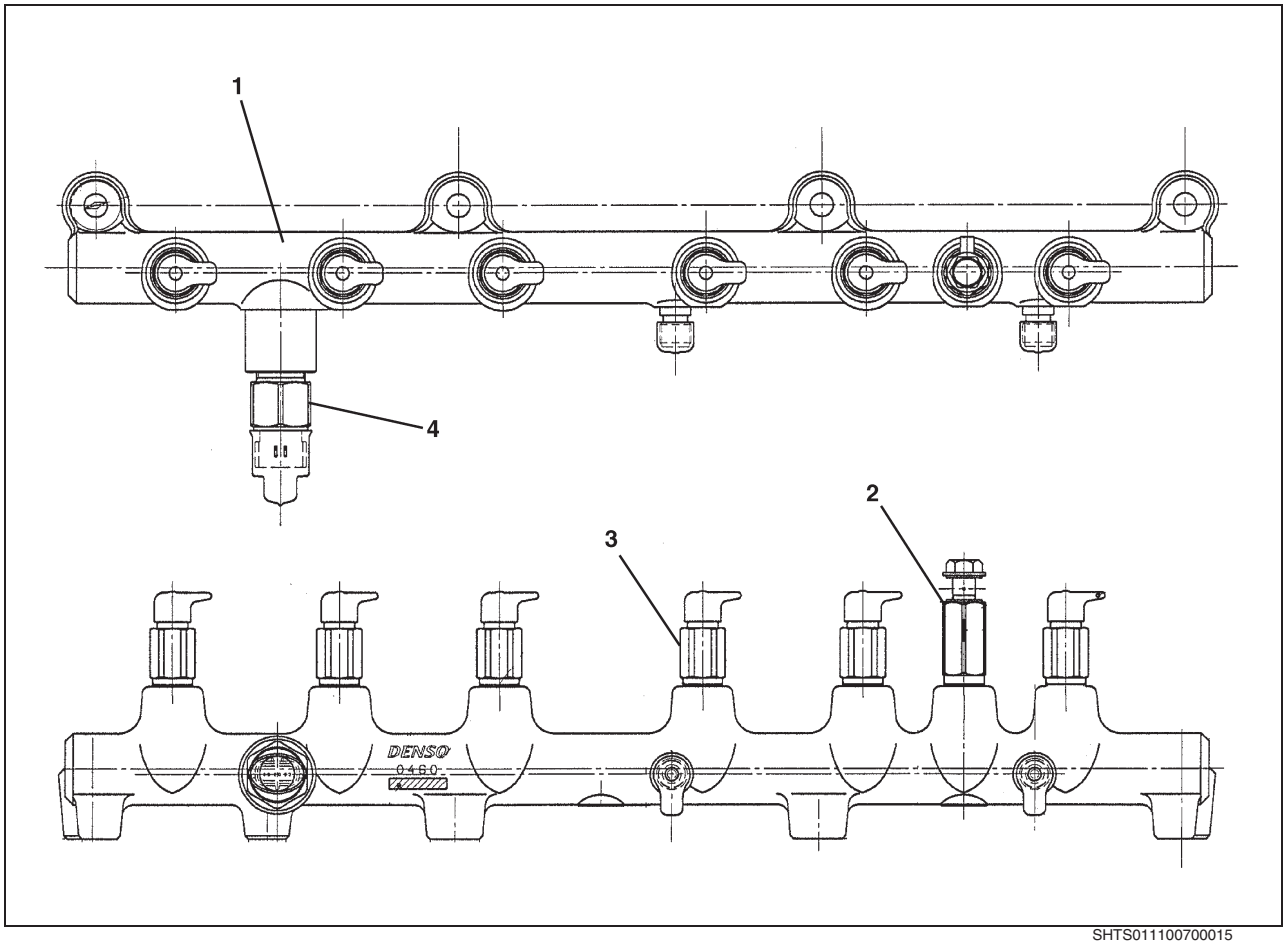
2. RESET THE ECU DEFAULT VALUE.

NOTICE
It is necessary to reset the ECU default value using the diagnosis tool at the time of supply pump service replacement. In addition, the ECU has a function enabling it to learn the performance of the supply pump at the time of ECU service replacement, so ensure sufficient time (several minutes) is available.

COMMON RAIL

DESCRIPTION

EN0111007J100002

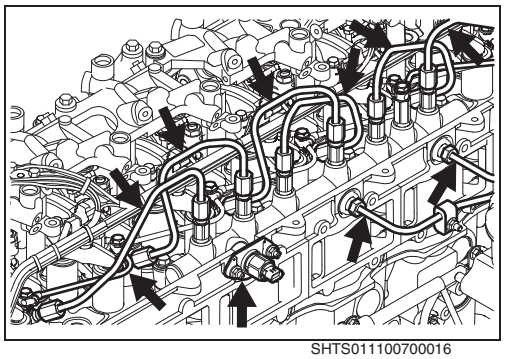


SHTS011100700015

1	Common rail	3	Flow damper
2	Pressure limiter	4	Pressure sensor

OVERHAUL

EN0111007H200002



SHTS011100700016

IMPORTANT POINTS - DISMOUNTING

1. CLEAN OFF SURROUNDING AREA OF THE INJECTOR AND THE FUEL LINE CONNECTORS.

NOTICE

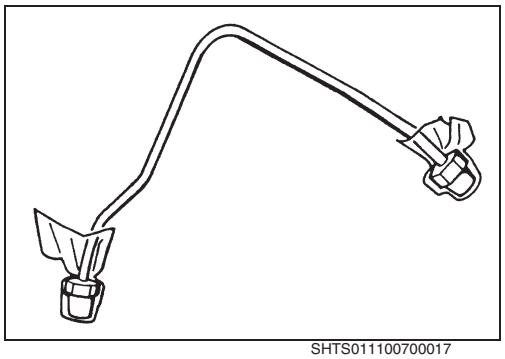
If foreign matter is allowed to enter the combustion chamber, engine trouble may result.

2. REMOVE THE FUEL INJECTION PIPE AND PRESSURE SENSOR OIL SEAL.

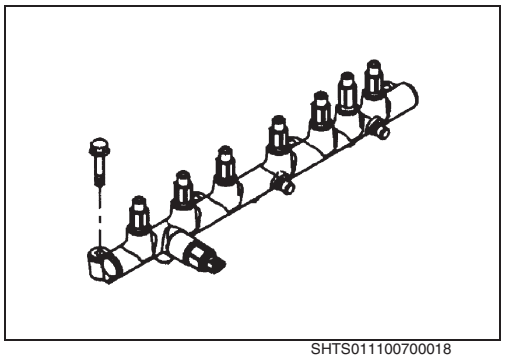
(1) Remove the leakage pipe and injection pipes.
(2) Remove the pressure sensor oil seal.

NOTICE

Cover open ends of the pipes and fuel supply pump to prevent entry of dirt.



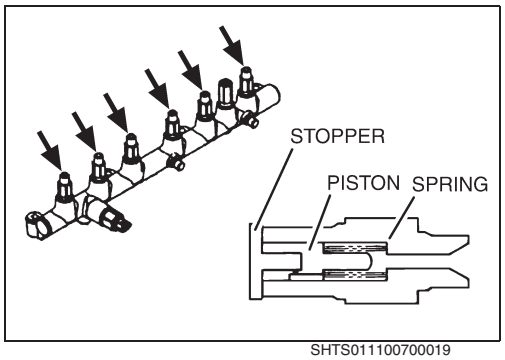
SHTS011100700017



SHTS011100700018

3. REMOVE THE COMMON RAIL

(1) Disconnect the connectors.
(2) Remove the 4 bolts and common rail.



SHTS011100700019

IMPORTANT POINTS - DISASSEMBLY

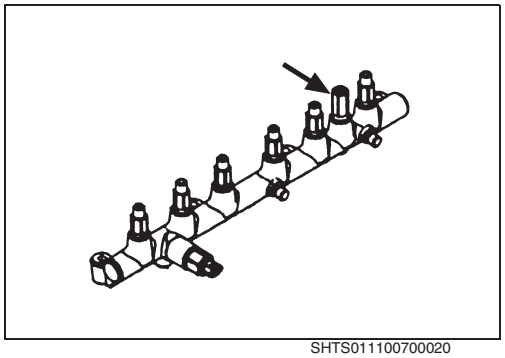
1. REMOVE THE FLOW DAMPER.

(1) Using a 19 mm {0.748 in.} width across flats deep socket wrench, loosen the flow damper by turning in counterclockwise direction.

(2) Remove the flow damper assembly (spring, piston and stopper).

NOTICE

Be careful not to drop parts into common rail.


SHTS011100700020

2. REMOVE THE PRESSURE LIMITER.

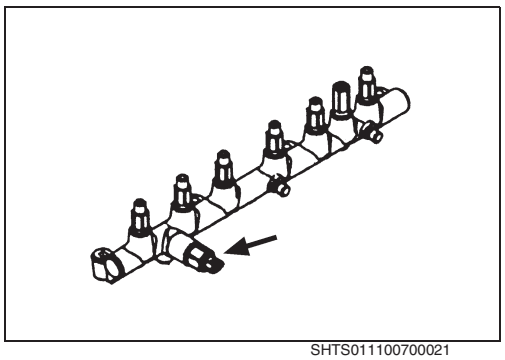
(1) Using a 19 mm {0.748 in.} width across flats deep socket wrench, loosen the pressure limiter by turning in counterclockwise direction.

(2) Remove the pressure limiter.

(3) Using tweezers, remove the gasket.

NOTICE

Be careful not to damage the seal surface.


SHTS011100700021

3. REMOVE THE COMMON RAIL PRESSURE SENSOR.

(1) Using a 30 mm {1.181 in.} width across flats deep socket wrench, loosen the common rail sensor by turning in counter clockwise direction.

(2) Remove the common rail sensor.

NOTICE

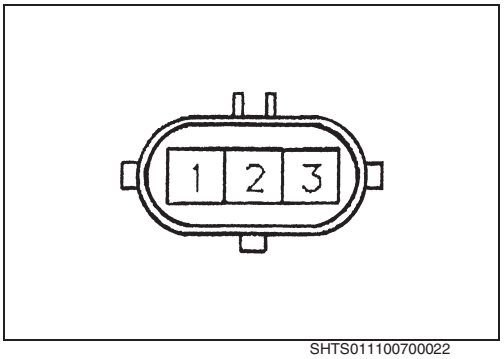
Never reuse a used common rail pressure sensor.
Because if it is reused, its thread may break.

IMPORTANT POINTS - ON VEHICLE INSPECTION

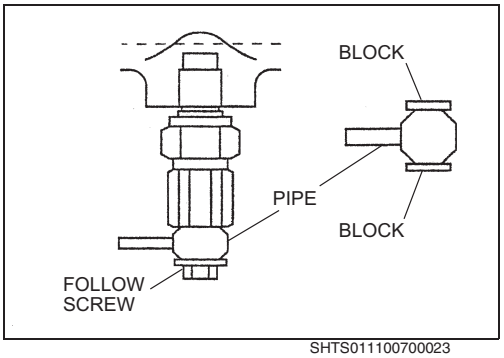
1. INSPECT THE PRESSURE SENSOR.

(1) If the check engine lamp lights up, and the following malfunction is displayed at the diagnosis system, replace the pressure sensor.
   a. Harness disconnection or short-circuit in the pressure sensor circuit
   b. Common rail pressure does not change at a certain time while the engine is running.

(2) Measure the resistance between terminals.
If not standard value, replace sensor.
Standard: (Engine stop condition)
Terminal 2 and 3: 6.5 - 18.5 kΩ
Terminal 1 and 2: 0.5 - 3.0 kΩ



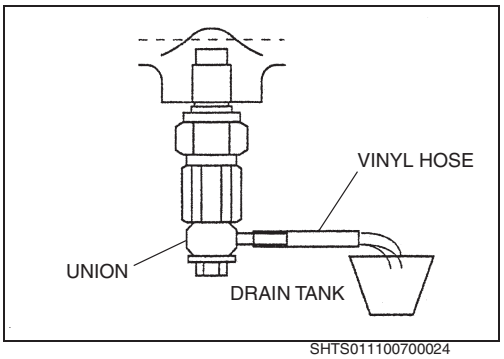
SHTS011100700022



SHTS011100700023

2. INSPECT THE PRESSURE LIMITER.

(1) Remove the follow screw from pressure limiter.
(2) Block pipe ends to prevent fuel leak.



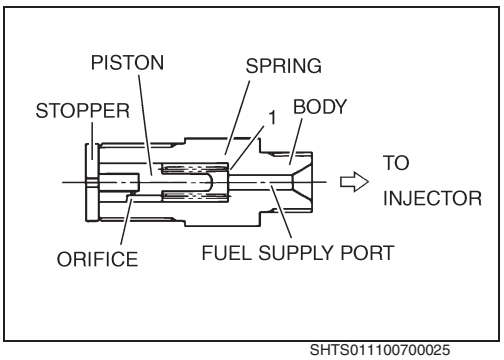
SHTS011100700024

(3) Install the union to the pressure limiter.
(4) Set a vinyl hose to the union and set a drain tank.
(5) Start the engine. If the fuel flows continuously, replace the pressure limiter.

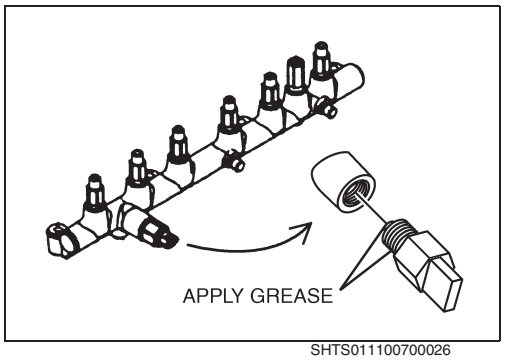
⚠ WARNING
When the pressure limiter is working, fuel flows out at a high temperature and pressure. Serious injury like scalding could result from this hot fuel being blown out under pressure.

3. INSPECT THE FLOW DAMPER.

(1) Check that the piston is not sticking in the body. If the piston sticks, replace the flow damper.
(2) Inspect the contact surface 1 between piston and fuel supply port. If there is wear and damage, replace the flow damper assembly.
(3) Inspect clogging on the piston orifice. Clean or replace the flow damper assembly.



SHTS011100700025



SHTS011100700026

IMPORTANT POINTS - ASSEMBLY

NOTICE

- **Every part of the common rail should be washed clean carefully laying threaded side below.**
- **Be careful to prevent dust from entering inside.**

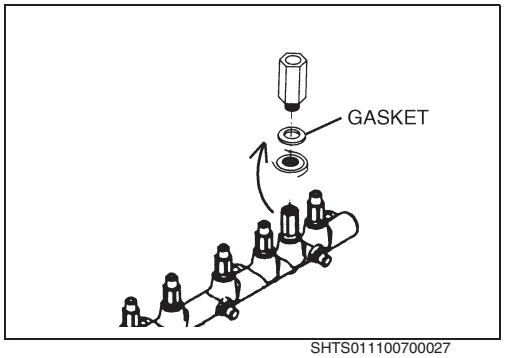
1. INSTALL THE COMMON RAIL PRESSURE SENSOR.

(1) Install the new common rail pressure sensor.

NOTICE

- **Apply clean grease to the pressure sensor as shown in the figure.**
- **Be careful to prevent dust from entering inside.**

(2) Tighten the new pressure sensor.
Tightening Torque:
98 N·m {1,000 kgf·cm, 72 lbf·ft}

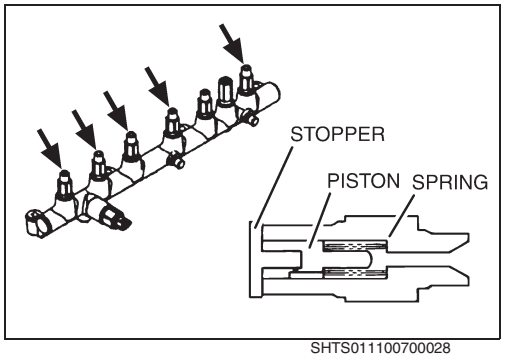


SHTS011100700027

2. INSTALL THE PRESSURE LIMITER.

(1) Install the pressure limiter with a new gasket.

Tightening Torque:
172 N·m {1,750 kgf·cm, 126 lbf·ft}

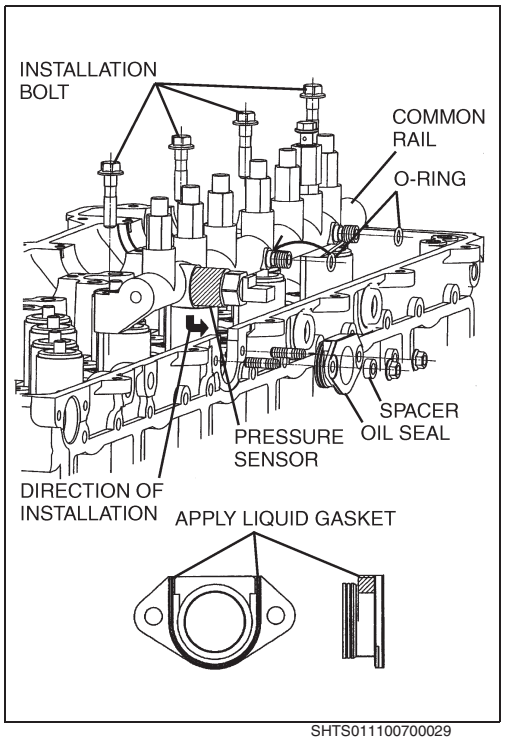


SHTS011100700028

3. INSTALL THE FLOW DAMPER.

(1) Install the stopper.

(2) Install the flow damper with the piston and spring.
Tightening Torque:
128 N·m {1,305 kgf·cm, 94 lbf·ft}



SHTS011100700029

IMPORTANT POINTS - MOUNTING

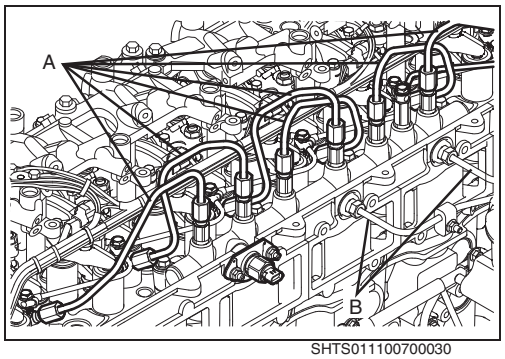
1. INSTALL THE COMMON RAIL ASSEMBLY.

(1) Install the O-rings to the injection pipe installation part of common rail.

(2) Install the common rail on the cylinder head and tighten the 4 bolts.

(3) Apply liquid gasket (ThreeBond TB1207B or equivalent) to the pressure sensor oil seal, then install the oil seal to the cylinder head.
Tightening Torque:
25 N·m {255 kgf·cm, 18 lbf·ft}

NOTICE
Wipe out excess liquid gasket completely.

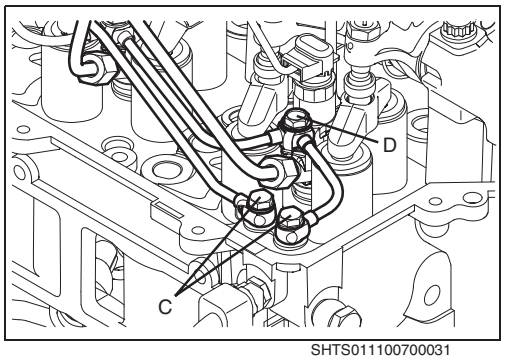


SHTS011100700030

2. INSTALL THE INJECTION PIPE AND LEAKAGE PIPE.

(1) Install the injection pipe (A) and tighten the pipe nuts to the specified torque.

(2) Install the injection pipe (B) and tighten the pipe nuts to the specified torque.



SHTS011100700031

(3) Install the leakage pipe and tighten the union bolt to the specified torque.
Union bolt (C): M10x1.5 (Cylinder head side)
Union bolt (D): M10x1.0 (Injector side)

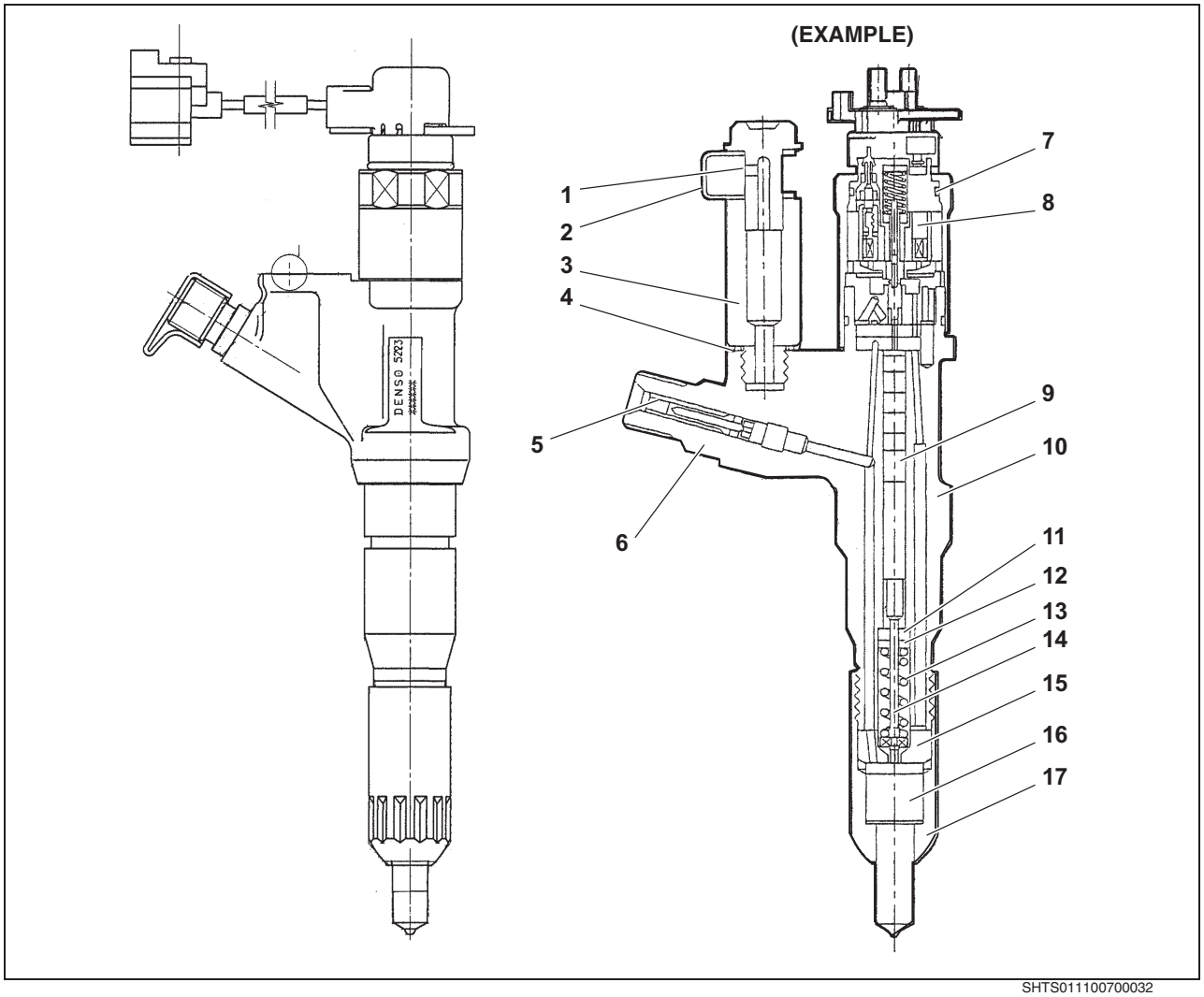
NOTICE

- **If the tightening torque of the nuts is less than the specified value, it may cause a fuel leak. If the tightening torque of the nuts is greater than the specified value it may have a negative influence on the engine function. As a result, always perform torque management.**
- **After the operation is] completed, wipe off the fuel which leaked and start the engine. Make sure that the fuel does not leak again.**

INJECTOR

DESCRIPTION

EN0111007C100002

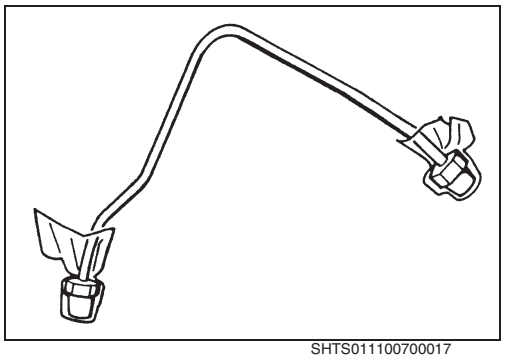


SHTS011100700032

1	Return joint bolt	10	Lower body
2	Gasket	11	Guide bushing
3	Outlet connector	12	Shim
4	Steel washer	13	Nozzle spring
5	Filter	14	Pressure pin
6	Inlet connector	15	Tip seal
7	O-ring	16	Nozzle
8	Two-way valve (TWV)	17	Retaining nut
9	Piston		

OVERHAUL

EN0111007H200003



SHTS011100700017

IMPORTANT POINTS - DISMOUNTING

1. CLEAN OFF SURROUNDING AREA OF THE INJECTOR AND THE FUEL LINE CONNECTORS.

NOTICE

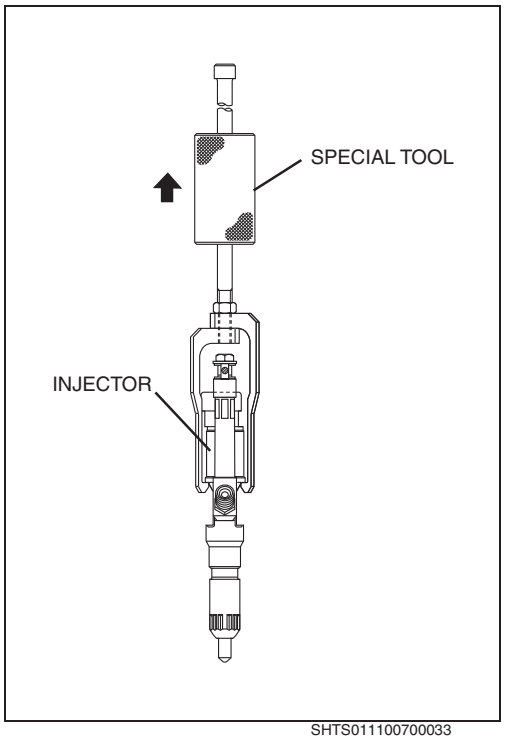
If foreign matter is allowed to enter the combustion chamber, engine trouble may result.

2. REMOVE THE INJECTOR.

(1) Disconnect of the harness couplers.
(2) Remove the leakage pipe.
(3) Remove the injection pipe.

NOTICE

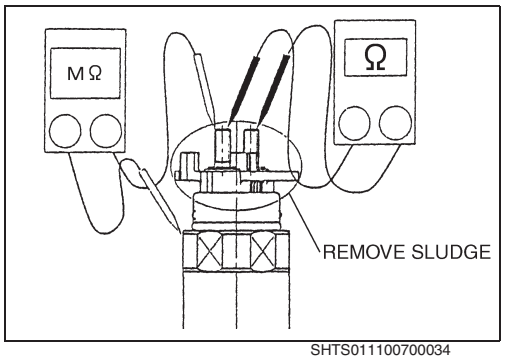
Cover open ends of the pipes and supply pump to prevent entry of dirt.



SHTS011100700033

3. REMOVE THE INJECTOR ASSEMBLY.

(1) Remove the injector clamp bolt.
(2) Use the special tool to pull out the injector and remove the injector clamp simultaneously.
SST: Puller (09420-2010)



SHTS011100700034

IMPORTANT POINT - ON VEHICLE INSPECTION

1. INSPECT THE INJECTOR.

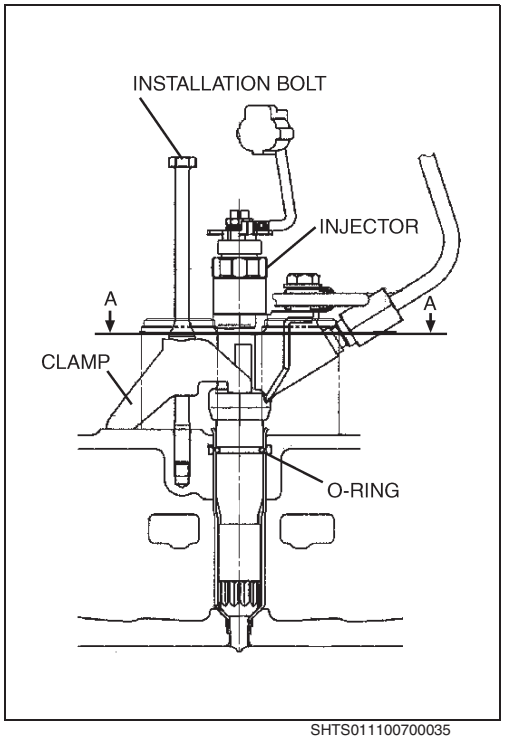
(1) Measure the resistance between terminals.
If not standard value, replace injector assembly.
Standard:
0.4-0.5 Ω at 20°C {68°F}

(2) Measure the resistance of insulation between terminals and upper body. If not standard value, replace injector assembly.
Standard:
More than 10 MΩ

NOTICE
Other inspections and nozzle replacements should be done by Denso service dealer.

(3) Inspect terminals.
a. Remove any sludge adhering to the terminals or area surrounding the terminals.

NOTICE
When removing sludge, do not use cleaning fluids.
Use dry cloth. (If cleaning fluids are used, there is a possibility that an electrical malfunction will occur.)



SHTS011100700035

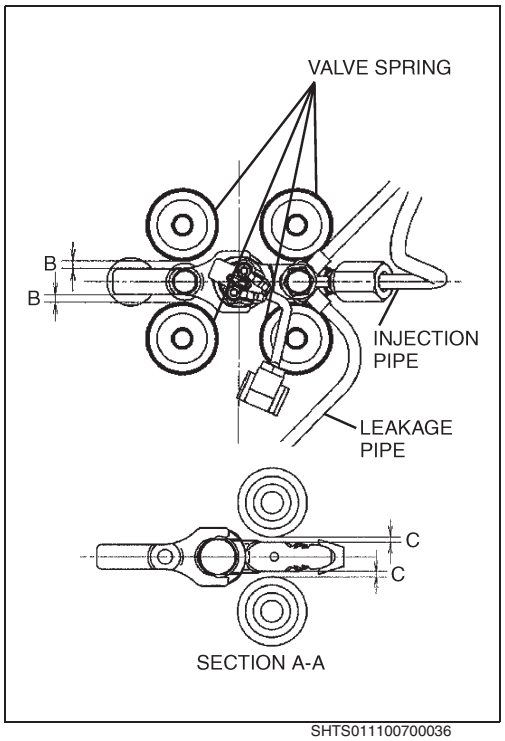
IMPORTANT POINTS - MOUNTING

1. INSTALL THE INJECTOR ASSY.

(1) Install a new O-ring into the groove of the injector, and then insert the injector with the injector clamp.

NOTICE

- **Apply engine oil to the O-ring, so that the O-ring will not be caught.**
- **Do not fix the injector clamp before the injection pipe is temporarily installed.**



SHTS011100700036

(2) Install the leakage pipe temporarily.

NOTICE

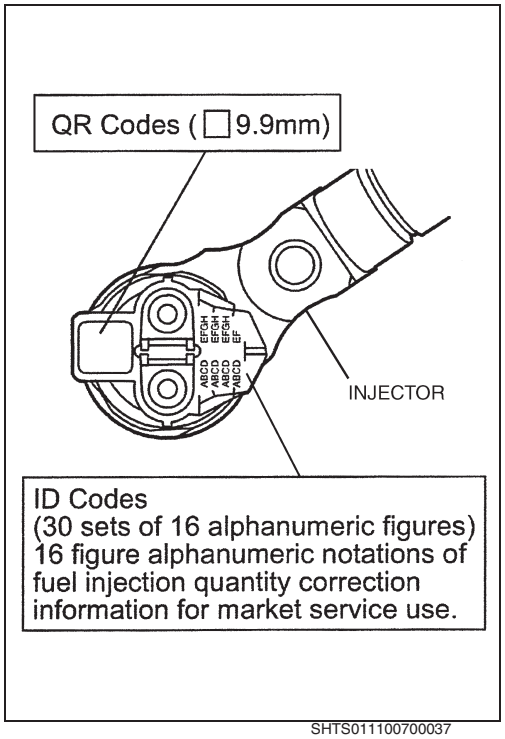
The screw pitch of the union bolt in the cylinder head connection part is different from union bolts of injector head. As a result, pay adequate attention not to make any mistakes when storing the union bolts.

M10x1.0: Injector side

M10x1.5: Cylinder head side

(3) Install the injection pipe temporarily.
(4) Check the gap as shown in the figure.
B: APPROX. 4.3 mm {0.1693 in.}
C: APPROX. 3.0 mm {0.1181 in.}

(5) Tighten the injector clamp installation bolt to the specified torque.
(6) Tighten the nuts of injection pipe to specified torque.
(7) Tighten the leakage pipe bolt.
(8) Connect the harness connectors.



SHTS011100700037

2. ENTER THE ID CODES IN THE ECU.

(1) QR (Quick Response) codes displaying various injector characteristics and the ID codes showing these in numeric form (30 alphanumeric figures) are engraved on the injector head.

NOTICE

When replacing injectors with QR codes, or the engine ECU, it is necessary to record the ID codes (QR codes) in the ECU by using the Diagnostic tool. (If the ID codes of the installed injector are not registered correctly, engine failure such as rough idling and noise will result.)

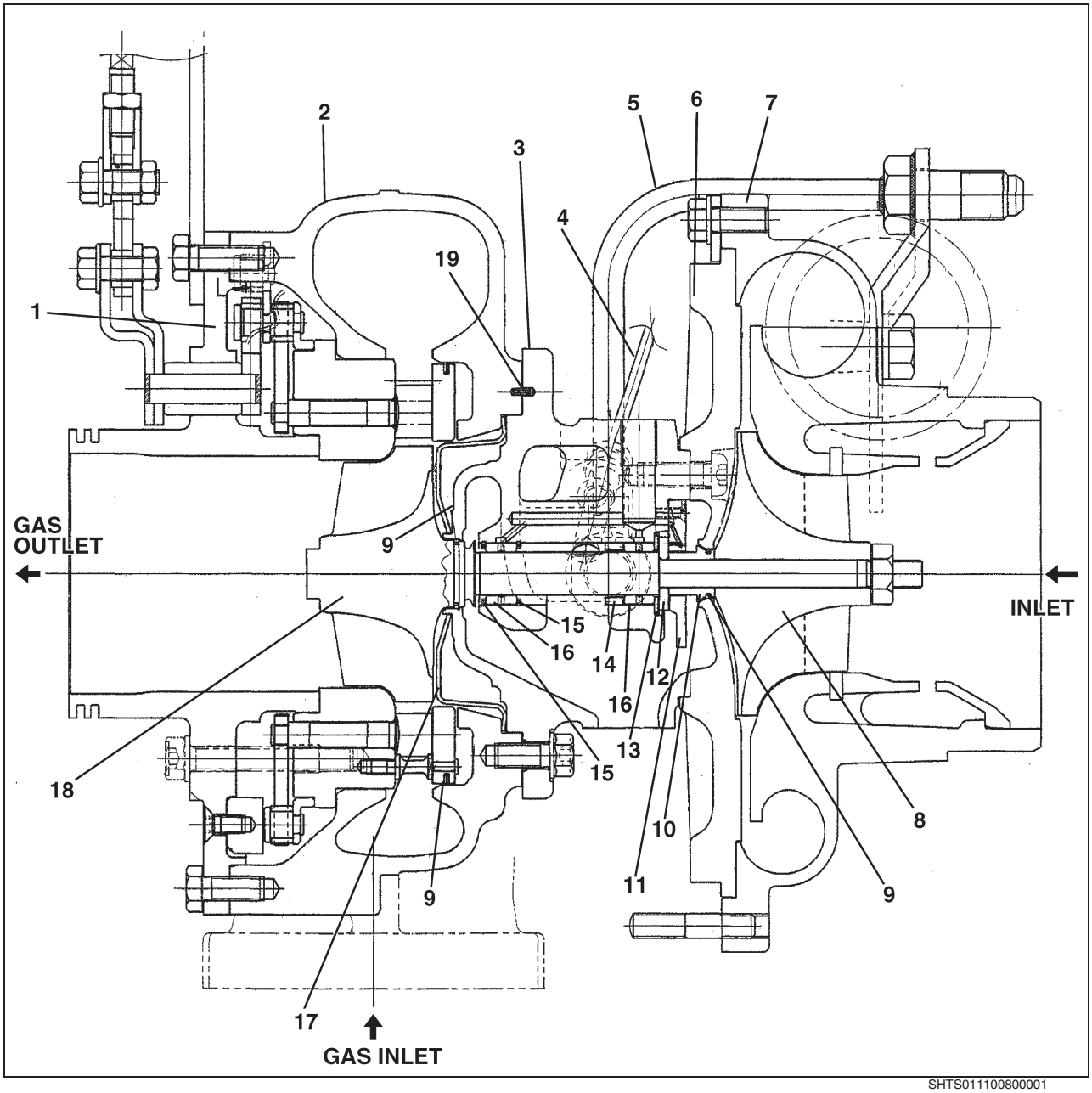
TURBOCHARGER (E13C)

EN08-001

TURBOCHARGER

DESCRIPTION

EN0111008C100001



SHTS011100800001

1	Variable geometry turbocharger (VGT) assembly	11	Thrust bearing (Blower side)
2	Turbine case	12	Thrust collar
3	Bearing case	13	Thrust bearing (Turbine side)
4	Turbocharger speed sensor	14	Spacer
5	Coolant pipe	15	Retainer ring
6	Back plate	16	Floating metal
7	Blower case	17	Heat protector
8	Blower impeller	18	Turbine shaft
9	Seal ring	19	Spring pin
10	Oil thrower		

TROUBLESHOOTING

EN0111008F300001

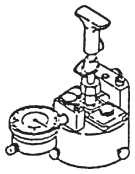
Symptom	Possible cause	Remedy/Prevention
Dense black smoke (Insufficient intake)	Air cleaner is choked with dust, causing greater intake air resistance.	Disassemble and clean or replace the air cleaner element.
	Air inlet is choked	Repair.
	Air is leaking from intake manifold	Repair.
	Blower impeller and turbine shaft not turning freely	Disassemble and repair.
	VGT 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.
	Abnormal wear or damage of seal ring caused by wear of floating metal, due to insufficient lubrication.	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.
	Seal ring may be broken or worn due to abnormal wear of thrust washer.	Replace the thrust washer.
	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.
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.
	VGT assembly malfunction	Inspect and replace.
Poor response of turbocharger	Carbon accumulation on the turbine side seal ring and heavy rotation	Change engine oil, clean turbocharger.
	Poor combustion	Check fuel system and improve combustion.
	Air or gas leaking from parts of the intake or exhaust system	Inspect and repair the problem area.
	VGT assembly malfunction	Inspect and replace.

Symptom	Possible cause	Remedy/Prevention
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	Replace.
	Air of gas leaking from parts of the intake or exhaust system	Inspect and repair the problem area.
	VGT assembly malfunction	Inspect and repair.
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.
Sudden shortage of lubricating oil	Abnormal wear or damage of seal ring caused by wear of floating metal.	Overhaul and repair.
	Oil is mixed with exhaust before turbocharger is engaged	Inspect and adjust the relevant parts of the engine.

SPECIAL TOOL

EN0111008K100001

Prior to starting a turbocharger overhaul, it is necessary to have this special tool.

Illustration	Part number	Tool name	Remarks
	09470-1340	TOOL ASSEMBLY	Attachment for measuring turbine shaft play

CHECKUP USING PC DIAGNOSIS TOOL

EN0111008H300001

1. OPERATION CHECK

(1) Connect PC diagnosis tool to check the turbocharger operating condition.
Refer to the CHAPTER “FUEL CONTROL”.

CHECKING VG ASSEMBLY

EN0111008H300002

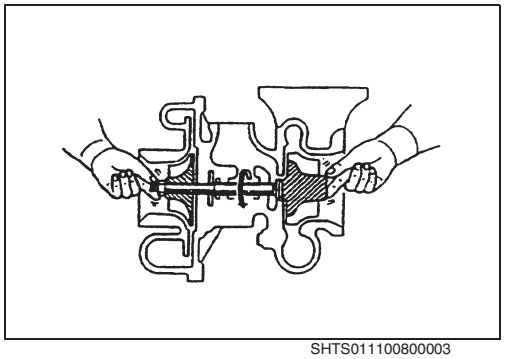
1. CHECKING THE CYLINDER STROKE

(1) Make sure that the air source is supplied.
(2) By using PC diagnosis tool, supply the air to each port of VGT assembly to check if the rod of VGT cylinder operates smoothly and if the specified lifting stroke is reserved.
Refer to the CHAPTER “FUEL CONTROL”.
(3) If any failure is found, carry out the following inspection. If the air source is not supplied: Check the operation and working voltage of the magnetic valve. (If the working voltage is defective, inspect the vehicle.)

OVERHAUL CRITERIA

EN0111008H300003

CONDITIONS WHICH DETARMINE WHEN TURBOCHARGER OVERHAUL MAY BE NEEDED.



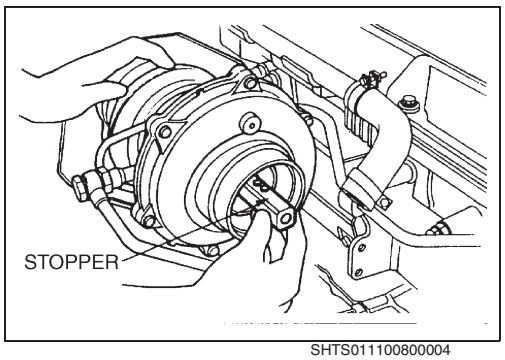
SHTS011100800003

1. INSPECT THE TURBINE SHAFT ROTATION.

(1) Rotate the blower impeller by hand to see if it turns smoothly. If it does not turn smoothly, clean and inspect the bearing and turbine rotor.

NOTICE

The illustration showing the radial and thrust play is an example how to use the tool assembly. Turbocharger related parts on the illustration might differ to those actually mounted on the engine.



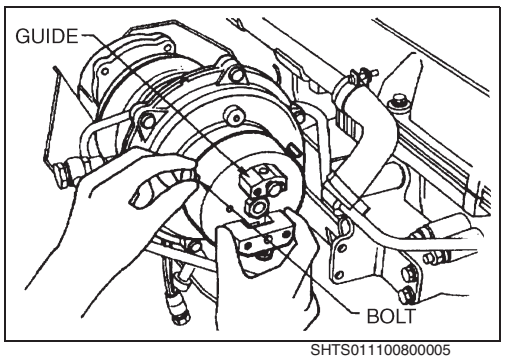
SHTS011100800004

2. INSPECTION THE TURBINE SHAFT RADIAL PLAY.

⚠ CAUTION

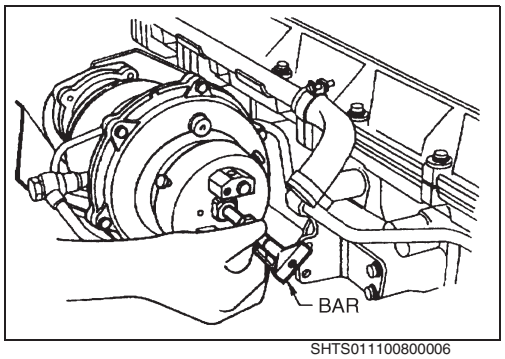
Make sure the engine is stopped before performing the steps below.

(1) Screw a stopper onto the threaded portion sticking out of the lock nut on the end of the blower impeller. (The stopper must be turned counterclockwise.)



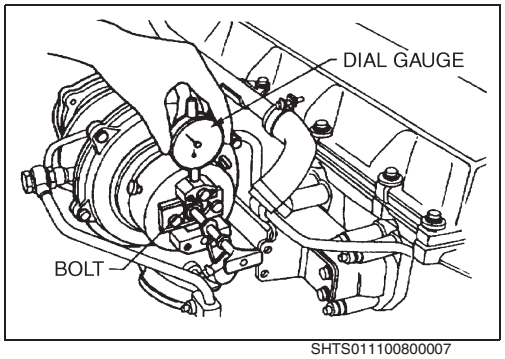
SHTS011100800005

(2) Insert a guide into the air intake side of the blower case and tighten the bolt to secure it in place.



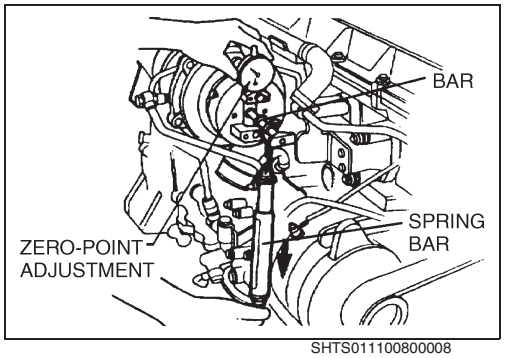
SHTS011100800006

(3) Screw a bar into the stopper to lock it.



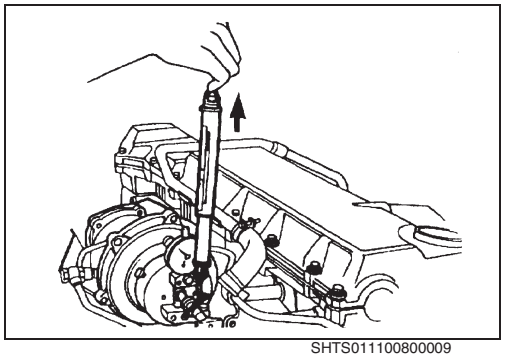
SHTS011100800007

(4) Insert a dial gauge into the plate and secure it in place with a bolt.



SHTS011100800008

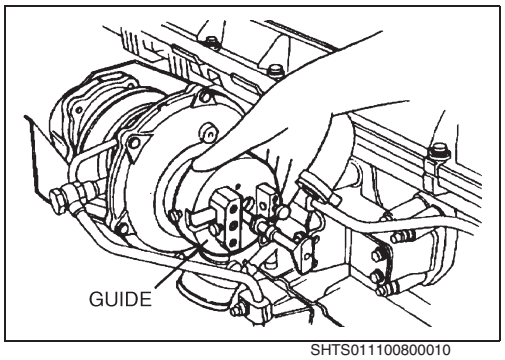
(5) Attach a bar onto the hook on the end of the bar. Then, while pulling down with a force of 4.9-5.9 N {0.5-0.6 kgf, 1.10-1.32 lbf}, set the needle of the dial gauge to zero.


SHTS011100800009

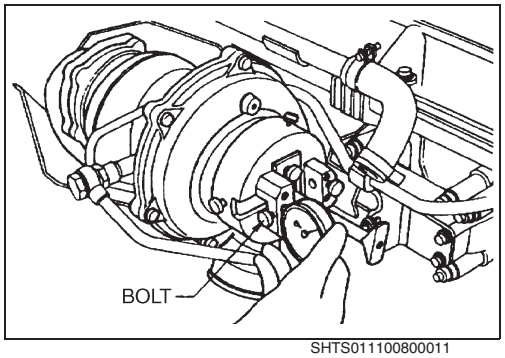
(6) While pulling up on the bar with a force of 4.9-5.9 N {0.5-0.6 kgf, 1.10-1.32 lbf}, measure the radial play using the dial gauge.

(7) Perform the measurement three times and calculate the average value. If this value exceeds the service limit, either perform an overhaul or replace the part with a new one.
Radial play
Service limit: 1.40 mm {0.0551 in.}

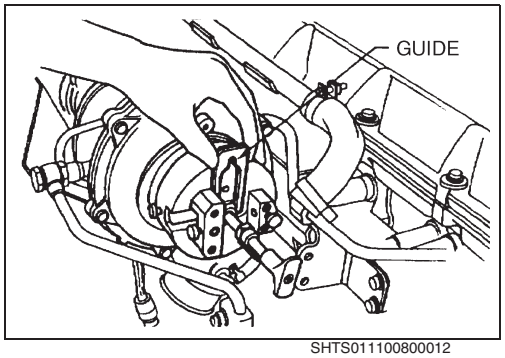
NOTICE
If the turbocharger is overhauled or the assembly is replaced, the inspection steps following this item are not required.



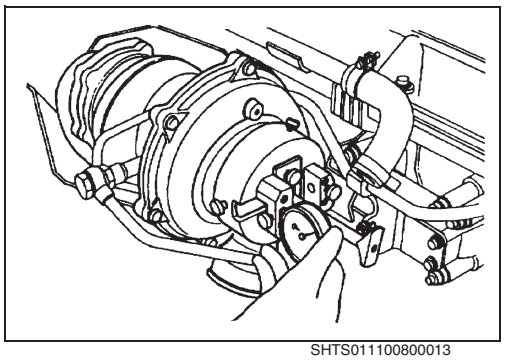
SHTS011100800010

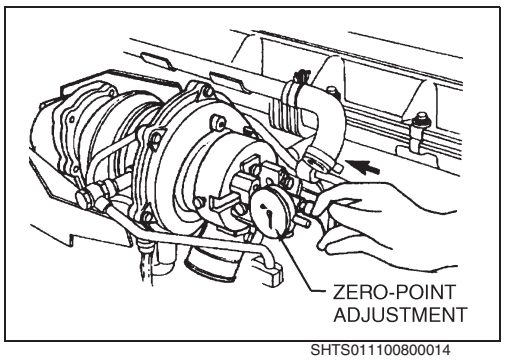


SHTS011100800011



SHTS011100800012


SHTS011100800013



SHTS011100800014

3. INSPECT THE TURBINE SHAFT THRUST PLAY.

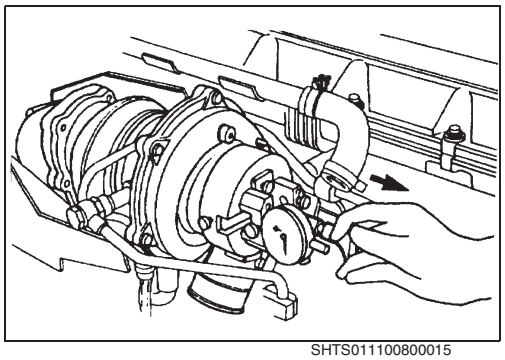
⚠ CAUTION
Make sure the engine is stopped before performing the steps below.

(1) Remove the dial gauge, loosen the bolt on the guide and turn the guide 90°. Insert a dial gauge into the plate undergoing the thrust play inspection and secure it in place with a bolt.

(2) To prevent the measuring tool from moving to the left or right, insert a guide.

(3) To secure the guide in place, move the bar up and down and secure the guide with a stopper so that the movement of the needle of the dial gauge is centered in the middle.

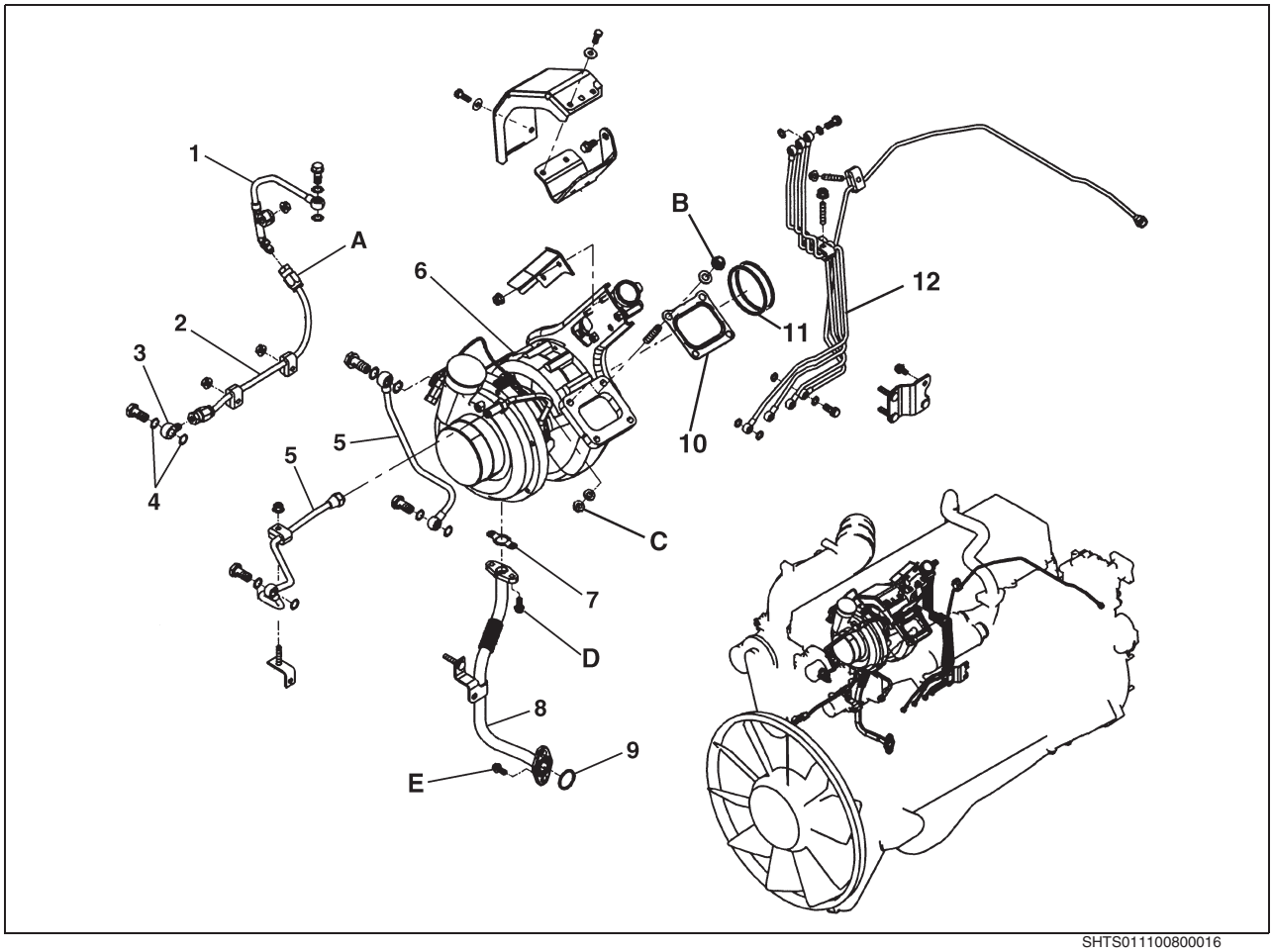
(4) Grasp the puller and while pushing it against the turbine in the thrust direction, set the needle of the dial gauge to zero.


SHTS011100800015

(5) Then, pull in the opposite direction and measure movement in the thrust direction.
(6) Perform the measurement three times and calculate the average value. If this value exceeds the service limit, either perform an overhaul or replace the part with a new one.
Thrust play
Service limit: 0.11 mm {0.0043 in.}

COMPONENT LOCATOR

EN0111008D100001

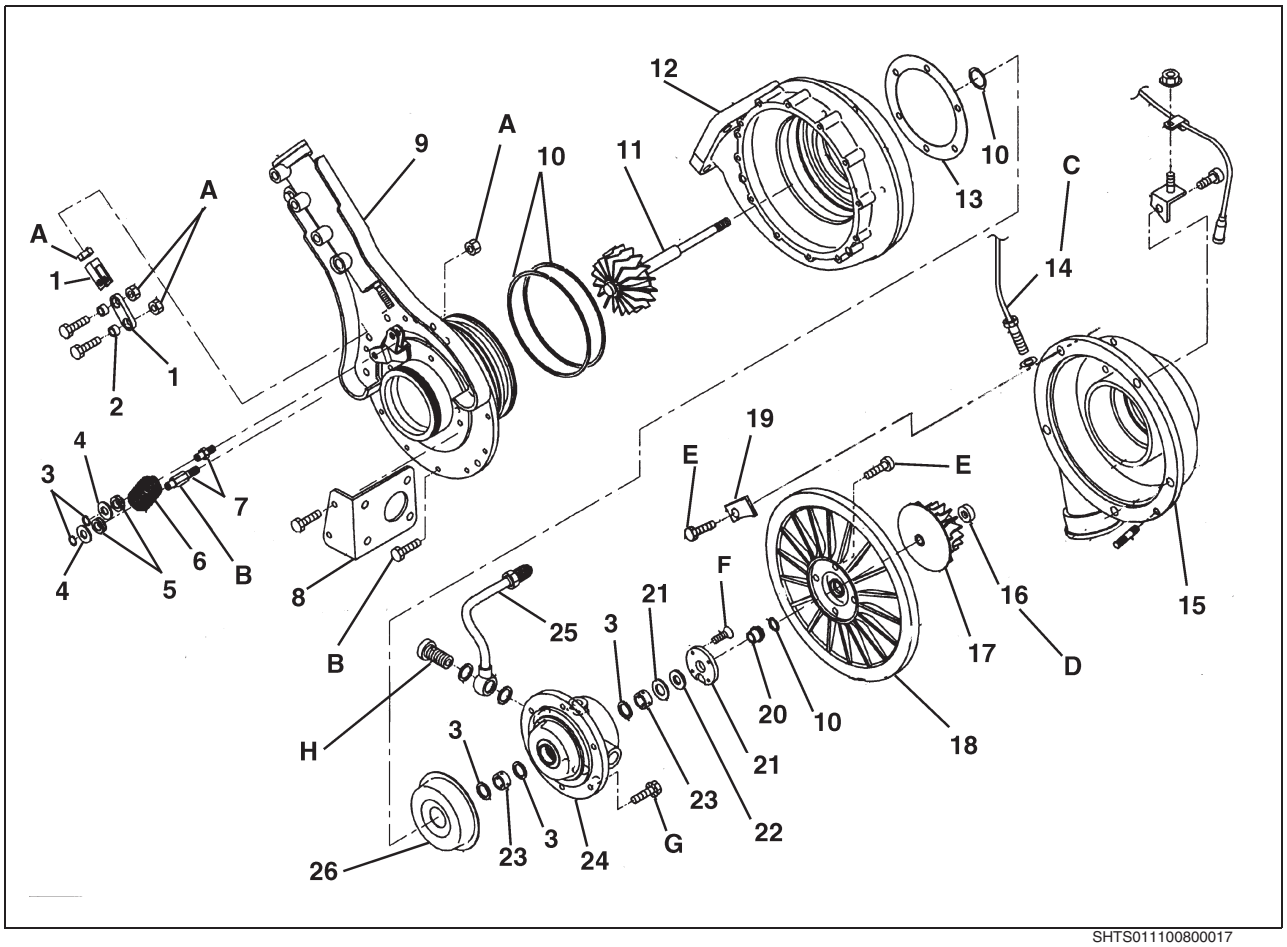


SHTS011100800016

1	Oil inlet pipe	7	Oil outlet pipe gasket
2	Oil hose	8	Oil outlet pipe
3	Eye	9	O-ring
4	Soft washer	10	Gasket
5	Coolant pipe	11	Seal ring
6	Turbocharger assembly	12	Air pipe

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

A	24.5 {250, 18}	D	28.5 {290, 21}
B	108 {1,100, 80}	E	55 {560, 41}
C	59 {600, 44}		



SHTS011100800017

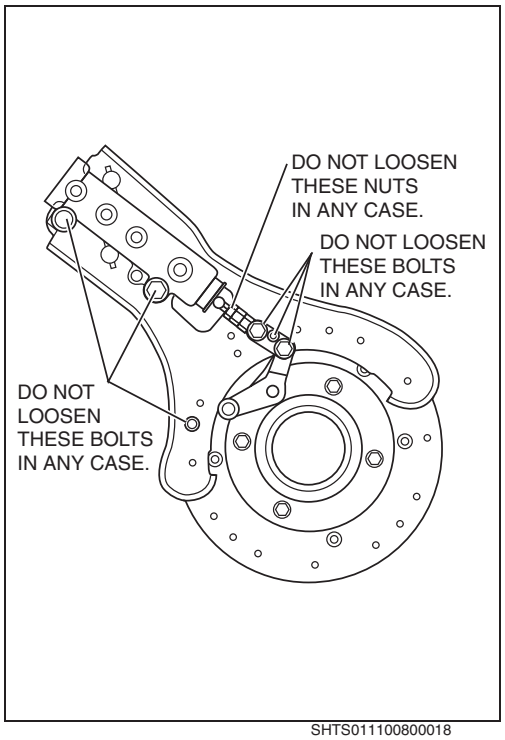
1	Clevis	14	Turbocharger speed sensor
2	Collar	15	Blower case
3	Retainer ring	16	Lock nut
4	Spacer	17	Blower impeller
5	Spring hanger	18	Back plate
6	Tension spring	19	Plate
7	Pin bolt	20	Oil thrower
8	Insulator bracket	21	Thrust bearing
9	Valiable grometry turbocharger (VGT) assembly	22	Thrust collar
10	Seal ring	23	Floating metal
11	Turbine shaft	24	Bearing case
12	Turbine case	25	Coolant pipe
13	Gasket	26	Heat protector

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

A	14-15.4 {143-157, 10.4-11.3}	E	21.6-23.6 {221-240, 16-17.4}
B	27-29 {276-295, 20-21}	F	1.17-1.37 {12-13, 0.9-1}
C	10.5-11.5 {108-117, 7.8-8.4}	G	30.9-32.9 {316-335, 23-24}
D	20.6-22.6 {211-230, 15.2-16.6}	H	32-36 {327-367, 24-26}

OVERHAUL

EN0111008H300004



SHTS011100800018

IMPORTANT POINT - DISMOUNTING

1. REMOVE THE TURBOCHARGER.

NOTICE

- **Do not remove the air cylinder or the air cylinder bracket from the turbocharger.**
- **If these parts are removed, the performance of the turbocharger may be degraded.**
- **Oil and cooling water are filled in the pipes and the turbocharger. Pay attention not to have them leaked.**
- **Seal each oil and water hole of the turbocharger to prevent any foreign objects from coming into it.**

IMPORTANT POINTS - AFTER MOUNTING

1. DRIVING PROCEDURE

(1) After mounting the turbocharger on the engine, start the engine to check any leakage of air, oil, cooling water, or exhaust gas from related parts.

NOTICE

- **Do not put the engine in high-speed rotation immediately after starting the engine. If the turbocharger is driven in insufficient lubricated condition, which is inevitable immediately after starting the engine, failure such as bearing seizing may be caused.**
- **Before stopping the engine, idle the engine approximately for 5 minutes. If the engine is stopped suddenly without idling, the turbocharger is forced to rotate without oil pressure. This may eliminate the necessary oil film and cause the bearing wear.**

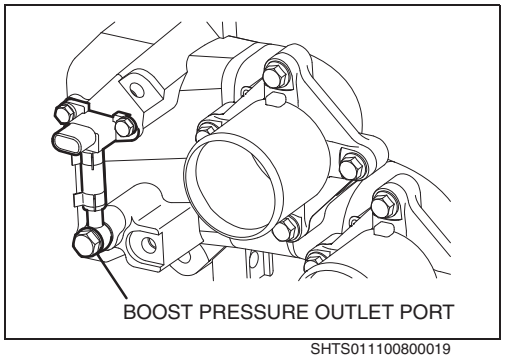
2. CHECKING THE BOOST PRESSURE

Normal boost pressure

Service standard (at maximum speed without load)	**9.8 kPa {0.10 kgf/cm^2, 0.0061 lbf/in^2.} or above**

NOTICE

When PC diagnosis tool is used, the displayed pressure is the sum of the atmospheric pressure and the boost pressure. (Check the pressure when the engine is stopped.)



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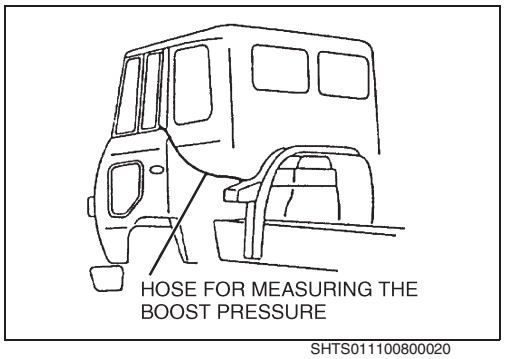
(1) Remove the boost pressure sensor on the intake pipe and connect the special tool on the intake pipe. (When connecting to the special tool, use the gasket that is used for the plug.)
SST:
Gauge (09444-1250)
Hose for measuring the boost pressure (17108-1040)



SHTS011100800020

(2) Bring the special tool (gauge) in the cab as the illustration shows. After fully warming up the engine, step on the clutch pedal to disengage it and step on fully the accelerator pedal. Measure the boost pressure by the special tool (gauge) at the maximum engine speed without load.

NOTICE

Make sure to maintain the special tool (gauge) to get up. Otherwise the pointer may swing and you cannot get the accurate measurement.

(3) If the measured value does not reach the normal boost pressure, the possible causes would be air leakage from the air sealed parts of the air intake system, clogging of the air filter, clogging of the intercooler, or defective VGT. Check to find the cause and repair it.

NOTICE

After the measurement, make sure to install the soft washer and plug.

IMPORTANT POINTS - DISASSEMBLY

NOTICE

- **Because the turbocharger is a precision mechanism, pay the utmost attention to disassemble it. Especially at the cause analysis such as failure diagnosis, correct diagnosis becomes impossible if disassembling damages the turbocharger.**
- **The mounting angles are determined for the turbocharger to be mounted to the VGT assembly, turbine case, bearing case, and blower case according to its mounting condition on the engine. So, make sure to put match marks before disassembling.**

1. REMOVE THE COOLANT PIPE AND THE TURBOCHARGER SPEED SENSOR.

2. REMOVE THE VGT ASSEMBLY.

(1) Remove the bolts (11 pieces) on the outer circumferential area of the cover.

NOTICE

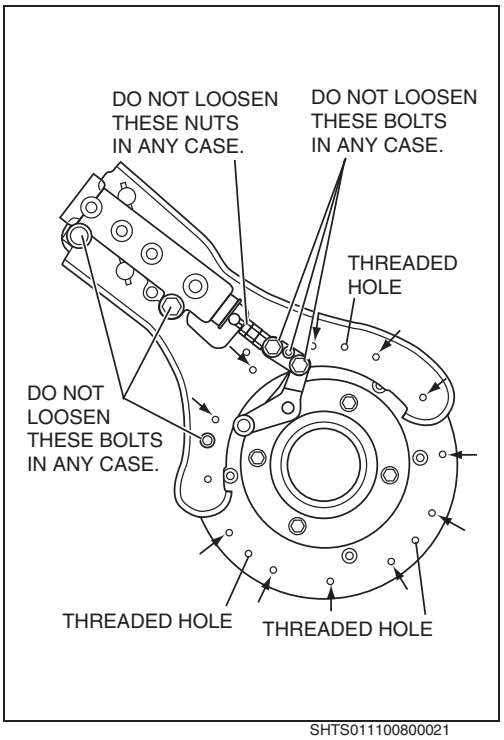
- **Do not loosen any bolts other than the above in any cases.**
- **VGT opening angle is conditioned for VGT assembly. So, if the bolts or nuts above-mentioned are loosened, nozzle opening angle of VGT assembly may change and this may affect the performance and reliability.**

HINT

Width across flats of the bolt is 13 mm {0.5118 in.}.

(2) Mount the removed bolts (3 pieces) to the threaded holes (M8 x 1.25) (3 points) of the cover.

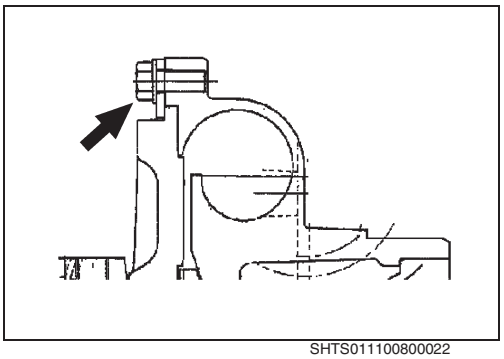
(3) Screw in the bolts (3 pieces) evenly and separate VGT assembly from the turbine case.



SHTS011100800021

3. REMOVE THE BLOWER CASE.

(1) Remove the blower case fitting bolts and plates.



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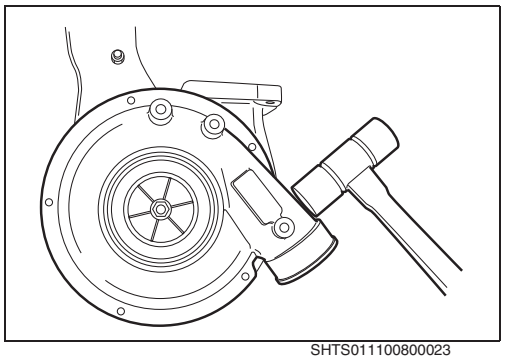
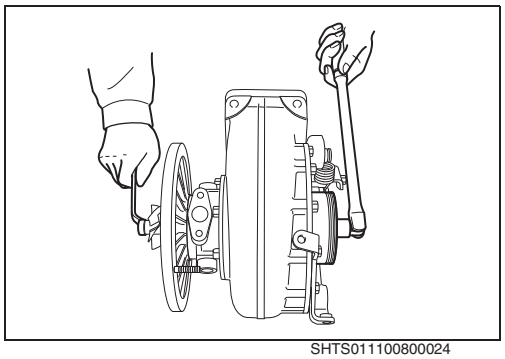

SHTS011100800023

NOTICE

- **If the blower case cannot easily be removed by hand, tap it carefully all around using a plastic hammer and carefully remove it.**
- **Do not damage the blower impeller.**


SHTS011100800024

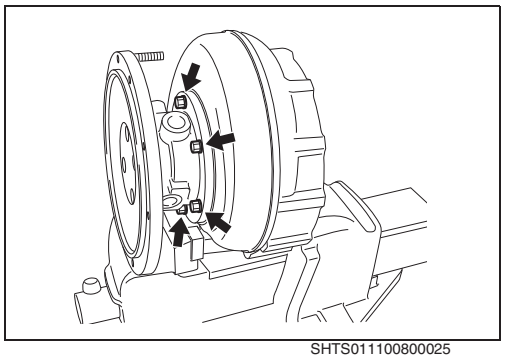
4. REMOVE THE BLOWER IMPELLER.

(1) Remove the blower impeller fitting nut.

NOTICE

Turn the lock nut clockwise to loosen the nut (Left hand threads and 17 mm {0.6693 in.} width across flats).

(2) Remove the blower impeller from the turbine shaft.

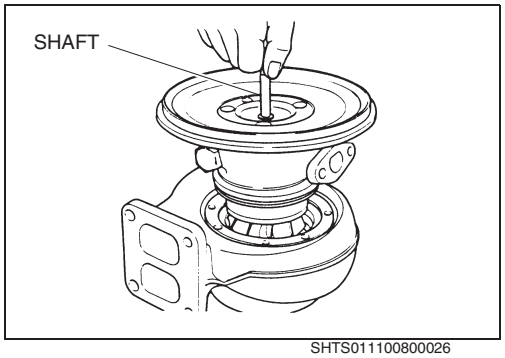

SHTS011100800025

5. REMOVE THE BEARING CASE WITH TURBINE SHAFT FROM THE TURBINE CASE.

(1) Remove the bearing case fitting bolts.

NOTICE

- **Because the bolts on the turbine side are exposed to high temperature, if they have seized, do no apply an unreasonable force to remove them because they may break. Spray a lubricant onto them, then wait for about 15 minutes and loosen them.**
- **If the turbine case cannot easily be removed by hand, tap it carefully all round using a plastic hammer and carefully remove it.**
- **Do not drop the turbine shaft when removing the bearing case from the turbine case.**



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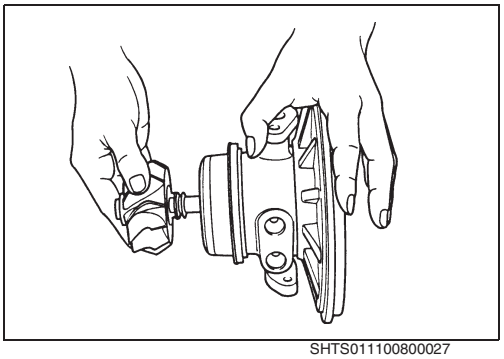

SHTS011100800027

6. PULL OUT THE TURBINE SHAFT AND HEAT PROTECTOR.

(1) Remove the turbine shaft.

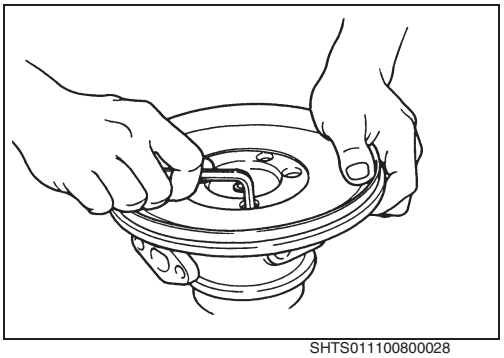
NOTICE

If the turbine shaft cannot easily be removed by hand, tap the shaft end of blower side.

(2) Remove the heat protector.

NOTICE

If the heat protector cannot easily be removed, tap it with a chisel.


SHTS011100800028

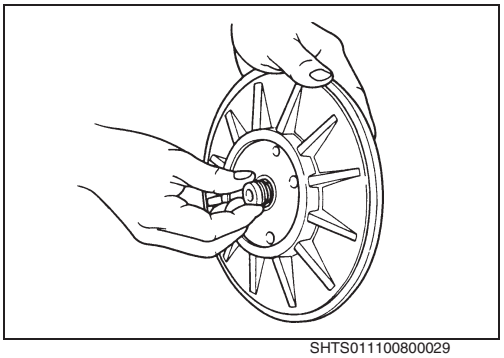
7. REMOVE THE BACK PLATE.

(1) Remove the back plate fitting bolts using the torx wrench.

(2) Remove the back plate from the bearing case.

NOTICE

If the back plate cannot be easily removed by hand, tap it carefully all around with a plastic hammer.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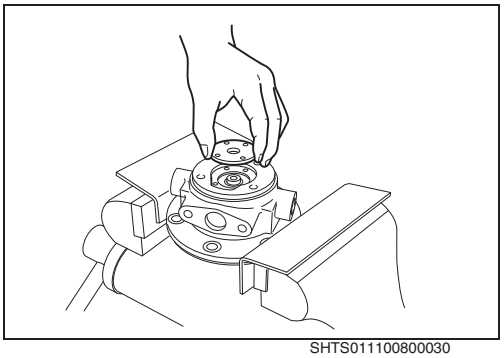
(3) Remove the oil thrower from the back plate.


SHTS011100800030

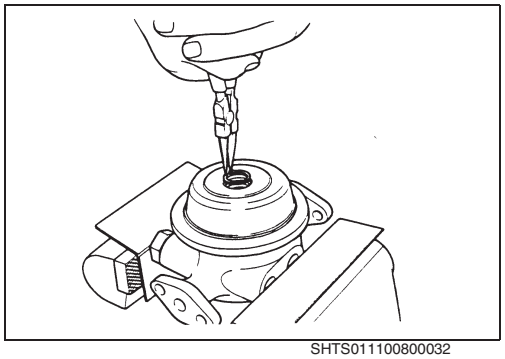
8. DISASSEMBLE THE BEARING CASE.

(1) Remove the thrust bearing fitting screws with a torx screw driver.

(2) Remove the thrust bearing and thrust collar with a 10 mm {0.394 in.} diameter copper rod.

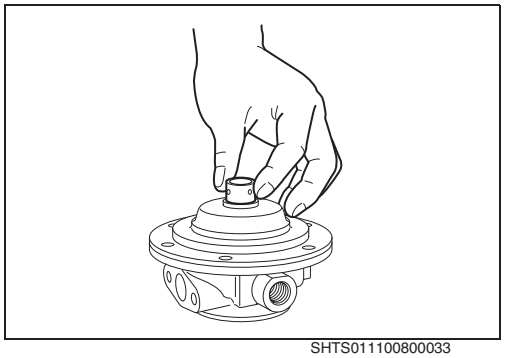
NOTICE

When removing the thrust bearing and thrust collar, be careful not to damage the thrust bearing hole in the bearing case.


SHTS011100800032

(3) Remove the floating metal for blower side.
(4) Remove the outer retainer ring for turbine side.

NOTICE
When removing the retainer ring, be careful not to damage the front face of the hole in the bearing case.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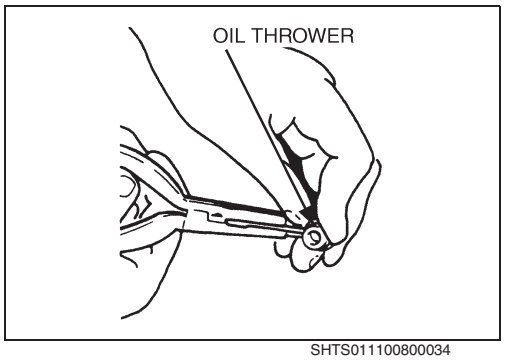
(5) Remove the floating metal.



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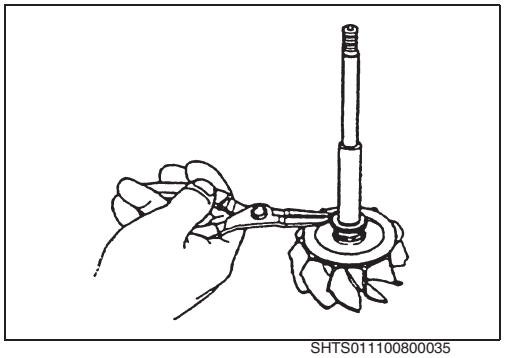
9. REMOVE THE SEAL RINGS.

NOTICE
When removing the seal ring, do not damage the turbine shaft surface and the groove of the seal ring.


SHTS011100800035

IMPORTANT POINTS - ASSEMBLY

1. CLEAN ALL PARTS.

(1) Before cleaning, the disassembled parts should be visually inspected to check for burning, abrasion, carbon deposits, gas and oil leakage.

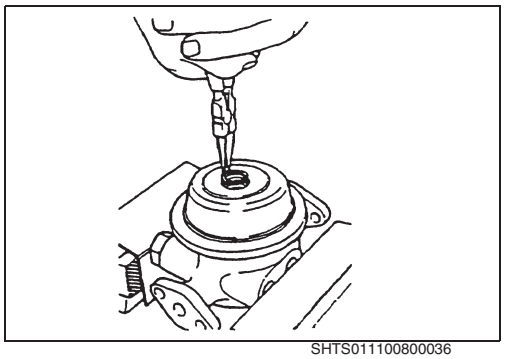
(2) Thoroughly clean all the parts with diesel fuel, using a soft brush, and dry with compressed air.

NOTICE

- **Never use a caustic cleaning solution, as it may attack aluminum.**
- **Never use a wire brush.**

2. ASSEMBLE THE FLOATING METALS.

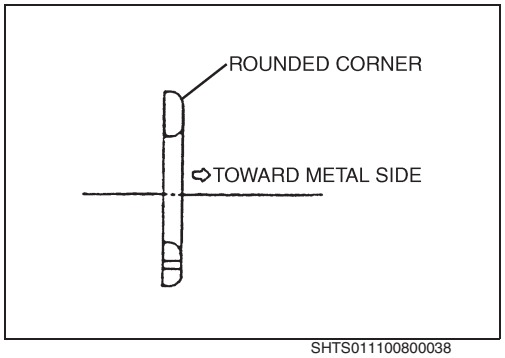
(1) After fitting the retainer ring into the bearing case, mount the floating metal. Fit the retainer ring onto the outside to secure the floating metal in place.



SHTS011100800036

NOTICE

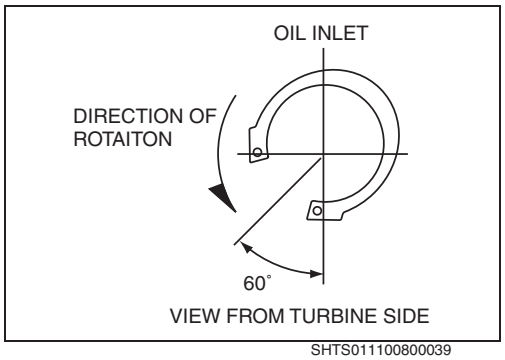
When mounting the retainer ring, the side with the rounded corner should be facing the metal.



SHTS011100800038

NOTICE

- **The opening of the retainer ring should be positioned as shown in the figure.**
- **Apply clean engine oil to the floating metals before mounting them.**



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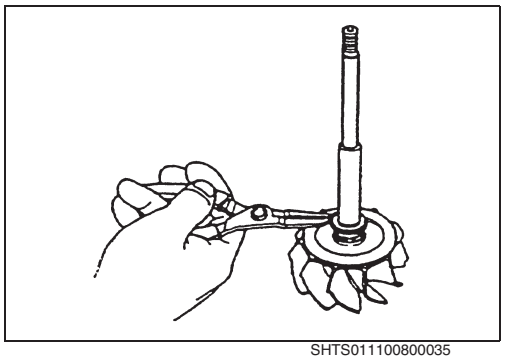
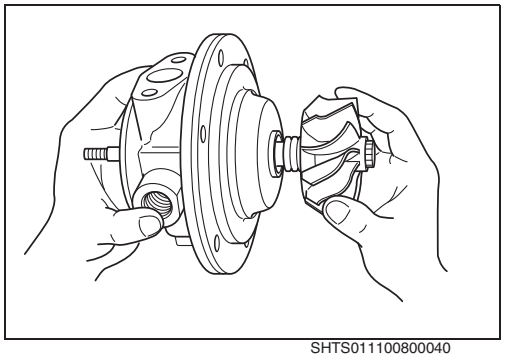

SHTS011100800035

3. ASSEMBLE THE TURBINE SHAFT.

(1) Install the seal ring into the ring groove of the turbine shaft.

NOTICE

- **The seal ring should be replaced with a new one.**
- **Insert the seal ring concentric with the turbine shaft. If it is inserted with unreasonable force, it may be damaged.**

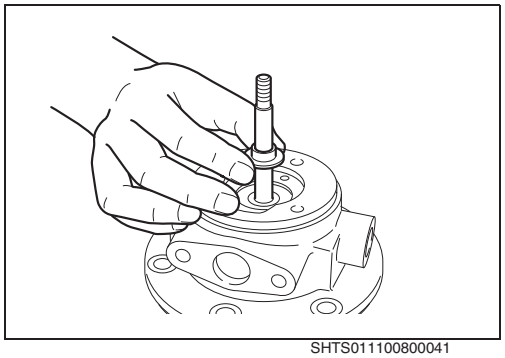

SHTS011100800040

(2) Position the heat protector on the bearing case.

(3) Coat the journals of the turbine shaft with clean engine oil and install the turbine shaft in the bearing case.

NOTICE

- **The gap in the seal ring of the turbine shaft must face towards the oil inlet.**
- **When inserting the turbine shaft, be very careful not damage the floating metal.**


SHTS011100800041

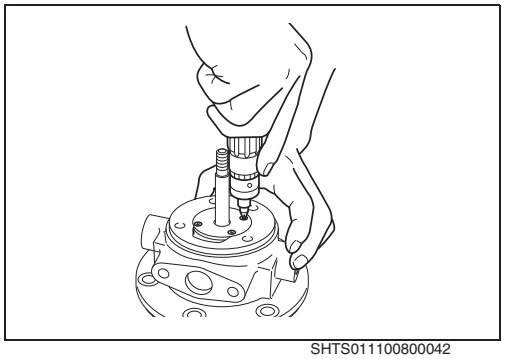
4. ASSEMBLE THE FLOATING METAL, THRUST COLLAR AND THRUST BEARING.

(1) Coat the floating metal with clean engine oil and install it onto the turbine shaft.

(2) Coat the clean engine oil to the thrust bearing and put it on the bearing case.

(3) Coat the clean engine oil to the thrust collar and put it on the thrust bearing.

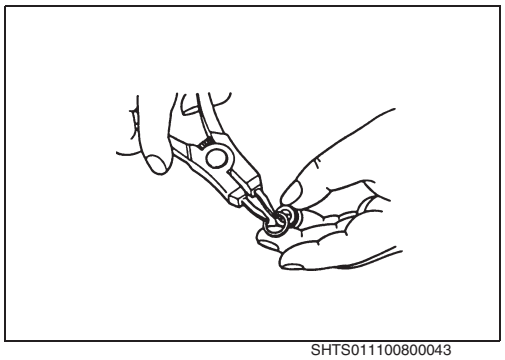
(4) Coat the clean engine oil to the thrust bearing and put it on the thrust collar.


SHTS011100800042

(5) Tighten the thrust bearing fitting screws with a torx screw driver.

NOTICE

- **The screws should be replaced with new one.**
- **Apply LOCTITE No. 242 or equivalent to thread of the screws.**

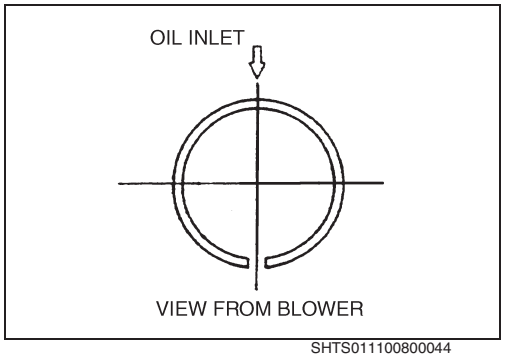

SHTS011100800043

5. INSTALL THE BACK PLATE.

(1) Insert the seal ring on the oil thrower.

NOTICE

The seal ring should be replaced with new one.

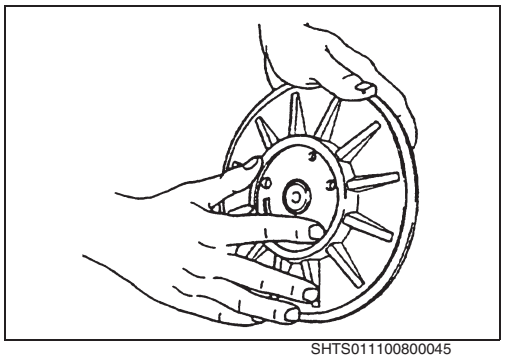


SHTS011100800044

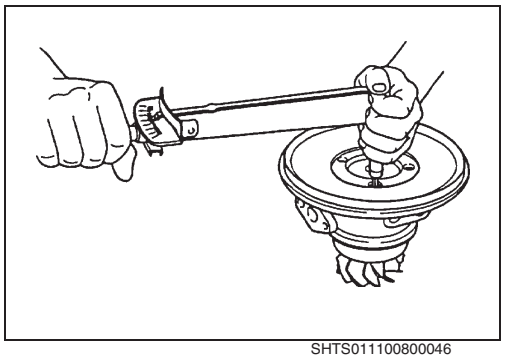
(2) Install the oil thrower into the back plate.

NOTICE

- **The openings of seal ring should be positioned as shown in the figure.**
- **If it is inserted with unreasonable force, it may be damaged.**


SHTS011100800045

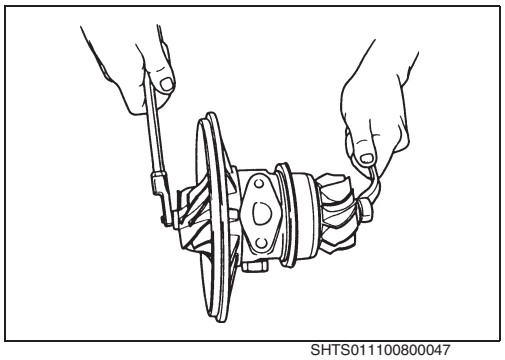
(3) Apply a thin (approximately 0.1-0.2 mm {0.0040-0.0078 in.}) layer of liquid gasket (ThreeBond TB1215 or equivalent) to the turbine side flange surface of the back plate.


SHTS011100800046

(4) Then mount the bearing case and use a torque wrench to tighten the torx bolt, to which LOCTITE No. 242 or equivalent has been applied.

NOTICE

Take care that the sealer does not protrude from the flange.

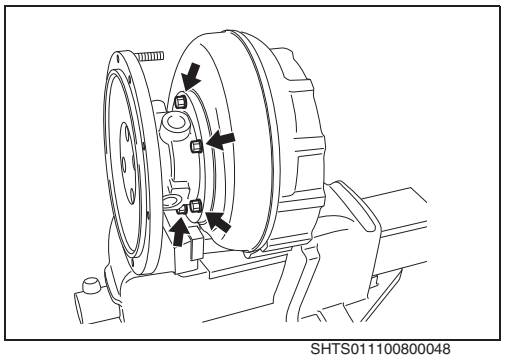

SHTS011100800047

6. ASSEMBLE THE BLOWER IMPELLER ON TO THE TURBINE SHAFT.

(1) Install the blower impeller onto the turbine shaft and tighten the nut.

NOTICE

Take care that this nut has left hand threads.


SHTS011100800048

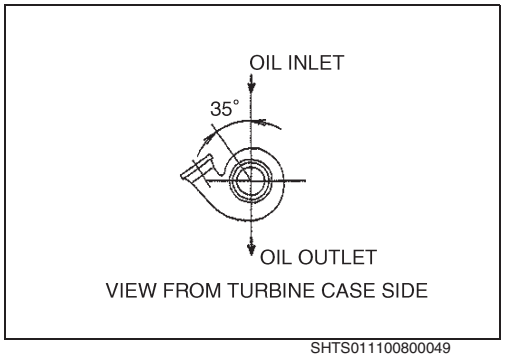
7. ASSEMBLE THE TURBINE CASE AND BEARING CASE.

(1) Install the gasket.

NOTICE

The gasket should be replaced with a new one.

(2) Align the spring pin and the spring pin hole, install the turbine case to the bearing case.



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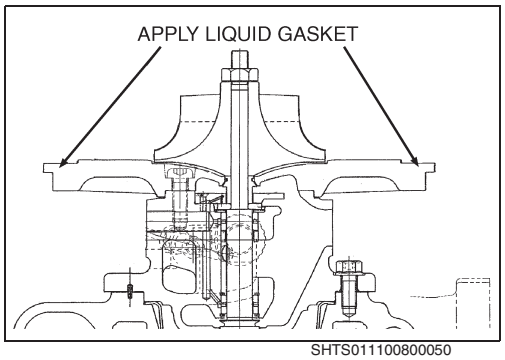

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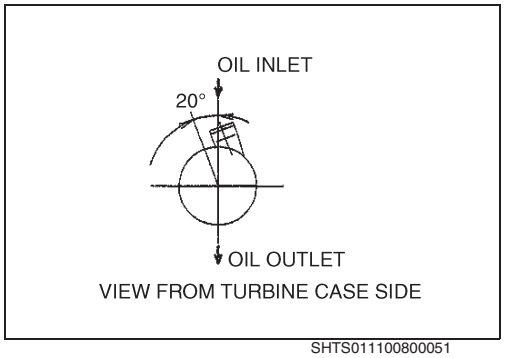

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8. MOUNT THE BLOWER CASE.

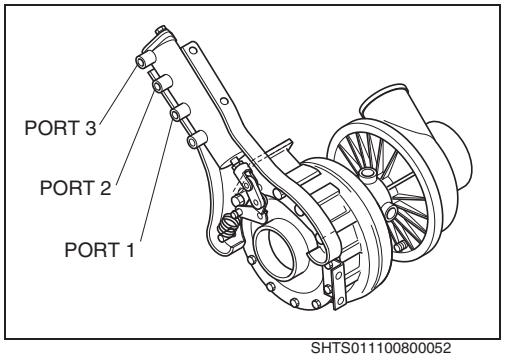
(1) Apply a thin (APPROX. 0.1-0.2 mm {0.0040-0.0078 in.}) layer of liquid gasket (ThreeBond TB1215 or equivalent) to the flange surface of the back plate.

(2) Align the aligning mark of the blower case and bearing case.

NOTICE

In case of replacing the parts, confirm the oil port position and air outlet port position.

9. INSTALL THE COOLANT PIPE AND THE TURBOCHARGER SPEED SENSOR.



SHTS011100800052

10. CHECKING THE OPERATION OF VGT ASSEMBLY

(1) Supply the air (490 to 780 kPa (5.0 to 8.0 kgf/cm^2) to each port of VGT assembly to check if the rod of VG cylinder functions smoothly.

(2) Measure the lifting stroke of VGT cylinder.

Unit: mm {in.}

Port No.	1	2	3	All ports
Stroke	3 {0.118}	6 {0.236}	12 {0.472}	21 {0.827}

(3) If any failures are found in (1) above, dismount VGT assembly and remount it after air-blowing it.

(4) Check the lifting stroke in the same manner as (2) above. If the stroke is normal, reuse VGT assembly. If abnormal, replace VGT assembly with new one.

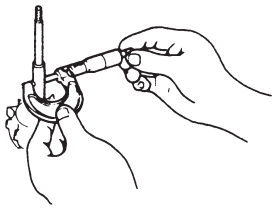
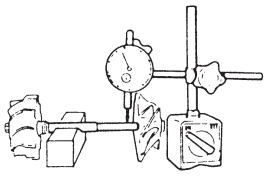
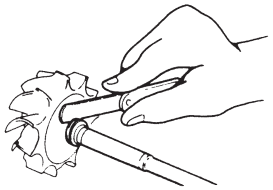
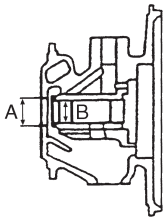
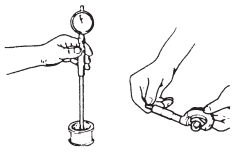
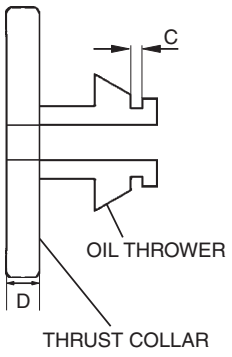
HINT

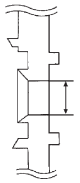
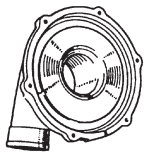
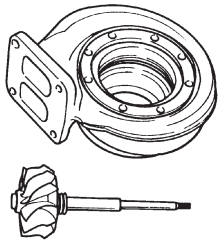
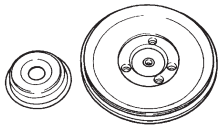
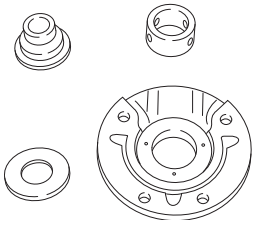
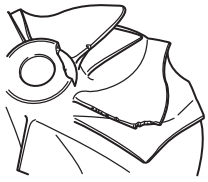
The size of port screw is M10 x 1.5, 12 mm {0.472 in.} of length.

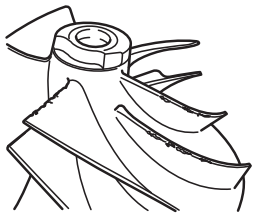
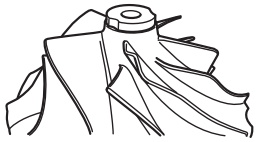
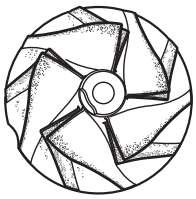
INSPECTION AND REPAIR

EN0111008H300005

Unit: mm {in.}

Inspection item	Standard	Limit	Remedy	Inspection procedure
Turbine shaft diameter	—	13.98 {0.5504}	Replace.	Measure 
Turbine shaft bend	—	0.011 {0.0004}	Replace.	Measure 
Turbine shaft seal ring groove width	—	1.85 {0.0728}	Replace shaft assembly.	Measure 
Bearing case inside diameter	—	A: 22.45 {0.8839} B: 20.11 {0.7917}	Replace.	Measure 
Floating metal inside diameter	—	14.07 {0.5539}	Replace.	Measure 
Floating metal outside diameter	—	19.97 {0.7862}	Replace.	
Oil thrower seal ring groove width	—	C: 1.75 {0.0689}	Replace.	Measure 
Thrust collar thickness	—	D: 2.95 {0.1161}	Replace.	

Inspection item	Standard	Limit	Remedy	Inspection procedure
Back plate sealing bore	—	16.05 {0.6319}	Replace.	Measure 
Blower case: Crack and damage	—	—	Replace.	Visual check 
Turbine case: Scratch, crack, distortion and damage Turbine blade: Bent, scratch and damage Turbine shaft: Distortion, wear and damage	—	—	Replace.	Visual check 
Heat protector, bearing case and seal plate: Scratch, crack, distortion and damage	—	—	Replace.	Visual check 
Retainer ring: Wear and damage	—	—	Replace.	Visual check 
Thrust collar, thrust bearing, oil thrower and floating metal: Wear and damage	—	—	Replace.	Visual check 
Blower impeller blade: Chipped	—	—	Replace.	Visual check 

Inspection item	Standard	Limit	Remedy	Inspection procedure
Blower impeller blade: Dented	—	—	**Replace.**	**Visual check** 
Blower impeller blade: Bent	—	—	**Replace.**	**Visual check** 
Blower impeller blade contact with blower case	—	—	**Replace.**	**Visual check** 
Blower impeller blade: Corrosion	—	—	**Replace.**	**Visual check** 

AIR COMPRESSOR (E13C: 340 cm^3 TYPE)

EN13-001

AIR COMPRESSOR

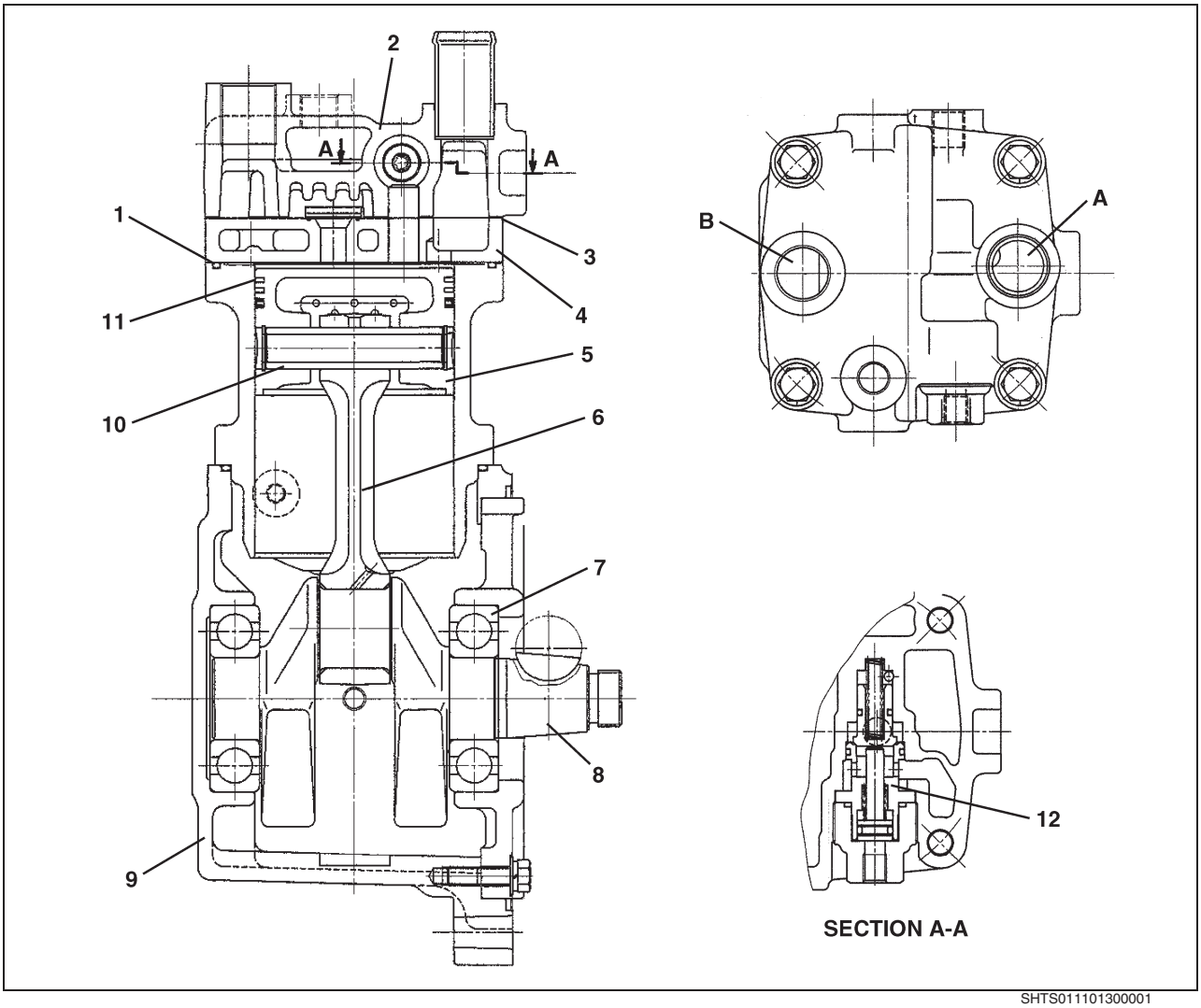
DATA AND SPECIFICATIONS

EN0111013I200001

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

EN0111013C100001



SHTS011101300001

1	O-ring	8	Crankshaft
2	Cylinder head assembly	9	Crankcase
3	Gasket	10	Piston pin
4	Valve seat	11	Piston ring
5	Piston	12	Unloader valve
6	Connecting rod	A	Suction
7	Bearing	B	Delivery

TROUBLESHOOTING

EN0111013F300001

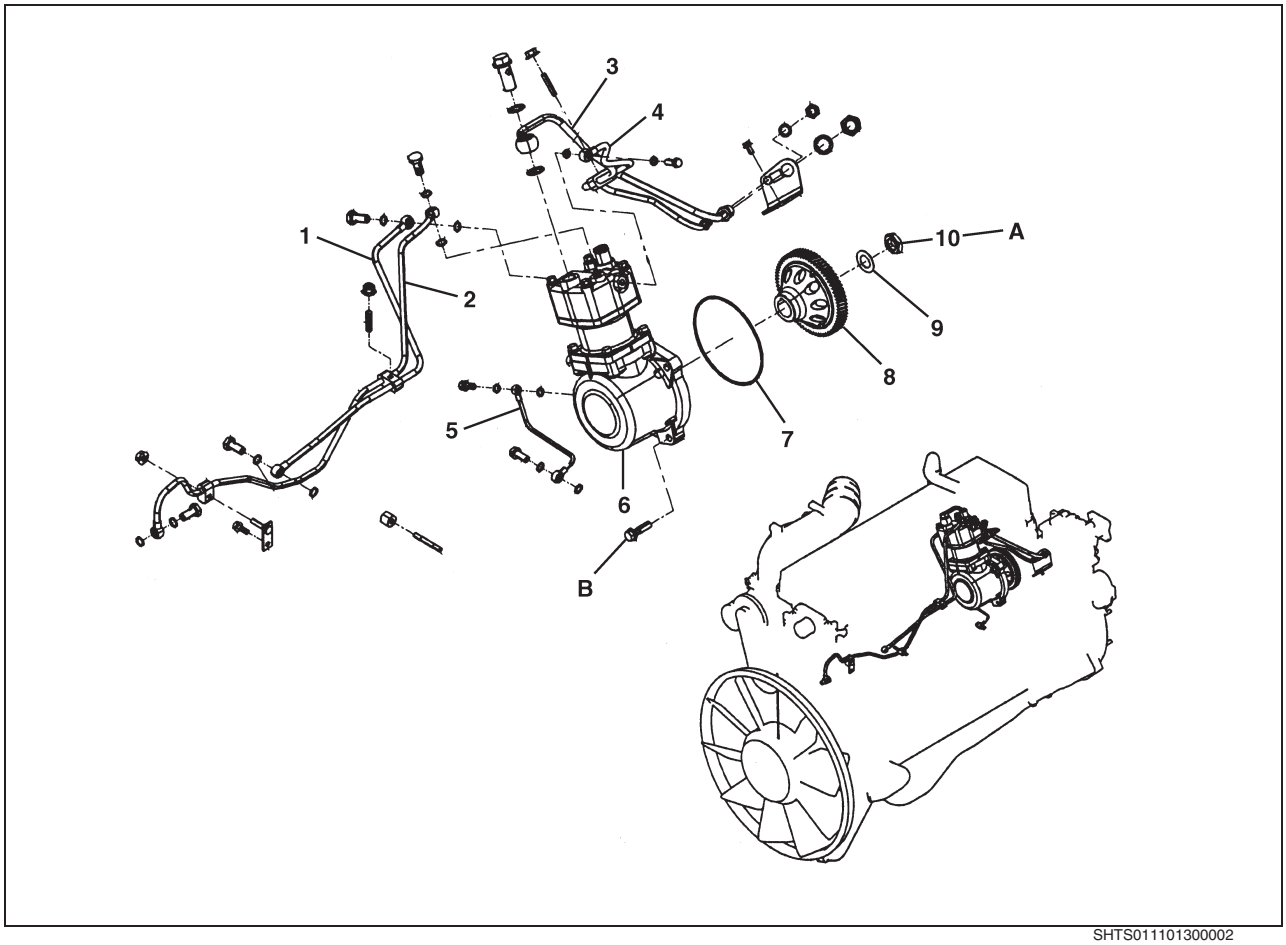
Symptom	Possible cause	Remedy/Prevention
Charging efficiency dropped (Valve)	Abnormal wear, damage, or poor contact	Replace.
Charging efficiency dropped (Piston, cylinder liner and piston rings)	Worn piston and cylinder liner	Replace.
	Seized piston	Replace (piston, piston rings and cylinder liner).
	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	Replace.
Charging efficiency dropped (Air cleaner)	Clogged element	Clean or replace element.

Symptom	Possible cause	Remedy/Prevention
Noisy operation (Piston)	Wear of piston pin boss or piston pin	Replace.
	Seized, damaged or worn connecting rod small end	Replace.
	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.

Symptom	Possible cause	Remedy/Prevention
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.
	Malfunction of piston rings	Replace piston rings and/or cylinder liner.
Excessive carbon or oil in the compressor cylinder head or discharge line (Cylinder liner and piston rings)	Worn cylinder liner and piston rings	Replace.

COMPONENT LOCATOR

EN0111013D100001



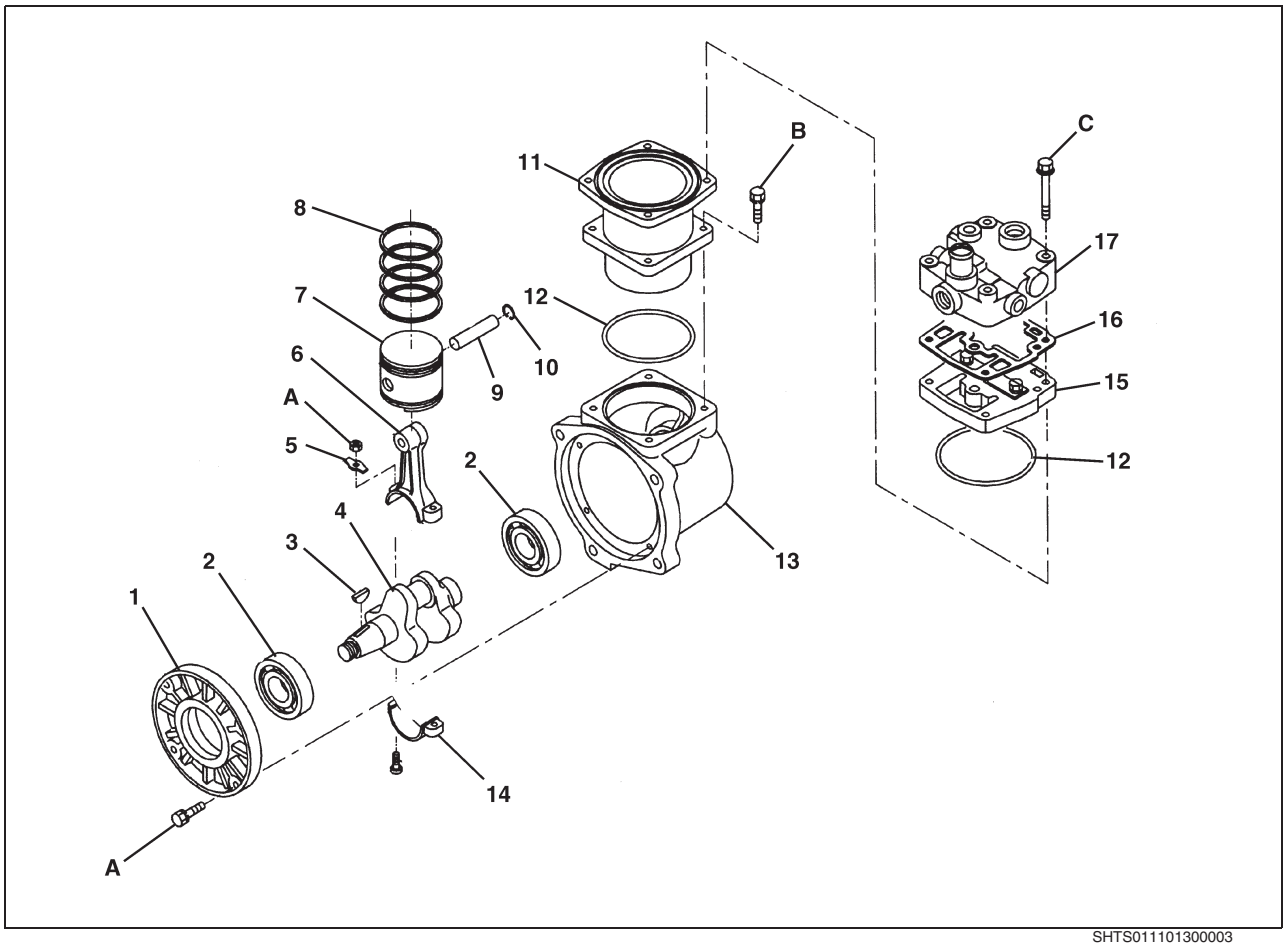
SHTS011101300002

1	Coolant inlet pipe	6	Air compressor
2	Coolant outlet pipe	7	O-ring
3	Air delivery pipe	8	Compressor drive gear
4	Air unloader pipe	9	Collar
5	Oil feed pipe	10	Nut

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

A	142 {1,450, 105} #	B	97 {990, 72}

#= Apply oil to the threads and seat surface before tightening.



SHTS011101300003

1	Bearing holder	10	Retainer ring
2	Ball bearing	11	Cylinder liner
3	Woodruff key	12	O-ring
4	Crankshaft	13	Cylinder block
5	Lock washer	14	Connecting rod cap
6	Connecting rod	15	Valve seat
7	Piston	16	Gasket
8	Piston ring	17	Cylinder head
9	Piston pin		

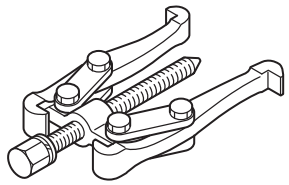
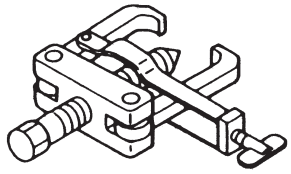
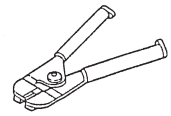
Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

A	23-26 {235-265, 17-19}	C	29-34 {300-350, 22-25}
B	25-29 {255-295, 19-21}		

SPECIAL TOOL

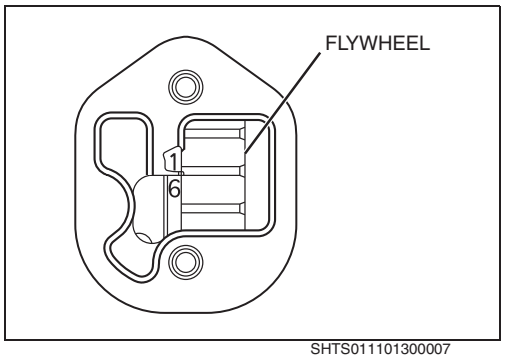
EN0111013K100001

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

Illustration	Part number	Tool name	Remarks
	09420-1830	PULLER	
	09650-1101	BEARING PULLER	
	09440-1060	PISTON RING EXPANDER	

OVERHAUL

EN0111013H200001

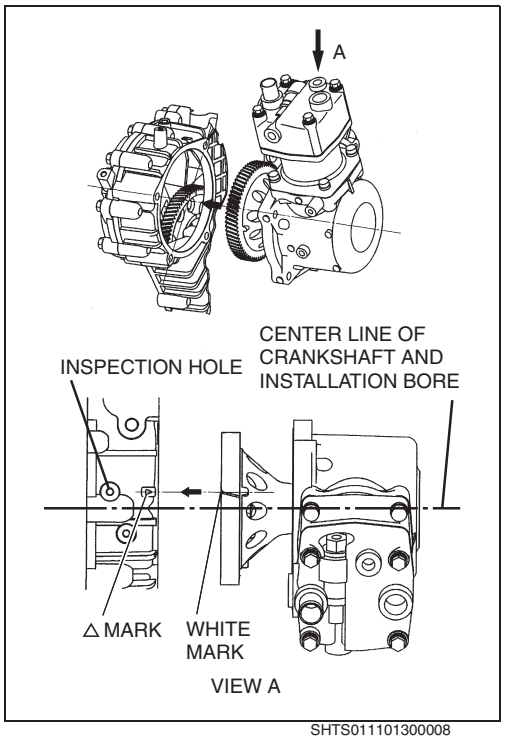


SHTS011101300007

IMPORTANT POINT - MOUNTING

1. INSTALLATION PROCEDURES

(1) Set the No.1 or No.6 cylinder to the top dead center of the compression stroke.



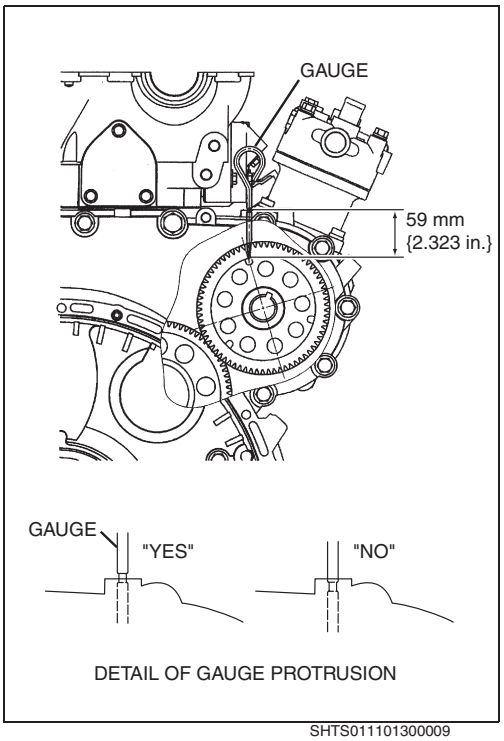
SHTS011101300008

(2) Install the O-ring to the groove of the air compressor.

(3) Align the white mark on the drive gear and the mark on the timing gear case, then install the air compressor into the timing gear case.

NOTICE

Do not rotate the drive gear until gears are engaged.



SHTS011101300009

(4) Use a 6 mm {0.236 in.} diameter rod with a mark inscribed at a depth of 59 mm {2.323 in.} as a gauge, and insert it into the timing gear case through the inspection hole. Confirm that the inscribed mark on the gauge protrudes from the top of the timing gear case. If it does not, repeat step (3) above.

(5) Tighten the inspection hole plug.
Tightening Torque:
13 N·m {133 kgf·cm, 10 lbf·ft}

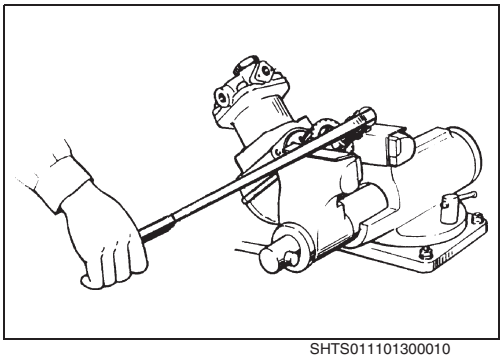
NOTICE
Do not re-use the inspection hole plug gasket.

IMPORTANT POINTS - DISASSEMBLY

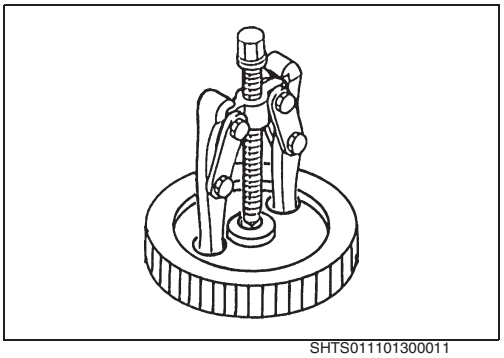
1. REMOVE THE DRIVE GEAR.

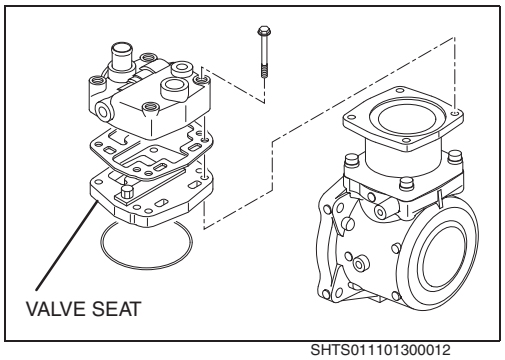
(1) Remove the lock nut from the compressor drive gear.

NOTICE
If the spread is insufficient, the drive gear will be damaged when loosing the nut.


SHTS011101300010

(2) Pull the drive gear from the crankshaft, then remove the woodruff key.
SST: Puller (09420-1830)


SHTS011101300011



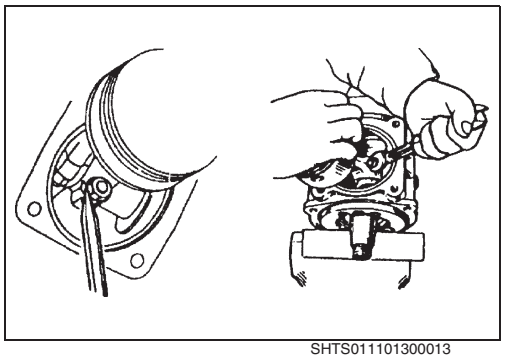
SHTS011101300012

2. REMOVE THE CYLINDER HEAD, GASKET, VALVE SEAT AND O-RING.

(1) Remove the cylinder head, gasket, valve seat and o-ring.

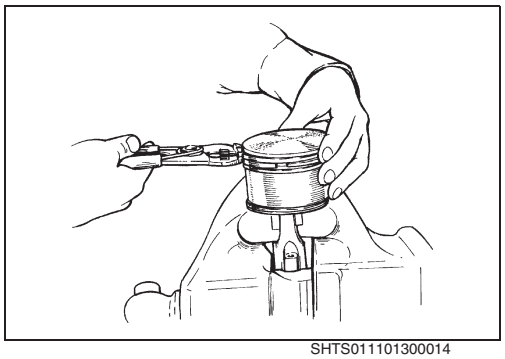
NOTICE

- **Put the marking through the cylinder head to the cylinder liner.**
- **Do not disassemble the valve seat.**


SHTS011101300013

3. REMOVE THE CONNECTING ROD WITH THE PISTON.

(1) Rotate the crankshaft to the top dead center position.
(2) Spread the staking of the nut completely with a chisel, then loosen the nut.
(3) Remove the connecting rod with piston.

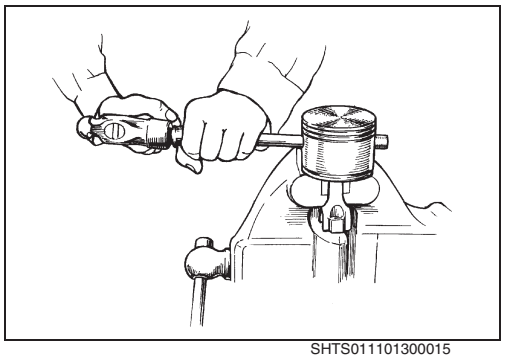

SHTS011101300014

4. REMOVE THE PISTON RINGS.

(1) Remove the piston rings.
SST: Piston ring expander (09440-1060)

NOTICE

- **Handle the piston rings carefully because they are made of a special casting which is easily broken.**
- **When reusing the piston rings, first arrange them face up and in the correct installation sequence in order to prevent installing them incorrectly.**


SHTS011101300015

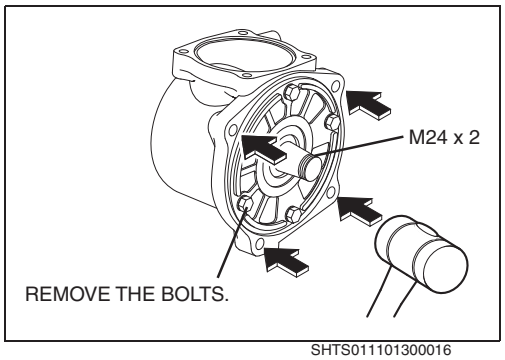
5. REMOVE THE PISTON.

(1) Remove the retainer rings installed on both ends of the piston, using retainer ring pliers.

⚠ WARNING
Wear a pair of safety goggles, because the retainer rings may spring out the groove at the time of removal.

(2) Strike out the piston pin.

NOTICE
Warm up the piston first in hot water, 80-90°C {176-194°F}, for approximately 5 minutes before removing the piston pin.



SHTS011101300016

6. REMOVE THE CRANKSHAFT.

(1) Remove the bearing holder fitting bolts.

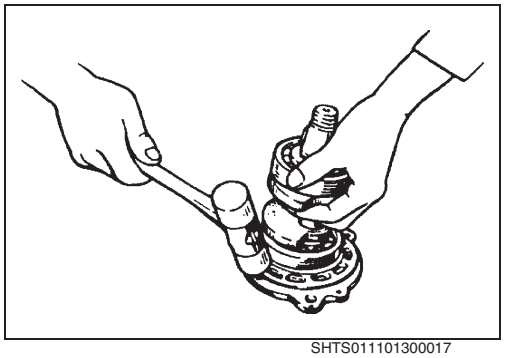
(2) Using a plastic hammer, tap the flange lightly to remove the bearing holder and crankshaft.

NOTICE

Be careful not to damage the bearing holder.

HINT

Remove the crankshaft with bearing holder, using a commercial sliding hammer.

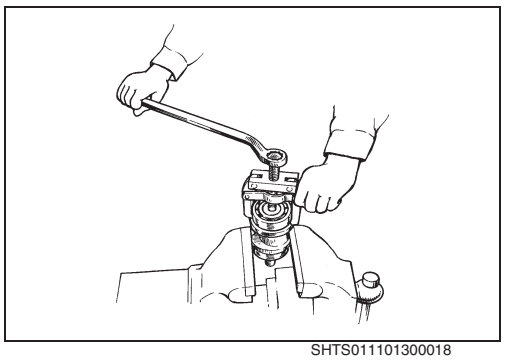

SHTS011101300017

7. REMOVE THE BEARING HOLDER.

(1) Strike the circumference of the holder lightly with a plastic hammer or a mallet and remove the holder.

NOTICE

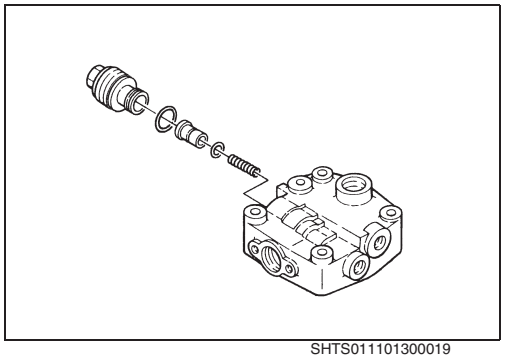
Be careful not to damage the bearing holder.


SHTS011101300018

8. REMOVE THE BALL BEARING.

(1) Using the special tool, remove the ball bearing from the end of the crankshaft.

SST: Bearing puller (09650-1101)

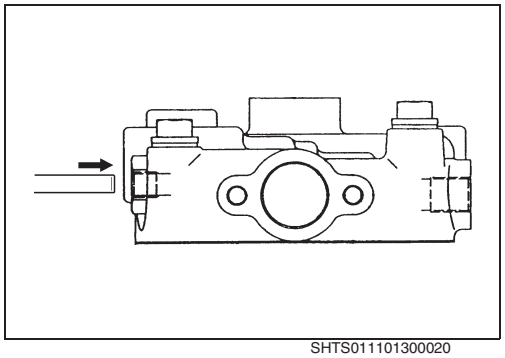

SHTS011101300019

IMPORTANT POINTS - ASSEMBLY

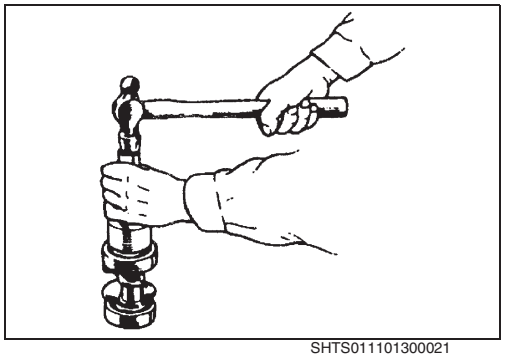
1. INSTALL THE UNLOADER VALVE.

(1) Apply adequate amount of silicone grease on the O-ring, O-ring groove and sliding surfaces.

(2) Install the unloader valve into the cylinder head.
Tightening Torque:
118-138 N·m {1,200-1,400 kgf·cm, 87-101 lbf·ft}

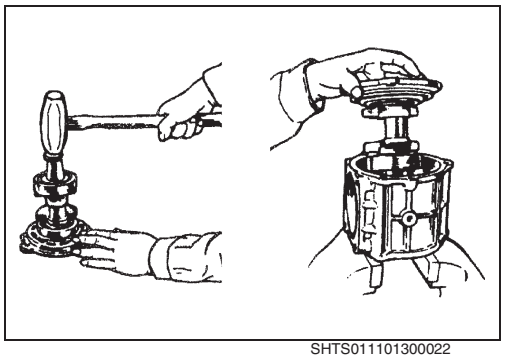

SHTS011101300020

(3) Push the unloader valve with a bar and check that the unloader valve and spring move smoothly.


SHTS011101300021

2. INSTALL THE BALL BEARING.

(1) Install the ball bearing onto the both ends of the crankshaft.

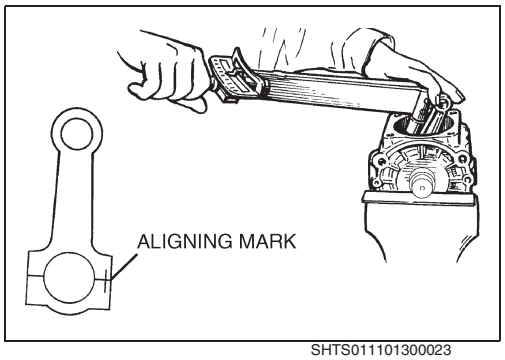

SHTS011101300022

3. INSTALL THE CRANKSHAFT.

(1) Using a copper hammer, install the crankshaft to the bearing holder.

(2) Install the crankshaft and bearing holder into the crankcase.

(3) Tighten the bearing holder fitting bolt.



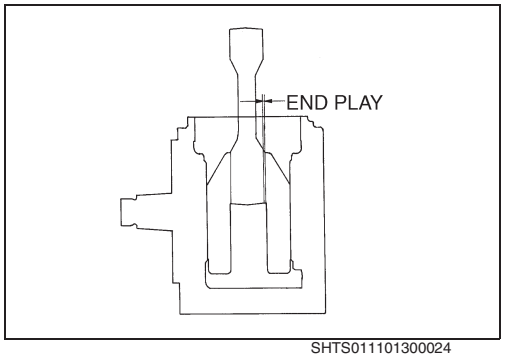
SHTS011101300023

4. INSTALL THE CONNECTING ROD AND MEASURE THE END PLAY.

NOTICE

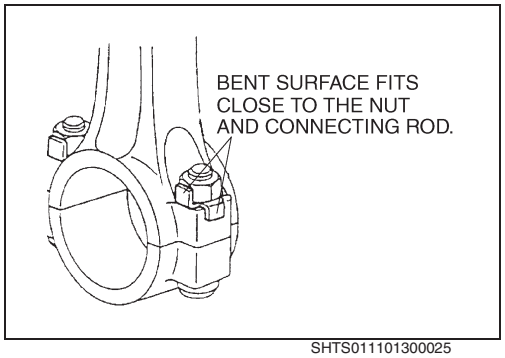
- **Be sure to align the aligning mark.**
- **Apply engine oil to the connecting rod and cap.**

(1) Apply engine oil to the thread before installing the connecting rod bolt.



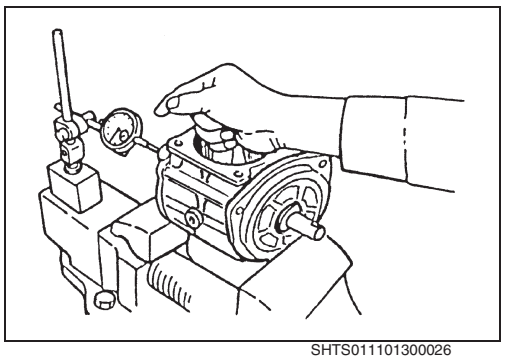
SHTS011101300024

(2) Measure the connecting rod end play.
Assembly standard: 0.2-0.4 mm {0.008-0.015 in.}
Limit: 0.5 mm {0.02 in.}

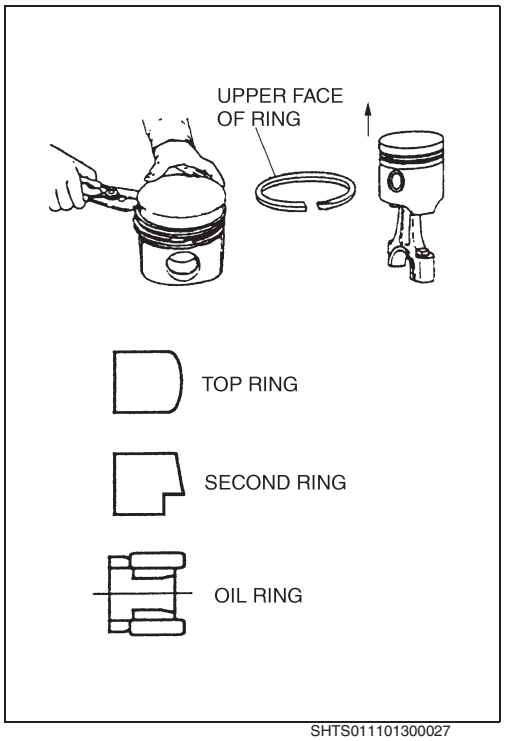


SHTS011101300025

(3) Lock the nut with a lock washer.


SHTS011101300026

5. MEASURE THE END PLAY OF THE CRANKSHAFT.
Assembly standard: 0-0.6 mm {0-0.0236 in.}
Limit: 1.0 mm {0.0394 in.}



SHTS011101300027

6. ASSEMBLE THE PISTON.

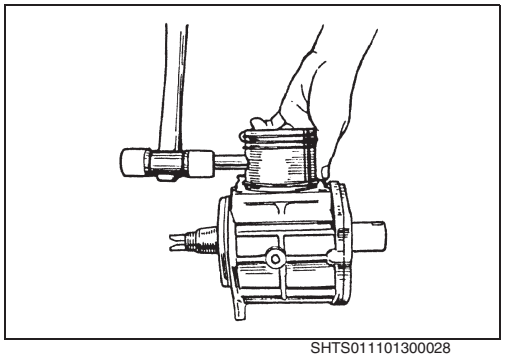
NOTICE

Assemble the various parts after applying engine oil to the sliding parts.

(1) When installing the piston rings on the piston, ensure that the piston skirt is at the bottom, and use the special tool.
SST: Piston ring expander (09440-1060)

NOTICE

Install the piston rings in order shown in the figure.



SHTS011101300028

7. ASSEMBLE THE PISTON AND CONNECTING ROD.

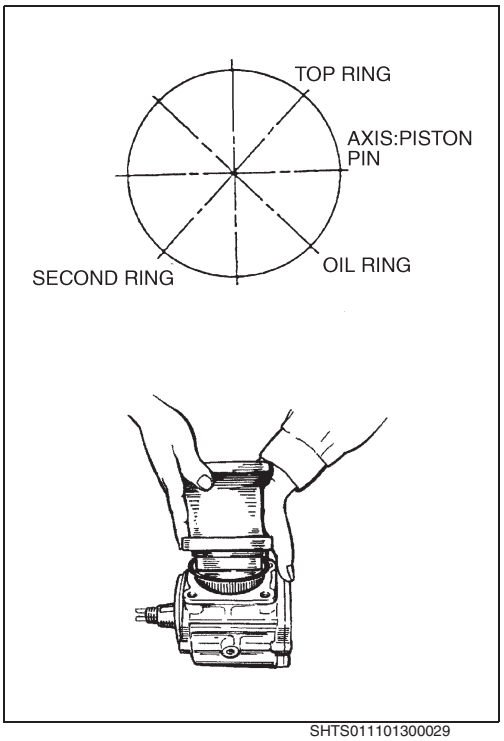
NOTICE

Warm up the piston first in hot water, to 80-90°C {176-194°F}, for approximately 5 minutes.

(1) Install the retainer ring at one end of the piston pin holes.
(2) Apply engine oil to the piston pin.
(3) Fix the piston and connecting rod by inserting the pin.
(4) Fit the new retainer ring at the other end.

⚠ CAUTION

The retainer ring may spring out of the groove during assembly. Wear a pair of safety goggles during assembly.



SHTS011101300029

8. INSTALL THE CYLINDER LINER AND CYLINDER HEAD.

NOTICE

Do not twist the O-ring when installing it on the cylinder liner and cylinder head.

(1) Rotate the crankshaft to the top dead center position.
(2) Arrange the piston rings so that their gaps are equally spaced.
(3) Install the cylinder liner and cylinder head.

9. INSTALL THE DRIVE GEAR.

(1) Install the woodruff key to the crankshaft.
(2) Insert the drive gear.
(3) Insert the collar and lock nut.
Tightening Torque:
142 N·m {1,450 kgf·cm, 105 lbf·ft}

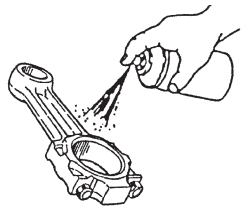
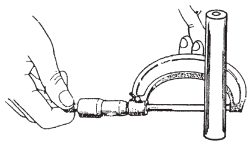
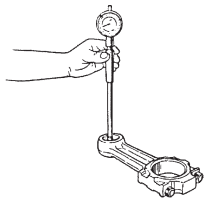
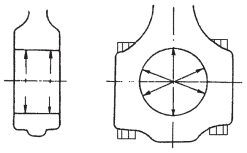
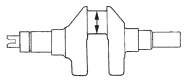
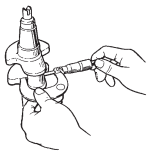
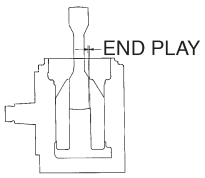
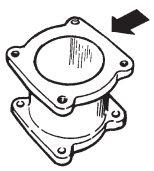
NOTICE

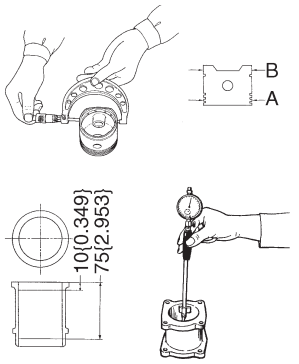
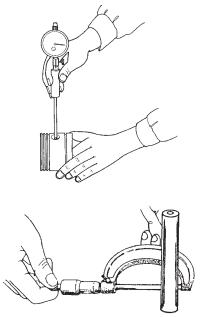
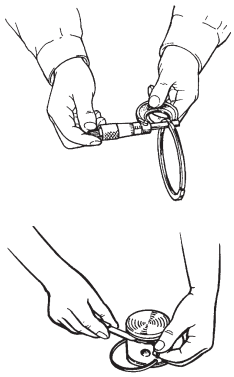
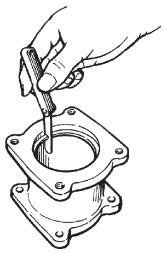
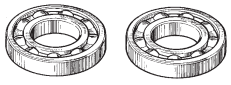
Apply oil to the threads and seat surface before tightening.

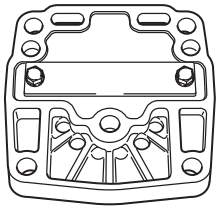
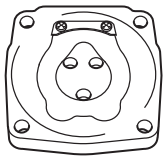
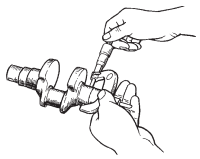
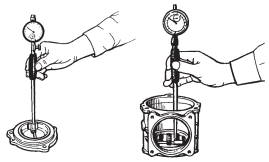
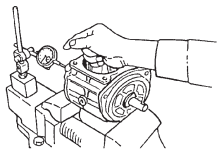
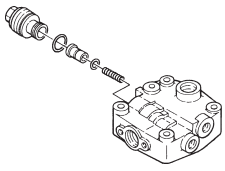
INSPECTION AND REPAIR

EN0111013H300001

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 
Outside diameter of the crankshaft journal	Drive gear side	35 {1.378}	34.995 {1.3778}	Replace.	Measure 
	Opposite drive gear side	30 {1.1811}	29.995 {1.1809}		
Inside diameter of the bearing holder	Cylinder block	80 {3.1496}	80.04 {3.1512}	Replace.	Measure 
	Bearing holder	80 {3.1496}	80.04 {3.1512}		
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 

AIR COMPRESSOR (E13C: 496cm^3 TYPE)

EN13-002

AIR COMPRESSOR

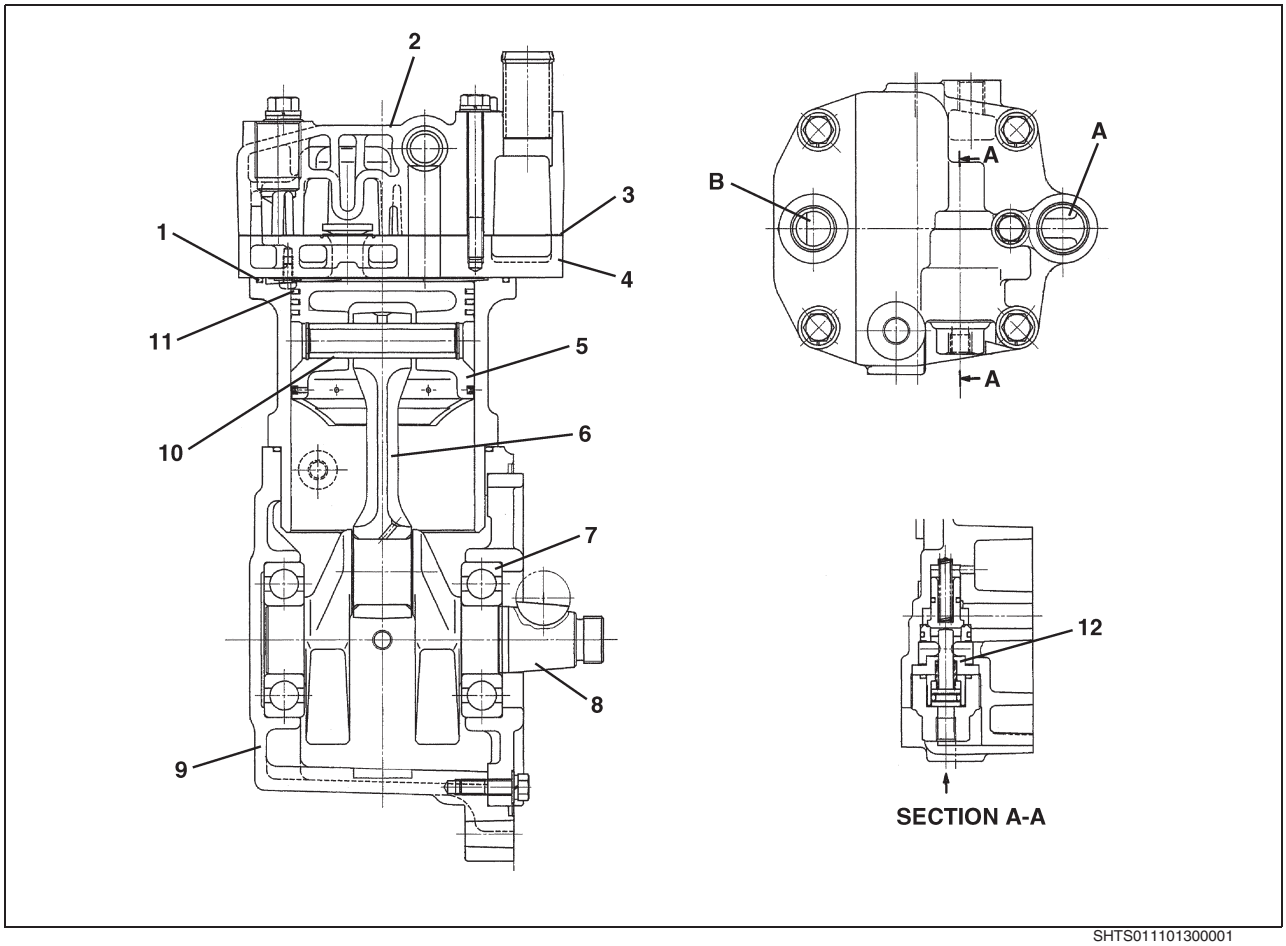
DATA AND SPECIFICATIONS

EN0111013I200001

Type	Reciprocating, single cylinder
Discharge amount	496 cm^3 {30.3 cu.in.}
Bore x stroke	95 mm x 70 mm {3.74 in. x 2.76 in.}
Lubrication system	Forced feed lubrication
Cooling system	Forced water-circulated

DESCRIPTION

EN0111013C100001



SHTS011101300001

1	O-ring	8	Crankshaft
2	Cylinder head assembly	9	Crankcase
3	Gasket	10	Piston pin
4	Valve seat	11	Piston ring
5	Piston	12	Unloader valve
6	Connecting rod	A	Suction
7	Bearing	B	Delivery

TROUBLESHOOTING

EN0111013F300001

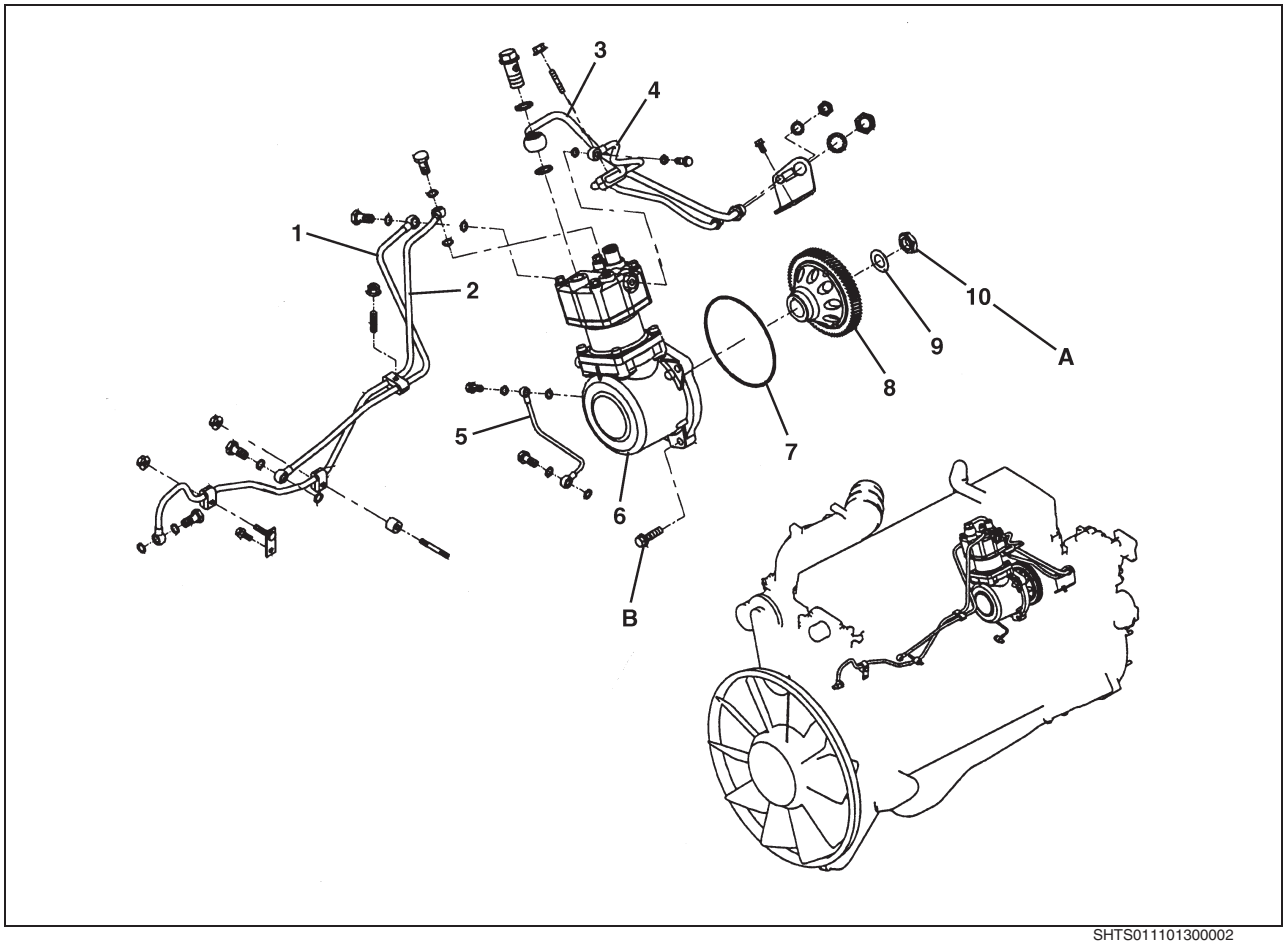
Symptom	Possible cause	Remedy/Prevention
Charging efficiency dropped (Valve)	Abnormal wear, damage, or poor contact	Replace.
Charging efficiency dropped (Piston, cylinder liner and piston rings)	Worn piston and cylinder liner	Replace.
	Seized piston	Replace (piston, piston rings and cylinder liner).
	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	Replace.
Charging efficiency dropped (Air cleaner)	Clogged element	Clean or replace element.

Symptom	Possible cause	Remedy/Prevention
Noisy operation (Piston)	Wear of piston pin boss or piston pin	Replace.
	Seized, damaged or worn connecting rod small end	Replace.
	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.

Symptom	Possible cause	Remedy/Prevention
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.
	Malfunction of piston rings	Replace piston rings and/or cylinder liner.
Excessive carbon or oil in the compressor cylinder head or discharge line (Cylinder liner and piston rings)	Worn cylinder liner and piston rings	Replace.

COMPONENT LOCATOR

EN0111013D100001



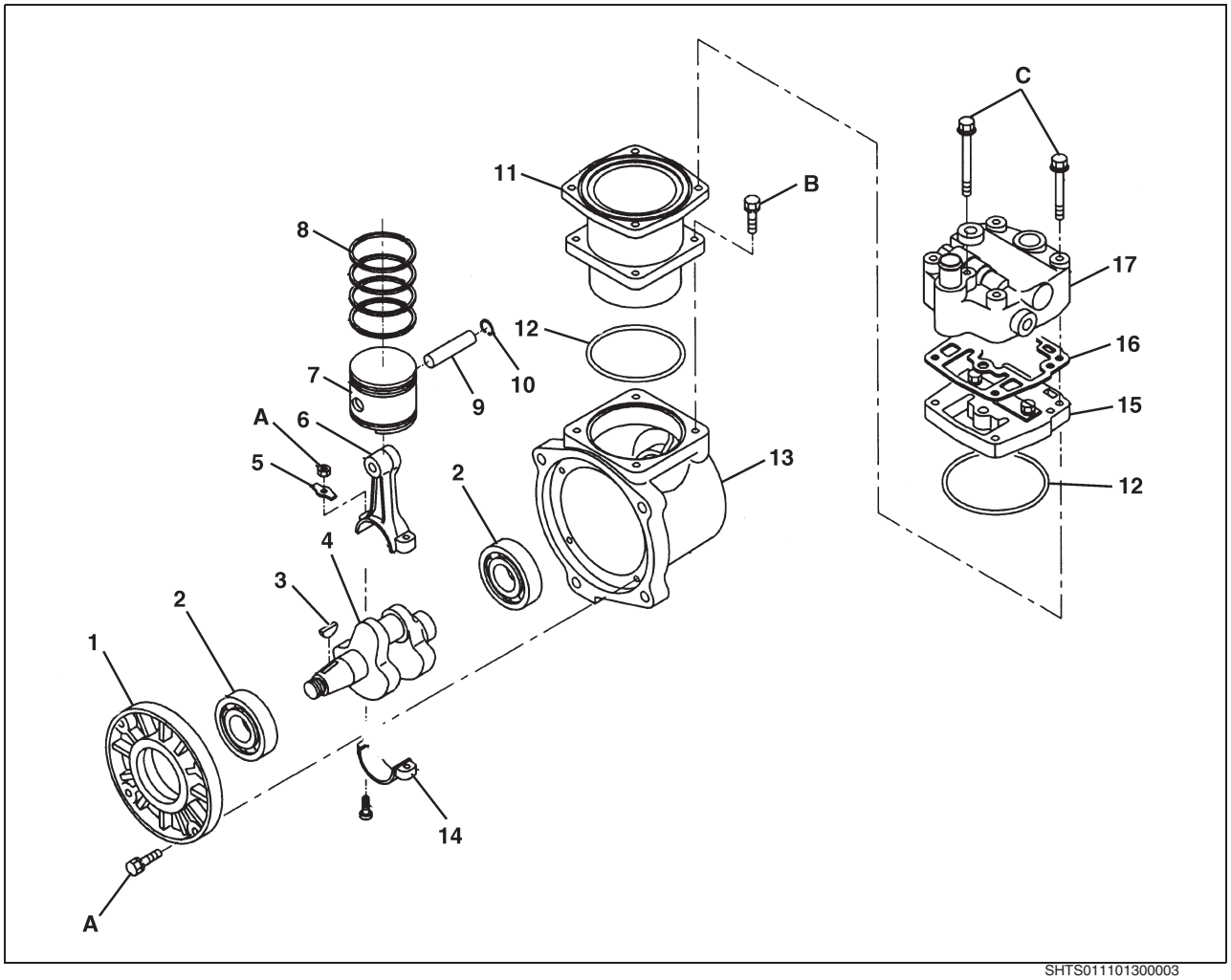
SHTS011101300002

1	Coolant inlet pipe	6	Air compressor
2	Coolant outlet pipe	7	O-ring
3	Air delivery pipe	8	Compressor drive gear
4	Air unloader pipe	9	Collar
5	Oil feed pipe	10	Nut

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

A	142 {1,450, 105} #	B	97 {990, 72}

#= Apply oil to the threads and seat surface before tightening.



SHTS011101300003

1	Bearing holder	10	Retainer ring
2	Ball bearing	11	Cylinder liner
3	Woodruff key	12	O-ring
4	Crankshaft	13	Cylinder block
5	Lock washer	14	Connecting rod cap
6	Connecting rod	15	Valve seat
7	Piston	16	Gasket
8	Piston ring	17	Cylinder head
9	Piston pin		

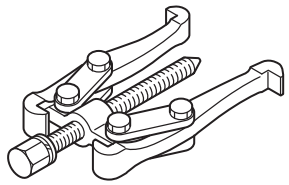
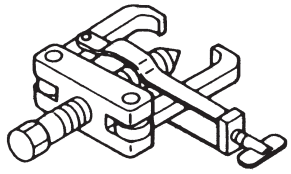
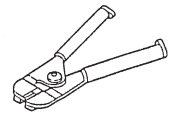
Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

A	23-26 {235-265, 17-19}	C	29-34 {300-350, 22-25}
B	25-29 {255-295, 19-21}		

SPECIAL TOOL

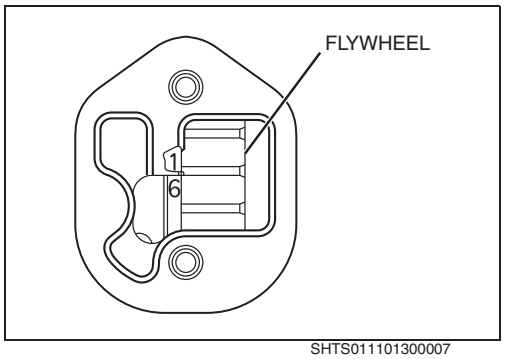
EN0111013K100001

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

Illustration	Part number	Tool name	Remarks
	09420-1830	PULLER	
	09650-1101	BEARING PULLER	
	09440-1060	PISTON RING EXPANDER	

OVERHAUL

EN0111013H200001

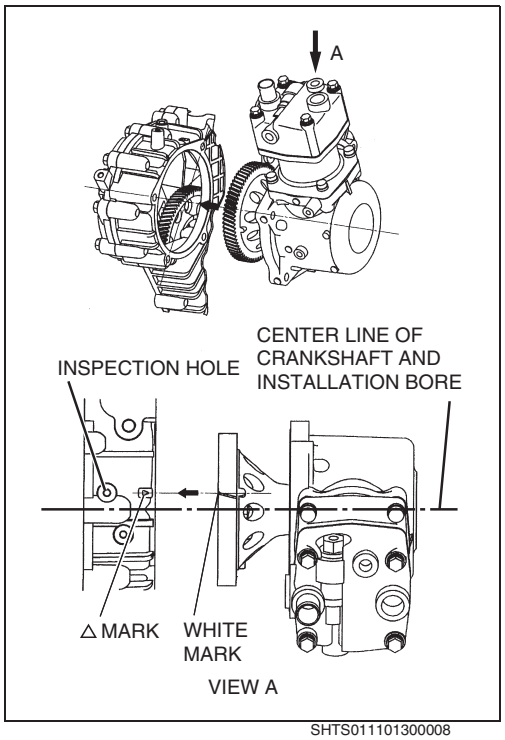


SHTS011101300007

IMPORTANT POINT - MOUNTING

1. INSTALLATION PROCEDURES

(1) Set the No.1 or No.6 cylinder to the top dead center of the compression stroke.



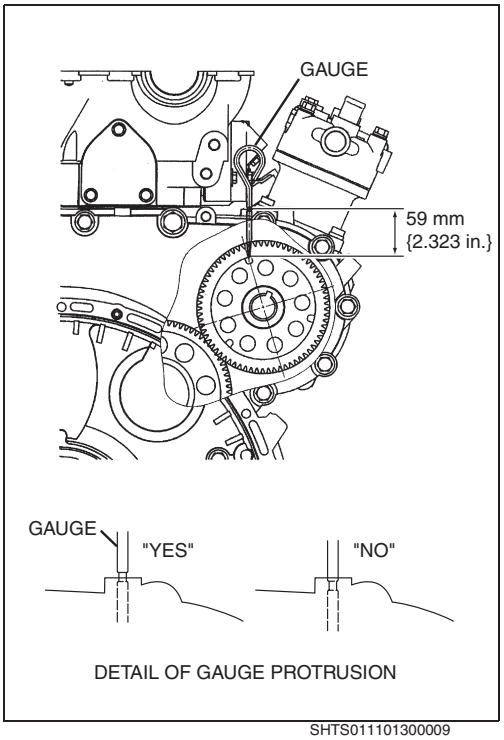
SHTS011101300008

(2) Install the O-ring to the groove of the air compressor.

(3) Align the white mark on the drive gear and the mark on the timing gear case, then install the air compressor into the timing gear case.

NOTICE

Do not rotate the drive gear until gears are engaged.



SHTS011101300009

(4) Use a 6 mm {0.236 in.} diameter rod with a mark inscribed at a depth of 59 mm {2.323 in.} as a gauge, and insert it into the timing gear case through the inspection hole. Confirm that the inscribed mark on the gauge protrudes from the top of the timing gear case. If it does not, repeat step (3) above.

(5) Tighten the inspection hole plug.
Tightening Torque:
13 N·m {133 kgf·cm, 10 lbf·ft}

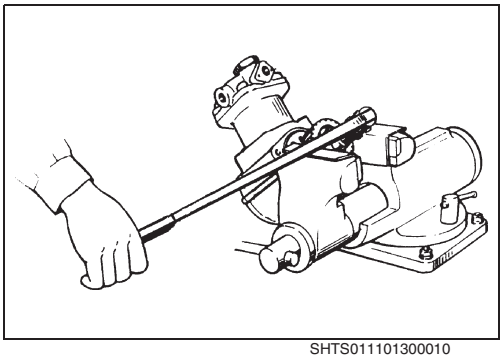
NOTICE
Do not re-use the inspection hole plug gasket.

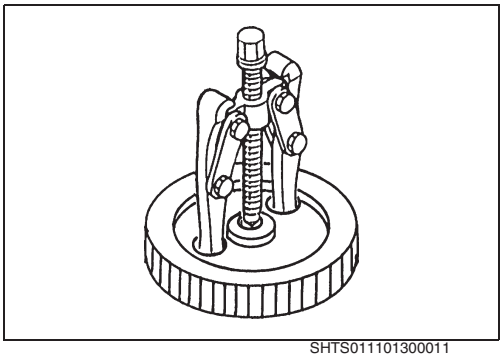
IMPORTANT POINTS - DISASSEMBLY

1. REMOVE THE DRIVE GEAR.

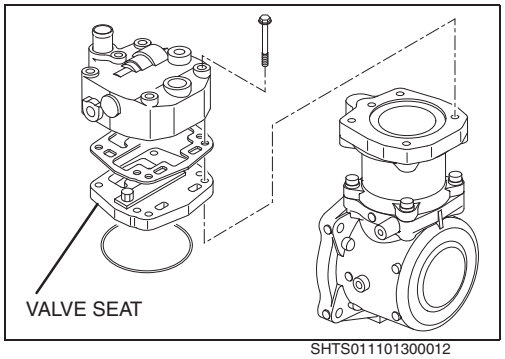
(1) Remove the lock nut from the compressor drive gear.

NOTICE
If the spread is insufficient, the drive gear will be damaged when loosing the nut.


SHTS011101300010


SHTS011101300011

(2) Pull the drive gear from the crankshaft, then remove the woodruff key.
SST: Puller (09420-1830)



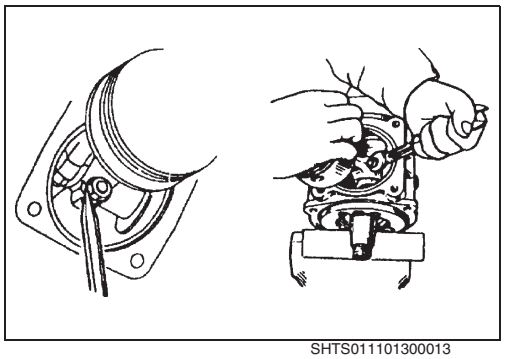
SHTS011101300012

2. REMOVE THE CYLINDER HEAD, GASKET, VALVE SEAT AND O-RING.

(1) Remove the cylinder head, gasket, valve seat and o-ring.

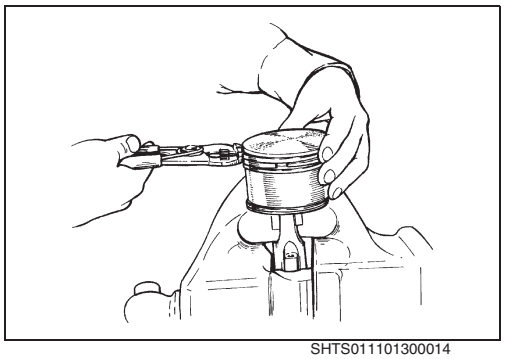
NOTICE

- **Put the marking through the cylinder head to the cylinder liner.**
- **Do not disassemble the valve seat.**


SHTS011101300013

3. REMOVE THE CONNECTING ROD WITH THE PISTON.

(1) Rotate the crankshaft to the top dead center position.
(2) Spread the staking of the nut completely with a chisel, then loosen the nut.
(3) Remove the connecting rod with piston.

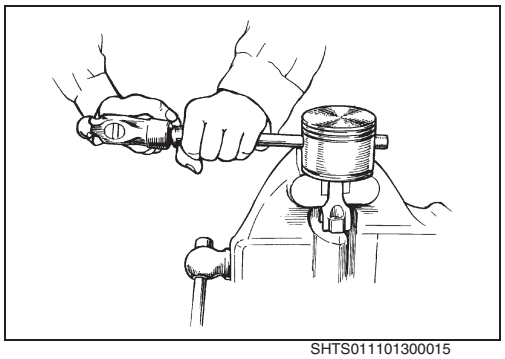

SHTS011101300014

4. REMOVE THE PISTON RINGS.

(1) Remove the piston rings.
SST: Piston ring expander (09440-1060)

NOTICE

- **Handle the piston rings carefully because they are made of a special casting which is easily broken.**
- **When reusing the piston rings, first arrange them face up and in the correct installation sequence in order to prevent installing them incorrectly.**


SHTS011101300015

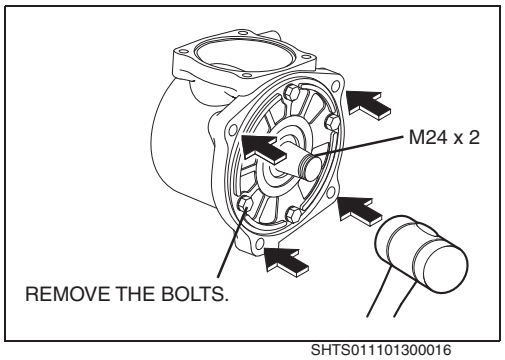
5. REMOVE THE PISTON.

(1) Remove the retainer rings installed on both ends of the piston, using retainer ring pliers.

⚠ WARNING
Wear a pair of safety goggles, because the retainer rings may spring out the groove at the time of removal.

(2) Strike out the piston pin.

NOTICE
Warm up the piston first in hot water, 80-90°C {176-194°F}, for approximately 5 minutes before removing the piston pin.



SHTS011101300016

6. REMOVE THE CRANKSHAFT.

(1) Remove the bearing holder fitting bolts.

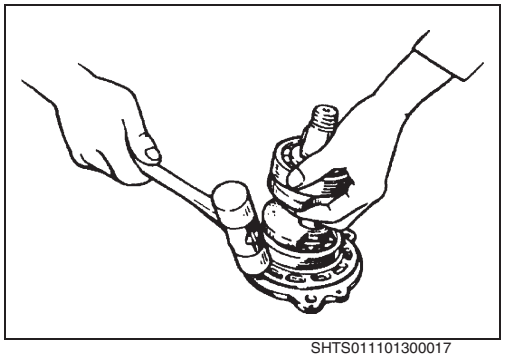
(2) Using a plastic hammer, tap the flange lightly to remove the bearing holder and crankshaft.

NOTICE

Be careful not to damage the bearing holder.

HINT

Remove the crankshaft with bearing holder, using a commercial sliding hammer.

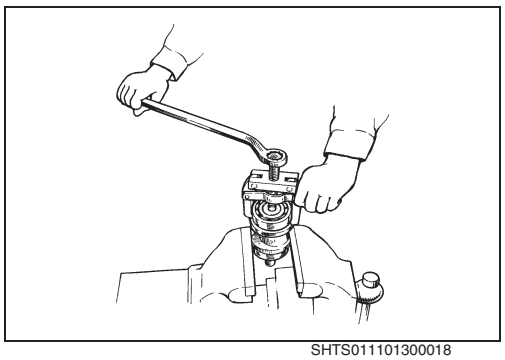

SHTS011101300017

7. REMOVE THE BEARING HOLDER.

(1) Strike the circumference of the holder lightly with a plastic hammer or a mallet and remove the holder.

NOTICE

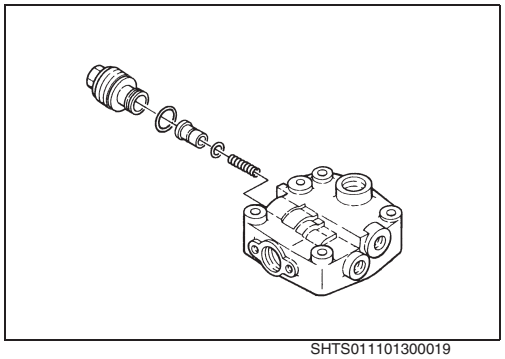
Be careful not to damage the bearing holder.


SHTS011101300018

8. REMOVE THE BALL BEARING.

(1) Using the special tool, remove the ball bearing from the end of the crankshaft.

SST: Bearing puller (09650-1101)

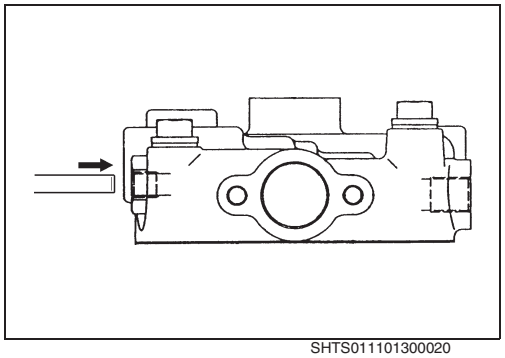

SHTS011101300019

IMPORTANT POINTS - ASSEMBLY

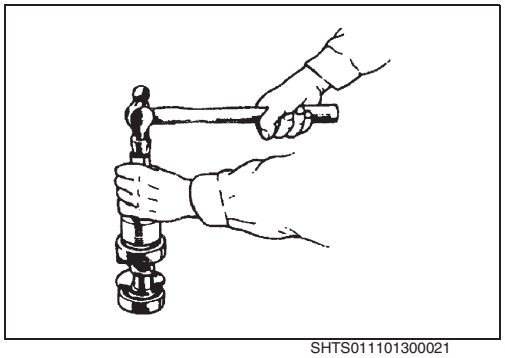
1. INSTALL THE UNLOADER VALVE.

(1) Apply adequate amount of silicone grease on the O-ring, O-ring groove and sliding surfaces.

(2) Install the unloader valve into the cylinder head.
Tightening Torque:
118-138 N·m {1,200-1,400 kgf·cm, 87-101 lbf·ft}

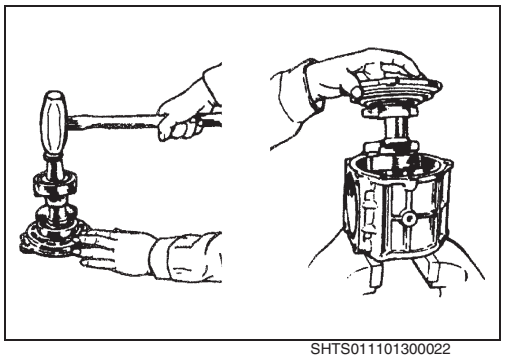

SHTS011101300020

(3) Push the unloader valve with a bar and check that the unloader valve and spring move smoothly.


SHTS011101300021

2. INSTALL THE BALL BEARING.

(1) Install the ball bearing onto the both ends of the crankshaft.

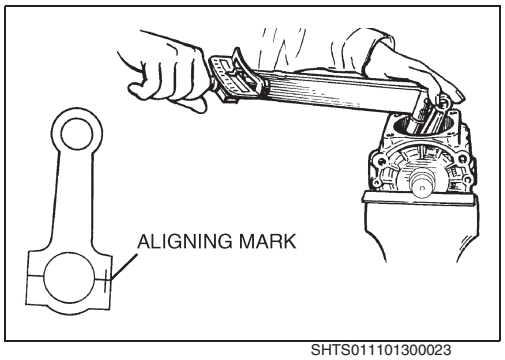

SHTS011101300022

3. INSTALL THE CRANKSHAFT.

(1) Using a copper hammer, install the crankshaft to the bearing holder.

(2) Install the crankshaft and bearing holder into the crankcase.

(3) Tighten the bearing holder fitting bolt.



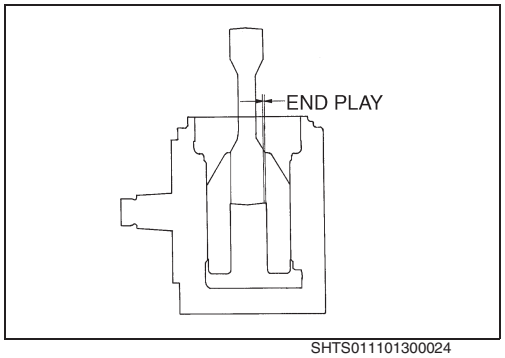
SHTS011101300023

4. INSTALL THE CONNECTING ROD AND MEASURE THE END PLAY.

NOTICE

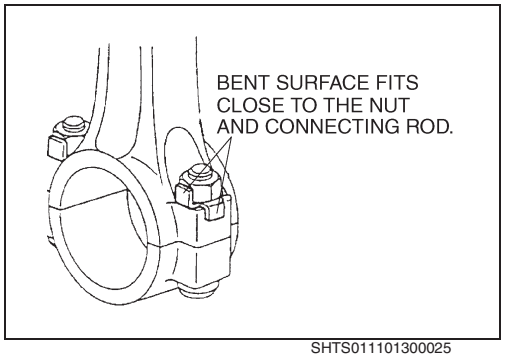
- **Be sure to align the aligning mark.**
- **Apply engine oil to the connecting rod and cap.**

(1) Apply engine oil to the thread before installing the connecting rod bolt.



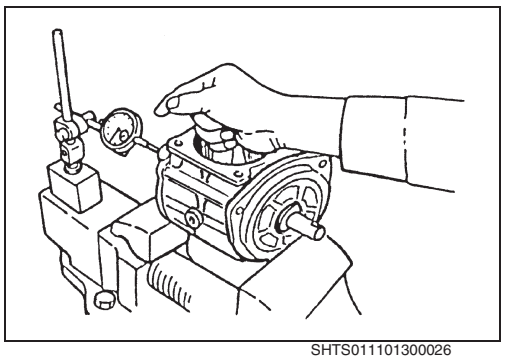
SHTS011101300024

(2) Measure the connecting rod end play.
Assembly standard: 0.2-0.4 mm {0.008-0.015 in.}
Limit: 0.5 mm {0.02 in.}

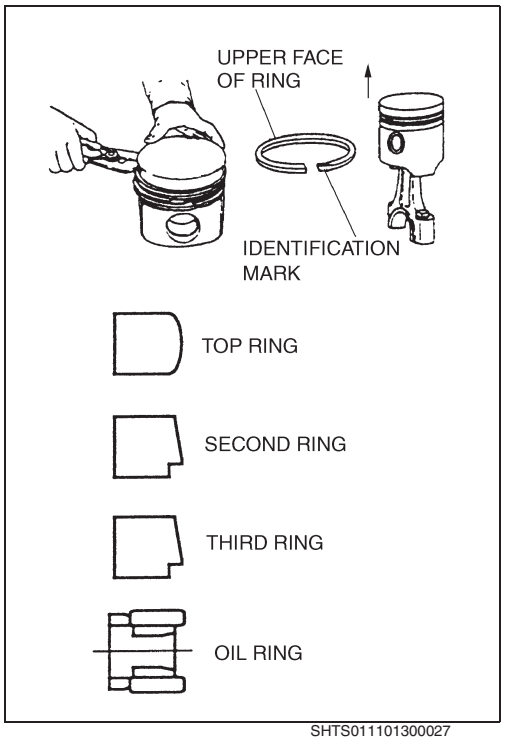


SHTS011101300025

(3) Lock the nut with a lock washer.


SHTS011101300026

5. MEASURE THE END PLAY OF THE CRANKSHAFT.
Assembly standard: 0-0.6 mm {0-0.0236 in.}
Limit: 1.0 mm {0.0394 in.}



SHTS011101300027

6. ASSEMBLE THE PISTON.

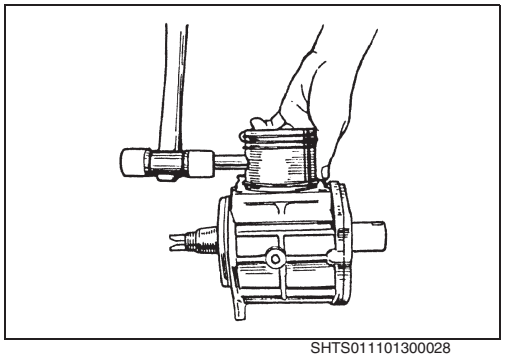
NOTICE

Assemble the various parts after applying engine oil to the sliding parts.

(1) When installing the piston rings on the piston, ensure that the piston skirt is at the bottom, and use the special tool.
SST: Piston ring expander (09440-1060)

NOTICE

Install the piston rings in order shown in the figure.


SHTS011101300028

7. ASSEMBLE THE PISTON AND CONNECTING ROD.

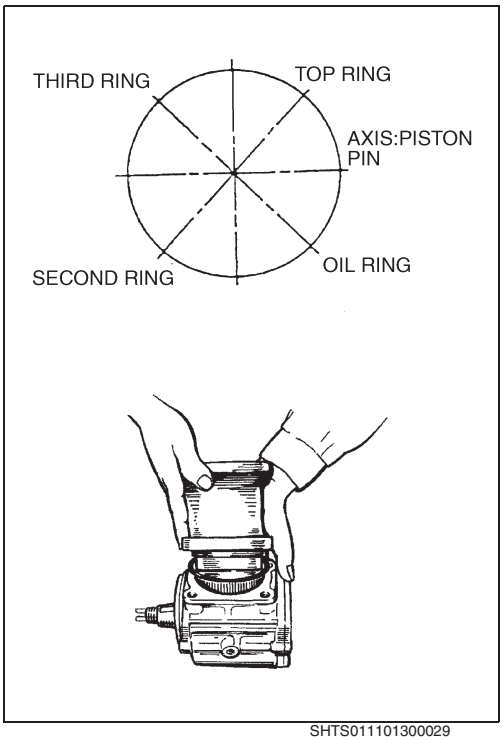
NOTICE

Warm up the piston first in hot water, to 80-90°C {176-194°F}, for approximately 5 minutes.

(1) Install the retainer ring at one end of the piston pin holes.
(2) Apply engine oil to the piston pin.
(3) Fix the piston and connecting rod by inserting the pin.
(4) Fit the new retainer ring at the other end.

⚠ CAUTION

The retainer ring may spring out of the groove during assembly. Wear a pair of safety goggles during assembly.



SHTS011101300029

8. INSTALL THE CYLINDER LINER AND CYLINDER HEAD.

NOTICE

Do not twist the O-ring when installing it on the cylinder liner and cylinder head.

(1) Rotate the crankshaft to the top dead center position.
(2) Arrange the piston rings so that their gaps are equally spaced.
(3) Install the cylinder liner and cylinder head.

9. INSTALL THE DRIVE GEAR.

(1) Install the woodruff key to the crankshaft.
(2) Insert the drive gear.
(3) Insert the collar and lock nut.
Tightening Torque:
142 N·m {1,450 kgf·cm, 105 lbf·ft}

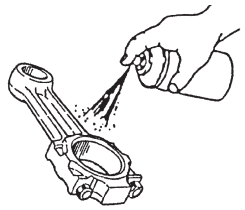
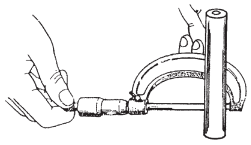
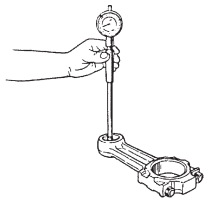
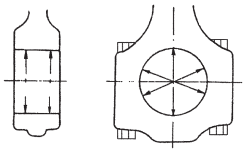
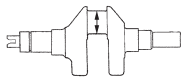
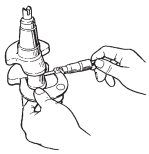
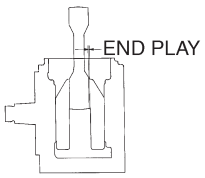
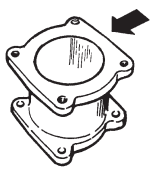
NOTICE

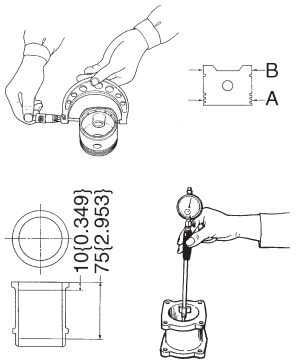
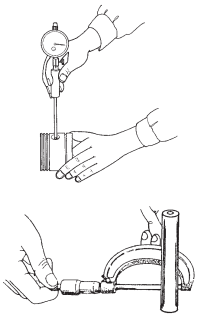
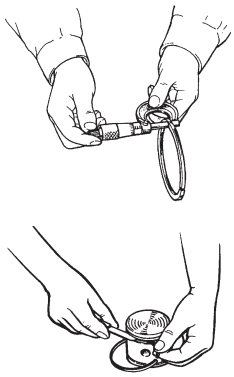
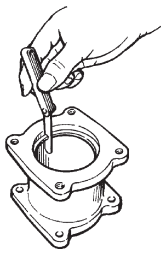
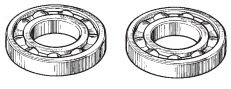
Apply oil to the threads and seat surface before tightening.

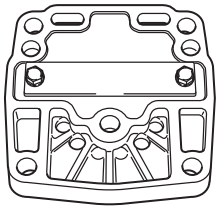
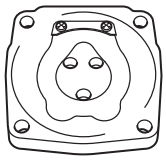
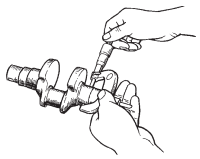
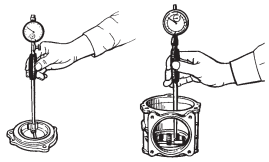
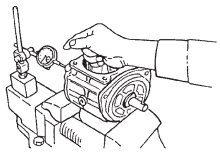
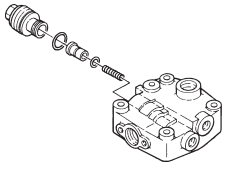
INSPECTION AND REPAIR

EN0111013H300001

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		95 {3.740}	—	Replace.	Measure 
Inside diameter of the cylinder liner		95 {3.740}	—		
Clearance between the piston and the cylinder liner		A: 0.18-0.245 {0.0071-0.0096}	0.285 {0.0112}		
		B: 0.119-0.149 {0.0047-0.0058}	0.189 {0.0074}		
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	2.5 {0.0984}	—	Replace.	Measure 
	Oil ring	4.0 {0.1575}	—		
Piston ring groove	Compression ring	2.5 {0.0984}	—		
	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	0.15-0.3 {0.0060-0.0118}	1.0 {0.0394}	Replace.	Measure 
	2nd	0.15-0.3 {0.0060-0.0118}	1.0 {0.0394}		
	3rd	0.15-0.3 {0.0060-0.0118}	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 
Outside diameter of the crank-shaft journal	Drive gear side	35 {1.378}	34.995 {1.3778}	Replace.	Measure 
	Opposite drive gear side	30 {1.1811}	29.995 {1.1809}		
Inside diame-ter of the bearing holder	Cylinder block	80 {3.1496}	80.04 {3.1512}	Replace.	Measure 
	Bearing holder	80 {3.1496}	80.04 {3.1512}		
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 

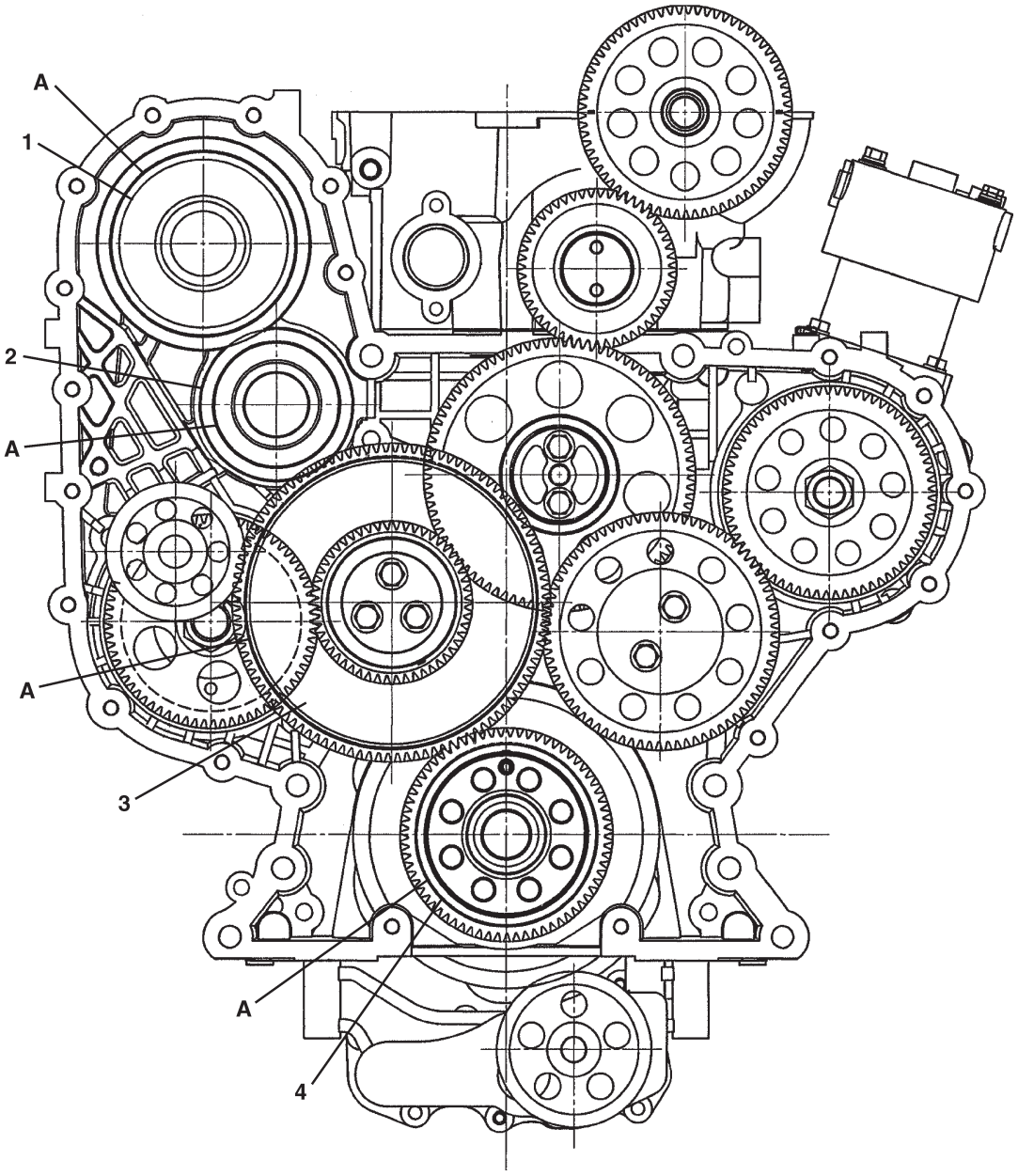
ENGINE P.T.O. (POWER TAKE-OFF) (E13C)

EN14-001

POWER TAKE-OFF ASSEMBLY

DESCRIPTION

EN0111014C100001



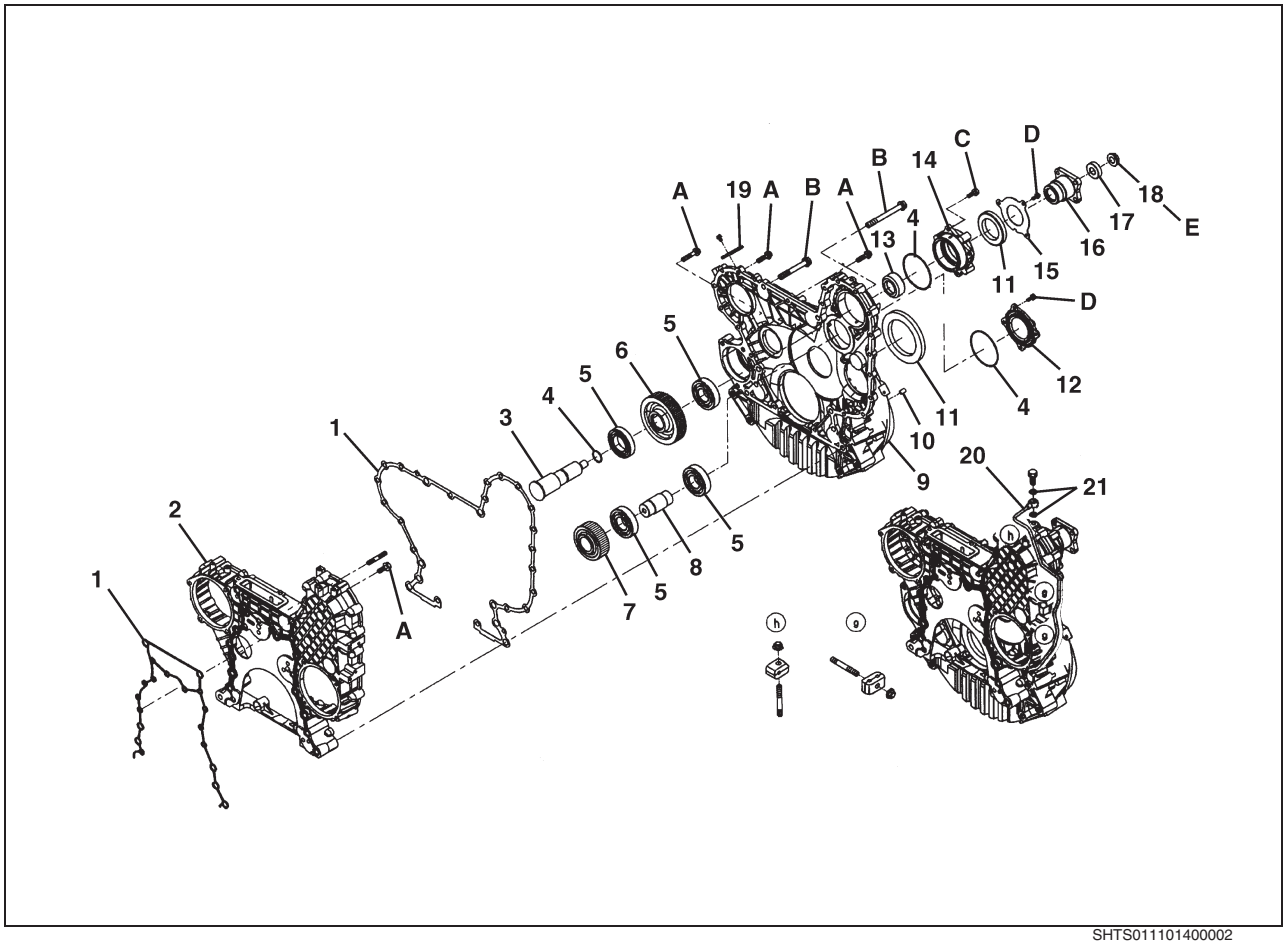
NOTICE: The gears for power take-off are identified by groove (A) in the face of the gear as shown in the figure.

SHTS011101400001

1	Power take-off driven gear	4	Crankshaft gear
2	Power take-off idle gear	A	Identification mark (Groove)
3	Main idle gear		

COMPONENT LOCATOR

EN0111014D100001



SHTS011101400002

1	Gasket	8	Idle gear shaft	15	Oil seal cover
2	Timing gear case	9	Flywheel housing	16	Flange
3	Driven shaft	10	Pin	17	Collar
4	O-ring	11	Oil seal	18	Lock nut
5	Ball bearing	12	Idle gear cover	19	Dust cover
6	Driven gear	13	Sleeve	20	Oil pipe
7	Idle gear	14	Driven gear cover	21	Soft washer

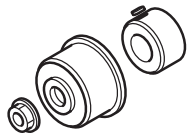
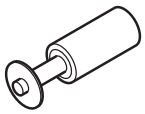
Tightening torque **Unit: N·m {kgf·cm, lbf·ft}**

A	125 {1,275, 92}	D	28.5 {290, 21}
B	225 {2,300, 166}	E	280 {2,850, 206}
C	55 {560, 41}		

SPECIAL TOOL

EN0111014K100001

Prior to starting a power take-off overhaul, it is necessary to have these special tools.

Illustration	Part number	Tool name	Remarks
	09407-1190	OIL SEAL PRESS	
	09402-1560	GUIDE	

OVERHAUL

EN0111014H200001

IMPORTANT POINTS - DISASSEMBLY

⚠ CAUTION
Do not work on the while it is still hot. This can result in personal injury.

1. BLOCK THE WHEELS.
(1) Park the vehicle on level ground.
(2) Block the wheels.

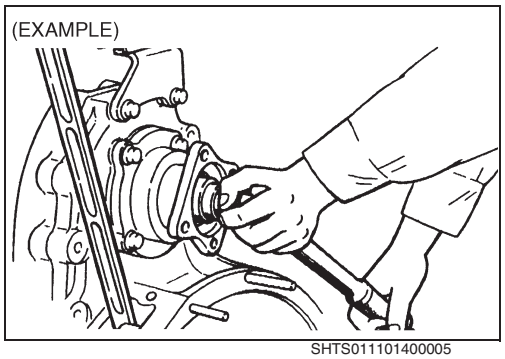
NOTICE
Be sure to apply wheel stoppers at the front tires.

2. DRAIN THE ENGINE OIL.

3. DISMOUNT THE TRANSMISSION.

4. DISMOUNT THE CLUTCH COVER ASSEMBLY AND CLUTCH DISC.

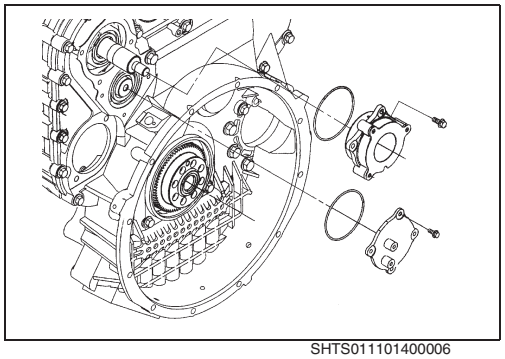
5. REMOVE THE COUPLING.
(1) Secure the flywheel with tire lever, then remove the lock nut.
(2) Remove the coupling.



SHTS011101400005

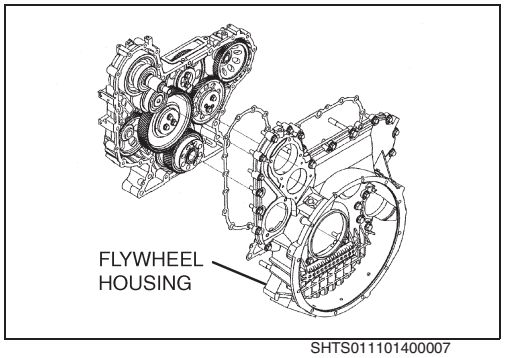
6. REMOVE THE FLYWHEEL.

7. REMOVE THE FLYWHEEL HOUSING STAY FROM BOTH SIDES OF THE HOUSING.


SHTS011101400006

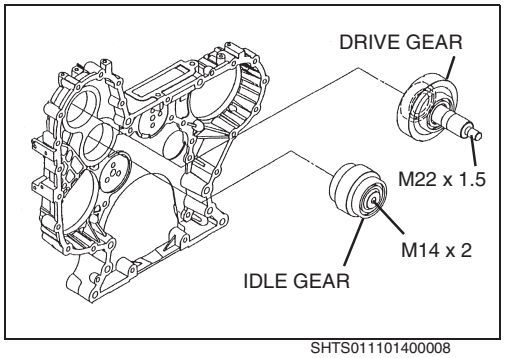
8. DISASSEMBLE THE POWER TAKE-OFF.

(1) Remove the idle gear cover and driven gear cover.



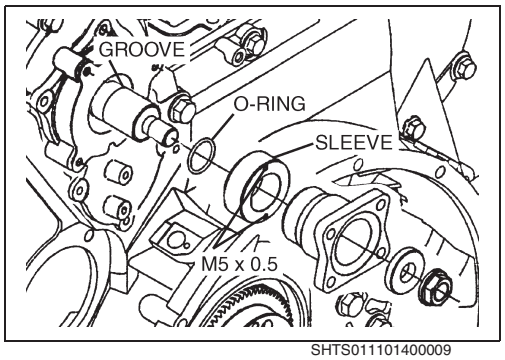
SHTS011101400007

(2) Remove the flywheel housing.



SHTS011101400008

(3) Remove the driven gear and idle gear using a commercial sliding hammer.

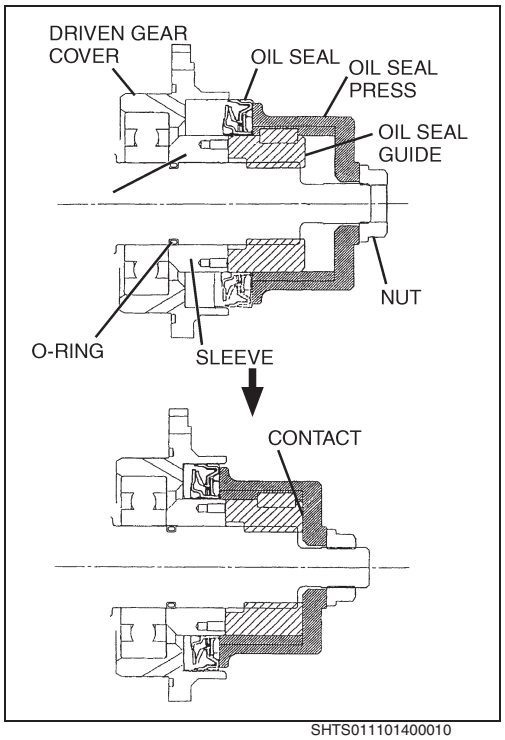


SHTS011101400009

IMPORTANT POINTS - REPLACEMENT

1. REPLACE THE O-RING OF THE DRIVEN GEAR SHAFT.

(1) Remove the flange.
(2) Remove the sleeve using a commercial puller.
(3) Apply engine oil to the new O-ring, then install it on the O-ring groove of the driven gear shaft.



SHTS011101400010

2. REPLACE THE OIL SEAL OF THE DRIVEN GEAR COVER.

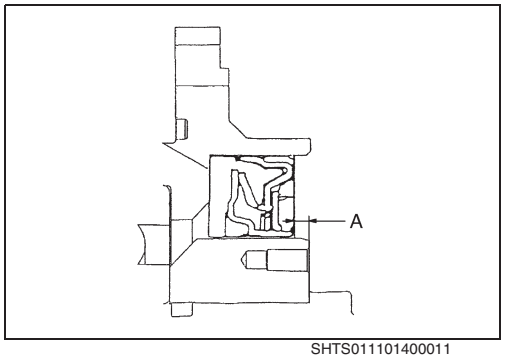
(1) Clean the edges and surface of the driven gear cover, sleeve and the special tools.
SST: Oil seal press (09407-1190)

(2) Apply a little engine oil to the new oil seal inner and outer ring surface.
(3) Making sure it is properly oriented, insert the new oil seal into the oil seal guide.

NOTICE
Install the oil seal so that the felt surface faces outward and the surface with the slinger (steel plate) faces in toward the engine.

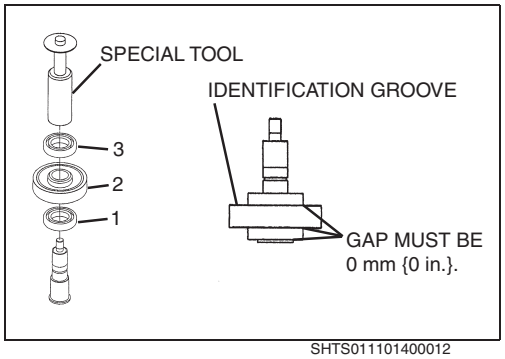
(4) Install the oil seal guide on the driven gear shaft.
(5) Install the key and fit the oil seal press over the oil seal guide, fix it in place by tightening the nut and then press-fit the oil seal.

NOTICE
Make sure the press is set so that pressure will be applied evenly around the entire circumference of the oil seal.



SHTS011101400011

(6) Tighten the press until it contacts the oil seal guide and then confirm that the oil seal is uniformly press-fitted.
Assembly standard (A): 3.2-3.8 mm {0.1260-0.1496 in.}

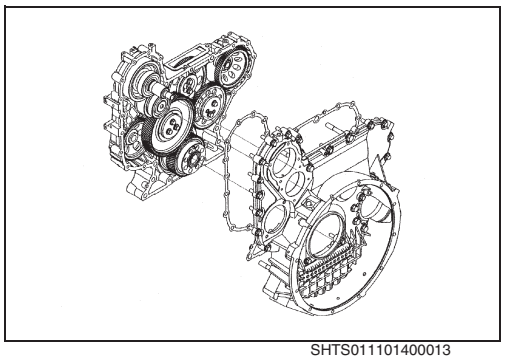


SHTS011101400012

3. REPLACE THE BALL BEARING.

(1) Remove the ball bearings and driven gear from the driven gear shaft using a press.

(2) Press the ball bearings and driven gear onto the driven gear shaft one at a time and in the order shown in the figure using a press and special tool.
SST: Guide (09402-1560)


SHTS011101400013

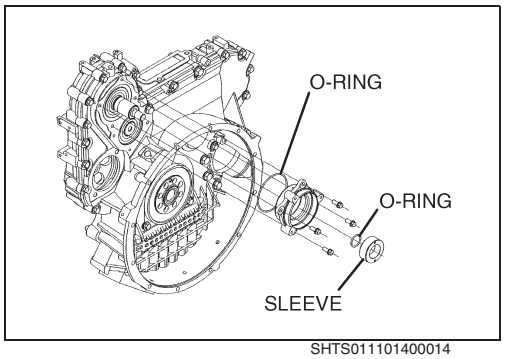
IMPORTANT POINTS - ASSEMBLY

1. ASSEMBLE THE POWER TAKE-OFF.

(1) Install the guide bolts (stud bolt: M12 x 1.75) to the timing gear case.

(2) Press the driven gear assembly and idle gear assembly into the timing gear case.

(3) Install the flywheel housing.

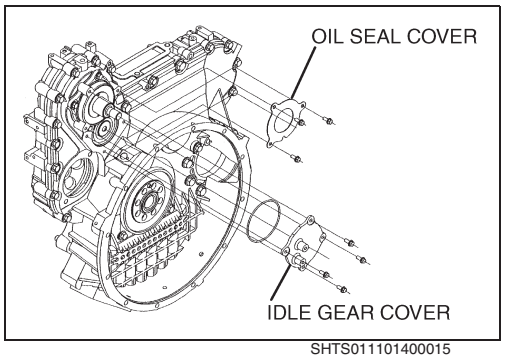


SHTS011101400014

(4) Install the driven gear cover with new O-ring.

NOTICE
When installing the driven gear cover, match the oil lead hole on the driven gear cover and flywheel housing.

(5) Install the O-ring to the driven gear shaft, install the sleeve onto the shaft.

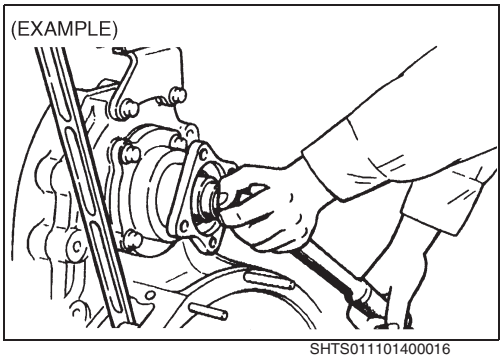


SHTS011101400015

(6) Install the oil seal into the driven gear cover.

(7) Install the oil seal cover.

(8) Install the idle gear cover.



SHTS011101400016

2. INSTALL THE FLYWHEEL.

NOTICE
Refer to CHAPTER "ENGINE MECHANICAL" for details.

3. INSTALL THE FLANGE.
(1) Install the flange and collar.
(2) Secure the flywheel with tire lever, then tighten the lock nut.

4. CHECK THE GEAR BACKLASH.
(1) Measure the backlash between the gears with a dial gauge. (Refer to the table of INSPECTION AND REPAIR.)

5. INSTALL THE FLYWHEEL HOUSING STAY TO BOTH SIDES OF THE HOUSING.

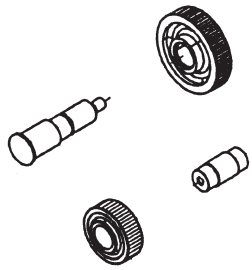
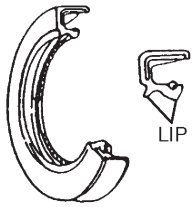
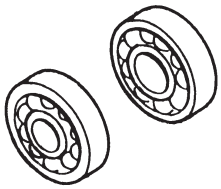
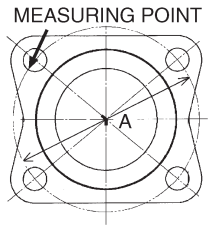
6. MOUNT THE CLUTCH DISC AND CLUTCH COVER ASSEMBLY.
(1) Refer to CHAPTER "CLUTCH MAIN UNIT" for details.

7. MOUNT THE TRANSMISSION.
(1) Refer to CHAPTER "TRANSMISSION MAIN UNIT" for details.

INSPECTION AND REPAIR

EN0111014H300001

Unit: mm {in.}

Inspection item		Standard	Limit	Remedy	Inspection procedure
Shaft and gear: Wear and damage		—	—	Replace.	Visual check 
Oil seal lip: Wear and damage		—	—	Replace.	Visual check 
Bearing improper rotation		—	—	Replace.	Visual check 
Power take-off gear back-lash	Main idle gear-Idle gear	0.040-0.188 {0.0016-0.0074}	0.4 {0.0157}	Replace.	Measure Reference value: Measure at bolt hole of flange.  Diameter (A): 100 mm {3.937 in.}
		Reference value 0.036-0.165 {0.0015-0.0064}	0.35 {0.0138}		
	Idle gear-Driven gear	0.041-0.0176 {0.0017-0.0069}	0.4 {0.0157}	Replace.	
		Reference value 0.026-0.110 {0.0011-0.0043}	0.25 {0.0098}		

FUEL CONTROL (E13C)

DN02-001

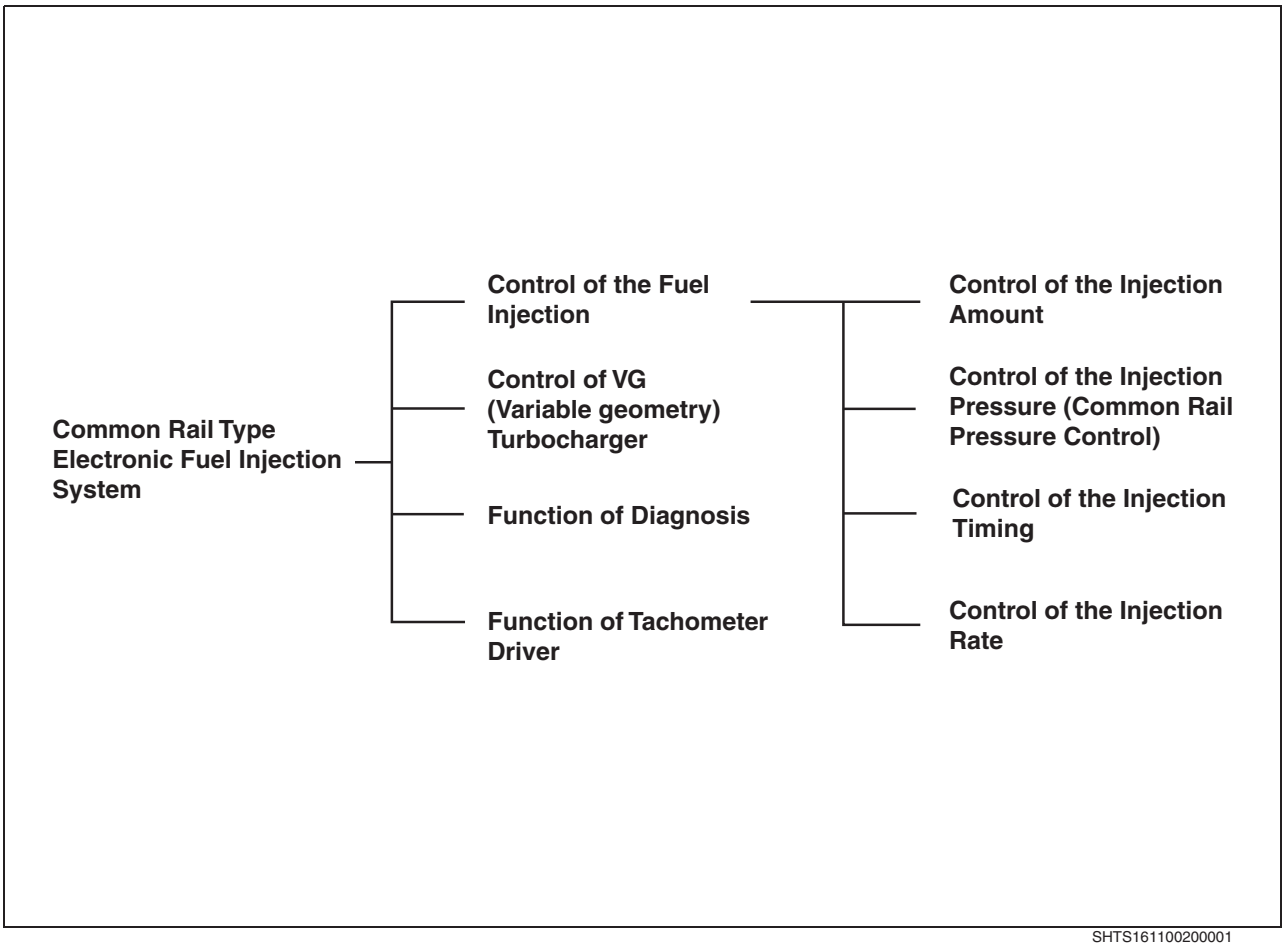
COMMON RAIL FUEL INJECTION SYSTEM

OVERVIEW

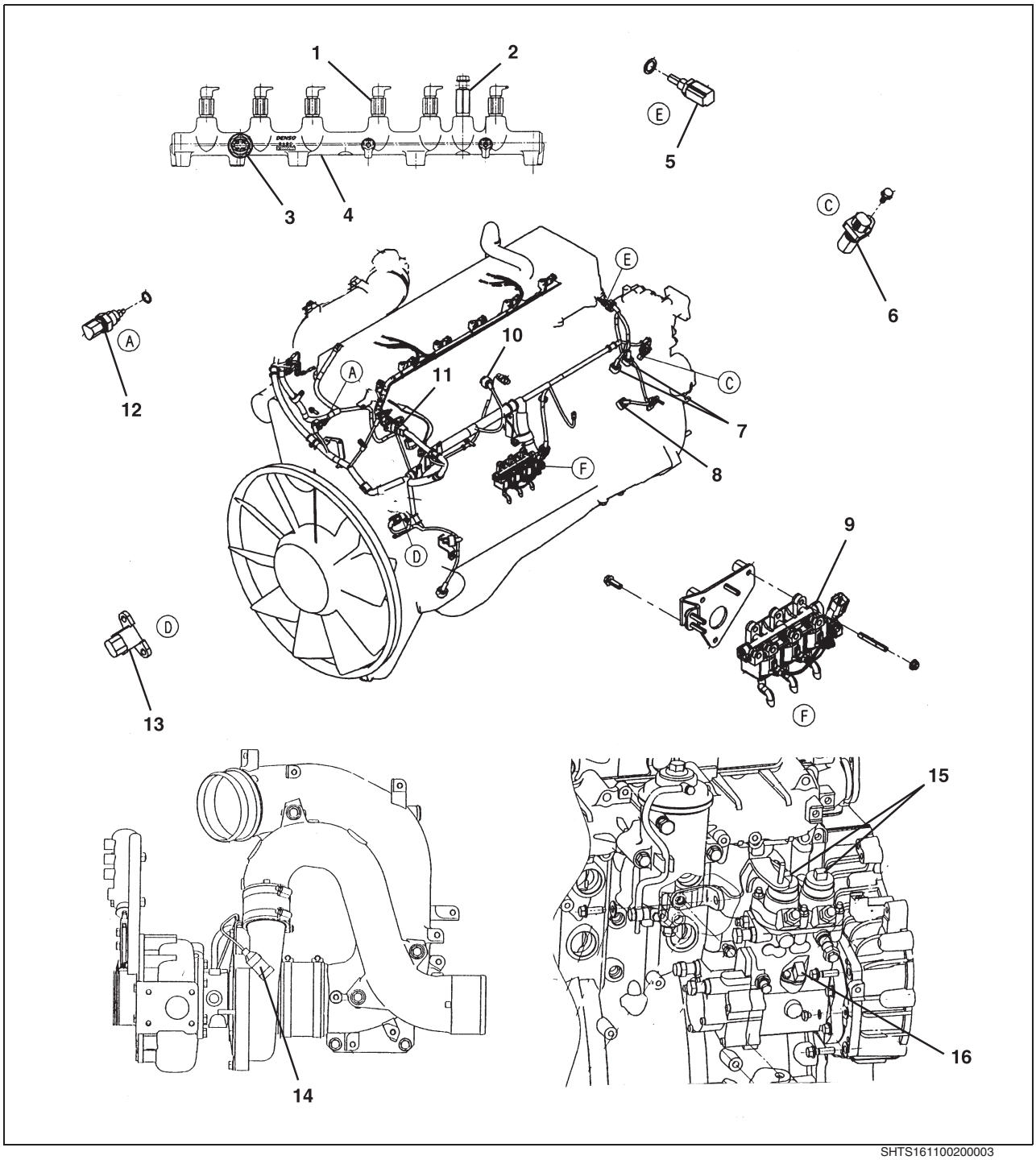
EN1611002F200001

COMMON RAIL FUEL INJECTION SYSTEM

The Common Rail Fuel Injection System has a lot of control functions than the conventional injection pump system. These functions are controlled by the ECU (Electronic Control Unit).



SHTS161100200001

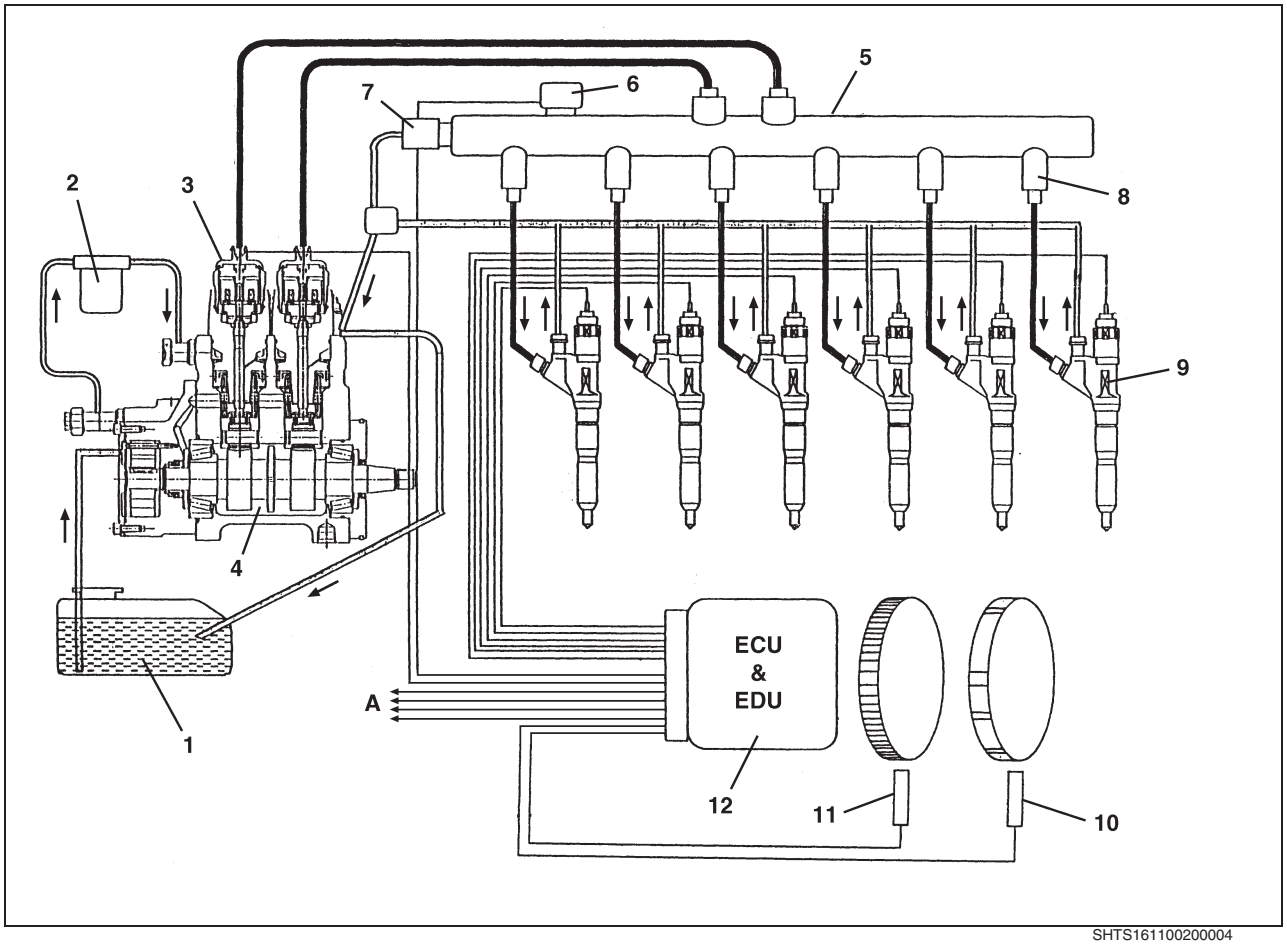


SHTS161100200003

1	Flow damper	9	Variable geometry turbocharger control valve (VGT control valve)
2	Pressure limiter	10	Common rail pressure sensor connector
3	Pressure sensor	11	Injector harness connector
4	Common rail assembly	12	Coolant temperature sensor
5	Fuel temperature sensor	13	Boost pressure sensor
6	Engine speed main sensor	14	Turbocharger speed sensor
7	Supply pump control valve (PCV) connector	15	Supply pump control valve (PCV)
8	Engine speed sub sensor connector	16	Engine speed sub sensor

DIAGRAM

EN1611002F200003

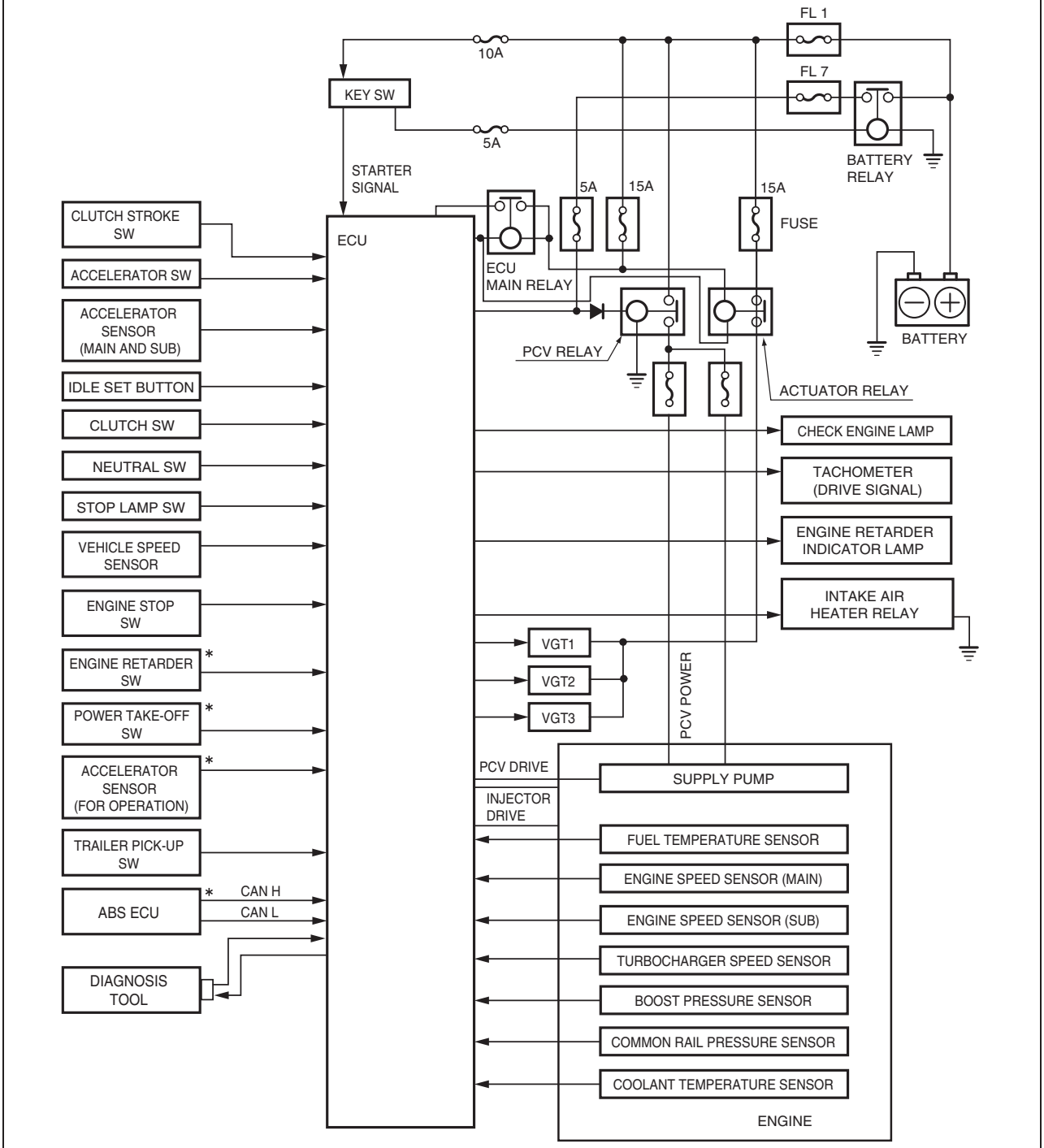


SHTS161100200004

1	Fuel tank	8	Flow damper
2	Fuel filter	9	Injector
3	Pump control valve	10	Engine speed sub sensor
4	Supply pump	11	Engine speed main sensor
5	Common rail	12	ECU
6	Pressure sensor	A	To sensors (Additional information)
7	Pressure limiter		

ELECTRICAL

EN1611002F200004



NOTICE:

- Item indicaled with a asterisk (*) symbol are special specification part.
- SW =Switch

SHTS161100200005

PRECAUTIONS

EN1611002F200005

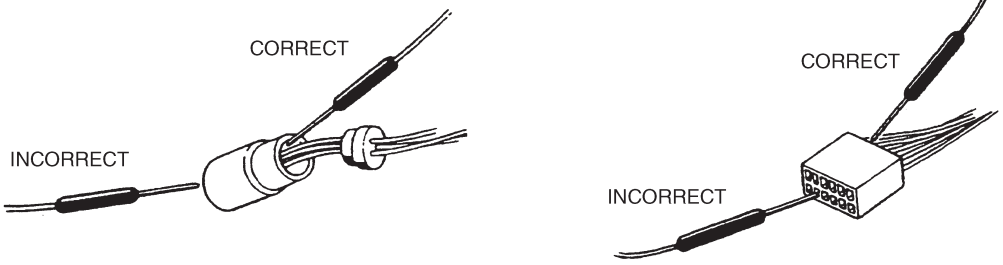
⚠ **WARNING**
Approximately 110V is generated for the injector drive actuation system. For this reason, electrical shock may result if the injector drive circuit is touched directly by hand. Turn the starter switch to the "LOCK" position if it is necessary to check or repair the computer, harnesses, or connectors.

1. BE CAREFUL NOT TO LET DIRT OR DUST GET INSIDE THE ACTUATOR OR MAGNETIC VALVES.

2. HARNESS WIRE CONNECTOR.

(1) Multi-contact connectors suitable for the small electrical signals of electronic circuitry are used for wiring connections to the sensors, actuator and control unit. Be very careful when handling them.

- Before disconnecting any connectors, make sure that the starter switch is in the "LOCK" position.
- When disconnecting connectors, try to pull them out in a straight line, disengaging the lock and holding onto the housing.
- Do not try to disconnect connectors by gripping the wires or twisting them, as this could bend the contacts.
- Do not disconnect connectors unnecessarily.
- When using a circuit tester, apply the tester probe to the harness wire side only. Never stick the tester probe into the holes on the connector terminal side, as this could cause poor contacts when the connector is reconnected.



HOW TO USE TESTER PROBE

SHTS161100200006

- Do not let water, oil or dust get on the connector when it is disconnected, as this could cause poor contacts when the connector is reconnected.
- Do not open the control unit cover. It could malfunction if dust or water gets inside.
- Take care to ensure that water, oil or dust do not get on or inside parts.
- When connecting in connectors, push them in all the way and make sure that the lock engages.

3. ERASING THE MALFUNCTION MEMORY STORED IN THE PAST, CHECK THE CURRENT MALFUNCTION BY PERFORMING A DIAGNOSIS OF THE PRESENT MALFUNCTION AGAIN.

4. AFTER COMPLETING THE MALFUNCTION ANALYSIS, ERASE THE MALFUNCTION MEMORY STORED IN THE PAST. OTHERWISE, THE MALFUNCTION CODES IN THE DISPLAY WILL REMAIN INDICATED.

5. CONNECTOR DRAWING, ALL OF WHICH HAS A VIEW TO BE SEEN FROM THE CONNECTION SIDE, INSERT THE TESTING LEAD FROM THE BACKSIDE.

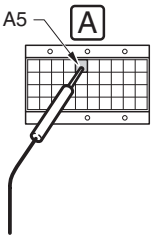
6. USING A CIRCUIT TESTER

- Use a circuit tester with an internal resistance of 100 kΩ or greater in the voltage measuring range.

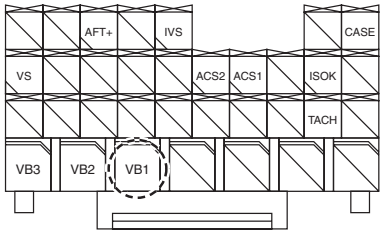
7. USING A SIGNAL CHECK HARNESS

- To prevent breakage of the ECU connector, connect the signal check harness and perform measuring by bringing the test lead into contact with the signal check harness side (Contact box).

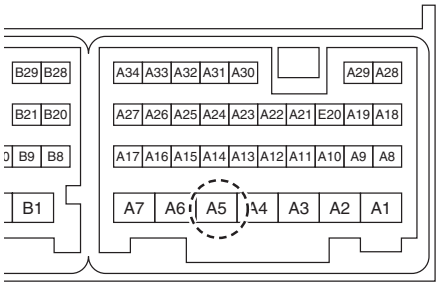
EXAMPLE:
ECU: A5 TERMINAL ⟷
SIGNAL CHECK HARNESS
CONTACT BOX:
A5 TERMINAL



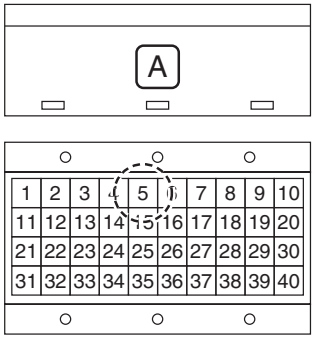
COMPUTER (ECU)
TERMINAL SIGNAL



COMPUTER (ECU)
TERMINAL No.



SIGNAL CHECK
HARNESS
(CONTACT BOX)



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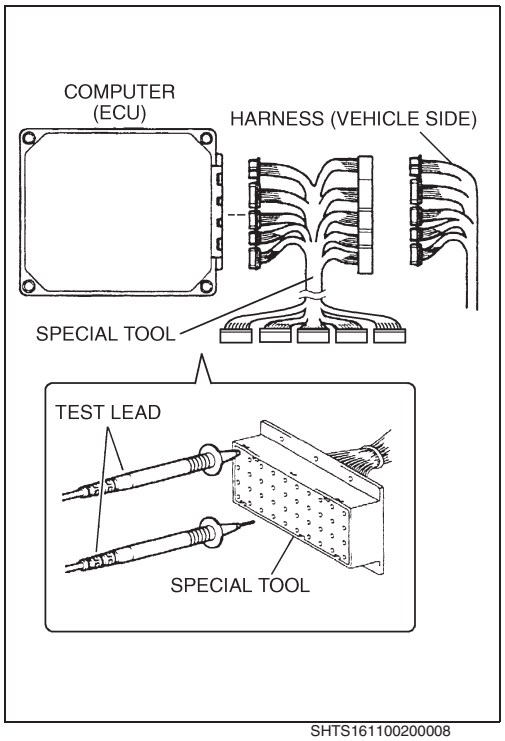


SHTS161100200008

8. CONNECT THE SIGNAL CHECK HARNESS.

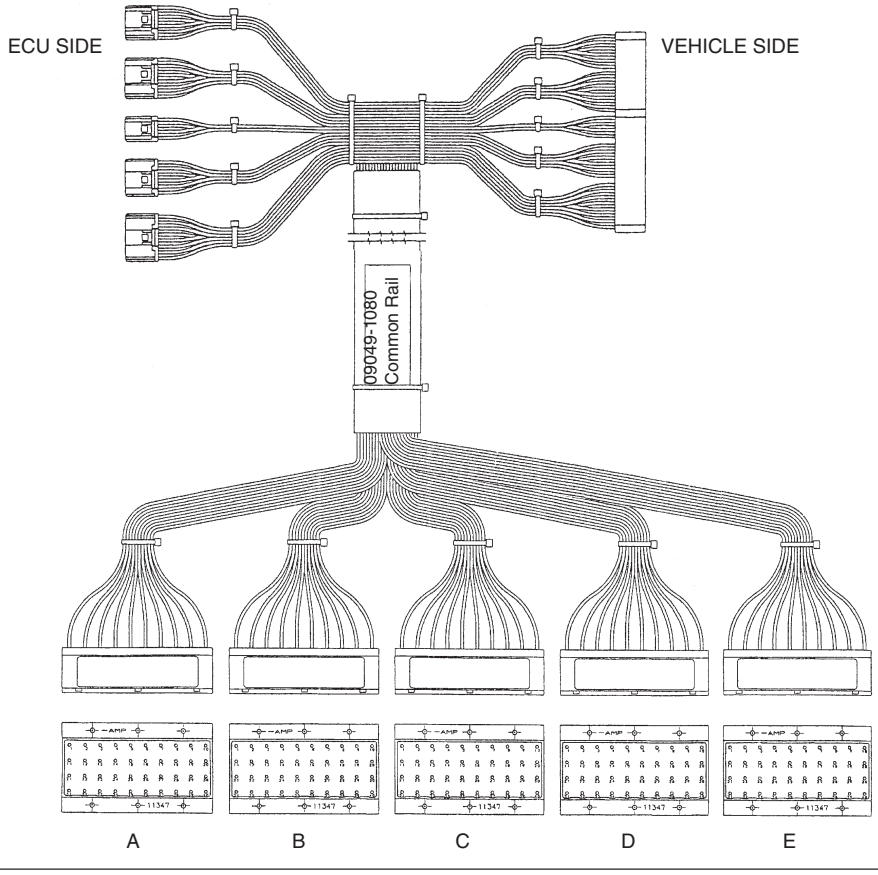
(1) Disconnect the connectors from the ECU.

(2) Connect a signal check harness to the vehicle harness and the ECU.

SST: Signal check harness (09049-1080)

(3) COMPUTER (ECU) PIN ASSIGNMENT

SIGNAL CHECK HARNESS (CONTACT BOX)



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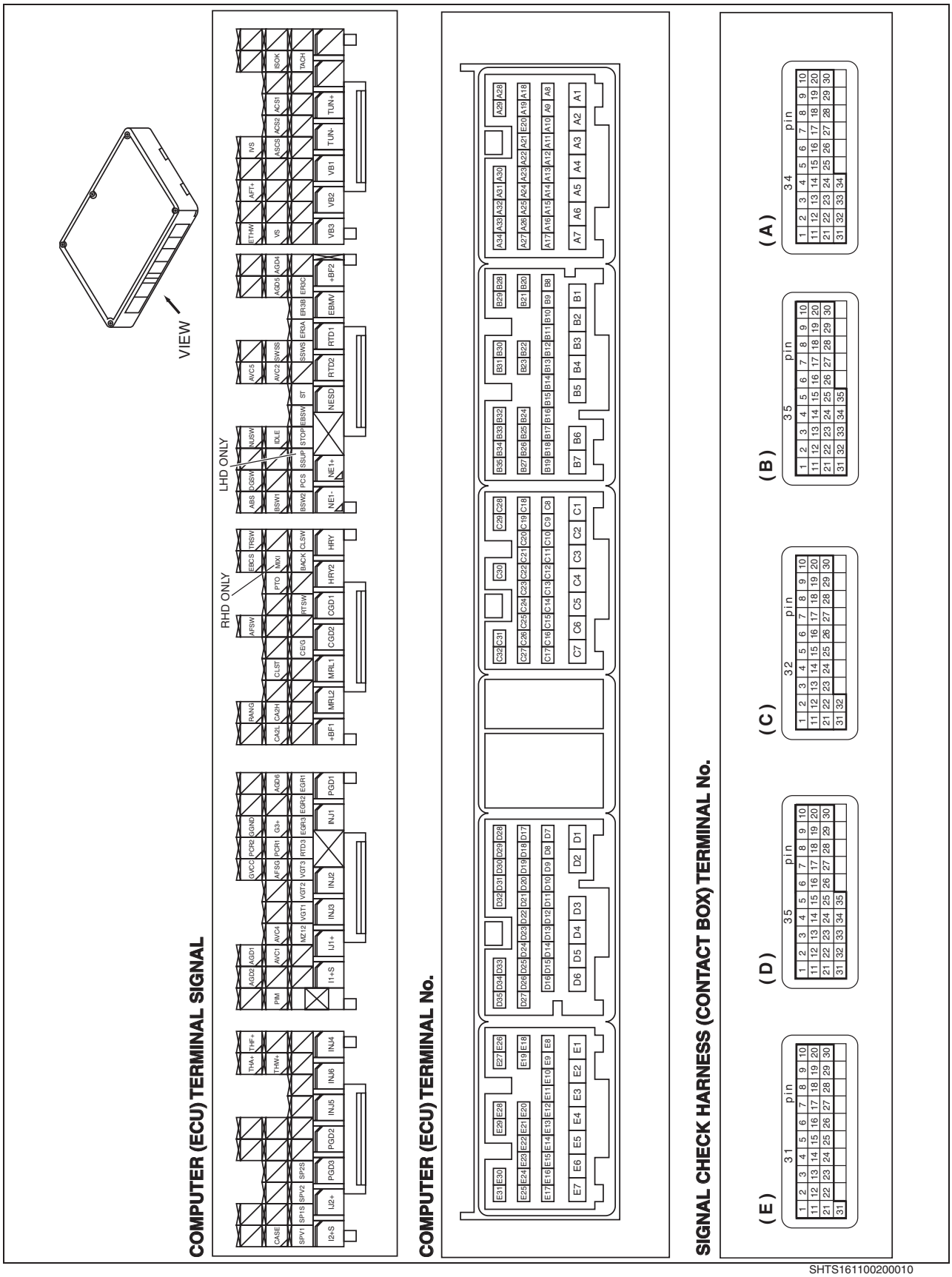


SHTS161100200010

9. 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	–		21	ACS1	Accelerator sensor 1
2	–		22	ACS2	Accelerator sensor 2
3	TUN–	Turbocharger speed sensor –	23	ASCS	Power take-off Accelerator sensor
4	TUN+	Turbocharger speed sensor +	24	–	
5	VB1	ECU main relay	25	–	
6	VB2	ECU main relay	26	–	
7	VB3	ECU main relay	27	VS	Vehicle speed pulse converter
8	–		28	–	
9	TACH	Tachometer	29	–	
10	–		30	IVS	Throttle control signal
11	–		31	–	
12	–		32	ATF+	Not use
13	–		33	–	
14	–		34	ETHW	Not use
15	–		35		
16	–		36		
17	–		37		
18	–		38		
19	ISOK	Diagnosis connector	39		
20	–		40		

CONTACT BOX (B)					
No.	**Signal**	**Connection destination**	**No.**	**Signal**	**Connection destination**
1	+BF2	Actuator power relay	21	AGD5	Accelerator sensor
2	EBNV	Not use	22	SWSS	Fuse U2 (M)
3	RTD1	Magnetic valve (Retarder)	23	AVC2	Common rail pressure sensor
4	RTD2	Magnetic valve (Retarder)	24	IDLE	Accelerator sensor
5	NESD	Engine speed main sensor shield ground	25	–	
6	NE1+	Engine speed main sensor +	26	–	
7	NE1–	Engine speed main sensor –	27	BSW1	Brake switch
8	–		28	–	
9	ER3C	Not use	29	–	
10	ER3B	Not use	30	–	
11	ER3A	Not use	31	AVC5	Accelerator sensor
12	SSWS	Fuse U2 (M)	32	NUSW	Neutral switch
13	–		33	–	
14	ST	Starter relay	34	DGSW	Diagnosis connector
15	EBSW	Not use	35	ABS	ABS cut relay
16	STOP	Engine stop switch	36	–	
17	SSUP	Idle up switch (LHD only)	37	–	
18	PCS	Position switch (With HX07 T/M only)	38	–	
19	BSW2	Not use	39	–	
20	AGD4	Throttle control and power take-off accelerator sensor	40	–	

CONTACT BOX (C)					
No.	**Signal**	**Connection destination**	**No.**	**Signal**	**Connection destination**
1	HRY	Intake air heater relay	21	–	
2	HRY2	Intake air heater relay	22	–	
3	CGD1	Cab ground	23	–	
4	CGD2	Cab ground	24	CLST	Clutch stroke switch
5	MRL1	ECU main relay	25	–	
6	MRL2	ECU main relay	26	CA2H	Combination meter
7	+BF1	Actuator power relay	27	CA2L	Combination meter
8	CLSW	Clutch switch	28	TRSW	Trailer pick up switch
9	BACK	Back lamp switch	29	EBCS	Not use
10	–		30	AFSW	Not use
11	RTSW	Retarder switch	31	RANG	ZF16: Range HI switch MZ12: Range FR switch
12	–		32	–	
13	CE/G	Check engine light	33	–	
14	–		34	–	
15	–		35	–	
16	–		36	–	
17	–		37	–	
18	AT	Not use	38	–	
19	MIXI	Mixer idle up switch (RHD only)	39	–	
20	PTO	Power take-off switch	40	–	

CONTACT BOX (D)					
No.	**Signal**	**Connection destination**	**No.**	**Signal**	**Connection destination**
1	PGD1	Cab ground	21	AFSG	Not use
2	INJ1	No.1 Fuel injector	22	–	
3	INJ2	No.2 Fuel injector	23	–	
4	INJ3	No.3 Fuel injector	24	AVC4	Throttle control and P.T.O. accelerator sensor
5	IJ1+	No.1 Fuel injector	25	AVC1	Boost sensor
6	I1+S	No.2, 3 Fuel injector	26	–	
7	EGR1	Not use	27	PIM	Boost sensor
8	EGR2	Not use	28	–	
9	EGR3	Not use	29	–	
10	RTD3	Magnetic valve	30	GGND	Engine speed sub sensor
11	VGT3	Magnetic valve	31	PCR2	Common rail pressure sensor
12	VGT2	Magnetic valve	32	GVCC	Engine speed sub sensor
13	VGT1	Magnetic valve	33	AGD1	Boost sensor and common rail pressure sensor
14	MZ12	Over run relay (With MZ12 T/M only)	34	AGD2	Coolant temperature sensor and fuel temperature sensor
15	–		35	–	
16	–		36	–	
17	AGD6	Not use	37	–	
18	–		38	–	
19	G3+	Engine speed sub sensor	39	–	
20	PCR1	Common rail pressure sensor	40	–	

CONTACT BOX (E)					
No.	**Signal**	**Connection destination**	**No.**	**Signal**	**Connection destination**
1	INJ4	No.4 Fuel injector	21	–	
2	INJ6	No.6 Fuel injector	22	–	
3	INJ5	No.5 Fuel injector	23	–	
4	PGD2	Cab ground	24	–	
5	PGD3	Cab ground	25	CASE	Engine ground
6	IJ2+	No.4, 5 Fuel injector	26	THF+	Fuel temperature sensor
7	I2+S	No.6 Fuel injector	27	THA+	Not use
8	–		28	–	
9	–		29	–	
10	–		30	–	
11	–		31	–	
12	–		32	–	
13	–		33	–	
14	SP2S	No.2 Pump control valve (PCV2)	34	–	
15	SPV2	No.2 Pump control valve (PCV2)	35	–	
16	SP1S	No.1 Pump control valve (PCV1)	36	–	
17	SPV1	No.1 Pump control valve (PCV1)	37	–	
18	–		38	–	
19	THW+	Coolant temperature sensor	39	–	
20	–		40	–	

10. RADIO INSTALLATION

- There is a danger that the control unit might malfunction if a high output radio transmitter (Over 50W) is installed in the vehicle.

11. USING A QUICK CHARGER

- Disconnect both battery terminals before using a quick charger.

12. AIR CONDITIONER INSTALLATION

- Be careful not to scratch or damage the engine, chassis or the harness inside the cab when installing an air conditioner. Also, make sure to reattach afterward any connectors that were disconnected during the installation process.

13. PERFORMING ELECTRIC WELDING

- Disconnect connector to the control unit before performing any electric welding.

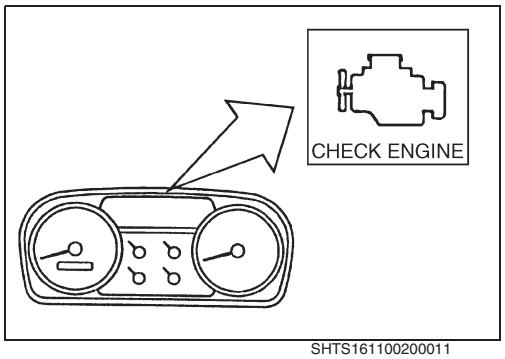
14. OTHER

- Make sure to check the other connectors before connecting them in to prevent incorrect connections.
- Be careful not to allow the connectors to become soiled with dust, water, fuel or oil when performing inspections or removing and replacing parts.

INSPECTION

EN1611002F200006

CHECK ENGINE LAMP STATUS



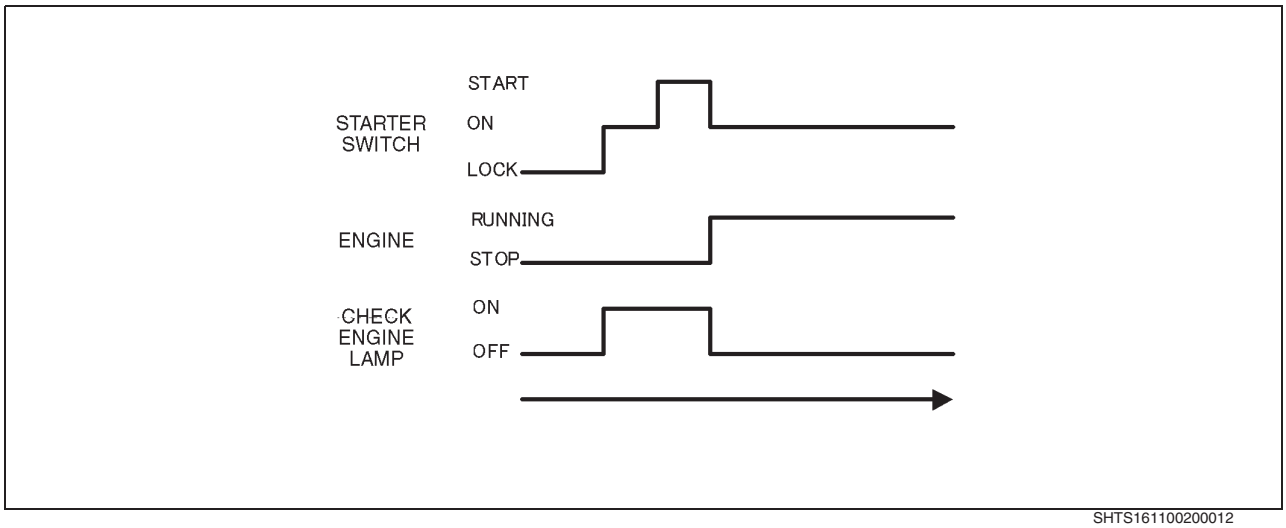
SHTS161100200011

1. INSPECTION PROCEDURE

(1) Turn the starter switch to the “ON” position (Do not start the engine) and confirm that the check engine lamp in the indicator area lights up.

(2) Start the engine.
(3) If the engine is normal, the check engine lamp goes out.
(4) If the check engine lamp does not go out, the system is abnormal. Check the system according to diagnosis on the following page.

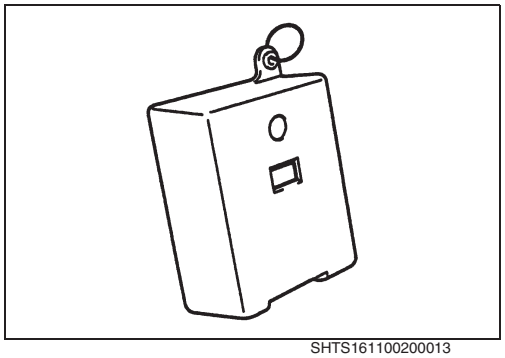
CHECK ENGINE LAMP ILLUMINATION PATTERN



SHTS161100200012

DIAGNOSIS USING THE DIAGNOSIS MONITOR

EN1611002F200007

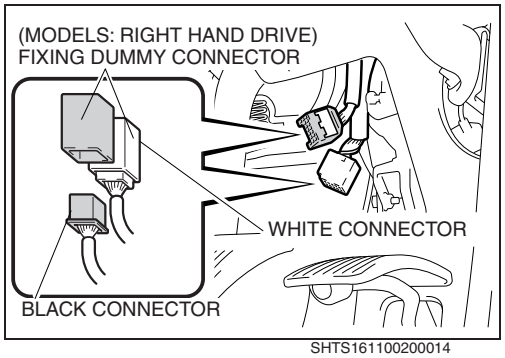


SHTS161100200013

1. CONNECT THE DIAGNOSIS MONITOR.
SST: Diagnosis monitor (09630-1370)

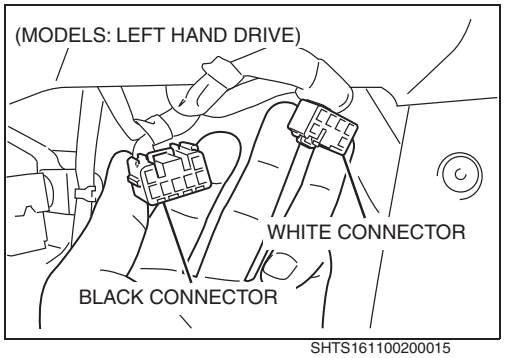
NOTICE
Trouble diagnosis also can be performed using the diagnosis monitor. The malfunction codes are indicated by sound and light.

(1) Turn the starter switch to the "ON".



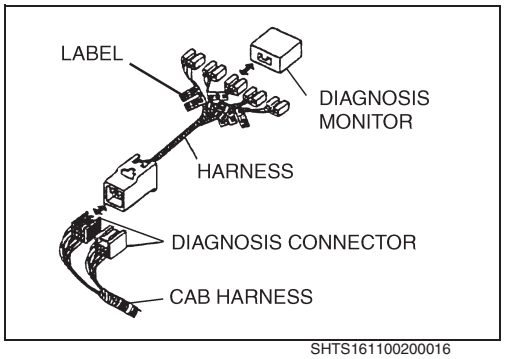
SHTS161100200014

(2) Connect the harness to the diagnosis connector.
SST: Harness (09630-2300)



SHTS161100200015

(3) Connect the diagnosis monitor to the connector which tagged a "STD-ENG" label.



SHTS161100200016

2. READ OUT THE MALFUNCTION CODE.

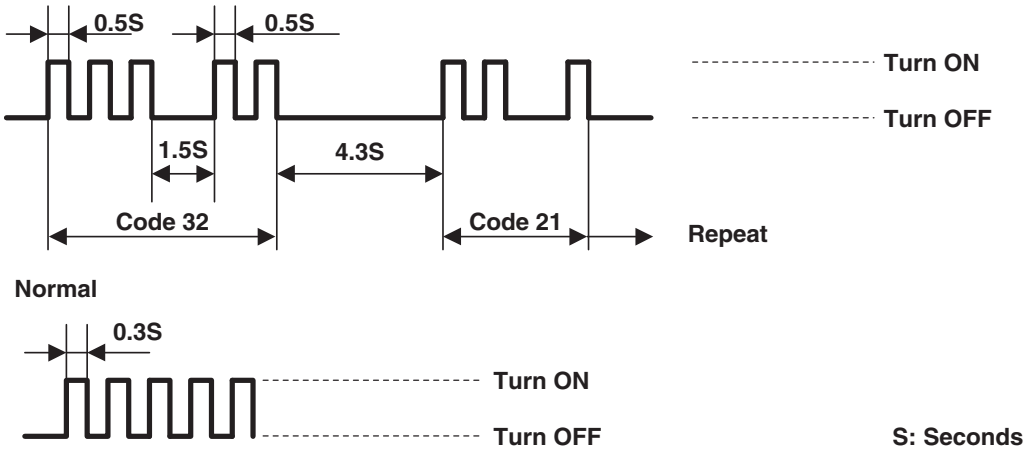
(1) Read out the malfunction codes and write down the malfunction codes that are indicated.

NOTICE

Malfunction codes are indicated, starting from the lowest and progressing upward, with no distinction between present and past malfunction codes.

MALFUNCTION CODE INDICATION PATTERN

Malfunction Code 32 and 21



Normal

S: Seconds

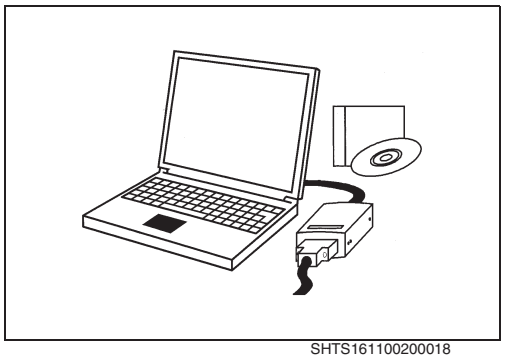
SHTS161100200017

3. ERASE THE MALFUNCTION CODE MEMORY.

(1) Erase the malfunction code memory using the PC DIAGNOSIS TOOL (Hino DX).

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

EN1611002F200008



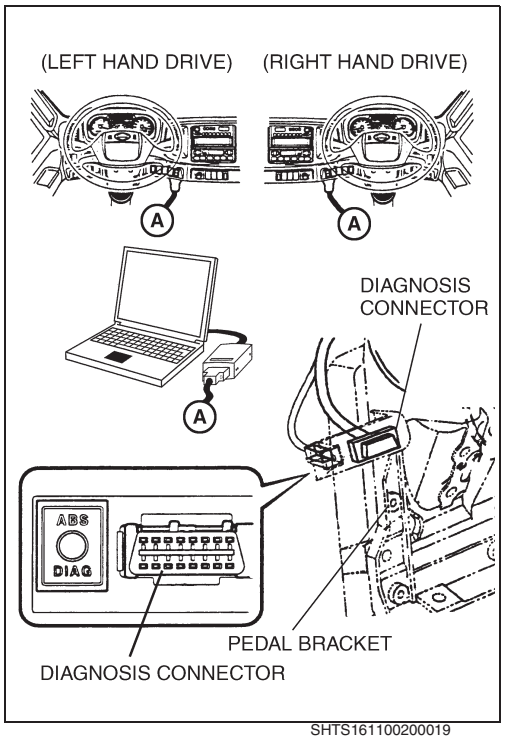
SHTS161100200018

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 (09121-1010)
Diagnosis cable (09042-1150)
Diagnosis software: HINO Diagnostic explorer (DX)
Reprogramming software: HINO Reprog Manager

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



SHTS161100200019

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.

DIAGNOSIS MONITOR CODE AND DIAGNOSIS TROUBLE CODE TABLE

EN1611002F200009

NOTICE
MC No.: Diagnosis Monitor Code (Using the diagnosis monitor)
DTC No.: Diagnosis Trouble Code (Using the PC diagnosis tool)
A: Engine does not start
B: Engine stops
C: Engine has low power
YES: Check engine lamp: Light
NO: Check engine lamp: Not light

CHECK ENGINE LAMP	SYMP-TOM	MC No.	DTC NO.	DIAGNOSIS ITEM	INSPECTION ITEM	REFER PAGE
—	—	–	—	Check the ECU power supply voltage	Wire harness, Fuse, Battery	24
—	—	–	—	Check the ground	Wire harness	25
YES	—	2	P1601	Injector correction data conforming error	ECU (ECU connector)	25
YES	C	3	P0605	Flash ROM error	ECU (ECU connector)	26
YES	A, B	3	P0606	CPU malfunction (Hard detection)	ECU (ECU connector)	26
YES	C	3	P0607	Monitoring IC malfunction in CPU	ECU (ECU connector)	26
YES	—	5	P0686	Main relay malfunction	Main relay, Wire harness, ECU (ECU connector)	26
NO	C	6	P0217	Engine overheat	ECU (ECU connector), Coolant temperature sensor, Engine cooling system	28
NO	—	7	P0219	Engine overrun	—	28
YES	—	11	P0117	Coolant temperature sensor circuit low input	Wire harness, ECU (ECU connector), Coolant temperature sensor	29
YES	—	11	P0118	Coolant temperature sensor circuit high input	Wire harness, ECU (ECU connector), Coolant temperature sensor	29
YES	—	12	P0340	Engine speed sub sensor circuit malfunction	Wire harness, ECU (ECU connector), Engine speed sub sensor	30
YES	A,B	13	P0335	Engine speed main sensor circuit malfunction	Wire harness, ECU (ECU connector), Engine speed main sensor	32
YES	—	14	P0187	Fuel temperature sensor circuit low input	Wire harness, ECU (ECU connector), Fuel temperature sensor	34
YES	—	14	P0188	Fuel temperature sensor circuit high input	Wire harness, ECU (ECU connector), Fuel temperature sensor	34
YES	—	15	P2228	Atmospheric pressure sensor circuit low input	ECU (ECU connector)	35

CHECK ENGINE LAMP	SYMP-TOM	MC No.	DTC NO.	DIAGNOSIS ITEM	INSPECTION ITEM	REFER PAGE
YES	—	15	P2229	Atmospheric pressure sensor circuit high input	ECU (ECU connector)	35
YES	—	21	P0500	Vehicle speed sensor circuit low input	ECU (ECU connector), Wire harness, Vehicle speed sensor	35
YES	—	21	P0501	Vehicle speed sensor circuit high input	ECU (ECU connector), Wire harness, Vehicle speed sensor	35
YES	C	22	P2120	Accelerator sensor 1 and 2 malfunction	Wire harness, ECU (ECU connector), Accelerator sensor	36
YES	—	22	P2121	Accelerator sensor 1 malfunction	Wire harness, ECU (ECU connector), Accelerator sensor	37
YES	—	22	P2122	Accelerator sensor circuit 1 low voltage	Wire harness, ECU (ECU connector), Accelerator sensor	39
YES	—	22	P2123	Accelerator sensor circuit 1 high voltage	Wire harness, ECU (ECU connector), Accelerator sensor	39
YES	—	22	P2126	Accelerator sensor 2 malfunction	Wire harness, ECU (ECU connector), Accelerator sensor	40
YES	—	22	P2127	Accelerator sensor circuit 2 low voltage	Wire harness, ECU (ECU connector), Accelerator sensor	42
YES	—	22	P2128	Accelerator sensor circuit 2 high voltage	Wire harness, ECU (ECU connector), Accelerator sensor	42
NO	—	23	P1132	Accelerator sensor (For operation of P.T.O.)	Wire harness, ECU (ECU connector), Accelerator sensor	43
NO	—	23	P1133	Accelerator sensor (For operation of P.T.O.)	Wire harness, ECU (ECU connector), Accelerator sensor	43
NO	—	25	P0540	Air intake heater relay	Wire harness, ECU (ECU connector), Air intake heater relay	45
NO	—	26	P1462	Engine retarder 1 open circuit, short to GND	Wire harness, ECU (ECU connector), Engine retarder valve	46
NO	—	26	P1463	Engine retarder 1 short to BATT	Wire harness, ECU (ECU connector), Engine retarder valve	46
NO	—	27	P1467	Engine retarder 2 open circuit, short to GND	Wire harness, ECU (ECU connector), Engine retarder valve	46
NO	—	27	P1468	Engine retarder 2 short to BATT	Wire harness, ECU (ECU connector), Engine retarder valve	46
YES	C	31	P0047	VGT valve 1 open circuit, short to GND	Wire harness, ECU (ECU connector), VGT valve	48
YES	C	31	P0048	VGT valve 1 short to BATT	Wire harness, ECU (ECU connector), VGT valve	48
YES	C	32	P1062	VGT valve 2 open circuit, short to GND	Wire harness, ECU (ECU connector), VGT valve	49
YES	C	32	P1063	VGT valve 2 short to BATT	Wire harness, ECU (ECU connector), VGT valve	49
YES	C	33	P1067	VGT valve 3 open circuit, short to GND	Wire harness, ECU (ECU connector), VGT valve	51
YES	C	33	P1068	VGT valve 3 short to BATT	Wire harness, ECU (ECU connector), VGT valve	51

CHECK ENGINE LAMP	SYMP-TOM	MC No.	DTC NO.	DIAGNOSIS ITEM	INSPECTION ITEM	REFER PAGE
YES	C	37	P0108	Boost pressure sensor circuit high input	Wire harness, ECU (ECU connector), Boost pressure sensor	52
YES	C	37	P0237	Boost pressure sensor circuit low input	Wire harness, ECU (ECU connector), Boost pressure sensor	52
NO	—	38	P1071	Turbocharger speed sensor circuit high input	Wire harness, ECU (ECU connector), Turbocharger speed sensor	55
NO	—	38	P1072	Turbocharger speed sensor circuit low input	Wire harness, ECU (ECU connector), Turbocharger speed sensor	55
NO	C	39	P0049	Turbocharger overrun	ECU (ECU connector), Turbocharger system	56
NO	C	39	P0234	Turbocharger over boost	ECU (ECU connector), Turbocharger system	56
NO	—	41	P0704	Clutch switch malfunction	ECU (ECU connector), Wire harness, Clutch switch	57
NO	—	42	P510	Accelerator switch malfunction	ECU (ECU connector), Wire harness, Idle switch	58
NO	—	44	P1142	Idle set controller low voltage	ECU (ECU connector), Wire harness, Idle set controller	59
NO	—	44	P1143	Idle set controller high voltage	ECU (ECU connector), Wire harness, Idle set controller	59
NO	—	45	P0617	Starter signal malfunction	Wire harness, Starter signal, ECU (ECU connector)	61
NO	—	46	P1530	Engine stop switch malfunction	ECU (ECU connector), Wire harness, Engine stop switch	62
NO	—	47	P0850	Neutral switch malfunction	ECU (ECU connector), Wire harness, Neutral switch	63
NO	—	48	P1676	Transmission position detect switch malfunction	ECU (ECU connector), Wire harness, Transmission position detect switch	64
YES	C	51	P0201	Injector circuit malfunction - cylinder 1	ECU (ECU connector), Wire harness, Injector	65
YES	C	52	P0202	Injector circuit malfunction - cylinder 2	ECU (ECU connector), Wire harness, Injector	65
YES	C	53	P0203	Injector circuit malfunction - cylinder 3	ECU (ECU connector), Wire harness, Injector	65
YES	C	54	P0204	Injector circuit malfunction - cylinder 4	ECU(ECU connector), Wire harness, Injector	65
YES	C	55	P0205	Injector circuit malfunction - cylinder 5	ECU (ECU connector), Wire harness, Injector	65
YES	C	56	P0206	Injector circuit malfunction - cylinder 6	ECU (ECU connector), Wire harness, Injector	65
YES	C	57	P1211	Injector common 1 short to GND	Wire harness, Injector, ECU (ECU connector)	68
YES	C	57	P1212	Injector common 1 short to BATT	Wire harness, Injector, ECU (ECU connector)	69

CHECK ENGINE LAMP	SYMP-TOM	MC No.	DTC NO.	DIAGNOSIS ITEM	INSPECTION ITEM	REFER PAGE
YES	C	58	P1214	Injector common 2 short to GND	Wire harness, Injector, ECU (ECU connector)	68
YES	C	58	P1215	Injector common 2 short to BATT	Wire harness, Injector, ECU (ECU connector)	69
YES	C	59	P0200	ECU charge circuit high input	ECU (ECU connector)	71
YES	C	59	P0611	ECU charge circuit malfunction	ECU (ECU connector)	71
NO	—	61	P0263	Cylinder 1 contribution/balance fault	Flow damper, Injector, Fuel filter, Injection pipe, ECU (ECU connector)	71
NO	—	62	P0266	Cylinder 2 contribution/balance fault	Flow damper, Injector, Fuel filter, Injection pipe, ECU (ECU connector)	71
NO	—	63	P0269	Cylinder 3 contribution/balance fault	Flow damper, Injector, Fuel filter, Injection pipe, ECU (ECU connector)	71
NO	—	64	P0272	Cylinder 4 contribution/balance fault	Flow damper, Injector, Fuel filter, Injection pipe, ECU (ECU connector)	71
NO	—	65	P0275	Cylinder 5 contribution/balance fault	Flow damper, Injector, Fuel filter, Injection pipe, ECU (ECU connector)	71
NO	—	66	P0278	Cylinder 6 contribution/balance fault	Flow damper, Injector, Fuel filter, Injection pipe, ECU (ECU connector)	71
YES	C	67	P0191	Common rail pressure sensor malfunction	Common rail pressure sensor, Wire harness, ECU (ECU connector)	73
YES	C	67	P0192	Common rail pressure sensor circuit low input	ECU (ECU connector), Wire harness, Common rail pressure sensor	74
YES	C	67	P0193	Common rail pressure sensor circuit high input	ECU (ECU connector), Wire harness, Common rail pressure sensor	74
YES	C	68	P0088	Excessive common rail pressure (1st step)	Common rail pressure sensor, ECU (ECU connector), Wire harness	76
YES	C	69	P0088	Excessive common rail pressure (2nd step)	Common rail pressure sensor, ECU (ECU connector), Wire harness	76
YES	C	71	P0628	PCV 1 malfunction	Supply pump, Wire harness, ECU (ECU connector)	76
YES	C	71	P0629	PCV 1 output short to BATT	Supply pump, Wire harness, ECU (ECU connector)	80
YES	C	72	P2633	PCV 2 malfunction	Supply pump, Wire harness, ECU (ECU connector)	82
YES	C	72	P2634	PCV 2 output short to BATT	Supply pump, Wire harness, ECU (ECU connector)	85

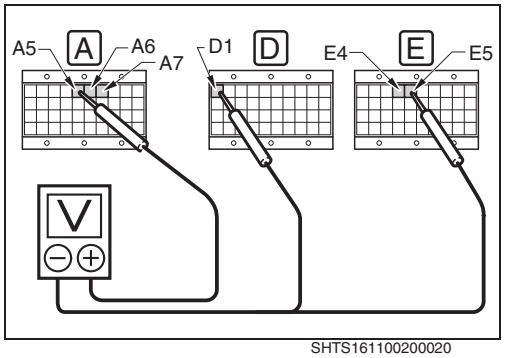
CHECK ENGINE LAMP	SYMP-TOM	MC No.	DTC NO.	DIAGNOSIS ITEM	INSPECTION ITEM	REFER PAGE
YES	A, B	73	P0628	PCV malfunction	Supply pump, Wire harness, ECU (ECU connector)	86
YES	A, B	73	P0629	PCV malfunction	Supply pump, Wire harness, ECU (ECU connector)	86
YES	C	76	P0088	Excessive common rail pressure, supply pump excess forced feed	Supply pump, Common rail pressure sensor, ECU (ECU connector), Wire harness	87
YES	C	76	P1229	Supply pump excess forced feed	Common rail pressure sensor, Supply pump, Fuel system	87
YES	C	77	P1266	Supply pump malfunction	Common rail pressure sensor, Supply pump, Fuel system	88
YES	A, B	78	P0093	Fuel leakage	ECU (ECU connector), Fuel system	88

NOTICE

- **It is necessary to reset the ECU default value using the diagnosis tool at the time of supply pump service replacement. In addition, the ECU has a function enabling it to learn the performance of the supply pump at the time of ECU service replacement, so ensure sufficient time (Several minutes) is available.**
- **When an injector is newly installed in a vehicle, it is necessary to enter the ID codes in the engine ECU using the diagnosis tool.**

CHECK THE ECU POWER SUPPLY VOLTAGE

EN1611002F200010



SHTS161100200020

1. CHECK THE VOLTAGE BETWEEN TERMINALS.

(1) Set the starter switch to "LOCK" and connect the signal check harness.
(2) Set the starter switch to "ON" (The engine is stopped).
(3) Measure the voltage between VB1 (A5), VB2 (A6), VB3 (A7) and PGD1 (D1), PGD2 (E4), PGD3 (E5) terminals of ECU connector (Vehicle harness side).
Standard: More than 20V

NO

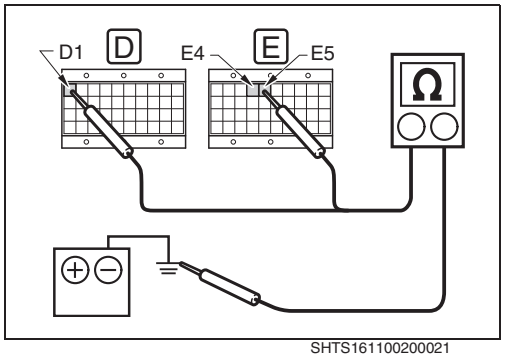
- 0V: Fuse blows, harness malfunction, ground malfunction.
- Less than 20V: Battery retrogradation, ground malfunction.

YES

Normal

CHECK THE GROUND

EN1611002F200011



SHTS161100200021

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 PGD1 (D1), PGD2 (E4), PGD3 (E5) and battery (–) terminals.
Standard: Less than 1 Ω

NO

- Ground harness disconnection.
- Bad contact of terminal.

YES

Normal

INJECTOR CORRECTION DATA

EN1611002F200012

MC No.	2	DTC No.	P1601	Injector correction data conforming error

1. CHECK THE QR CODE.
(1) Read the QR codes using "Injector Calibration" menu.
Standard: Same as the installed injector or service record.

NO

Re-input the QR codes

YES

Replace the ECU

ECU

EN1611002F200013

MC No.	3	DTC No.	P0605	Flash ROM error
MC No.	3	DTC No.	P0606	CPU malfunction (Hard detection)
MC No.	3	DTC No.	P0607	Monitoring IC malfunction in CPU

1. After the starter switch is positioned on the "LOCK" once, it should be turned to "ON" position again.

2. After erasing the MC or DTC, check that the same code is displayed again.

NO → Malfunction of ECU.

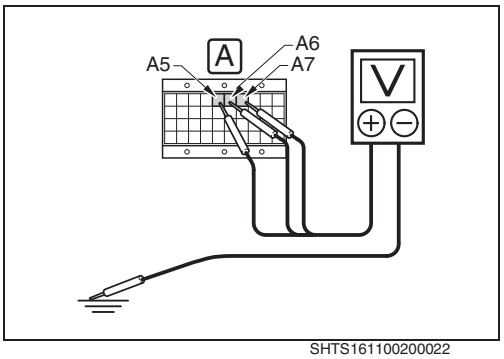
YES

Normal
(Temporary malfunction because of radio interference noise.)

MAIN RELAY

EN1611002F200014

MC No.	5	DTC No.	P0686	Main relay malfunction



SHTS161100200022

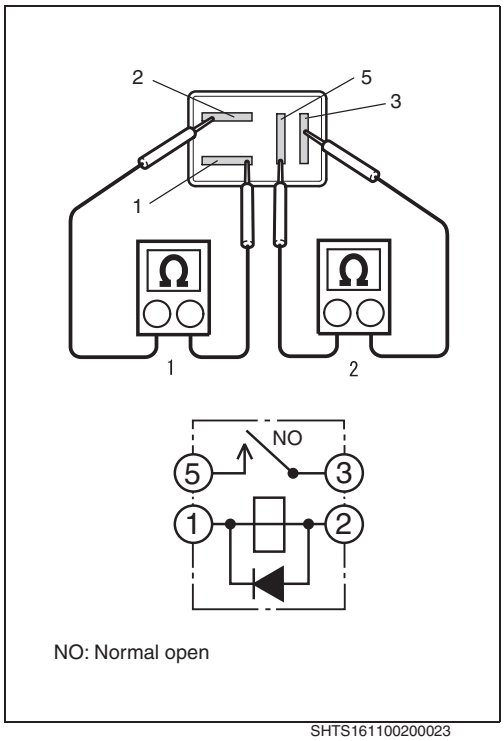
1. CHECK THE VOLTAGE BETWEEN TERMINALS.

(1) Set the starter switch to "LOCK" and connect the signal check harness.
(2) Disconnect the signal check harness on the ECU side.
(3) Set the starter to "ON" position.
(4) Measure the voltage between VB1 (A5), VB2 (A6), VB3 (A7) terminal and chassis GND.
Standard: 0V

NO → Proceed 2

YES

- Malfunction of ECU
- Malfunction of ECU connectors



NO: Normal open

SHTS161100200023

2. CHECK THE RESISTANCE BETWEEN RELAY TERMINALS.

(1) Set the starter switch to "LOCK" and remove the main relay.

(2) Measure the resistance between terminals.

Standard:

1. 320 Ω (1↔2)

2. ∞ Ω (3↔5)

NO

Malfunction of main relay

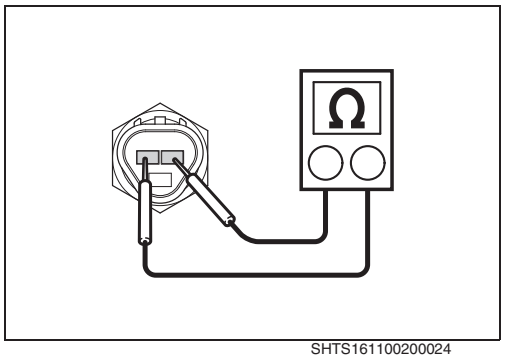
YES

Malfunction of harness

ENGINE OVERHEAT

EN1611002F200015

MC No.	6	DTC No.	P0217	Engine overheat



SHTS161100200024

1. CHECK THE COOLANT TEMPERATURE SENSOR.
(1) Set the starter switch to "LOCK".
(2) Disconnect the connector of coolant temperature sensor.
(3) Measure the resistance between terminals.

HINT
Measure the resistance under any of the following conditions.

Standard:
2.45 kΩ at 20°C {68°F}
1.15 kΩ at 40°C {104°F}
584 Ω at 60°C {140°F}
318 Ω at 80°C {176°F}

NO → Malfunction of coolant temperature sensor

YES

Malfunction of engine cooling system

HINT
This code will 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 less than 80°C {176°F}.

ENGINE OVERRUN

EN1611002F200016

MC No.	7	DTC No.	P0219	Engine overrun

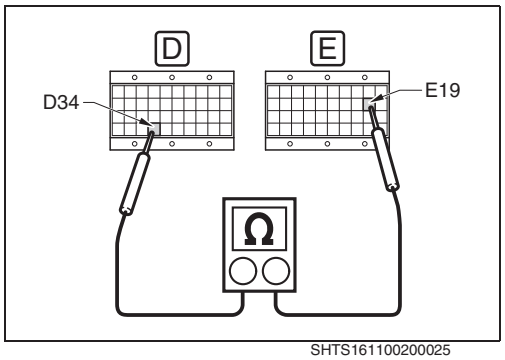
1. The MC or DTC will be displayed, once detected over 2,750 r/min. in the Engine revolution. Also, the fuel injection will be suspended during the MC or DTC to be detected and the fuel injection will be resumed when Engine revolution goes down less than 2,650 r/min.

NOTICE
The 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 detection of wrong shifting, etc.) Also, there is a case in which "overrun" will be detected by misunderstanding the engine revolution, with a noise to be generated by harness malfunction and its modification.

COOLANT TEMPERATURE SENSOR

EN1611002F200017

MC No.	11	DTC No.	P0117	Coolant temperature sensor circuit low input
MC No.	11	DTC No.	P0118	Coolant temperature sensor circuit high input



SHTS161100200025

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 THW+ (E19) and AGD2 (D34) terminals of ECU connector (Vehicle harness side).

HINT

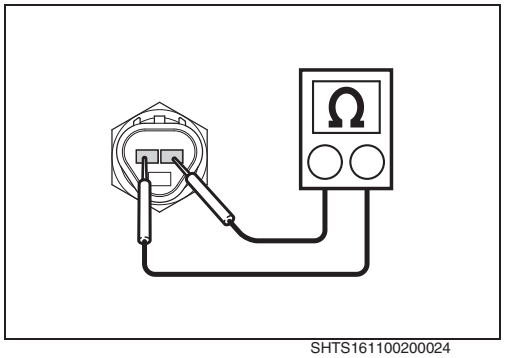
Measure the resistance under any of the following conditions.

Standard:
2.45 kΩ at 20°C {68°F}
1.15 kΩ at 40°C {104°F}
584 Ω at 60°C {140°F}
318 Ω at 80°C {176°F}

NO → Proceed to 2

YES →

- Malfunction of ECU
- Malfunction of ECU connectors
- Malfunction of harness (Short circuit)



SHTS161100200024

2. CHECK THE COOLANT TEMPERATURE SENSOR.

(1) Disconnect the connector of coolant temperature sensor.
(2) Measure the resistance of the coolant temperature sensor.

HINT

Measure the resistance under any of the following conditions.

Standard:
2.45 kΩ at 20°C {68°F}
1.15 kΩ at 40°C {104°F}
584 Ω at 60°C {140°F}
318 Ω at 80°C {176°F}

NO → Malfunction of coolant temperature sensor

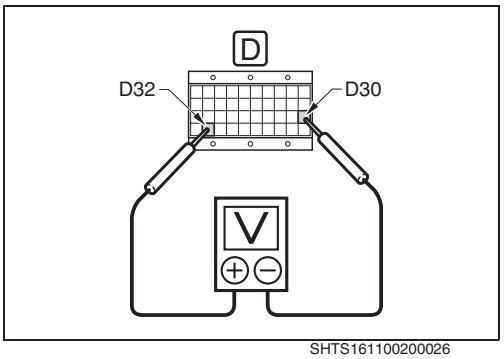
YES →

- Harness disconnection
- Malfunction of connectors
- Bad contact of connectors

ENGINE SPEED SUB SENSOR

EN1611002F200018

MC No.	12	DTC No.	P0340	Engine speed sub sensor circuit malfunction



SHTS161100200026

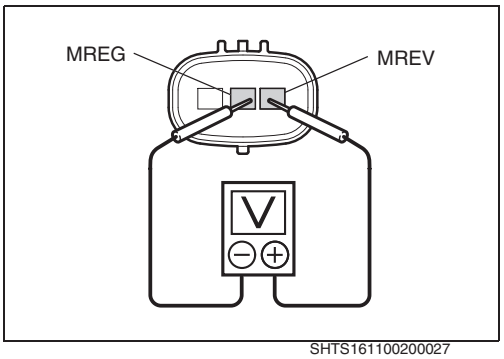
1. CHECK THE VOLTAGE BETWEEN TERMINALS.

(1) Set the starter switch to "LOCK " and connect the signal harness.
(2) Disconnect the connector of the engine speed sub sensor.
(3) Set the starter switch to "ON" (The engine is stopped).
(4) Measure the voltage between GVCC (D32) terminal and GGND (D30) terminals.
Standard: 4.5 — 5.5V

NO

- Bad contact of ECU connectors
- Malfunction of ECU

YES



SHTS161100200027

2. CHECK THE VOLTAGE BETWEEN ENGINE SPEED SUB SENSOR TERMINALS

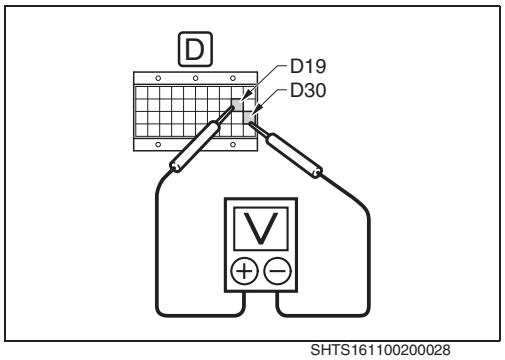
(1) Measure the voltage between MREV terminal and MREG terminal of the engine speed sub sensor. (Vehicle harness side)

Standard: 4.5 — 5.5V

NO

- Malfunction of harness (Short circuit)
- Harness disconnection

YES



SHTS161100200028

3. CHECK THE VOLTAGE BETWEEN TERMINALS.

(1) Set the starter switch to "OFF".
(2) Connect the connector of the engine speed sub sensor.
(3) Set the starter switch to "ON" (The engine is stopped).
(4) Measure the voltage between G3+ (D19) and GGND (D30) terminals.

Standard: 0.2 — 4.8V

NO

- Malfunction of engine speed sub sensor
- Malfunction of harness (Short to circuit)
- Harness disconnect

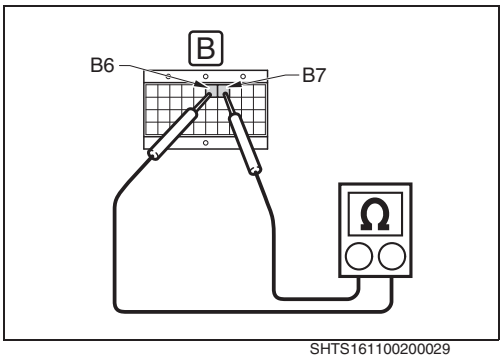
YES

Normal

ENGINE SPEED MAIN SENSOR

EN1611002F200019

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



SHTS161100200029

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}

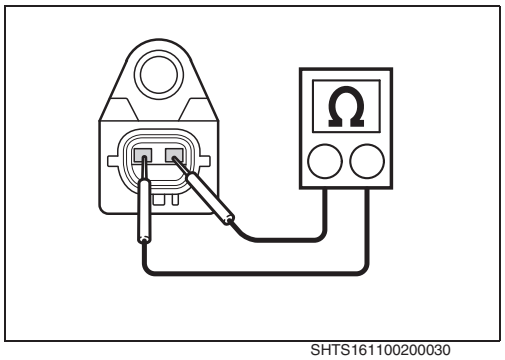
NO → Proceed to 3

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



SHTS161100200030

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}

NO → Malfunction of engine speed main sensor

YES

- Harness disconnection
- Bad contact of connectors

ENGINE SPEED MAIN AND SUB SENSOR

EN1611002F200020

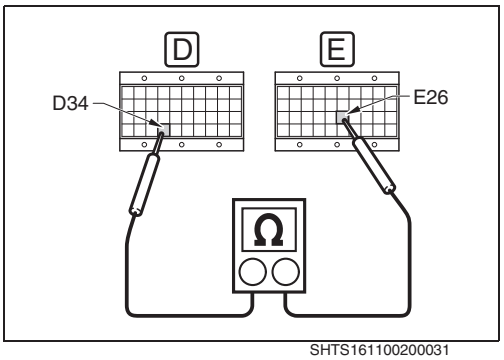
MC No.	13	DTC No.	P0335	Engine speed main and sub sensor circuit malfunction

1. MAKE SURE TO INSPECT IT IN ACCORDANCE WITH THE CONTENTS OF MC No.12, 13 OR DTC No. P0335, P0340.

FUEL TEMPERATURE SENSOR

EN1611002F200021

MC No.	14	DTC No.	P0187	Fuel temperature sensor circuit low input
MC No.	14	DTC No.	P0188	Fuel temperature sensor circuit high input



SHTS161100200031

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 THF+ (E26) and AGD2 (D34) terminals.

HINT

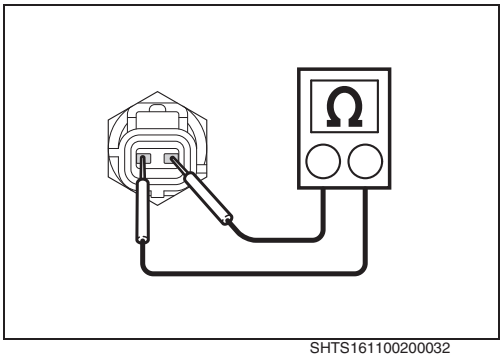
Measure the resistance under any of the following conditions.

Standard:
2.45 kΩ at 20°C {68°F}
1.15 kΩ at 40°C {104°F}
584 kΩ at 60°C {140°F}
318 kΩ at 80°C {176°F}

NO → Proceed to 2

YES

- Malfunction of ECU
- Malfunction of ECU connectors
- Malfunction of harness (Short circuit)



SHTS161100200032

2. CHECK THE FUEL TEMPERATURE SENSOR.

(1) Disconnect the connector of fuel temperature sensor.
(2) Measure the resistance of the fuel temperature sensor.

HINT

Measure the resistance under any of the following conditions.

Standard:
2.45 kΩ at 20°C {68°F}
1.15 kΩ at 40°C {104°F}
584 kΩ at 60°C {140°F}
318 kΩ at 80°C {176°F}

NO → Malfunction of fuel temperature sensor

YES

- Harness disconnection
- Malfunction of connectors
- Bad contact of connectors

ECU

EN1611002F200022

MC No.	15	DTC No.	P2228	Atmospheric pressure circuit low input
MC No.	15	DTC No.	P2229	Atmospheric pressure circuit high input

1. After the starter switch is positioned on the "LOCK" once, it should be turned to "ON" position again.

2. After erasing the MC or DTC, check that the same code is displayed again.

NO → Malfunction of ECU.

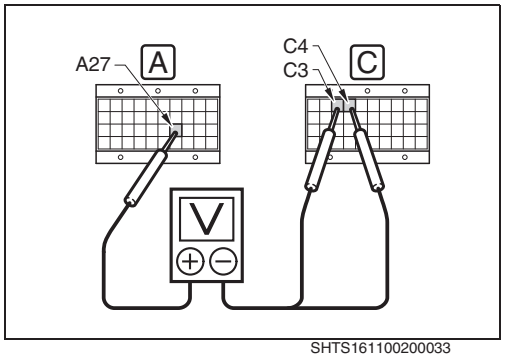
YES

Normal
(Temporary malfunction because of radio interference noise.)

VEHICLE SPEED SENSOR

EN1611002F200023

MC No.	21	DTC No.	P0500	Vehicle speed sensor circuit low input
MC No.	21	DTC No.	P0501	Vehicle speed sensor circuit high input



SHTS161100200033

1. CHECK THE VOLTAGE BETWEEN TERMINALS.
(1) Set the starter switch to "LOCK" and connect the signal check harness.
(2) Start the engine.
(3) Prepare the voltage measurement between VS (A27) and CGD1 and CDG2 (C3 and C4) terminals.
(4) Measure the voltage while the vehicle starts to run at the speed of 10 km/h {6.2 miles/h}.

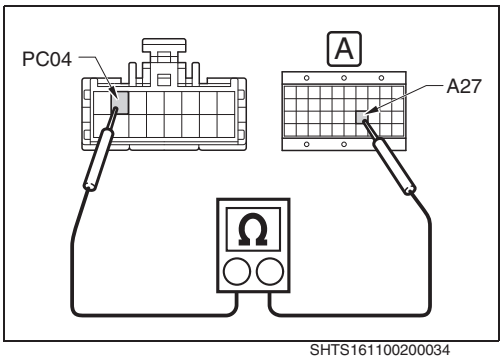
⚠ WARNING
Start the vehicle with caution to surroundings.

Standard: Pulse wave-shape by 5V ↔ 0V
(5) Stop the vehicle.

NO → Proceed to 2

YES

- Malfunction of ECU
- Bad contact of ECU connector



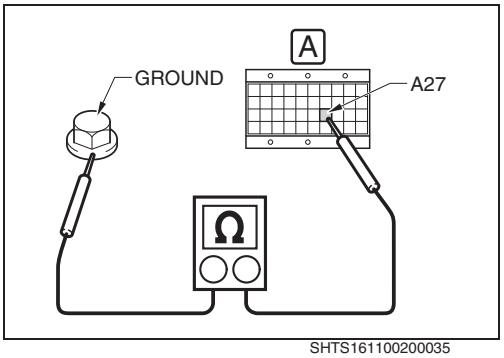
SHTS161100200034

2. CHECK THE CONTINUITY BETWEEN TERMINALS.

(1) Set the starter switch to "LOCK" and disconnect the signal check harness connector on the ECU side.
(2) Disconnect the connector of pulse converter.
(3) Measure the resistance between VS (A27) terminal and PC04 terminal of connector (Vehicle harness side).
Standard: Less than 1 Ω

NO → Harness disconnection of vehicle speed sensor circuit

YES



SHTS161100200035

(4) Set the starter switch to "LOCK" and connect the signal check harness connector on the ECU side.
(5) Measure the resistance between VS (A27) terminal and ground.
Standard: ∞ Ω

NO → Short circuit due to vehicle speed sensor circuit connection to ground

YES

Malfunction of vehicle speed sensor (The vehicle speed sensor should be solely checked. Erase the MC or DTC and if displayed again the same code on the screen after testing, ECU should be replaced with a new one.)

ACCELERATOR SENSOR 1 & 2

EN1611002F200024

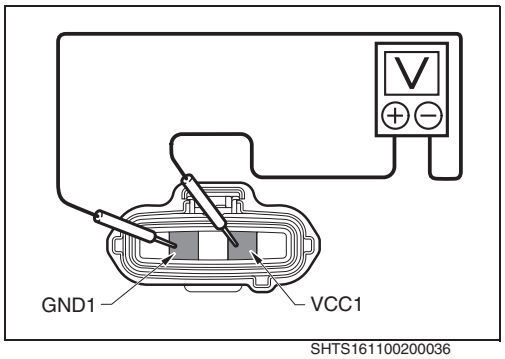
MC No.	22	DTC No.	P2120	Accelerator sensor 1 and 2 malfunction

1. MAKE SURE TO INSPECT IT IN ACCORDANCE WITH THE CONTENTS OF MC No.22 or DTC No. P2121, 2126.

ACCELERATOR SENSOR 1

EN1611002F200025

MC No.	22	DTC No.	P2121	Accelerator sensor 1 malfunction



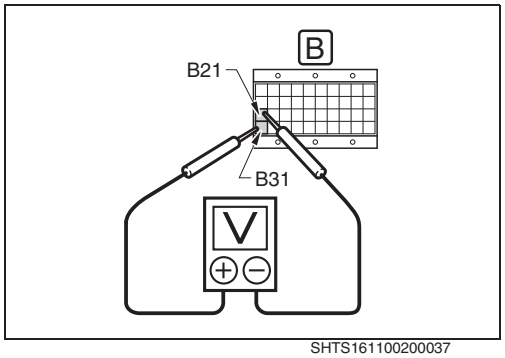
SHTS161100200036

1. CHECK THE VOLTAGE BETWEEN TERMINALS.

(1) Set the starter switch to "LOCK" and connect the signal check harness.
(2) Disconnect the connector of the accelerator sensor.
(3) Set the starter switch to "ON" (The engine is stopped).
(4) Measure the voltage between VCC1 and GND1 terminals of accelerator sensor (Vehicle harness side).
Standard: 4.5 – 5.5V

NO → Proceed to (5)

YES → Proceed to (6)

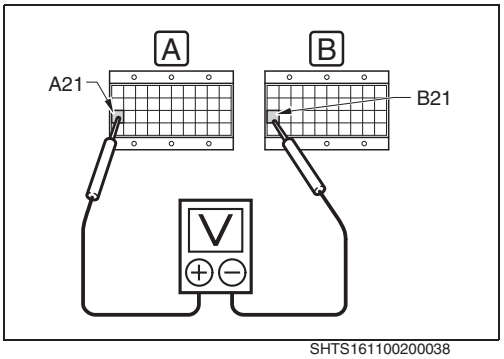


SHTS161100200037

(5) Measure the voltage between AVC5 (B31) and AGD5 (B21) terminals.
Standard: 4.5 – 5.5V
(After measurement, turn the starter switch to "LOCK" position.)

NO →
- Malfunction of ECU
- Malfunction of ECU connectors

YES → Malfunction of harness



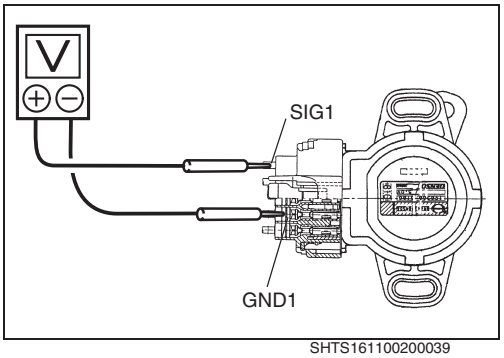
SHTS161100200038

(6) Connect the connector of the accelerator sensor.
(7) Set the starter switch to "ON" (The engine is stopped).
(8) Measure the voltage between ASC1 (A21) and AGD5 (B21) terminals.
Standard:
0.7 — 1.0V: Release the accelerator pedal.
3.7 — 4.4V: Depress the accelerator pedal fully.
(After measurement, turn the starter switch to "LOCK" position.)

NO → Proceed to (9)

YES →

- Malfunction of ECU
- Malfunction of ECU connectors



SHTS161100200039

(9) Connector of accelerator sensor remain connected.
(10) Set the starter switch to "ON" (The engine is stopped).
(11) Measure the voltage between SIG1 and GND1 terminals of accelerator sensor (Vehicle harness side).
Standard:
0.7 — 1.0V: Release the accelerator pedal.
3.7— 4.4V: Depress the accelerator pedal fully.
(After measurement, turn the starter switch to "LOCK" position.)

NO → Malfunction of accelerator sensor

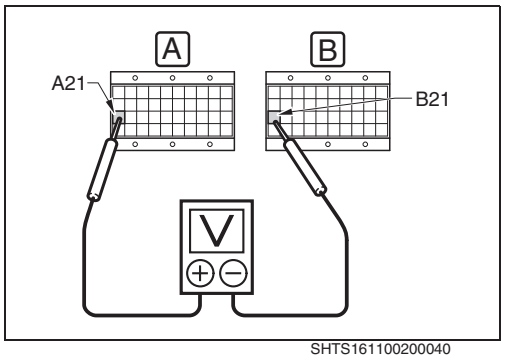
YES →

Harness disconnection or short circuit

ACCELERATOR SENSOR 1

EN1611002F200026

MC No.	22	DTC No.	P2122	Accelerator sensor circuit 1 low voltage
MC No.	22	DTC No.	P2123	Accelerator sensor circuit 1 high voltage



SHTS161100200040

1. CHECK THE VOLTAGE BETWEEN TERMINALS.

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

(2) Set the starter switch to "ON" (The engine is stopped).

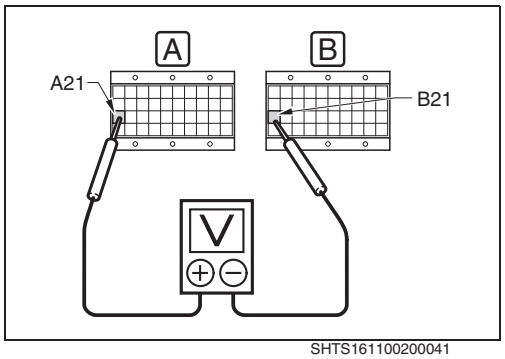
(3) Measure the voltage between ACS1 (A21) and AGD5 (B21) terminals.

Standard: 0.7 –1.0V: Release the accelerator pedal.

NO

Malfunction of accelerator sensor

YES



SHTS161100200041

(4) Measure the voltage between ACS1 (A21) and AGD5 (B21) terminals while depressing the accelerator pedal.

Standard: 1V or more, with the voltage change proportional to the accelerator pedal depression amount.

NO

Malfunction of accelerator sensor

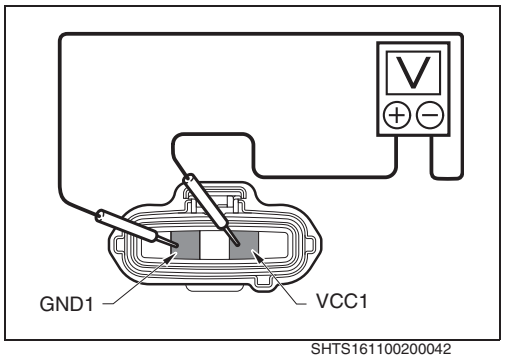
YES

Malfunction of harness

ACCELERATOR SENSOR 2

EN1611002F200027

MC No.	22	DTC No.	P2126	Accelerator sensor 2 malfunction



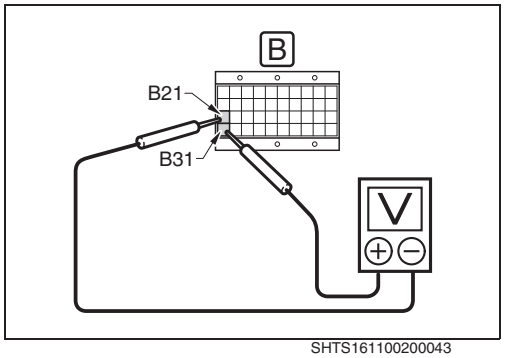
SHTS161100200042

1. CHECK THE VOLTAGE BETWEEN TERMINALS.

(1) Set the starter switch to "LOCK" and connect the signal check harness
(2) Disconnect the connector of the accelerator sensor.
(3) Set the starter switch to "ON" (The engine is stopped).
(4) Measure the voltage between the terminals VCC1 and GND1 terminals of accelerator sensor (Vehicle harness side).
Standard: 4.5 — 5.5V

NO → Proceed to (5)

YES → Proceed to (6)

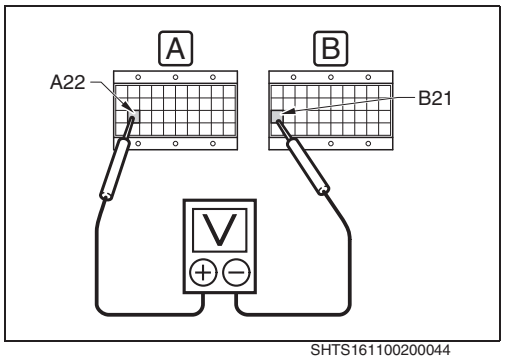


SHTS161100200043

(5) Measure the voltage between AVC5 (B31) and AGD5 (B21) terminals.
Standard: 4.5 — 5.5V
(After measurement, turn the starter switch to "LOCK" position.)

NO →
- Malfunction of ECU
- Malfunction of ECU connectors

YES → Malfunction of harness



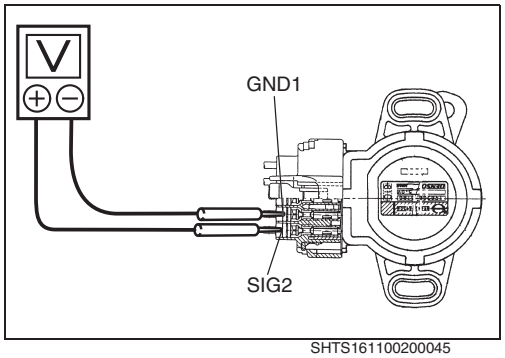
SHTS161100200044

(6) Connect the connector of the accelerator sensor.
(7) Set the starter switch to "ON" (The engine is stopped).
(8) Measure the voltage between ASC2 (A22) and AGD5 (B21) terminals.
Standard:
0.7 — 1.0V: Release the accelerator pedal.
3.7 — 4.4V: Depress the accelerator pedal fully.
(After measurement, turn the starter switch to "LOCK" position.)

NO → Proceed to (9)

YES →

- Malfunction of ECU
- Malfunction of ECU connectors



SHTS161100200045

(9) Connector of the accelerator sensor remain connected
(10) Set the starter switch to "ON" (The engine is stopped).
(11) Measure the voltage between SIG2 and GND1 terminals of accelerator sensor.
Standard:
0.7 — 1.0V: Release the accelerator pedal.
3.7 — 4.4V: Depress the accelerator pedal fully.
(After measurement, turn the starter switch to "LOCK" position.)

NO → Malfunction of accelerator sensor

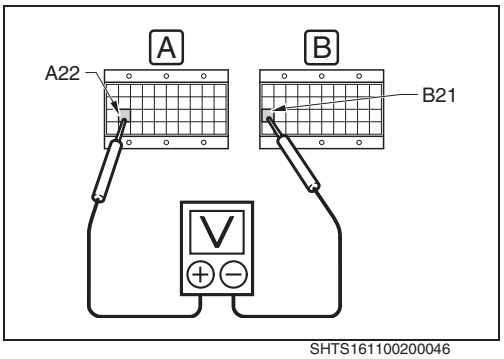
YES →

Harness disconnection or short circuit

ACCELERATOR SENSOR 2

EN1611002F200028

MC No.	22	DTC No.	P2127	Accelerator sensor circuit 2 low voltage
MC No.	22	DTC No.	P2128	Accelerator sensor circuit 2 high voltage



SHTS161100200046

1. CHECK THE VOLTAGE BETWEEN TERMINALS.

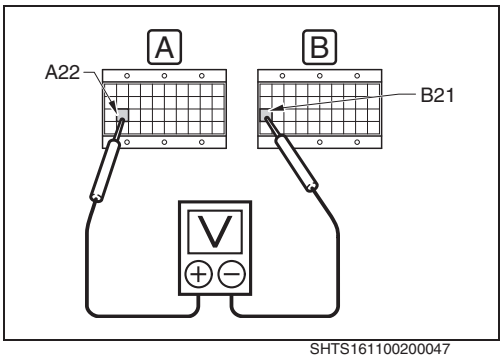
(1) Set the starter switch to "LOCK" and connect the signal check harness.

(2) Set the starter switch to "ON" (The engine is stopped).

(3) Measure the voltage between ACS2 (A22) and AGD5 (B21) terminals.
Standard: 0.7 –1.0V: Release the accelerator pedal.

NO → Malfunction of accelerator sensor

YES



SHTS161100200047

(4) Measure the voltage between ACS2 (A22) and AGD5 (B21) terminals while depressing the accelerator pedal.
Standard: 1V or more, with the voltage change proportional to the accelerator pedal depression amount.

NO → Malfunction of accelerator sensor

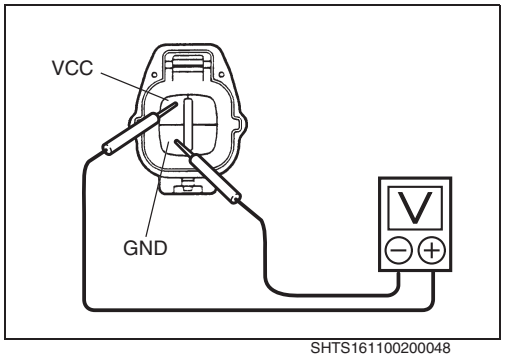
YES

Malfunction of harness

ACCELERATOR SENSOR (FOR OPERATION OF P.T.O.)

EN1611002F200029

MC No.	23	DTC No.	P1132	Accelerator sensor circuit low voltage
MC No.	23	DTC No.	P1133	Accelerator sensor circuit high voltage



SHTS161100200048

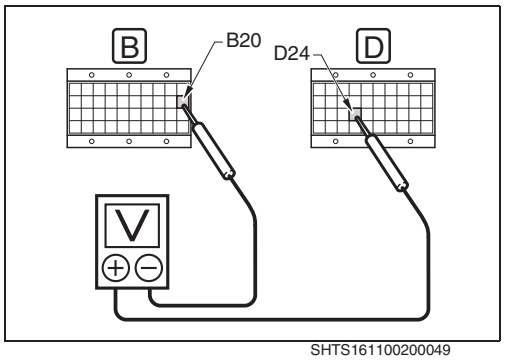
1. CHECK THE VOLTAGE BETWEEN TERMINALS.

(1) Set the starter switch to "LOCK" and connect the signal check harness.
(2) Disconnect the connector of the accelerator sensor.
(3) Set the starter switch to "ON" (The engine is stopped).
(4) Measure the voltage between VCC and GND terminals of accelerator sensor (Vehicle harness side).
Standard: 4.5 — 5.5V

NO → Proceed to (5)

YES

Proceed to (6)



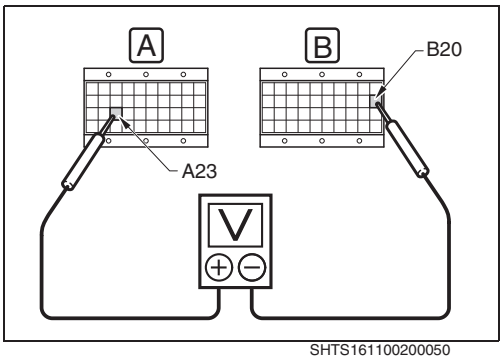
SHTS161100200049

(5) Measure the voltage between AVC4 (D24) and AGD4 (B20) terminals.
Standard: 4.5 — 5.5V
(After measurement, turn the starter switch to "LOCK" position.)

NO →
- Malfunction of ECU
- Malfunction of ECU connectors

YES

Malfunction of harness



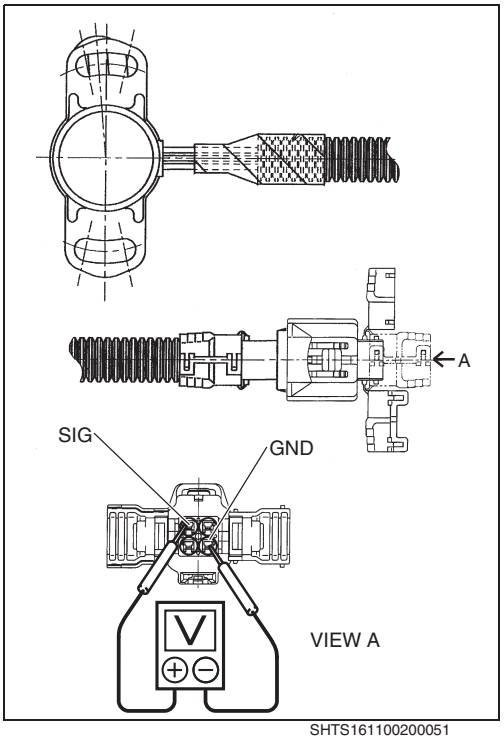
SHTS161100200050

(6) Connect the connector of the accelerator sensor.
(7) Set the starter switch to "ON" (The engine is stopped).
(8) Measure the voltage between ASCS (A23) and AGD4 (B20) terminals.
Standard:
APPROX. 0.6—4.6V (Idle to full throttle)
(After measurement, turn the starter switch to "LOCK" position.)

NO → Proceed to (9)

YES →

- Malfunction of ECU
- Malfunction of ECU connectors



SHTS161100200051

(9) Connect the connector of the accelerator sensor.
(10) Set the starter switch to "ON" (The engine is stopped).
(11) Measure the voltage between SIG and GND terminals of accelerator sensor (Vehicle harness side).
Standard:
APPROX. 0.6—4.6V (Idle to full throttle)

NO → Malfunction of accelerator sensor

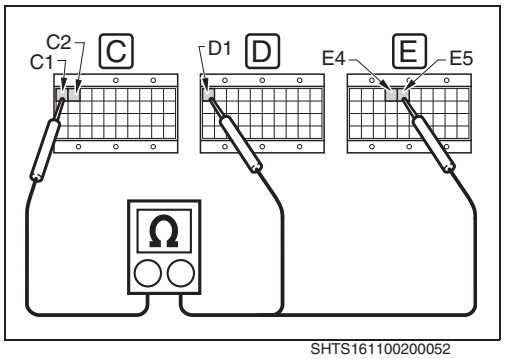
YES →

Harness disconnection or short circuit

AIR INTAKE HEATER

EN1611002F200030

MC No.	25	DTC No.	P0540	Air intake heater circuit malfunction



SHTS161100200052

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 terminals.

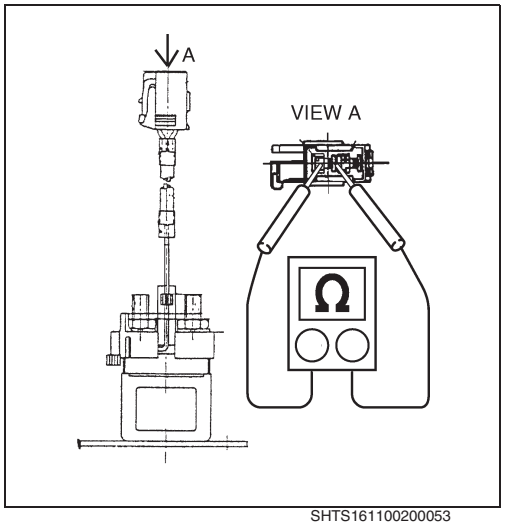
+ side	- side
HRY (C1)	PGD1 (D1), PGD2 (E4), PGD3 (E5)
HRY2 (C2)	PGD1 (D1), PGD2 (E4), PGD3 (E5)

Standard: 22.5–27.5 Ω

NO → Proceed to 2

YES →

- Malfunction of ECU
- Malfunction of ECU connectors



SHTS161100200053

2. CHECK THE RESISTANCE OF AIR INTAKE HEATER RELAY.

(1) Remove the air intake heater relay.
(2) Measure the resistance between terminals of air intake heater relay.

Standard: 24-25.6 Ω

NO → Malfunction of air intake heater relay

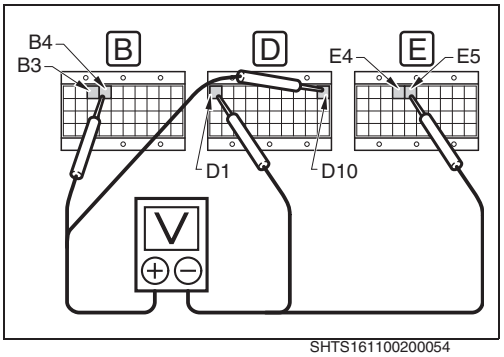
YES →

- Malfunction of ECU
- Malfunction of ECU connectors

ENGINE RETARDER

EN1611002F200031

MC No.	26	DTC No.	P1462	Engine retarder 1 open circuit, short to GND
MC No.	26	DTC No.	P1463	Engine retarder 1 short to BATT
MC No.	27	DTC No.	P1467	Engine retarder 2 open circuit, short to GND
MC No.	27	DTC No.	P1468	Engine retarder 2 short to BATT



SHTS161100200054

1. CHECK THE VOLTAGE 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) Set the starter switch to "ON" (The engine is stopped).
(4) Measure the voltage between terminals.

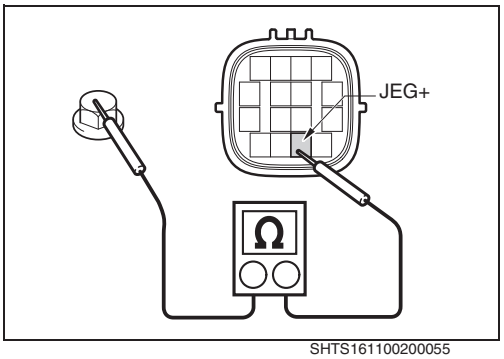
+ side	– side
RTD1 (B3)	PGD1 (D1), PGD2 (E4), PGD3 (E5)
RTD2 (B4)	PGD1 (D1), PGD2 (E4), PGD3 (E5)
RTD3 (D10)	PGD1 (D1), PGD2 (E4), PGD3 (E5)

Standard: more than 19V

NO → Proceed to 2

YES →

- Malfunction of ECU
- Malfunction of ECU connector



SHTS161100200055

2. CHECK THE CONTINUITY.

(1) Set the starter switch to "LOCK" and tilt the cab
(2) Disconnect the injector connector that is located on the front side of the cylinder head.
(3) Measure the continuity between JEG+ (Engine retarder side) and engine ground or another part with the same potential.

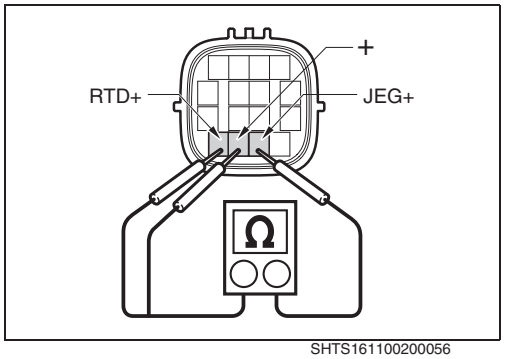
Standard: ∞ Ω

NO →

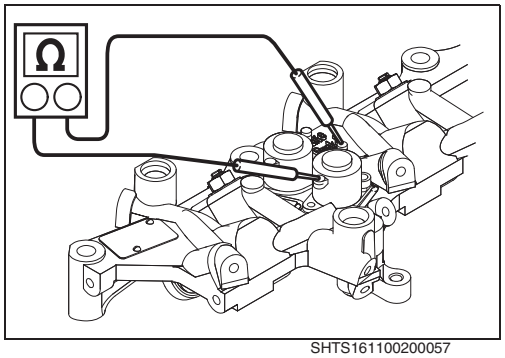
- Harness short circuit
- Connector short circuit

YES →

Proceed to 3



SHTS161100200056



SHTS161100200057

3. CHECK THE ENGINE RETADER VALVE.

(1) Measure the resistance between terminals (Engine retarder side).

Engine retarder 1 (No.1-No.3 cylinder)	JEG+ ↔ RTD1
Engine retarder 2 (No.4-No.6 cylinder)	JEG+ ↔ +

Standard: APPROX. 34–44 Ω

(2) If the above check shows abnormality, remove the cylinder head, remove the engine retarder valve harness and measure the resistance between terminals (Engine retarder valve side).

Standard: APPROX. 34–44 Ω

NO

Malfunction of engine retarder valve

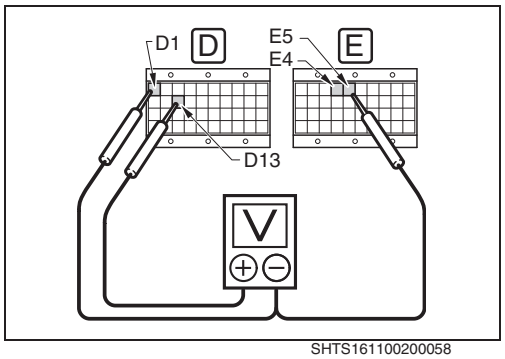
YES

- Malfunction of harness
- Malfunction of connector

VARIABLE GEOMETRY TURBOCHARGER (VGT) VALVE 1

EN1611002F200032

MC No.	31	DTC No.	P0047	VGT valve 1 open circuit, short to GND
MC No.	31	DTC No.	P0048	VGT valve 1 short to BATT



SHTS161100200058

1. CHECK THE VOLTAGE BETWEEN TERMINALS.

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

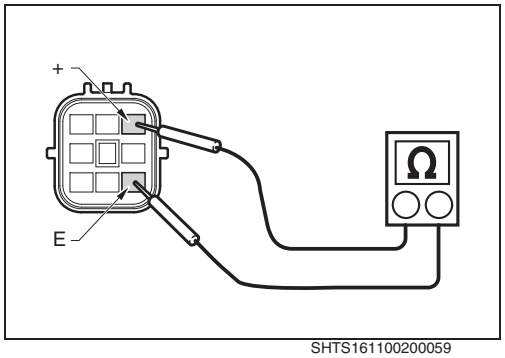
(2) Measure the voltage between VGT1 (D13) and PGD (D1), PGD2 (E4), PGD3 (E5) terminals.

Standard: more than 19V

NO → Proceed to 2

YES →

- Malfunction of ECU
- Malfunction of ECU connector
- Harness short circuit



SHTS161100200059

2. CHECK THE RESISTANCE BETWEEN TERMINALS.

(1) Set the starter switch to "LOCK".

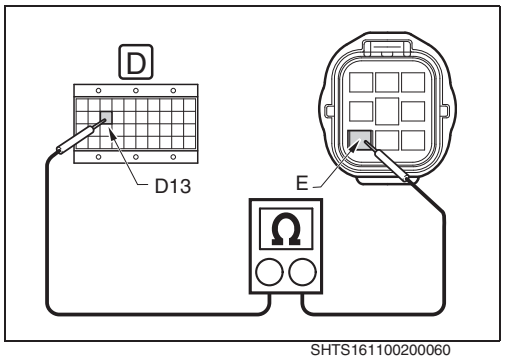
(2) Disconnect the connector of the VGT valve.

(3) Measure the resistance between + and E terminals of VGT valve 1 (VGT valve side).

Standard: 35–45 Ω

NO → Malfunction of VGT valve 1

YES →



SHTS161100200060

3. CHECK THE RESISTANCE BETWEEN TERMINALS.

(1) Set the starter switch to "LOCK" and disconnect the signal check harness connector on the ECU side.

(2) Measure the resistance between VGT1 (D13) and E terminal of VGT valve 1 (Vehicle harness side).

Standard: Less than 1 Ω

NO

- Harness disconnection
- Malfunction of connector

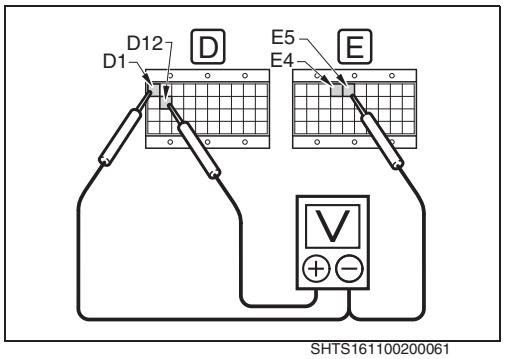
YES

Bad contact of harness connector

VARIABLE GEOMETRY TURBOCHARGER (VGT) VALVE 2

EN1611002F200033

MC No.	32	DTC No.	P1062	VGT valve 2 open circuit, short to GND
MC No.	32	DTC No.	P1063	VGT valve 2 short to BATT



SHTS161100200061

1. CHECK THE VOLTAGE BETWEEN TERMINALS.

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

(2) Measure the voltage between VGT2 (D12) and PGD (D1), PGD2 (E4), PGD3 (E5) terminals.

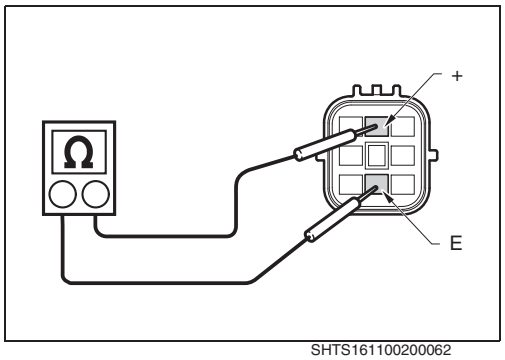
Standard: more than 19V

NO

Proceed to 2

YES

- Malfunction of ECU
- Malfunction of ECU connector
- Harness short circuit



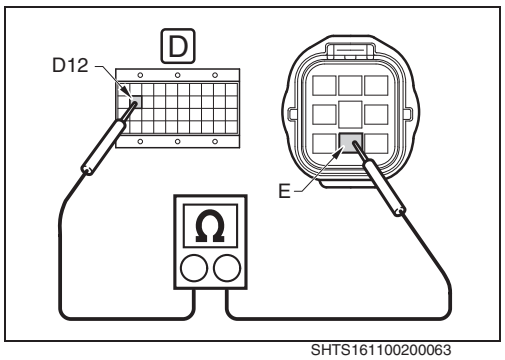
SHTS161100200062

2. CHECK THE RESISTANCE BETWEEN TERMINALS.
(1) Set the starter switch to "LOCK".
(2) Disconnect the connector of the VGT valve.
(3) Measure the resistance between + and E terminals of VGT valve 2 (VGT valve side).

Standard: 35–45 Ω

NO → Malfunction of VGT valve 2

YES



SHTS161100200063

3. CHECK THE RESISTANCE BETWEEN TERMINALS.
(1) Set the starter switch to "LOCK" and disconnect the signal check harness connector on the ECU side.
(2) Measure the resistance between VGT1 (D12) and E terminal of VGT valve 2 (Vehicle harness side).

Standard: Less than 1 Ω

NO →
- Harness disconnection
- Malfunction of connector

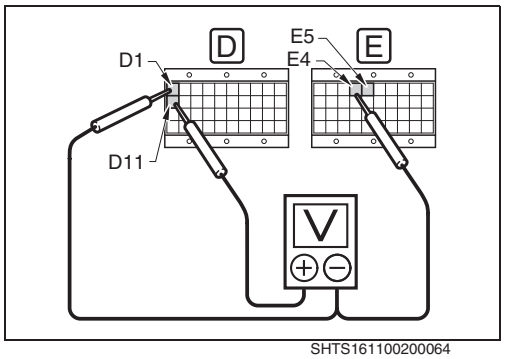
YES

Bad contact of harness connector

VARIABLE GEOMETRY TURBOCHARGER (VGT) VALVE 3

EN1611002F200034

MC No.	33	DTC No.	P1067	VGT valve 3 open circuit, short to GND
MC No.	33	DTC No.	P1068	VGT valve 3 short to BATT



SHTS161100200064

1. CHECK THE VOLTAGE BETWEEN TERMINALS.

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

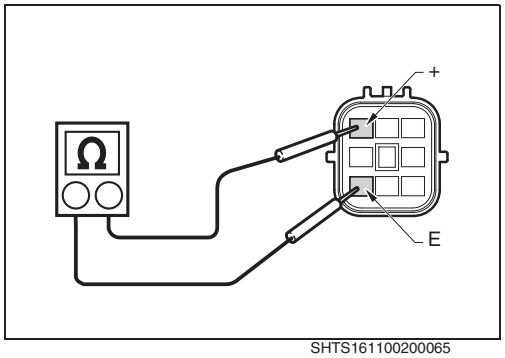
(2) Measure the voltage between VGT3 (D11) and PGD (D1), PGD2 (E4), PGD3 (E5) terminals.

Standard: more than 19V

NO → Proceed to 2

YES →

- Malfunction of ECU
- Malfunction of ECU connector
- Harness short circuit



SHTS161100200065

2. CHECK THE RESISTANCE BETWEEN TERMINALS.

(1) Set the starter switch to "LOCK".

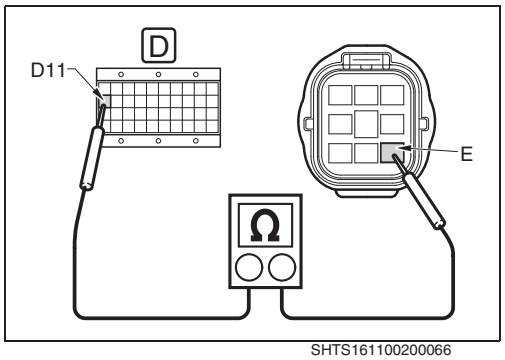
(2) Disconnect the connector of the VGT valve.

(3) Measure the resistance between + and E terminals of VGT valve 3 (VGT valve side).

Standard: 35–45 Ω

NO → Malfunction of VGT valve 3

YES →



SHTS161100200066

3. CHECK THE RESISTANCE BETWEEN TERMINALS.
(1) Set the starter switch to "LOCK" and disconnect the signal check harness connector on the ECU side.
(2) Measure the resistance between VGT3 (D11) and E terminal of VGT valve 3 (Vehicle harness side).

Standard: Less than 1 Ω

NO

- Harness disconnection
- Malfunction of connector

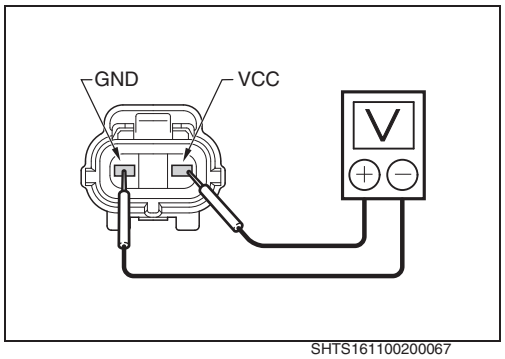
YES

Bad contact of harness connector

BOOST PRESSURE SENSOR

EN1611002F200035

MC No.	37	DTC No.	P0108	Boost pressure sensor circuit high input
MC No.	37	DTC No.	P0237	Boost pressure sensor circuit low input



SHTS161100200067

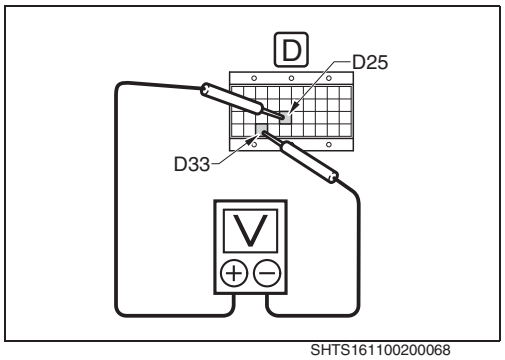
1. CHECK THE VOLTAGE BETWEEN TERMINALS.
(1) Set the starter switch to "LOCK" and connect the signal check harness.
(2) Tilt the cab and disconnect the connector of boost pressure sensor.
(3) Set the stater switch to "ON" (The engine is stopped).
(4) Measure the voltage between VCC and GND terminals of boost pressure sensor (Vehicle harness side).
Standard: 4.5 — 5.5V
(After measurement, turn the starter switch to "LOCK" position.)

NO

Proceed to 2

YES

Proceed to 3



SHTS161100200068

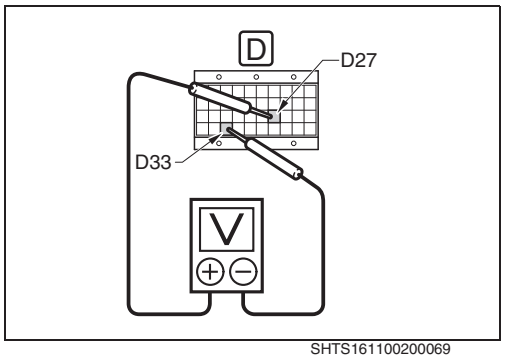
2. CHECK THE VOLTAGE BETWEEN TERMINALS.
(1) Set the stater switch to "ON" (The engine is stopped).
(2) Measure the voltage between AVC1 (D25) and AGD (D33) terminals.
Standard: 4.5 — 5.5V

NO

- Malfunction of ECU
- Malfunction of ECU connector

YES

Malfunction of harness



SHTS161100200069

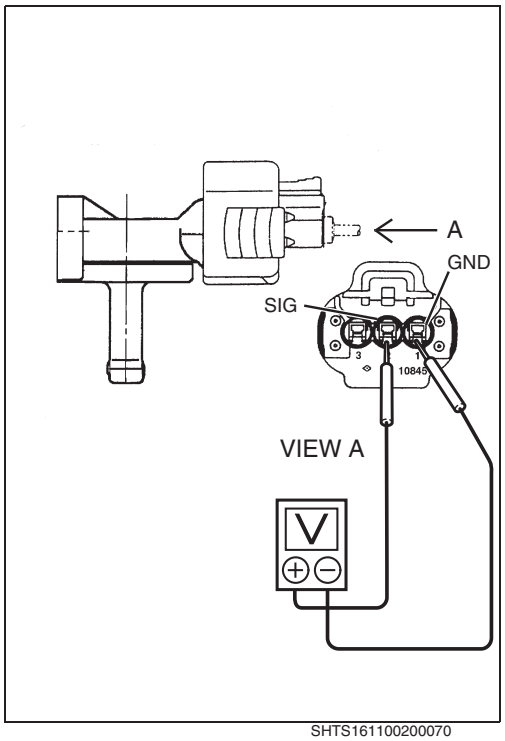
3. CHECK THE VOLTAGE BETWEEN TERMINALS.
(1) Set the starter switch to "LOCK".
(2) Connect the connector of boost pressure sensor.
(3) Set the starter switch to "ON" (The engine is stopped).
(4) Measure the voltage between the terminal PIM (D27) and AGD1 (D33) terminals.
Standard: 0.2—4.8V

NO

Proceed to 4

YES

- Malfunction of ECU
- Malfunction of ECU connector
- Malfunction of harness



SHTS161100200070

4. CHECK THE BOOST PRESSURE SENSOR.

(1) Connector of boost pressure sensor remain connected.

(2) Measure the voltage between SIG and GND terminals of boost pressure sensor.

Standard: 0.2—4.8V

NO

Malfunction of boost pressure sensor

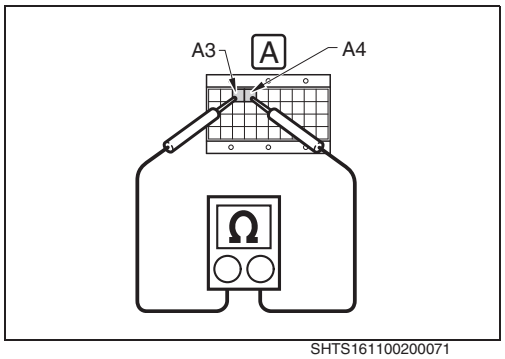
YES

Malfunction of harness

TURBOCHARGER SPEED SENSOR

EN1611002F200036

MC No.	38	DTC No.	P1071	Turbocharger speed circuit high input
MC No.	38	DTC No.	P1072	Turbocharger speed circuit low input



SHTS161100200071

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 on the ECU side.
(3) Measure the resistance between TUN– (A3) and TUN+ (A4) terminals.

Standard: APPROX. 850 Ω

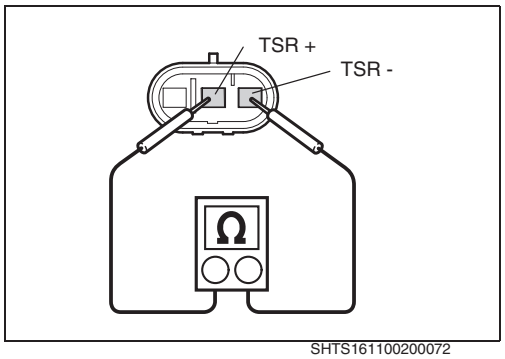
NO

Proceed to 2

YES

Connect the signal check harness connector on the ECU side and recheck the MC or DTC.
If the MC or DTC is displayed, one of the following defects can be assumed.

- Bad contact of ECU connector
- Malfunction of ECU
- Malfunction of harness (Short circuit)



SHTS161100200072

2. CHECK THE RESISTANCE BETWEEN TERMINALS OF TURBOCHARGER SPEED SENSOR.

(1) Set the starter switch to "LOCK" and disconnect the connector of the turbocharger speed sensor.
(2) Measure the resistance between TSR+ and TSR- terminals. (Sensor side).

Standard: 829–871 Ω

NO

Malfunction of turbocharger speed sensor

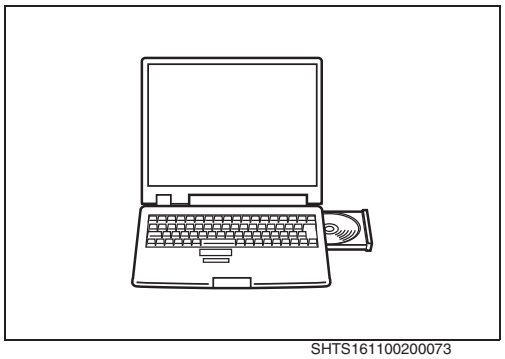
YES

- Malfunction of harness (Harness disconnection)
- Malfunction of connector

TURBOCHARGER OVERRUN

EN1611002F200037

MC No.	39	DTC No.	P0049	Turbocharger overrun



SHTS161100200073

1. CHECK THE VG TURBOCHARGER USING THE PC DIAGNOSIS TOOL (Hino DX).

(1) Connect the PC DIAGNOSIS TOOL (Hino DX).
(2) Start the engine.
(3) Select the "Check turbocharger" menu and check the turbocharger operation.

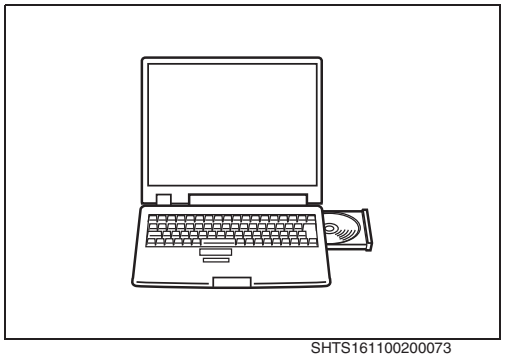
2. CHECK THE VG TURBOCHAGER CONTROL SYSTEM USING THE PC DIAGNOSIS TOOL (Hino DX).

(1) Connect the PC DIAGNOSIS TOOL (Hino DX).
(2) Set the starter switch to "ON" (The engine is stopped).
(3) Select the "Activation Test" menu and check the VGT solenoid valve operation.

TURBOCHARGER OVER BOOST

EN1611002F200038

MC No.	39	DTC No.	P0234	Turbocharger over boost



SHTS161100200073

1. CHECK THE VG TURBOCHARGER CONTROL SYSTEM USING THE PC DIAGNOSIS TOOL (Hino DX).

(1) Connect the PC DIAGNOSIS TOOl (Hino DX).
(2) Set the starter switch to "ON" (The engine is stopped).
(3) Select the "VGT check" menu and measure the VGT control rod stroke.

Standard: Normal

NO

YES

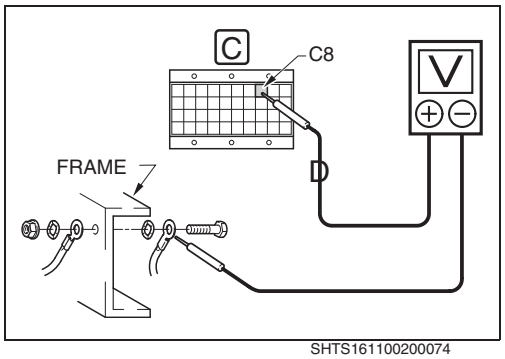
- Malfunction of VGT air cylinder
  (Replace the VG turbocharger assembly.)
- Malfunction of air piping

Carry out diagnosis of the boost pressure sensor MC No.37 or DTC No. P0108, P0237

CLUTCH SWITCH

EN1611002F200039

MC No.	41	DTC No.	P0704	Clutch switch malfunction



SHTS161100200074

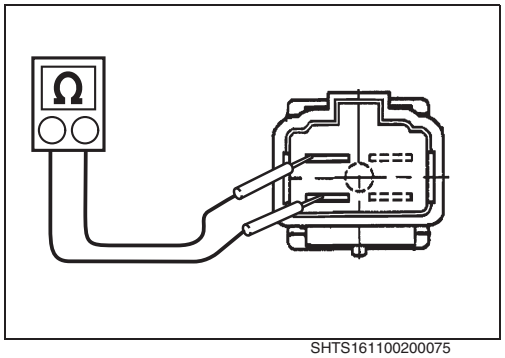
1. CHECK THE VOLTAGE BETWEEN TERMINAL AND GND.

(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 voltage between CLSW (C8) terminal and chassis GND.

Standard:
More than 19V (Clutch pedal pressed)
0V (Clutch pedal released)

NO → Proceed to 2

YES → Malfunction of ECU



SHTS161100200075

2. CHECK THE CLUTCH SWITCH.

(1) Set the starter switch to "LOCK".
(2) Disconnect the clutch switch connector.
(3) Measure the resistance between clutch switch terminals.

Standard:
∞ Ω (Clutch switch not pressed)
Less than 1 Ω (Clutch switch pressed)

NO → Malfunction of clutch switch

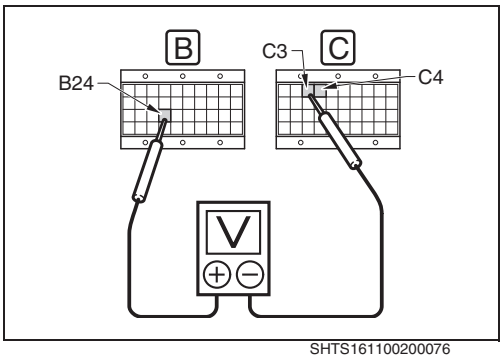
YES →

- Harness disconnection
- Malfunction of connectors
- Bad contact of connectors

ACCELERATOR SWITCH

EN1611002F200040

MC No.	42	DTC No.	P0510	Accelerator switch malfunction



SHTS161100200076

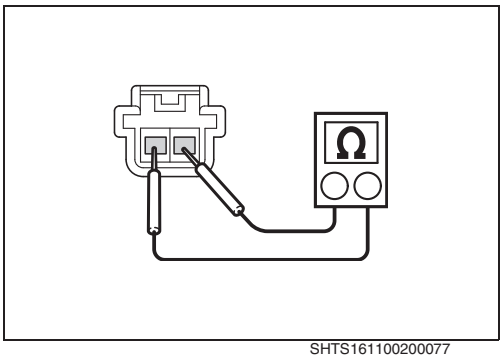
1. CHECK THE VOLTAGE BETWEEN TERMINALS.

(1) Set the starter switch to "LOCK" and connect the signal check harness.
(2) Set the starter switch to "ON" (The engine is stopped).
(3) Measure the voltage between IDLE (B24) and CGD1 (C3), CGD2 (C4) terminals.

Standard:
More than 19V (Accelerator pedal released)
0V (With full throttle)

NO → Proceed to 2

YES → Malfunction of ECU



SHTS161100200077

2. CHECK THE ACCELERATOR SWITCH.

(1) Set the starter switch to "LOCK".
(2) Disconnect connector of the idle switch.
(3) Measure the resistance between terminals (Switch side).

Standard:
Less than 2 Ω (Accelerator pedal released)
∞ Ω (With full throttle)

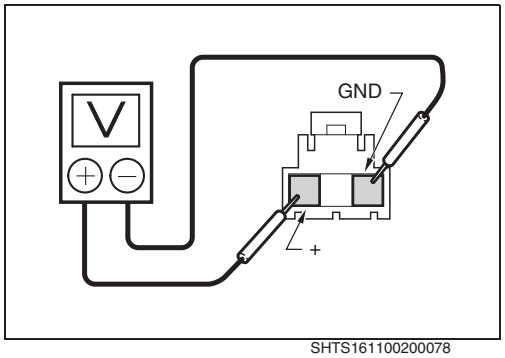
NO → Malfunction of accelerator switch

YES → Malfunction of harness

IDLE SET CONTROLLER

EN1611002F200041

MC No.	44	DTC No.	P1142	Idle set controller low voltage
MC No.	44	DTC No.	P1143	Idle set controller high voltage



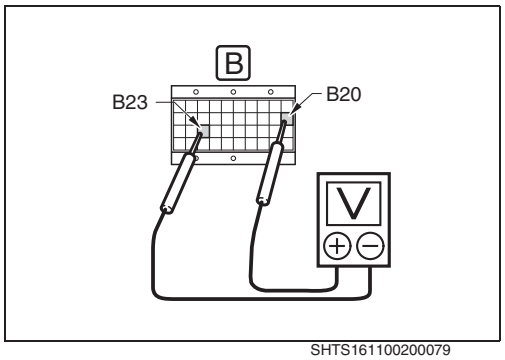
SHTS161100200078

1. CHECK THE VOLTAGE BETWEEN TERMINALS.

(1) Set the starter switch to "LOCK" and connect the signal check harness.
(2) Disconnect the connector of idle set controller.
(3) Set the starter switch to "ON" (The engine is stopped).
(4) Measure the voltage between + and GND terminals of idle set controller connectors (Vehicle harness side).
Standard: 4.5 — 5.5V
(After measurement, turn the starter switch to "LOCK" position.)

NO → Proceed to (5)

YES → Proceed to (7)

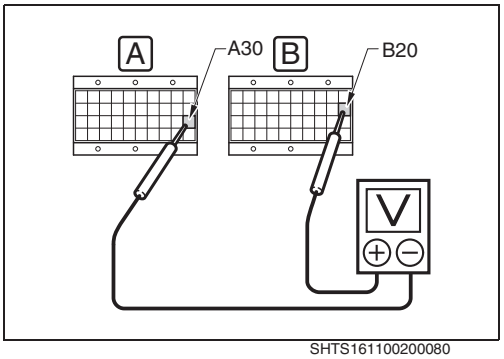


SHTS161100200079

(5) Set the starter switch to "ON" (The engine is stopped).
(6) Measure the voltage between AVC2 (B23) and AGD4 (B20) terminals.
Standard: 4.5 — 5.5V
(After measurement, turn the starter switch to "LOCK" position.)

NO →
- Malfunction of ECU
- Malfunction of ECU connectors

YES → Harness disconnection



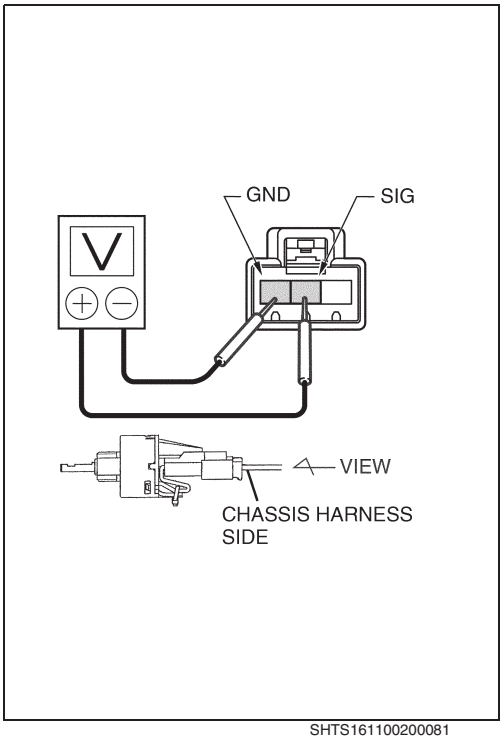
SHTS161100200080

(7) Connect the connector of idle set controller.
(8) Set the starter switch to "ON" (The engine is stopped).
(9) Measure the voltage between IVS (A30) and AGD4 (B20) terminals.
Standard:
APPROX. 0V: Turn control knob to left fully.
APPROX. 0.7V: Turn control knob to left.
APPROX. 4.3V: Turn control knob to right fully.
(After measurement, turn the starter switch to "LOCK" position.)

NO → Proceed to (9)

YES →

- Malfunction of ECU
- Malfunction of ECU connectors



SHTS161100200081

(10) Set the starter switch to "ON" (The engine is stopped).
(11) Measure the voltage between SIG and GND terminals of idle set controller connectors (chassis harness side).
Standard:
APPROX. 0V: Turn idle control knob to left fully.
APPROX. 0.7V: Turn idle control knob to left.
APPROX. 4.3V: Turn idle control knob to right fully.

NO → Malfunction of idle set controller

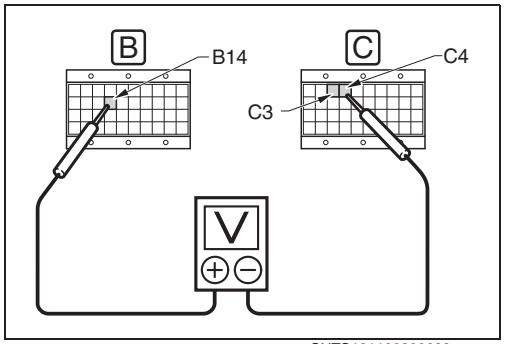
YES →

Harness disconnection or short circuit

STARTER SWITCH

EN1611002F200042

MC No.	45	DTC No.	P0617	Starter signal malfunction



SHTS161100200082

1. CHECK THE VOLTAGE BETWEEN TERMINALS.

NOTICE

Make sure that transmission is in neutral position.

(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 voltage between ST (B14) and CGD (C3 and C4) terminals.
Standard:
0V (Starter switch "LOCK")
24V (Starter switch "START")

NO → Malfunction of harness

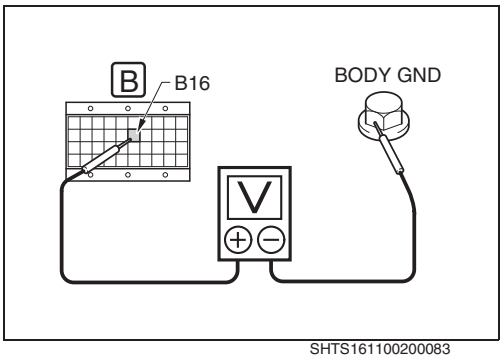
YES

- Malfunction of ECU
- Malfunction of ECU connectors
- Bad contact of ECU connectors

ENGINE STOP SWITCH

EN1611002F200043

MC No.	46	DTC No.	P1530	Engine stop switch malfunction



SHTS161100200083

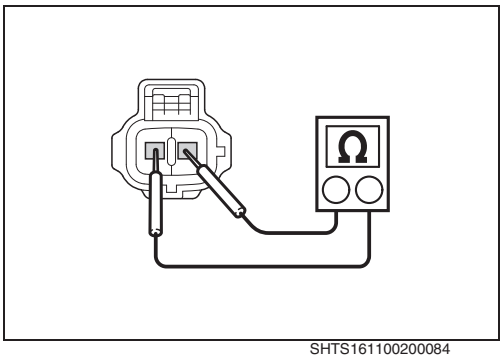
1. CHECK THE VOLTAGE BETWEEN TERMINAL AND GND.

(1) Set the starter switch to "LOCK" position and connect the signal check harness.
(2) Disconnect the signal check harness on ECU side.
(3) Set the starter switch to "ON".
(4) Measure the voltage between STOP (B16) terminal and body GND.

Standard:
More than 19V (Engine stop switch pressed)
0V (Engine stop switch not pressed)

NO → Proceed to 2

YES → Malfunction of ECU



SHTS161100200084

2. CHECK THE ENGINE STOP SWITCH.

(1) Set the starter switch to "LOCK".
(2) Disconnect the connector of engine stop switch.
(3) Measure the resistance between terminals (Engine stop switch side).

Standard:
∞ Ω (Engine stop switch not pressed)
Less than 1 Ω (Engine stop switch pressed)

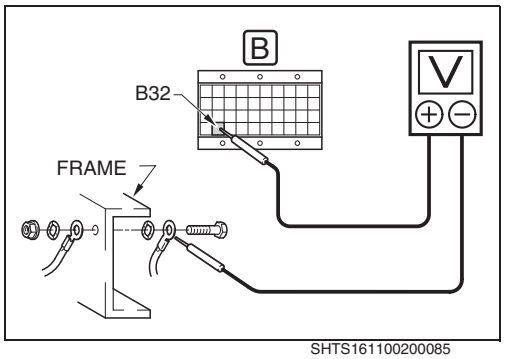
NO → Malfunction of engine stop switch

YES → Malfunction of harness

NEUTRAL SWITCH

EN1611002F200044

MC No.	47	DTC No.	P0850	Neutral switch malfunction



SHTS161100200085

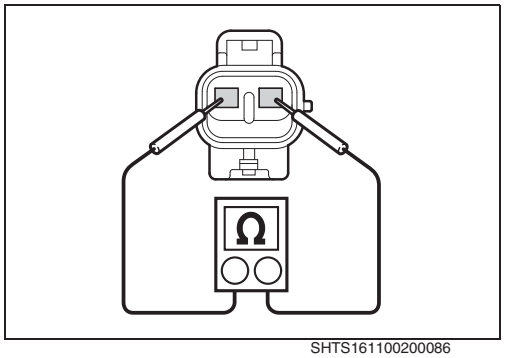
1. CHECK THE VOLTAGE BETWEEN TERMINAL AND GND.

(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) Set the starter switch to "ON" (The engine is stopped).
(4) Measure the voltage between NUSW terminal and chassis GND.

Standard:
More than 19V (Transmission: Neutral position)
0V (Transmission: Not neutral position)

NO → Proceed to 2

YES → Malfunction of ECU



SHTS161100200086

2. CHECK THE NEUTRAL SWITCH.

(1) Set the starter switch to "LOCK".
(2) Disconnect the connector of neutral switch.
(3) Measure the resistance between terminals (Neutral switch side).
Standard:
∞ Ω (Neutral switch not pressed)
Less than 1 Ω (Neutral switch pressed)

NO → Malfunction of neutral switch

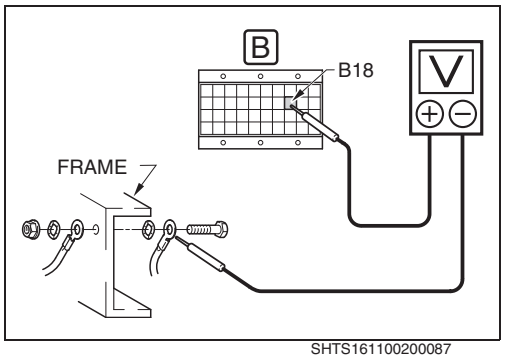
YES →

- Harness disconnection
- Malfunction of connectors
- Bad contact of connectors

TRANSMISSION POSITION DETECT SWITCH

EN1611002F200045

MC No.	48	DTC No.	P1676	Transmission position detect switch malfunction



SHTS161100200087

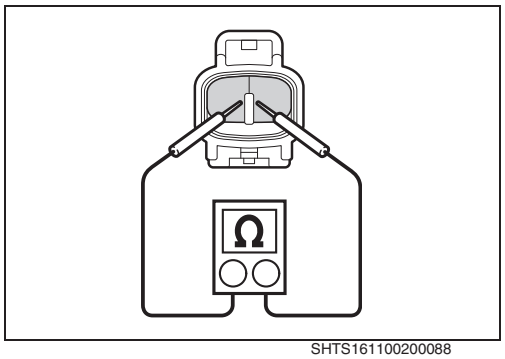
1. CHECK THE VOLTAGE BETWEEN TERMINAL AND GND.

(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) Set the starter switch to "ON" (The engine is stopped).
(4) Measure the voltage between PCS (B18) terminal and chassis GND.

Standard:
More than 19V (Transmission: Shift to Reverse, 1st and 2nd)
0V (Transmission: Shift to 3rd, 4th-7th)

NO → Proceed to 2

YES → Malfunction of ECU



SHTS161100200088

2. CHECK THE TRANSMISSION POSITION DETECT SWITCH.

(1) Set the starter switch to "LOCK".
(2) Disconnect the connector of transmission position detect switch.
(3) Measure the resistance between terminals (Switch side).
Standard:
∞ Ω **(Switch not pressed)**
Less than 1 Ω **(Switch pressed)**

NO → Malfunction of transmission position detect switch

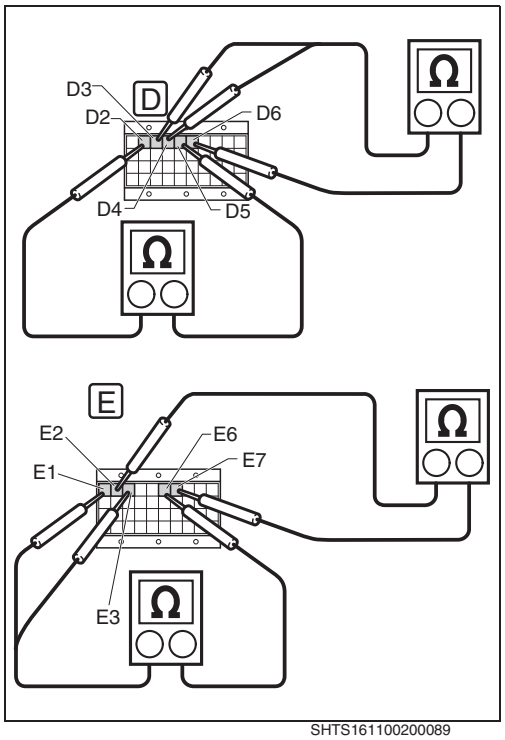
YES →

- Harness disconnection
- Malfunction of connectors
- Bad contact of connectors

INJECTOR SOLENOID VALVE SYSTEM BREAKING

EN1611002F200046

MC No.	51	DTC No.	P0201	Injector circuit malfunction -cylinder 1
MC No.	52	DTC No.	P0202	Injector circuit malfunction -cylinder 2
MC No.	53	DTC No.	P0203	Injector circuit malfunction -cylinder 3
MC No.	54	DTC No.	P0204	Injector circuit malfunction -cylinder 4
MC No.	55	DTC No.	P0205	Injector circuit malfunction -cylinder 5
MC No.	56	DTC No.	P0206	Injector circuit malfunction -cylinder 6



SHTS161100200089

1. CHECK THE RESISTANCE BETWEEN TERMINALS.

(1) Set the starter switch to "LOCK" and connect the signal check harness connector.
(2) Disconnect the signal check harness connector on the ECU.
(3) Measure the resistance between terminals.

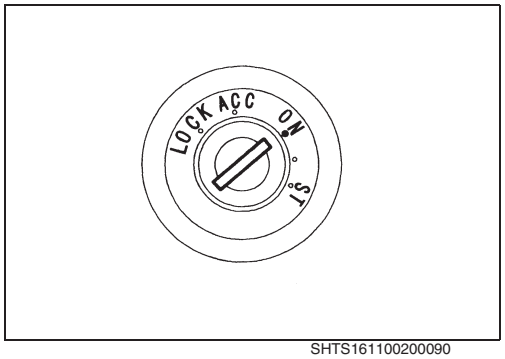
MAC NO.	DTC NO.	Failure position (Breaking position)	Terminals to measure the resistance
51	P0201	No.1 Injector	INJ1 (D2) ↔ IJ1+ (D5)
52	P0202	No.2 Injector	INJ2 (D3) ↔ I1+S (D6)
53	P0203	No.3 Injector	INJ3 (D4) ↔ I1+S (D6)
54	P0204	No.4 Injector	INJ4 (E1) ↔ IJ2+ (E6)
55	P0205	No.5 Injector	INJ5 (E3) ↔ IJ2+ (E6)
56	P0206	No.6 Injector	INJ6 (E2) ↔ I2+S (E7)

Standard: Less than 2 Ω

NO

Proceed to 3

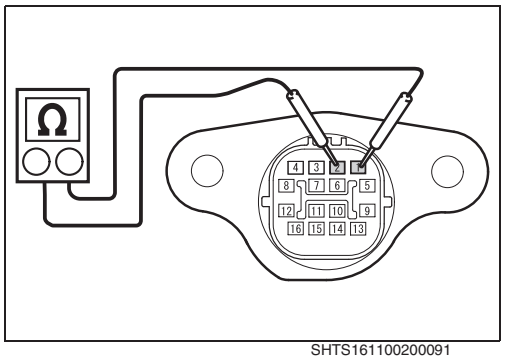
YES



SHTS161100200090

2. RECHECK THE MC OR DTC.

(1) Set the starter switch to "LOCK" position and connect the signal check harness connector on the ECU side.
(2) Start the engine and erase the MC or DTC.
(3) Check the present failure. If the same MC or DTC is displayed, replace ECU.
If there is no MC or DTC, then the connector contact would have been defective. As long as no MC or DTC is displayed, there is no problem.



SHTS161100200091

3. CHECK THE RESISTANCE BETWEEN TERMINALS.

(1) Set the starter switch to "LOCK".
(2) Tilt the cab. Disconnect the injector connector that is located at the front side of the cylinder head.
(3) Measure the resistance between the terminals of the injector connector. (Engine side)

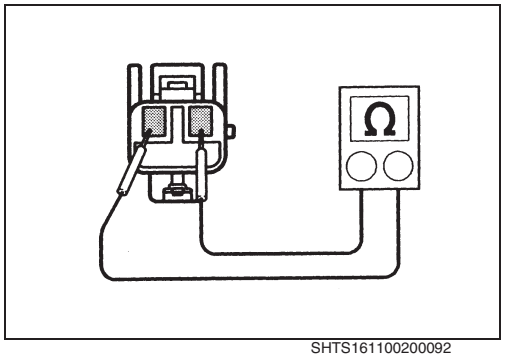
MC NO.	DTC NO.	Failure position (Breaking position)	Terminals to measure the resistance
51	P0201	No.1 indicator	1 ↔ 2
52	P0202	No.2 indicator	9 ↔ 10
53	P0203	No.3 indicator	6 ↔ 8
54	P0204	No.4 indicator	5 ↔ 7
55	P0205	No.5 indicator	11 ↔ 12
56	P0206	No.6 indicator	3 ↔ 4

Standard: Less than 2 Ω

NO → Proceed to 4

YES

Harness disconnections (Vehicle harness side)
(Check the harness between ECU and the injector connector.)



SHTS161100200092

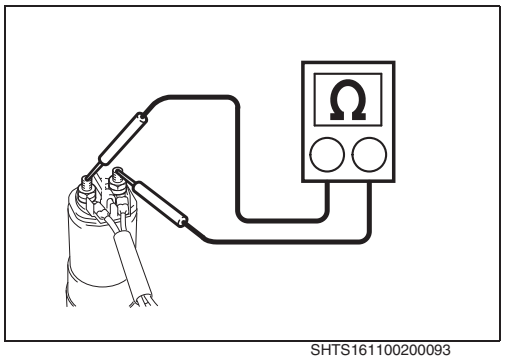
4. CHECK THE RESISTANCE BETWEEN TERMINALS OF THE INJECTOR.

(1) Set the starter switch to "LOCK".
(2) Dismount the head cover.
(3) Disconnect the injector connector (injector side) of the cylinder displayed by MC or DTC. Measure the resistance between the terminals of the injector (injector side).
Standard: 0.4—0.5 Ω

NO → Proceed to (4)

YES

Bad contact of the connector or the harness in the head cover
(Check the connector or the harness in the head cover.)


SHTS161100200093

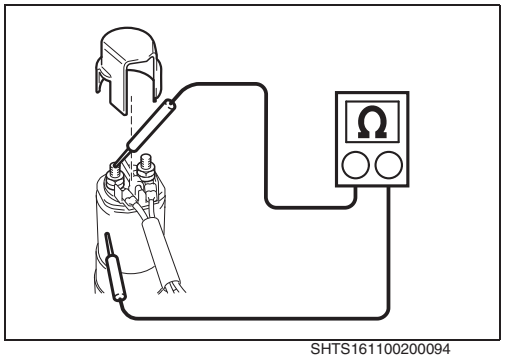
(4) Measure the resistance between the injector terminals.
Standard: 0.4—0.5 Ω

NO

YES

Injector coil disconnection (Replace the injector assembly.)

Injection harness disconnections (Replace the injector harness.)


SHTS161100200094

5. CHECK THE INSULATION RESISTANCE BETWEEN TERMINAL AND INJECTOR BODY.

(1) Remove the injector terminal cap of the cylinder display by MC or DTC.
Measure the insulation resistance between terminal and injector body.
Standard: More than 10 MΩ

NO

YES

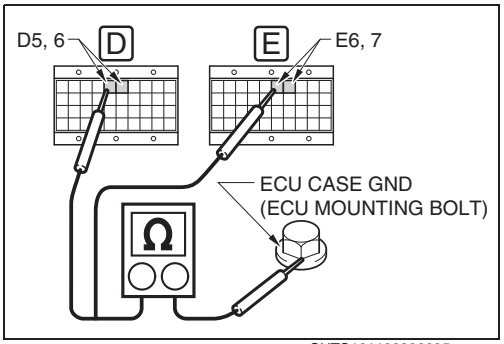
Injector coil short circuit

Normal

INJECTOR SOLENOID VALVE DRIVING SYSTEM GND SHORT-CIRCUIT

EN1611002F200047

MC No.	57	DTC No.	P1211	Injector common 1 short to GND
MC No.	58	DTC No.	P1214	Injector common 2 short to GND



SHTS161100200095

1. CHECK THE RESISTANCE BETWEEN TERMINAL AND GND.

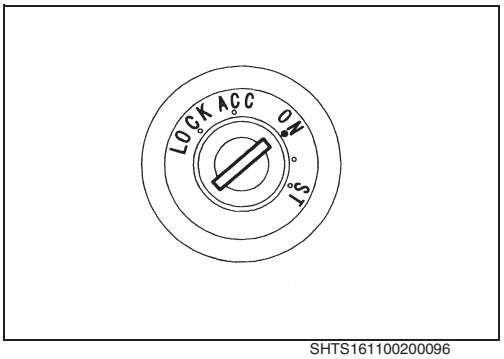
(1) Set the starter switch to "LOCK" and connect the signal check harness.
(2) Disconnect the signal check harness connector on the ECU side.
(3) Set the starter switch to "ON" (The engine is stopped).
(4) Measure the resistance between the terminals and ECU case GND.

MC No.	DTC NO.	Resistance measurement	
		+ side	- side
57	P1211	IJ1+ (D5), I1+S (D6)	ECU case GND
58	P1214	IJ2+ (E6), I2+S (E7)	ECU case GND

Standard: ∞ Ω

NO → Proceed to 3

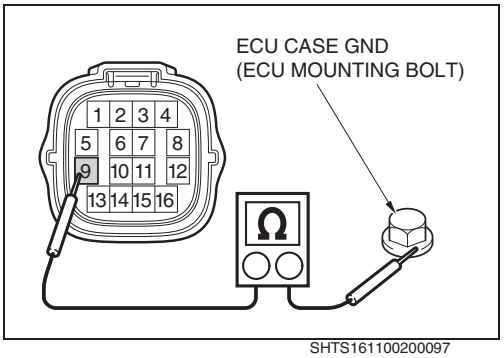
YES



SHTS161100200096

2. RECHECK THE MC OR DTC.

(1) Set the starter switch to "LOCK" position and reconnect the signal check harness on the ECU side.
(2) Start the engine and erase the MC or DTC.
(3) If the same MC or DTC is displayed, replace ECU. If no MC or DTC is displayed, a temporary failure would have occurred.



SHTS161100200097

3. CHECK THE RESISTANCE BETWEEN TERMINALS AND GND.

(1) Set the starter switch to "LOCK".
(2) Tilt the cab. Disconnect the injector connector that is located on the front side of the cylinder.
(3) Measure the resistance between the terminals of injector connector (Vehicle harness side) and ECU case GND.

MC NO.	DTC NO.	Failure position (Breaking position)	Terminals to measure the resistance	
			+ side	- side
57	P1211	No.1 indicator	1, 2	ECU case GND
		No.2 indicator	9, 10	
		No.3 indicator	6, 8	
58	P1214	No.4 indicator	5, 7	
		No.5 indicator	11, 12	
		No.6 indicator	3,4	

Standard: ∞ Ω

NO

YES

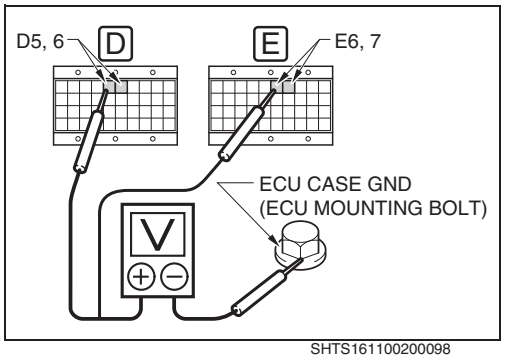
Malfunction of harness
(The harness of the terminal out of the standard value is defective.)

Check the harness in the head cover.
(A short-circuit would occur between the harness in the head cover and the GND line.)

INJECTOR SOLENOID VALVE DRIVING SYSTEM +B SHORT-CIRCUIT

EN1611002F200048

MC No.	57	DTC No.	P1212	Injector common 1 short to BATT
MC No.	58	DTC No.	P1215	Injector common 2 short to BATT



SHTS161100200098

1. CHECK THE VOLTAGE BETWEEN TERMINALS AND GND.

(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) Set the starter switch to "ON" (The engine is stopped).
(4) Measure the voltage between the terminals and ECU case GND.

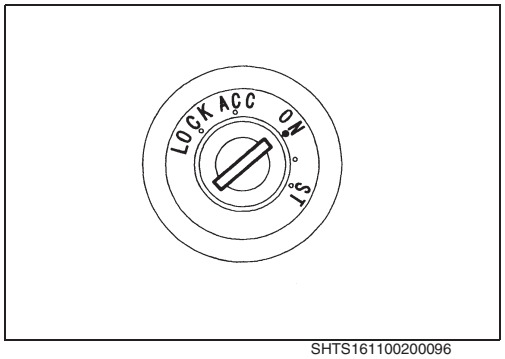
MC No.	DTC NO.	Resistance measurement	
		+ side	- side
57	P1212	IJ1+ (D5), I1+S (D6)	ECU case GND
58	P1215	IJ2+ (E6), I2+S (E7)	ECU case GND

Standard: Less than 2V

NO

YES

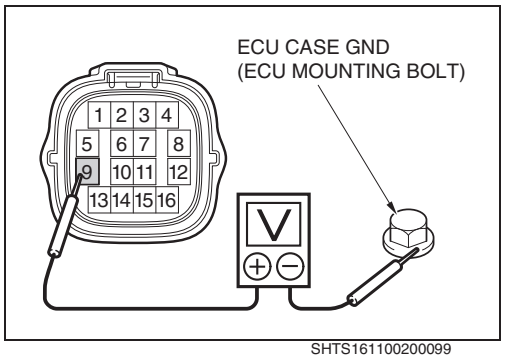
Proceed to 3



SHTS161100200096

2. RECHECK THE MC OR DTC.

(1) Set the starter switch to "LOCK" position and reconnect the signal check harness on the ECU side.
(2) Start the engine and erase the MC or DTC.
(3) If the same MC or DTC is displayed, replace ECU. If no MC or DTC is displayed, a temporary failure would have occurred.



SHTS161100200099

3. CHECK THE VOLTAGE BETWEEN TERMINALS AND GND.

(1) Set the starter switch to "LOCK".
(2) Tilt the cab. Disconnect the injector connector that is located on the front side of the cylinder.
(3) Set the starter switch to "ON" (The engine is stopped).
(4) Measure the voltage between the terminals of injector connector (Vehicle harness side) and ECU case GND.

MC NO.	DTC NO.	Failure position (Breaking position)	Terminals to measure the resistance	
			+ side	- side
57	P1212	No.1 indicator	1, 2	ECU case GND
		No.2 indicator	9, 10	
		No.3 indicator	6, 8	
58	P1215	No.4 indicator	5, 7	
		No.5 indicator	11, 12	
		No.6 indicator	3,4	

Standard: Less than 2V

NO

Malfunction of harness
(The harness of the terminal out of the standard value is defective.)

YES

Check the harness in the head cover.
(Harness disconnection would occur between the harness in the head cover and the GND line.)

ECU

EN1611002F200049

MC No.	59	DTC No.	P0200	ECU charge circuit high input
MC No.	59	DTC No.	P0611	ECU charge circuit malfunction

1. After the starter switch is positioned on the "LOCK" once, it should be turned to "ON" position again.

2. After erasing the MC or DTC, check that the same code is displayed again.

NO → Malfunction of ECU.

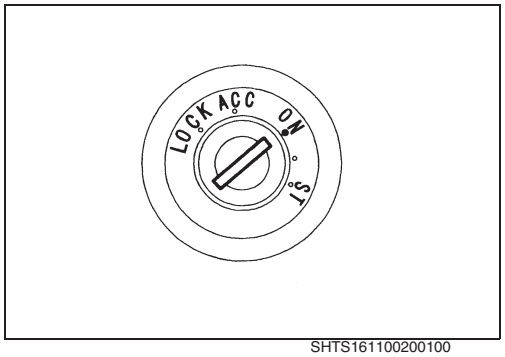
YES

Normal
(Temporary malfunction because of radio interference noise.)

CYLINDER CONTRIBUTION/BALANCE

EN1611002F200050

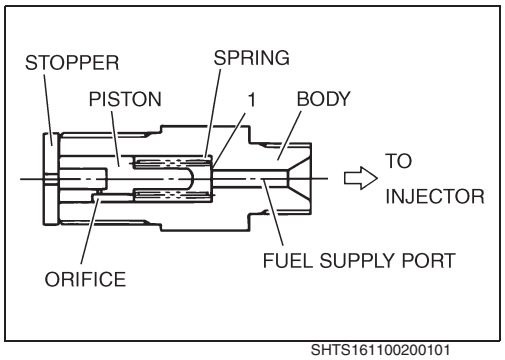
MC No.	61	DTC No.	P0263	Cylinder 1 contribution/balance fault
MC No.	62	DTC No.	P0266	Cylinder 2 contribution/balance fault
MC No.	63	DTC No.	P0269	Cylinder 3 contribution/balance fault
MC No.	64	DTC No.	P0272	Cylinder 4 contribution/balance fault
MC No.	65	DTC No.	P0275	Cylinder 5 contribution/balance fault
MC No.	66	DTC No.	P0278	Cylinder 6 contribution/balance fault



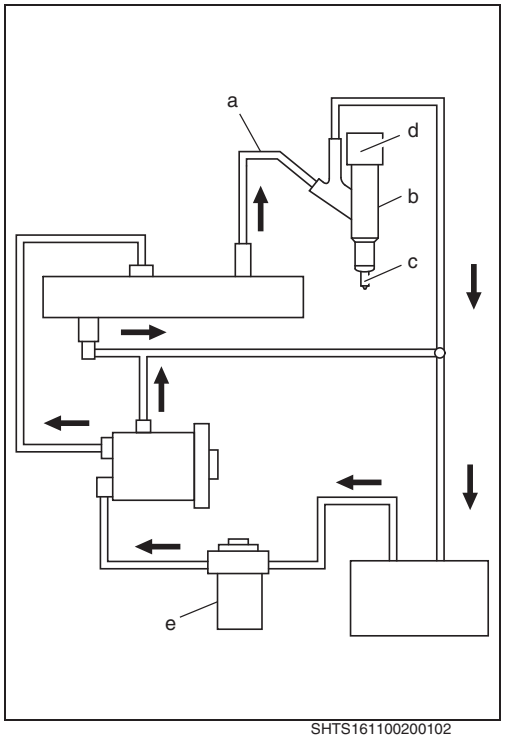
SHTS161100200100

1. CHECK THE FLOW DAMPER.

(1) Turn the starter switch to "LOCK" and stop the engine.
(2) Wait for about 30 seconds and then start the engine.
(3) Perform warm-up until the coolant temperature becomes 60°C {140°F} or higher. And erase the MC or DTC.



SHTS161100200101



SHTS161100200102

(4) If the same MC or DTC is displayed again after erasing it, inspect the flow damper of displayed cylinder.

Inspection:

a. When removing the flow damper from the common rail, check that the piston is not sticking in the body. If the piston sticks, replace the flow damper.

b. Inspect the contact surface 1 between piston and fuel supply port. If there is wear and damage, replace the flow damper assembly.

c. Inspect clogging on the piston orifice. Clean or replace the flow damper assembly.

2. RECHECK THE MC OR DTC.

(1) Check that the other MC or DTC is not displayed.
If the other MC or DTC is displayed, repair the trouble.
If the same MC or DTC is displayed again, it is possibly from the following problems.

a. Excessive fuel flow will cause fuel leakage from injection pipe (Between flow damper and injector) by bending, cracking and pipe connection looseness.
→ Check leakage.

b. Excessive or shortage fuel flow will cause an increase in the internal leakage of injector.
→ Check injector leakage using nozzle tester.

c. Excessive fuel flow will cause injector seat defection.
→ Check injector nozzle seat using nozzle tester.

d. Excessive or shortage fuel flow will cause injector operation malfunction.
→ Check by replacing the injector.

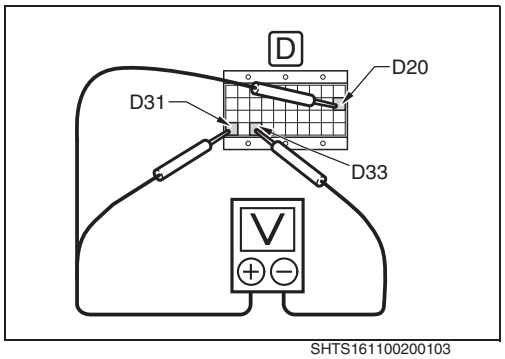
e. Shortage fuel flow will cause clogging of the fuel supply system.
→ Check fuel filter.

(2) The above problems can be diagnosed using the "Data Monitor" menu to determine the cylinder contribution quantity and "Activation Test" menu to stop the injector.

COMMON RAIL PRESSURE, FIXED OUTPUT

EN1611002F200051

MC No.	67	DTC No.	P0191	Common rail pressure sensor malfunction



SHTS161100200103

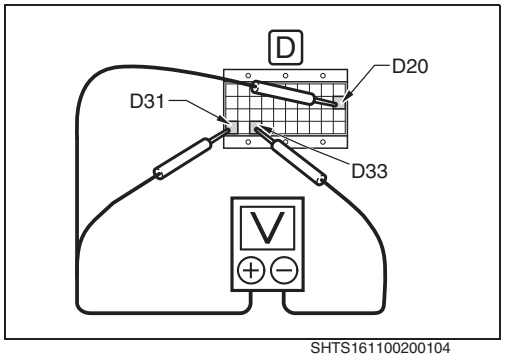
1. CHECK THE VOLTAGE BETWEEN TERMINALS.

(1) Set the starter switch to "LOCK" and connect the signal check harness.
(2) Set the starter switch to "ON" (The engine is stopped).
(3) Measure the voltage between PCR1 (D20), PCR2 (D31) and AGD1 (D33) terminals.
Standard: 0.9 — 1.1V

NO

- Malfunction of ECU
- Bad contact of harness connector

YES



SHTS161100200104

(4) Start the engine.
(5) While measuring the voltage between PCR1 (D20), PCR2 (D31) and AGD1 (D33) terminals of ECU connector, repeat opening and closing full throttle.
Standard: 1.0 to 3.2V (The voltage shall vary)

NO

- Malfunction of common rail pressure sensor
- Bad contact of harness connector

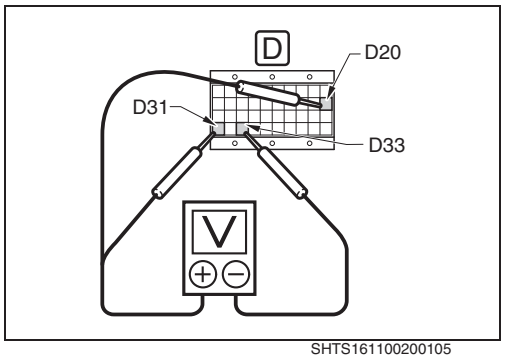
YES

- Malfunction of ECU
- Bad contact of harness connector

COMMON RAIL PRESSURE, SENSOR

EN1611002F200052

MC No.	67	DTC No.	P0192	Common rail pressure sensor circuit low input
MC No.	67	DTC No.	P0193	Common rail pressure sensor circuit high input



SHTS161100200105

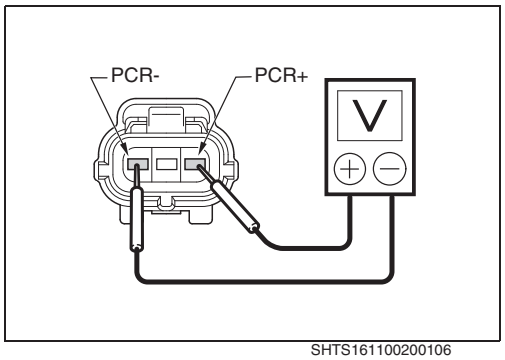
1. CHECK THE VOLTAGE BETWEEN TERMINALS.

(1) Set the starter switch to "LOCK" and connect the signal check harness.
(2) Set the starter switch to "ON" (The engine is stopped).
(3) Measure the voltage between PCR1 (D20), PCR2 (D31) and AGD 1 (D33) terminals.
Standard: 0.7 — 4.7V
(After measurement, turn the starter switch to "LOCK" position.)

NO → Proceed to 2

YES →

- Malfunction of ECU
- Malfunction of ECU connectors



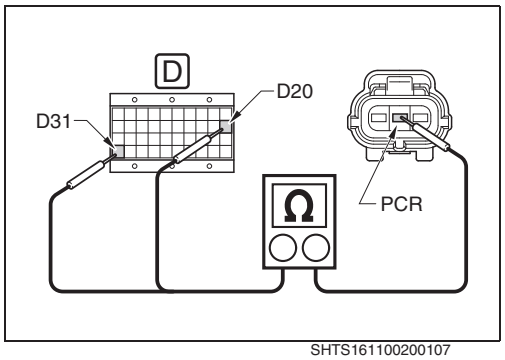
SHTS161100200106

2. CHECK THE VOLTAGE BETWEEN TERMINALS.

(1) Tilt the cab and disconnect the connector of common rail pressure sensor.
(2) Set the starter switch to "ON" (The engine is stopped).
(3) Measure the voltage between PCR+ and PCR- terminals of common rail pressure sensor (Vehicle harness side).
Standard: 4.5 — 5.5V

NO → Proceed to 3-(4)

YES →



SHTS161100200107

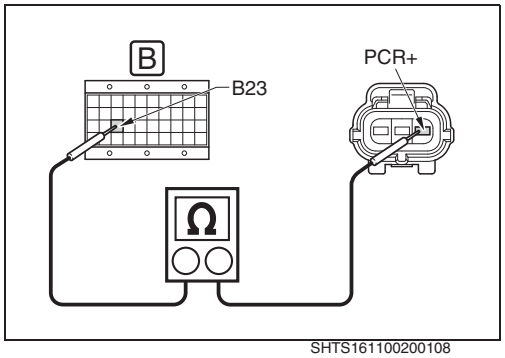
3. CHECK THE RESISTACE BETWEEN TERMINALS.

(1) Turn the starter switch to "LOCK".
(2) Disconnect the signal check harness connector on the ECU side.
(3) Measure the resistance between PCR1 and PCR2 (D20 and D31) terminals and PCR terminal of common rail pressure sensor (Vehicle harness side).
Standard: Less than 2 Ω

NO → Malfunction of harness

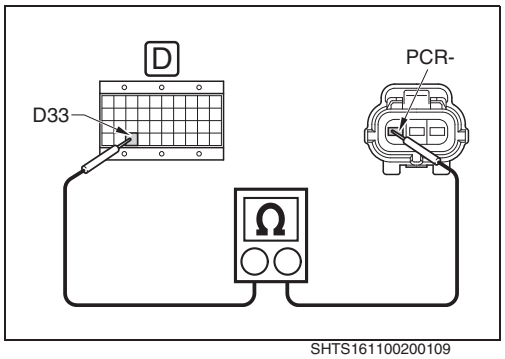
YES

Bad contact of harness connector



SHTS161100200108

(4) Measure the resistance between AVC2 (B23) terminals and PCR+ terminal of common rail pressure sensor (Vehicle harness side), AGD1 (D33) terminal and PCR- terminal of common rail pressure sensor (Vehicle harness side).
Standard: Less than 2 Ω



SHTS161100200109

NO → Malfunction of harness

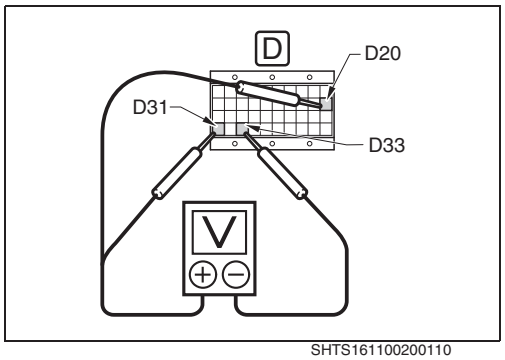
YES

- Malfunction of ECU
- Bad contact of harness connector

COMMON RAIL EXCESSIVE PRESSURE

EN1611002F200053

MC No.	68	DTC No.	P0088	Excessive common rail pressure (1st step)
MC No.	69	DTC No.	P0088	Excessive common rail pressure (2nd step)



SHTS161100200110

1. CHECK THE VOLTAGE BETWEEN TERMINALS.
(1) Set the starter switch to "LOCK" and connect the signal check harness.
(2) Set the starter switch to "ON" (The engine is stopped).
(3) Measure the voltage between PCR1 (D20), PCR2 (D31) and AGD1 (D33) terminals.
Standard: 3.6 — 4.7V

NO

- Malfunction of ECU
- Bad contact of harness
- Bad contact of connector

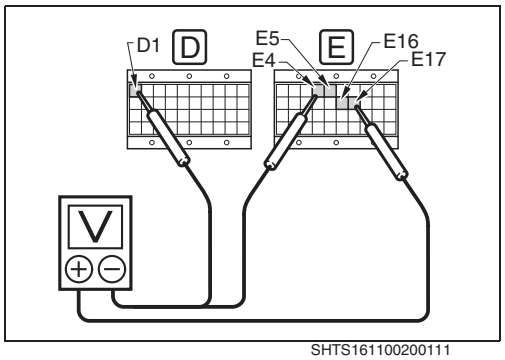
YES

Malfunction of common rail pressure sensor

PUMP CONTROL VALVE 1 (PCV1)

EN1611002F200054

MC No.	71	DTC No.	P0628	PCV1 malfunction



SHTS161100200111

1. CHECK THE VOLTAGE BETWEEN TERMINALS.
(1) Set the starter switch to "LOCK" and connect the signal check harness.
(2) Disconnect the signal check harness on the ECU side.
(3) Set the starter switch to "ON" (The engine is stopped).
(4) Measure the voltage between terminals.

+ side	- side
SP1S (E16)	PGD1 (D1), PGD2 (E4), PGD3 (E5)
SPV1 (E17)	PGD1 (D1), PGD2 (E4), PGD3 (E5)

Standard: More than 19V

NO

Proceed to 3

YES

2. CHECK THE MC OR DTC.

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

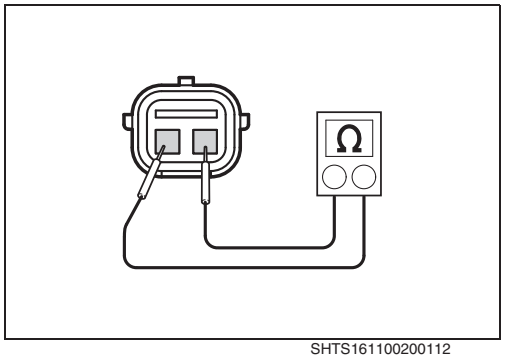
(2) Erase the MC or DTC and recheck the MC or DTC.

Standard: Normal

NO → Malfunction of ECU

YES

Normal



SHTS161100200112

3. CHECK THE RESISTANCE OF PCV1.

(1) Set the starter switch to "LOCK" position.

(2) Disconnect the connector of the PCV1 of supply pump.

NOTICE

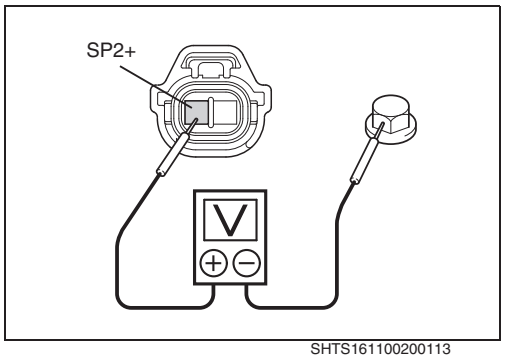
The harness with an identification tag (ENGINE FR) connected to PCV is for PCV2, and the one without a tag is for PCV1.

(3) Measure the resistance between the terminal of PCV1 connector. (PCV1 side)

Standard: 2.9—3.5 Ω

NO → Malfunction of PCV1 (Replace the supply pump)

YES



SHTS161100200113

4. CHECK THE VOLTAGE BETWEEN TERMINAL AND GND.

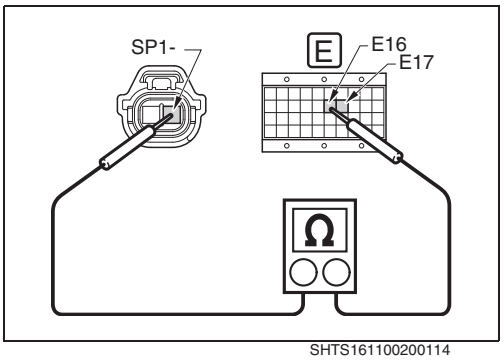
(1) Set the starter switch to "ON" (The engine is stopped).

(2) Measure the voltage between SP1+ of PCV1 (Vehicle harness side) and GND.

Standard: More than 19V

NO → Malfunction of PCV1 (Replace the supply pump)

YES



SHTS161100200114

5. CHECK THE VOLTAGE BETWEEN TERMINAL AND GND.

(1) Set the starter switch to "LOCK".

(2) Measure the resistance between SP1S and SPV1 (E16 and E17) and SP1- of PCV1 (Vehicle harness side).

Less than 2 Ω

NO

Malfunction of harness between PCV1 and ECU

YES

6. RECHECK THE MC OR DTC.

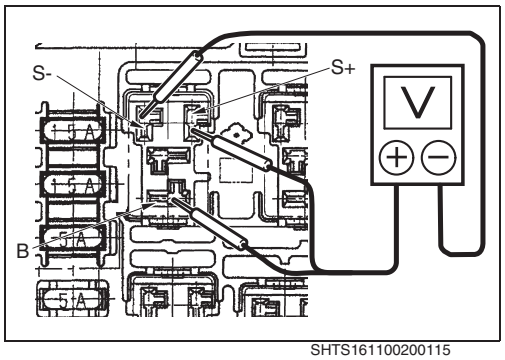
(1) Set the starter switch to "LOCK".

(2) Restore all connectors to their original state.

(3) Recheck the MC or DTC.

HINT

- **As defective connector contact can be considered, confirm if the same code is displayed after the past MC or DTC has been erased. If same MC or DTC is displayed, confirm again from the beginning.**
- **Measure the resistance between PCV1 and engine earth or another part with the same potential as the minus (-) pole of the battery and confirm the insulation.**

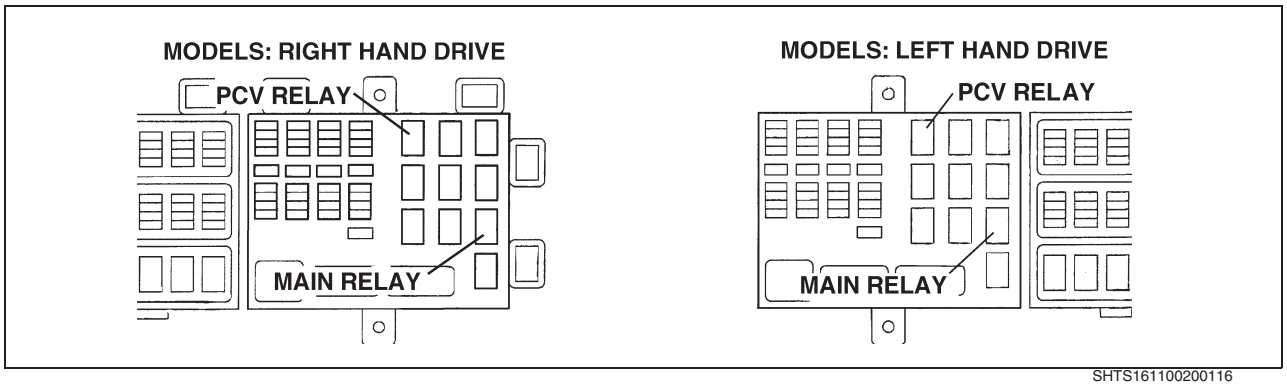


SHTS161100200115

7. CHECK THE VOLTAGE OF PCV RELAY POWER SUPPLY.

(1) Set the starter switch to "LOCK" and remove the PCV relay from the relay panel.
(2) Set the starter switch to "ON".
(3) Measure the voltage between S+ and S- terminals, B and S- terminals (Relay panel side).

Standard: More than 19V



SHTS161100200116

NO → Proceed 8

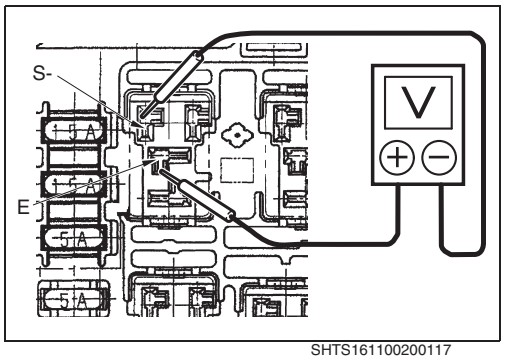
YES → Proceed 9

8. THE FOLLOWING DEFECTS CAN BE CONSIDERED.

a. Terminal S+ (5A fuse)
Blown fuse of battery relay (5A) or starter switch (10A),
defective harness between battery relay and starter switch.
Blown fuse of ENG ECU (5A),
defective harness between fusible link FL-1 and B terminal of the PCV relay.

b. Terminal S-
Measure the resistance between terminal S- and the minus terminal of the battery. this is normal when it is 0.2 Ω or less. When the resistance is not normal, the earth of terminal S- is defective.

c. Terminal B
Defective harness between fusible link FL-1 and B terminal of the PCV relay.



SHTS161100200117

9. CHECK THE VOLTAGE BETWEEN TERMINALS.

(1) Set the starter switch to "LOCK" and install the PCV relay at the original position on the relay panel.
(2) Set the starter switch to "ON" (The engine is stopped).
(3) Measure the voltage between B and E terminals (Relay panel side).

Standard: More than 19V

NO → Malfunction of PCV relay

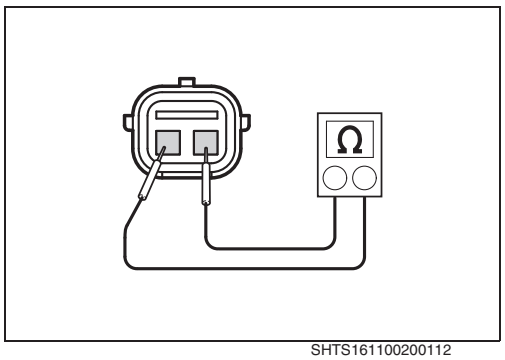
YES

Malfunction of harness between PCV relay and PCV1

PUMP CONTROL VALVE 1 (PCV1)

EN1611002F200055

MC No.	71	DTC No.	P0629	PCV out put short to GND



SHTS161100200112

1. CHECK THE RESISTANCE OF PCV1.

(1) Set the starter switch to "LOCK".
(2) Disconnect the connector of the PCV1 of supply pump.

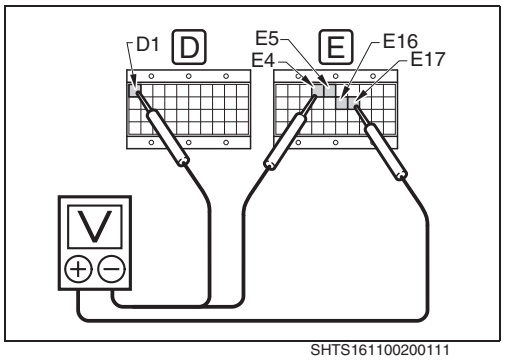
NOTICE

The harness with an identification tag (ENGINE FR) connected to PCV is for PCV2, and the one without a tag is for PCV1.

(3) Measure the resistance between the terminal of PCV1 connector (PCV1 side).
Standard: 2.9—3.5 Ω

NO → Malfunction of PCV1 (Replace the supply pump)

YES



SHTS161100200111

2. CHECK THE VOLTAGE OF TERMINALS.

(1) Set the starter switch to "LOCK" and connect the signal check harness.
(2) Disconnect the signal check harness on the ECU side.
(3) Set the starter switch to "ON" (The engine is stopped).
(4) Measure the voltage between terminals.

+ side	- side
SP1S (E16)	PGD1 (D1), PGD2 (E4), PGD3 (E5)
SPV1 (E17)	PGD1 (D1), PGD2 (E4), PGD3 (E5)

Standard: APPROX. less than 1.0V

NO

Malfunction of harness between PCV1 and ECU (Check the PCV1 harness and +24V system for short circuits).

YES

3. CHECK THE MC OR DTC.

(1) Set the starter switch to "LOCK" and connect the signal check harness on the ECU side.
(2) Erase the MC or DTC and recheck the MC or DTC.
Standard: Normal

NO

Malfunction of ECU

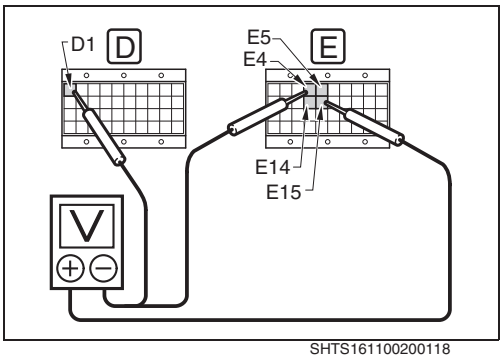
YES

Normal

PUMP CONTROL VALVE 2 (PCV2)

EN1611002F200056

MC No.	72	DTC No.	P2633	PCV2 malfunction



SHTS161100200118

1. CHECK THE VOLTAGE OF TERMINALS.

(1) Set the starter switch to "LOCK" and connect the signal check harness.
(2) Disconnect the signal check harness on the ECU side.
(3) Set the starter switch to "ON" (The engine is stopped).
(4) Measure the voltage between terminals.

+ side	- side
SP2S (E14)	PGD1 (D1), PGD2 (E4), PGD3 (E5)
SPV2 (E15)	PGD1 (D1), PGD2 (E4), PGD3 (E5)

Standard: More than 19V

NO → Proceed to 3

YES

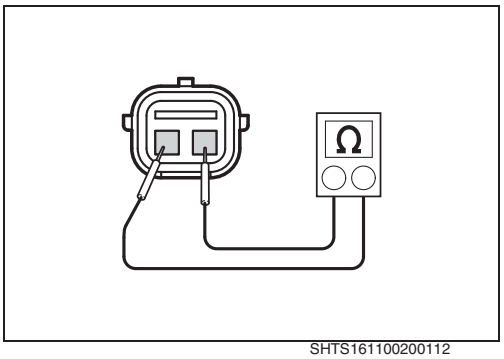
2. CHECK THE DTC.

(1) Set the starter switch to "LOCK" and connect the signal check harness on the ECU side.
(2) Erase the MC or DTC and recheck the MC or DTC.
Standard: Normal

NO → Malfunction of ECU

YES

Normal



SHTS161100200112

3. CHECK THE RESISTANCE OF PCV2.

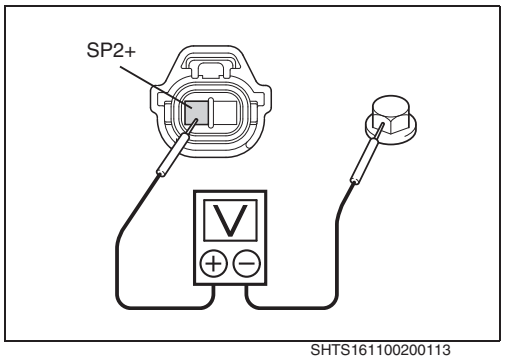
(1) Set the starter switch to "LOCK" position.
(2) Disconnect the connector of the PCV2 of supply pump.

NOTICE
The harness with an identification tag (ENGINE FR) connected to PCV is for PCV2, and the one without a tag is for PCV1.

(3) Measure the resistance between the terminal of PCV2 connector. (PCV2 side)
Standard: 2.9—3.5 Ω

NO → Malfunction of PCV2 (Replace the supply pump)

YES



SHTS161100200113

4. CHECK THE VOLTAGE BETWEEN TERMINAL AND GND.

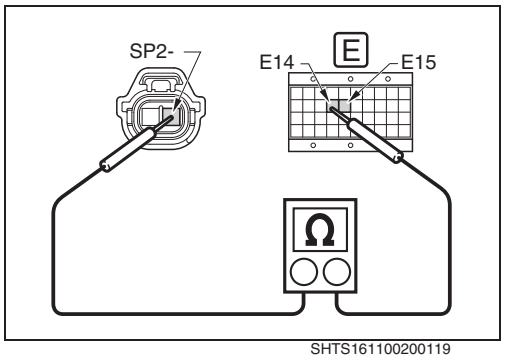
(1) Set the starter switch to "ON" (The engine is stopped).
(2) Measure the voltage between SP2+ of PCV2 (Vehicle harness side) and GND.

Standard: More than 19V

NO

Malfunction of PCV2 (Replace the supply pump)

YES



SHTS161100200119

5. CHECK THE RESISTANCE BETWEEN TERMINAL AND GND.

(1) Set the starter switch to "LOCK".
(2) Measure the resistance between SP2S and SPV2 (E14 and E15) and SP2- of PCV2 (Vehicle harness side).

Less than 2 Ω

NO

Malfunction of harness between PCV2 and ECU

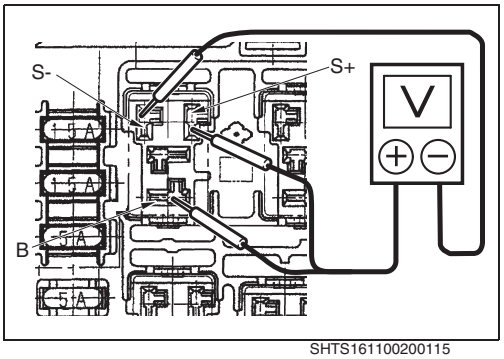
YES

6. RECHECK THE MC OR DTC.

(1) Set the starter switch to "LOCK".
(2) Restore all connectors to their original state.
(3) Recheck the MC or DTC.

HINT

- **As defective connector contact can be considered, confirm if the same code is displayed after the past MC or DTC has been erased. If same MC or DTC is displayed, confirm again from the beginning.**
- **Measure the resistance between PCV2 and engine earth or another part with the same potential as the minus (-) pole of the battery and confirm the insulation.**

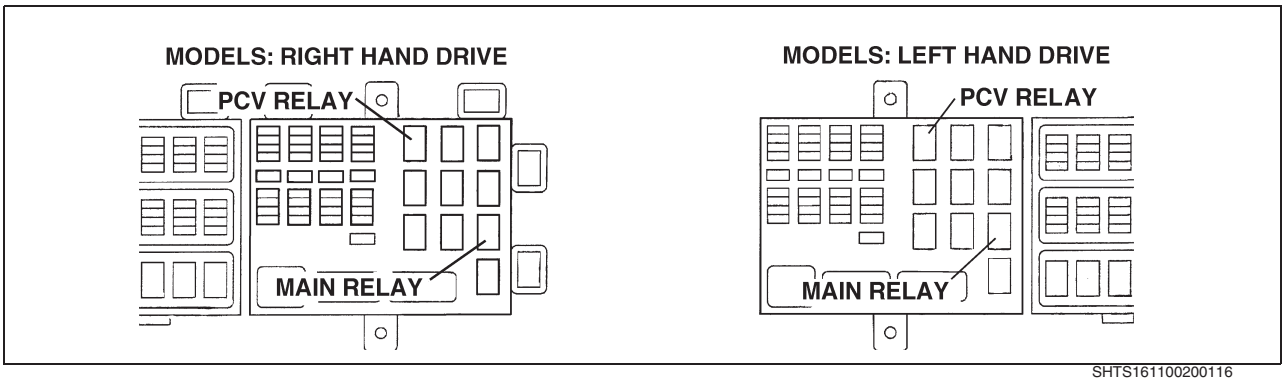


SHTS161100200115

7. CHECK THE VOLTAGE OF PCV RELAY POWER SUPPLY.

(1) Set the starter switch to "LOCK" and remove the PCV relay from the relay panel.
(2) Set the starter switch to "ON".
(3) Measure the voltage between S+ and S- terminals, B and S- terminals (Relay panel side).

Standard: More than 19V



SHTS161100200116

NO → Proceed 8

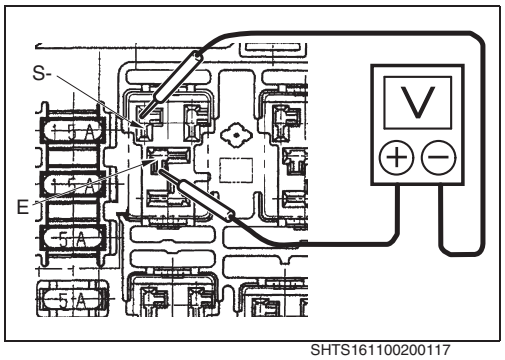
YES → Proceed 9

8. THE FOLLOWING DEFECTS CAN BE CONSIDERED.

a. Terminal S+ (5A fuse)
Blown fuse of battery relay (5A) or starter switch (10A), defective harness between battery relay and starter switch.
Blown fuse of ENG ECU (5A), defective harness between fusible link FL-1 and B terminal of the PCV relay.

b. Terminal S-
Measure the resistance between terminal S- and the minus terminal of the battery. this is normal when it is 0.2 Ω or less. When the resistance is not normal, the earth of terminal S- is defective.

c. Terminal B
Defective harness between fusible link FL-1 and B terminal of the PCV relay.



SHTS161100200117

9. CHECK THE VOLTAGE BETWEEN TERMINALS.
(1) Set the starter switch to "LOCK" and install the PCV relay at the original position on the relay panel.
(2) Set the starter switch to "ON" (the engine stopped).
(3) Measure the voltage between B and E terminals (Relay panel side).

Standard: More than 19V

NO → Malfunction of PCV relay

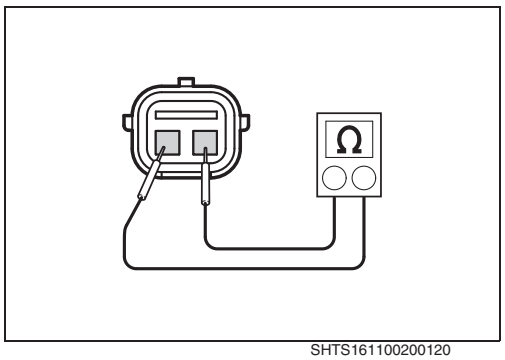
YES

Malfunction of harness between PCV relay and PCV2

PUMP CONTROL VALVE 2 (PCV2)

EN1611002F200057

MC No.	72	DTC No.	P2634	PCV out put short to GND



SHTS161100200120

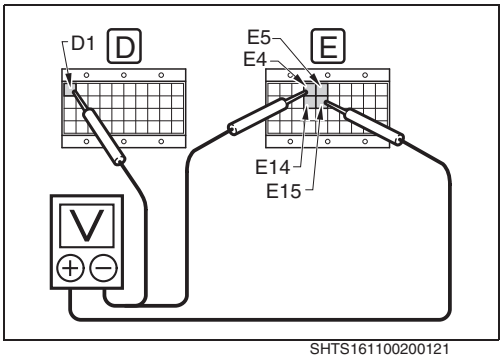
1. CHECK THE RESISTANCE OF PCV2.
(1) Set the starter switch to "LOCK".
(2) Disconnect the connector of the PCV2 of supply pump.

NOTICE
The harness with an identification tag (ENGINE FR) connected to PCV is for PCV2, and the one without a tag is for PCV1.

(3) Measure the resistance between the terminal of PCV2 connector (PCV2 side).
Standard: 2.9—3.5 Ω

NO → Malfunction of PCV2 (Replace the supply pump)

YES



SHTS161100200121

2. CHECK THE VOLTAGE OF TERMINALS.

(1) Set the starter switch to "LOCK" and connect the signal check harness.
(2) Disconnect the signal check harness on the ECU side.
(3) Set the starter switch to "ON" (The engine is stopped).
(4) Measure the voltage between terminals.

+ side	- side
SP2S (E14)	PGD1 (D1), PGD2 (E4), PGD3 (E5)
SPV2 (E15)	PGD1 (D1), PGD2 (E4), PGD3 (E5)

Standard: APPROX. less than 1.0V

NO → Malfunction of harness between PCV2 and ECU (Check the PCV2 harness and +24V system for short circuits).

YES

3. CHECK THE MC OR DTC.

(1) Set the starter switch to "LOCK" and connect the signal check harness on the ECU side.
(2) Erase the MC or DTC and recheck the MC or DTC.
Standard: Normal

NO → Malfunction of ECU

YES → Normal

PUMP CONTROL VALVE (PCV)

EN1611002F200058

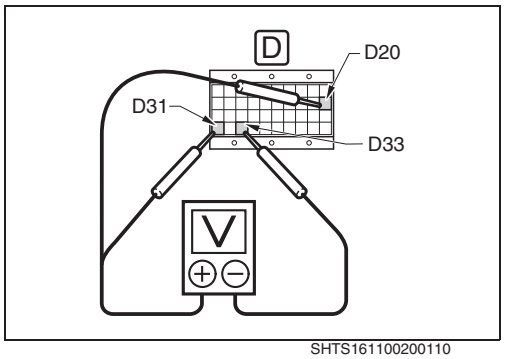
MC No.	73	DTC No.	P0628	PCV malfunction
MC No.	73	DTC No.	P0629	PCV malfunction

1. MAKE SURE TO INSPECT IT IN ACCORDANCE WITH THE CONTENTS OF MC NO.71, 72 OR DTC NO. P0628, P0629, P2633, P2634.

COMMON RAIL PRESSURE AND SUPPLY PUMP

EN1611002F200059

MC No.	76	DTC No.	P0088	Excessive common rail pressure, supply pump excess forced feed



SHTS161100200110

1. CHECK THE VOLTAGE BETWEEN TERMINALS.

(1) Set the starter switch to "LOCK" and connect the signal check harness.
(2) Start the engine.
(3) Perform warm-up until the coolant temperature becomes 60°C {140°F} or higher (Until the MC No.76 or DTC No.P0088 is displayed.)
(4) Adjust the engine speed APPROX. 450 r/min. The target pressure (PFIN) = APPROX. 25 MPa {255 kgf/cm^2, 3,626 lbf/in^2.} (APPROX. 1.5V)
(5) Measure the voltage between PCR1 (D20), PCR2 (D31) and AGD1 (D33) terminals.
Standard: Less than 1.56V

NO → Malfunction of common rail pressure sensor

YES

2. CHECK THE MC OR DTC.

(1) Confirm that no other MC or DTC is displayed. If another MC or DTC is displayed repair that trouble and confirm that the MC No.76 or DTC No. P0088 is displayed again. Especially in case of display MC or DTC in regard to engine speed sensor (main and sub) system, perform repair so that these MC or DTC are not displayed.
(2) Confirm the injection timing of the supply pump. If installation has not been done at top dead center 0°, install correctly.
(3) If the above check shows no abnormalities, erase the MC or DTC and start the engine. If the same MC or DTC is displayed again, malfunction of supply pump, malfunction of common rail pressure sensor system, and malfunction ECU can be assumed.
(4) Use PC diagnosis tool to perform a more detailed diagnosis.

SUPPLY PUMP

EN1611002F200060

MC No.	76	DTC No.	P1229	Supply pump excess forced feed

1. Judging condition by this failure diagnosis is that it is abnormal when the flow amount of supply pump shows Max. state continuously for a constant time. Once the failure is output, change the pressure limiter. When not corrected by changing it, it is supposed that the supply pump is abnormal.

2. More detailed diagnosis should be done by PC diagnosis tool (Hino DX).

SUPPLY PUMP

EN1611002F200061

MC No.	77	DTC No.	P1266	Supply pump malfunction

1. Judging condition by this failure diagnosis is that it is abnormal when the flow amount of supply pump shows Max. state continuously for a constant time without any failure by the trouble codes MC No.71, 72, 73 and 76 or DTC No. P0191, P0192, P0193, P0628, P0629, P2633 and P2634 and with engine revolution at more than 450 r/min. and water temperature at more than 60°C {140°F}. Once the failure is output, change the pressure limiter. When not corrected by changing it, it is supposed that the supply pump is abnormal.

2. More detailed diagnosis should be done by PC diagnosis tool (Hino DX).

SUPPLY PUMP

EN1611002F200062

MC No.	78	DTC No.	P0093	Fuel leakage

1. The judgment condition for this trouble diagnosis is that one of the following conditions a, b or c is detected and an abnormality is diagnosed while there is no trouble of the MC No.67, 71, 72, 73 and 77 or DTC No. P0191, P0192, P0193, P0628, P0629, P1266, P2633 and P2634, while the engine speed is 450 r/min. or higher, and while the engine coolant temperature is 60°C {140°F} or higher.

a. Although the supply pump is operating at the max. discharge condition (MC No. 77 or DTC No. P0093), the actual common rail pressure (NPC) has been 5 MPa {51 kgf/cm^2, 725 lbf/in.^{2}} lower than the target pressure (PFIN) for a specified time.

b. During idle speed control, while the difference between NPC and PFIN was within 5 MPa {51 kgf/cm^2, 725 lbf/in.^{2}}, the discharge volume of the supply pump was larger than with normal idling for a specified time.

c. In a condition of zero injection amount, with the difference between NPC and PFIN within 5 MPa {51 kgf/cm^2, 725 lbf/in.^{2}}, the discharge volume of supply pump was large for a specified time.
During detection of this trouble, the injection amount and the injection pressure are limited, so that the engine output is decreased.
When this MC or DTC has been displayed, check the high-pressure piping system for leaks and check the fuel supply system for clogging etc. When the high-pressure piping system is feed of abnormalities, an abnormal supply pump can be considered.

2. Use PC diagnosis tester for a more detailed diagnosis.