

Engine

SAA6D107E-1-A

Lift truck model Serial number

FD100-8	M246-7001 and up
FD115-8	M246-7001 and up
FD135-8	M247-7001 and up
FD150E-8	M247-7001 and up
FD160E-8	M247-7001 and up

00 Index and foreword

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How to read the shop manual

- Some attachments and optional parts in this shop manual may not be delivered to certain areas. If one of them is required, consult KOMATSU distributors.
- Materials and specifications are subject to change without notice.
- Shop manuals are divided into the “Chassis volume” and “Engine volume”.

1. Composition of shop manual

This shop manual contains the necessary technical information for services performed in a workshop. For ease of understanding, the manual is divided into the following sections.

00. Index and foreword

This section explains the shop manuals list, table of contents, safety, and basic information.

01. Specification

This section explains the specifications of the machine.

10. Structure, function and maintenance standard

This section explains the structure, function, and maintenance standard values of each component. The structure and function sub-section explains the structure and function of each component. It serves not only to give an understanding of the structure, but also serves as reference material for troubleshooting. The maintenance standard sub-section explains the criteria and remedies for disassembly and service.

20. Standard value table

This section explains the standard values for new machine and judgement criteria for testing, adjusting, and troubleshooting. This standard value table is used to check the standard values in testing and adjusting and to judge parts in troubleshooting.

30. Testing and adjusting

This section explains measuring instruments and measuring methods for testing and adjusting, and method of adjusting each part. The standard values and judgement criteria for testing and adjusting are explained in Testing and adjusting.

40. Troubleshooting

This section explains how to find out failed parts and how to repair them. The troubleshooting is divided by failure modes. The “S mode” of the troubleshooting related to the engine may be also explained in the Chassis volume and Engine volume. In this case, see the Chassis volume.

50. Disassembly and assembly

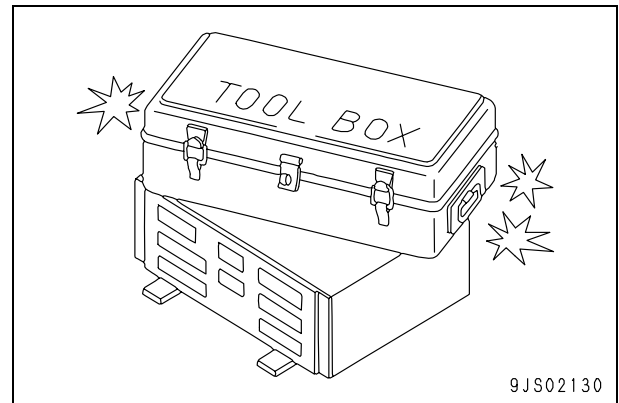
This section explains the special tools and procedures for removing, installing, disassembling, and assembling each component, as well as precautions for them. In addition, tightening torque and quantity and weight of coating material, oil, grease, and coolant necessary for the work are also explained.

2. Revision and distribution

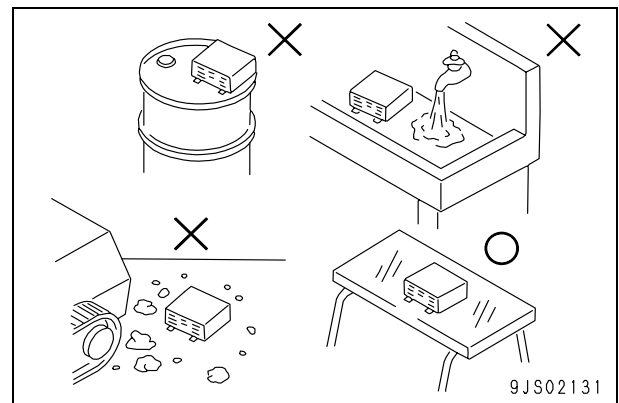
Any additions, revisions, or other change of notices will be sent to Komatsu Utility Co., Ltd. FORKLIFT COMPANY or your KOMATSU FORKLIFT distributor. Get the most up-to-date information before you start any work.

4. Handling controller

- 1) The controller contains a microcomputer and electronic control circuits. These control all of the electronic circuits on the machine, so be extremely careful when handling the controller.
- 2) Do not place objects on top of the controller.
- 3) Cover the control connectors with tape or a vinyl bag. Never touch the connector contacts with your hand.
- 4) During rainy weather, do not leave the controller in a place where it is exposed to rain.
- 5) Do not place the controller on oil, water, or soil, or in any hot place, even for a short time. (Place it on a suitable dry stand).
- 6) Precautions when carrying out arc welding
When carrying out arc welding on the body, disconnect all wiring harness connectors connected to the controller. Fit an arc welding ground close to the welding point.



9JS02130



9JS02131

5. Points to remember when troubleshooting electric circuits

- 1) Always turn the power OFF before disconnecting or connecting connectors.
- 2) Before carrying out troubleshooting, check that all the related connectors are properly inserted.
 - ★ Disconnect and connect the related connectors several times to check.
- 3) Always connect any disconnected connectors before going on to the next step.
 - ★ If the power is turned ON with the connectors still disconnected, unnecessary abnormality displays will be generated.
- 4) When carrying out troubleshooting of circuits (measuring the voltage, resistance, continuity, or current), move the related wiring and connectors several times and check that there is no change in the reading of the tester.
 - ★ If there is any change, there is probably defective contact in that circuit.

2. Precautions when carrying out installation work

- Tighten all bolts and nuts (sleeve nuts) to the specified (KES) torque.
 - Install the hoses without twisting or interference and fix them with intermediate clamps, if there are any.
 - Replace all gaskets, O-rings, cotter pins, and lock plates with new parts.
 - Bend the cotter pins and lock plates securely.
 - When coating with adhesive, clean the part and remove all oil and grease, then coat the threaded portion with 2 – 3 drops of adhesive.
 - When coating with gasket sealant, clean the surface and remove all oil and grease, check that there is no dirt or damage, then coat uniformly with gasket sealant.
 - Clean all parts, and correct any damage, dents, burrs, or rust.
 - Coat rotating parts and sliding parts with engine oil.
 - When press fitting parts, coat the surface with anti-friction compound (LM-P).
 - After fitting snap rings, check that the snap ring is fitted securely in the ring groove.
 - When connecting wiring connectors, clean the connector to remove all oil, dirt, or water, then connect securely.
 - When using eyebolts, check that there is no deformation or deterioration, screw them in fully, and align the direction of the hook.
 - When tightening split flanges, tighten uniformly in turn to prevent excessive tightening on one side.
- ★ When operating the hydraulic cylinders for the first time after reassembling cylinders, pumps and other hydraulic equipment removed for repair, always bleed the air as follows:
- 1) Start the engine and run at low idle.
 - 2) Operate the work equipment control lever to operate the hydraulic cylinder 4 – 5 times, stopping the cylinder 100 mm from the end of its stroke.
 - 3) Next, operate the hydraulic cylinder 3 – 4 times to the end of its stroke.
 - 4) After doing this, run the engine at normal speed.
- ★ When using the machine for the first time after repair or long storage, follow the same procedure.

3. Precautions when completing the operation

- 1) Refilling with coolant, oil and grease
 - If the coolant has been drained, tighten the drain valve, and add coolant to the specified level. Run the engine to circulate the coolant through the system. Then check the coolant level again.
 - If the hydraulic equipment has been removed and installed again, add engine oil to the specified level. Run the engine to circulate the oil through the system. Then check the oil level again.
 - If the piping or hydraulic equipment have been removed, always bleed the air from the system after reassembling the parts.
 - ★ For details, see Testing and adjusting, “Bleeding air”.
 - Add the specified amount of grease (molybdenum disulphide grease) to the work equipment parts.
- 2) Checking cylinder head and manifolds for looseness

Check the cylinder head and intake and exhaust manifold for looseness.
If any part is loosened, retighten it.

 - For the tightening torque, see “Disassembly and assembly”.
- 3) Checking engine piping for damage and looseness

Intake and exhaust system

Check the piping for damage, the mounting bolts and nuts for looseness, and the joints for air suction and exhaust gas leakage.
If any part is loosened or damaged, retighten or repair it.

Cooling system

Check the piping for damage, the mounting bolts and nuts for looseness, and the joints for coolant leakage.
If any part is loosened or damaged, retighten or repair it.

Fuel system

Check the piping for damage, the mounting bolts and nuts for looseness, and the joints for fuel leakage.
If any part is loosened or damaged, retighten or repair it.

Millimeters to inches

1 mm = 0.03937 in

	0	1	2	3	4	5	6	7	8	9
0	0	0.039	0.079	0.118	0.157	0.197	0.236	0.276	0.315	0.354
10	0.394	0.433	0.472	0.512	0.551	0.591	0.630	0.669	0.709	0.748
20	0.787	0.827	0.866	0.906	0.945	0.984	1.024	1.063	1.102	1.142
30	1.181	1.220	1.260	1.299	1.339	1.378	1.417	1.457	1.496	1.536
40	1.575	1.614	1.654	1.693	1.732	1.772	1.811	1.850	1.890	1.929
50	1.969	2.008	2.047	2.087	2.126	2.165	2.205	2.244	2.283	2.323
60	2.362	2.402	2.441	2.480	2.520	2.559	2.598	2.638	2.677	2.717
70	2.756	2.795	2.835	2.874	2.913	2.953	2.992	3.032	3.071	3.110
80	3.150	3.189	3.228	3.268	3.307	3.346	3.386	3.425	3.465	3.504
90	3.543	3.583	3.622	3.661	3.701	3.740	3.780	3.819	3.858	3.898

Kilogram to pound

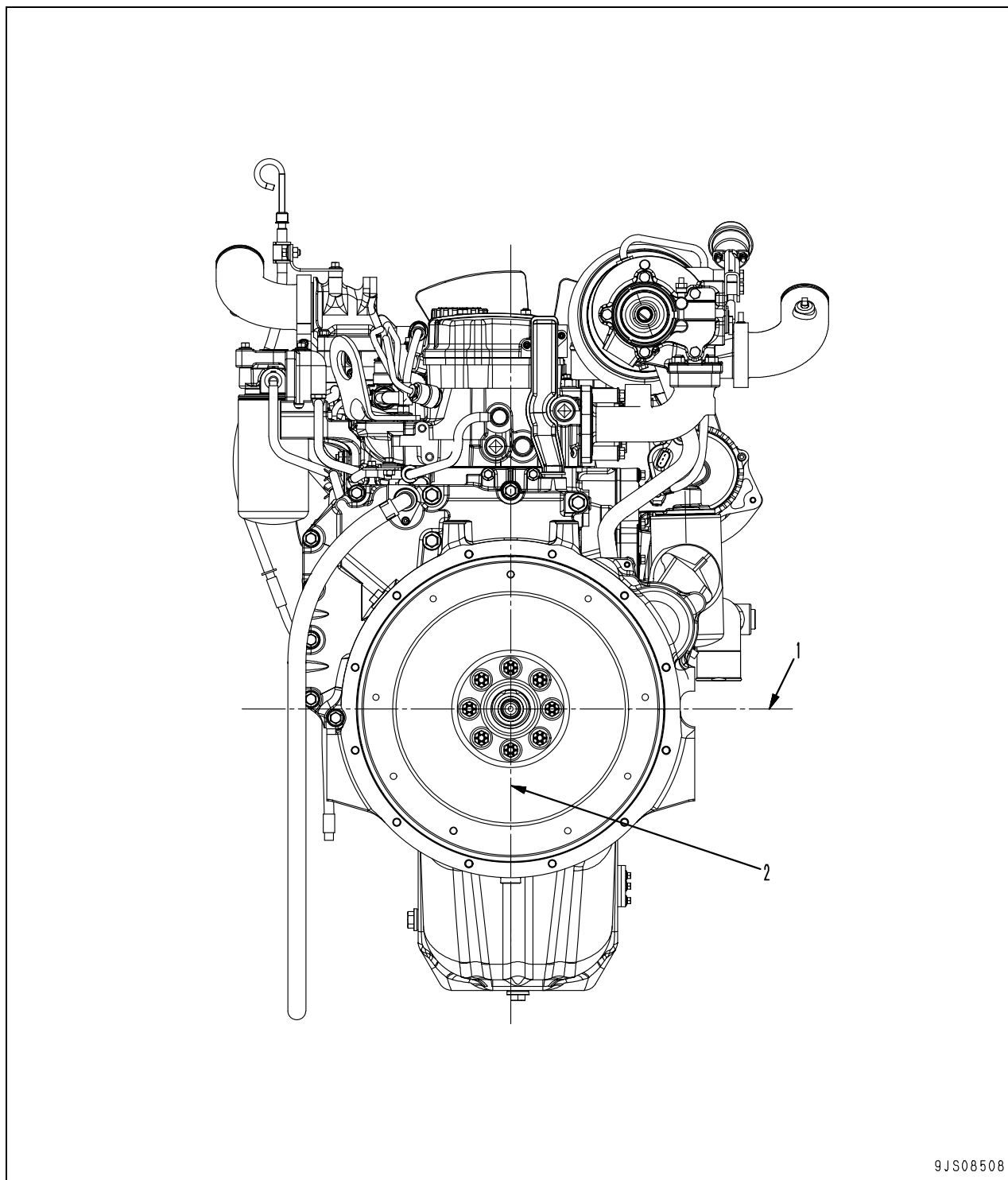
1 kg = 2.2046 lb

	0	1	2	3	4	5	6	7	8	9
0	0	2.20	4.41	6.61	8.82	11.02	13.23	15.43	17.64	19.84
10	22.05	24.25	26.46	28.66	30.86	33.07	35.27	37.48	39.68	41.89
20	44.09	46.30	48.50	50.71	51.91	55.12	57.32	59.53	61.73	63.93
30	66.14	68.34	70.55	72.75	74.96	77.16	79.37	81.57	83.78	85.98
40	88.18	90.39	92.59	94.80	97.00	99.21	101.41	103.62	105.82	108.03
50	110.23	112.44	114.64	116.85	119.05	121.25	123.46	125.66	127.87	130.07
60	132.28	134.48	136.69	138.89	141.10	143.30	145.51	147.71	149.91	152.12
70	154.32	156.53	158.73	160.94	163.14	165.35	167.55	169.76	171.96	174.17
80	176.37	178.57	180.78	182.98	185.19	187.39	189.60	191.80	194.01	196.21
90	198.42	200.62	202.83	205.03	207.24	209.44	211.64	213.85	216.05	218.26

Liters to U.S. Gallons

1 ℓ = 0.2642 U.S. Gal

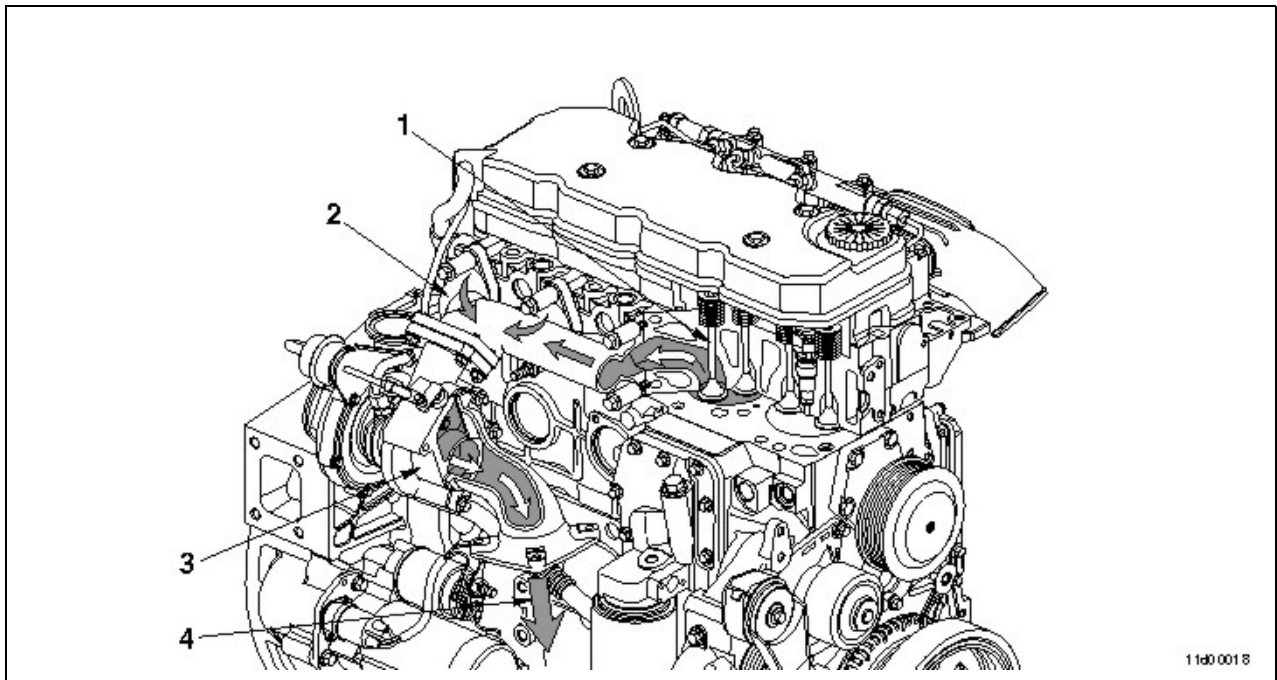
	0	1	2	3	4	5	6	7	8	9
0	0	0.264	0.528	0.793	1.057	1.321	1.585	1.849	2.113	2.378
10	2.642	2.906	3.170	3.434	3.698	3.963	4.227	4.491	4.755	5.019
20	5.283	5.548	5.812	6.076	6.340	6.604	6.869	7.133	7.397	7.661
30	7.925	8.189	8.454	8.718	8.982	9.246	9.510	9.774	10.039	10.303
40	10.567	10.831	11.095	11.359	11.624	11.888	12.152	12.416	12.680	12.944
50	13.209	13.473	13.737	14.001	14.265	14.529	14.795	15.058	15.322	15.586
60	15.850	16.115	16.379	16.643	16.907	17.171	17.435	17.700	17.964	18.228
70	18.492	18.756	19.020	19.285	19.549	19.813	20.077	20.341	20.605	20.870
80	21.134	21.398	21.662	21.926	22.190	22.455	22.719	22.983	23.247	23.511
90	23.775	24.040	24.304	24.568	24.832	25.096	25.361	25.625	25.889	26.153

SAA6D107E-1-A (Rear view of engine)**Machine model: FD100-8, FD115-8, FD135-8, FD150E-8, FD160E-8**

1. Crankshaft center
2. Cylinder center

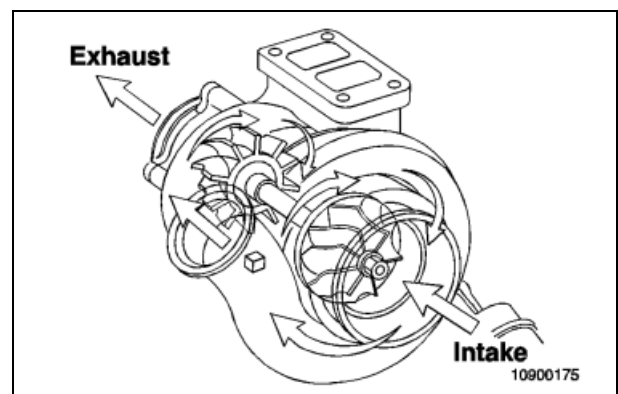
Exhaust system

General Information



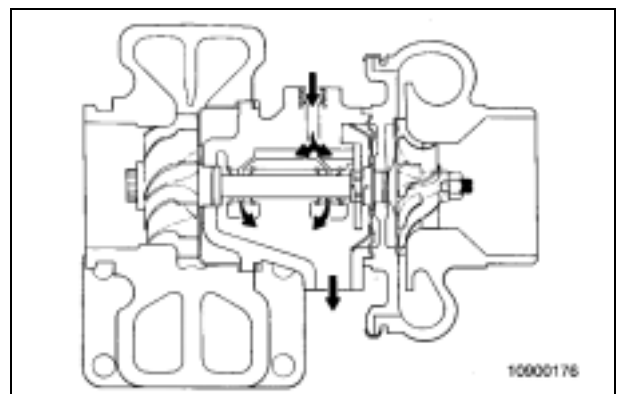
1. Exhaust valve
2. Exhaust manifold
3. Turbocharger
4. Turbocharger exhaust outlet

The turbocharger uses exhaust gas energy to turn the turbine wheel. The turbine wheel drives the compressor impeller, which provides pressurized air to the engine for combustion. The additional air provided by the turbocharger allows more fuel to be injected to increase the power output from the engine.



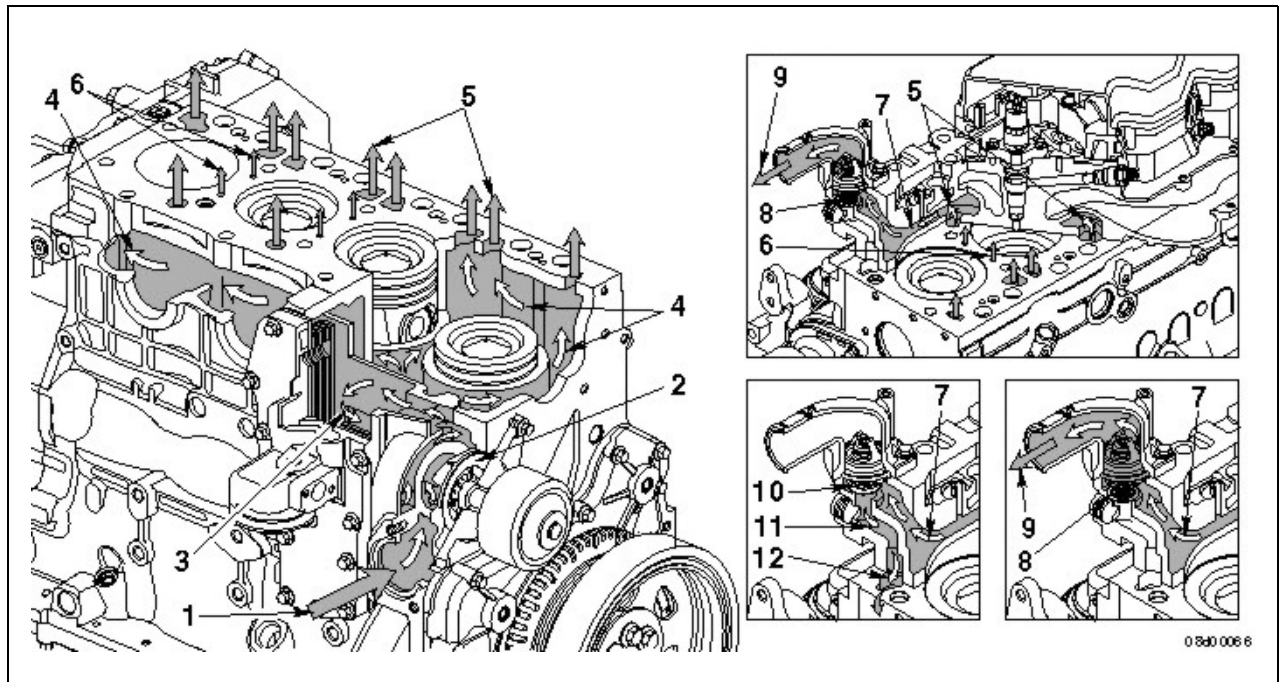
The turbine and compressor wheels share a common shaft (referred to as a rotor assembly), which is supported by two rotating bearings in the bearing housing.

Passages in the bearing housing direct filtered, pressurized engine oil to the shaft bearings and thrust bearings. The oil is used to lubricate and cool the rotating components. Oil then drains from the bearing housing to the engine sump through the oil drain line.



Cooling system

Flow Diagram



1. Coolant inlet
2. Pump impeller
3. Coolant flow past lubricating oil cooler
4. Coolant flow past cylinders
5. Coolant flow from cylinder block to cylinder head
6. Coolant flow between cylinders
7. Coolant flow to thermostat housing
8. Coolant bypass passage
9. Coolant flow back to radiator
10. Bypass open
11. Coolant bypass in cylinder head
12. Coolant flow to water pump inlet

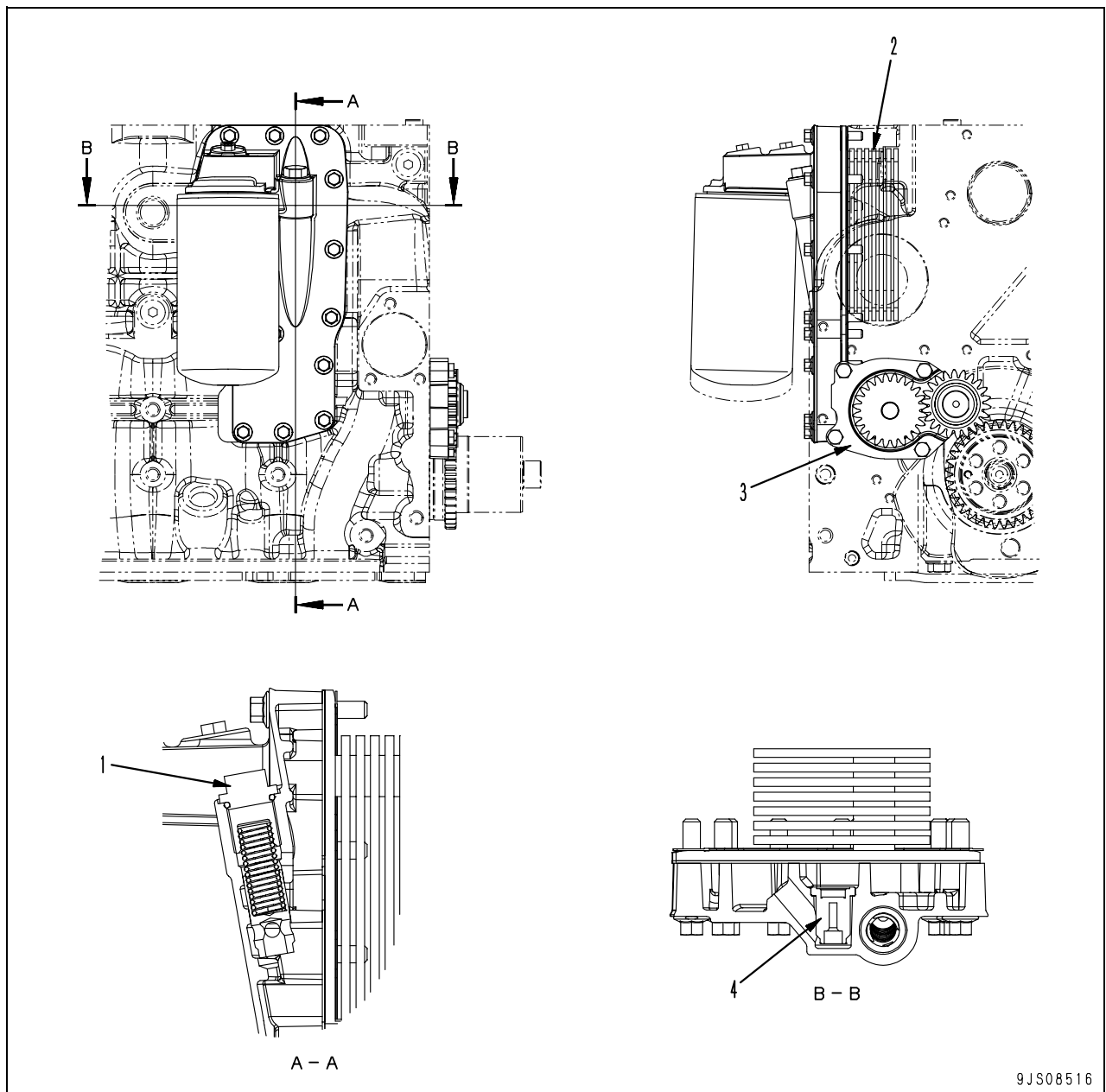
Unit: mm

No.	Check item	Criteria		Remedy
1	Strain of cylinder head mounting face	End-to-End	Max. 0.075	Correct by grinding or replace
		Side-to-Side	Max. 0.075	
2	Diameter of main bearing metal mounting hole	87.982 – 88.008		Replace main bearing metal cap
3	Inside diameter of main bearing metal	83.041 – 83.109		Replace bearing metal
4	Thickness of main bearing metal	2.456 – 2.464		
5	Diameter of cam bushing mounting hole	Max.: 59.248		Correct or replace block
6	Inside diameter of cam bushing	Max.: 54.164		Replace cam bushing
7	Tightening torque for main cap mounting bolt (Apply engine oil to threads)	Procedure	Target (Nm {kgm})	Tighten and retighten
		1st stage	60 {6.1}	
		2nd stage	80 {8.2}	
		3rd stage	Retighten 90°	
8	Tightening torque for oil pan mounting bolt	Target (Nm {kgm})		Tighten and retighten
		28 {2.8}		
9	Tightening torque for crankshaft pulley mounting bolt	Procedure	Target (Nm {kgm})	Tighten and retighten
		1st stage	50 {5.1}	
		2nd stage	Retighten 90°	
10	Inside diameter of cylinder	106.990 – 107.010		Correct by over-size or replace cylinder block
	Roundness of inside of cylinder	Repair limit: 0.038		
	Taper of inside of cylinder	Repair limit: 0.076		

Unit: mm

No.	Check item	Criteria			Remedy
1	Sunk depth (A) of valve	Intake	0.584 – 1.092		Replace valve or valve seat
		Exhaust	0.965 – 1.473		
2	Thickness (B) of valve head	Min. 0.79			Replace
3	Angle of valve seat	Valve	Angle	Repair limit	Correct or replace valve, valve seat
		Intake	30°	Judge condition of contact surface with vacuum test	
		Exhaust	45°		
4	Outside diameter of valve stem	6.96 – 7.01			Replace
5	Diameter of valve guide bore	7.027 – 7.077			
6	Clearance between valve guide and valve stem	0.017 – 0.117			Replace valve or valve guide
7	Depth of valve insert bore (standard insert)	34.847 – 34.863			Replace

Oil cooler



★ The shape is subject to applicable machines.

1. Regulator valve
2. Oil cooler core assembly
3. Oil pump
4. Safety valve

Specifications

Oil cooler

- Number of element stages: 7

Testing and adjusting item	Symbol	Part No.	Part name	Q'ty	Remarks
Removal and installation of engine coolant temperature sensor	—	Commercially available	Deep socket	1	21 mm deep socket (MITOLOY 4ML-21 or equivalent)
Diagnosis sensor and harness	—	799-601-7400	T-adapter assembly	1	AMP040 Connector
		799-601-7500	T-adapter assembly	1	AMP070 Connector
		799-601-9000	T-adapter assembly	1	DT, HD30 Connector
		799-601-9300	T-adapter assembly	1	DRC26-40 (5 pins)
		799-601-7360	Adapter	1	Relay (5 pins)
		799-601-7310	T-adapter	1	AWP (12 poles)
		799-601-7070	T-adapter	1	AWP (16 poles)
		799-601-4100	T-adapter assembly	1	Connected with engine
		799-799-5530	T-adapter	1	Engine coolant temperature
		799-601-4230	T-adapter	1	Boost temperature/pressure sensor
		799-601-4130	T-adapter	1	Ne sensor, CAM sensor
		799-601-4160	T-adapter	1	Hydraulic pressure sensor
		799-601-4211	T-adapter	1	Controller (50 poles)
		799-601-4220	T-adapter	1	Controller (60 poles)
		799-601-4140	T-adapter	1	Atmospheric pressure sensor
		799-601-4340	T-adapter	1	Pump actuator
799-601-4260	T-adapter	1	Controller (4 poles)		
799-601-4190	T-adapter	1	Common rail pressure sensor		

Testing fuel pressure

★ Testing tools for fuel pressure

Symbol	Part No.	Part name
1	799-101-5002	Hydraulic tester
	790-261-1204	Digital hydraulic tester
2	6732-81-3170	Adapter (10 × 1.0 mm → PT1/8)
	6215-81-9710	O-ring
3	799-401-2320	Hydraulic tester
4	795-790-5110	Screw
5	799-201-2202	Boost gauge kit

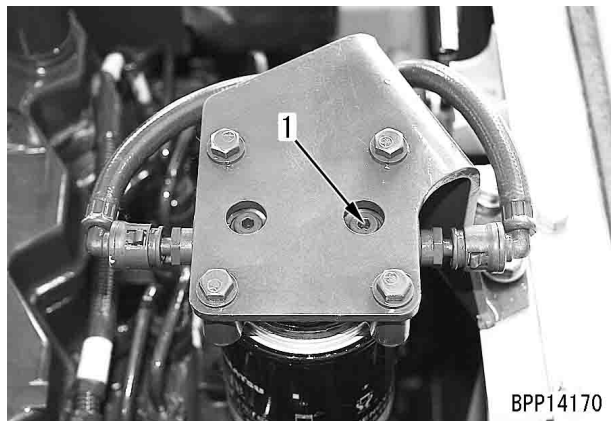
★ Test only the fuel pressure in the low-pressure circuit from the feed pump through the fuel main filter to the supply pump and in the return circuit from the supply pump through the common rail and the injector to the fuel tank.

⚠ **Since the pressure in the high-pressure circuit from the fuel supply pump through the common rail to the injector is very high, it cannot be measured.**

1. Testing fuel low-pressure circuit pressure

- 1) Remove fuel pressure pickup plug (1) from the fuel main filter fuel inlet.

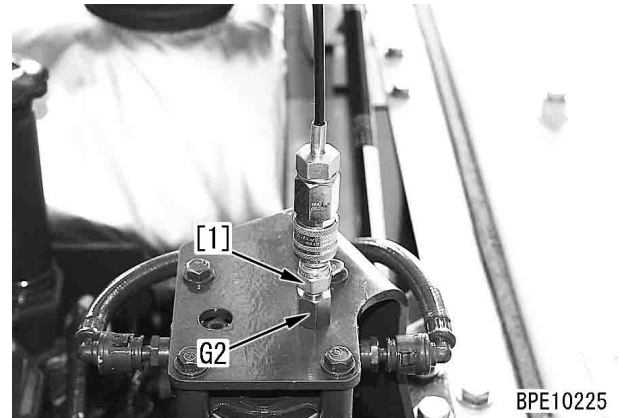
<The shape in the figure is a little different from the actual machine.>



- 2) Install adapter **G2** and nipple [1] of hydraulic tester **G1** and connect it to oil pressure gauge [2].

★ Use an oil pressure gauge of 2.5 MPa {25 kg/cm²}.

<The shape in the figure is a little different from the actual machine.>

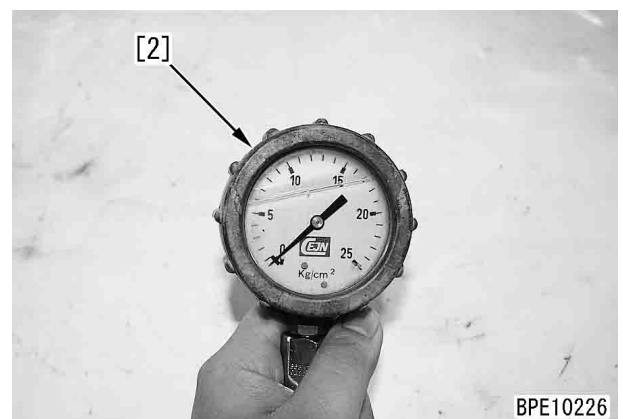


- 3) Run the engine at low idle and test the fuel low-pressure circuit pressure.

★ If the fuel low-pressure circuit pressure is in the following range, it is normal.

Low idle	0.5 – 1.3 MPa {5.1 – 13.3 kg/cm ² }
Cranking	0.3 – 1.1 MPa {3.1 – 11.3 kg/cm ² }

⚠ **When the engine cannot run, you may test it by cranking the engine with the starting motor. To protect the starting motor, do not continuously crank the engine 20 seconds or more.**



- 4) After finishing testing, remove the testing tools and return the removed parts.

☞ Fuel pressure pickup plug:

10 ± 2 Nm {1 ± 0.2 kgm}

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S-2 Engine does not start

a) Engine does not turn

General causes why engine does not turn

- Seized parts inside engine
→ See “S-4 Engine stops during operations”
- Defective electrical system
- Problem in drive devices on applicable machine side
→ Carry out troubleshooting for devices on applicable machine

		Causes								
		Broken flywheel ring gear	Defective or deteriorated battery	Defective connection of battery terminal	Defective battery relay	Defective starting switch	Defective safety relay	Defective starting motor (motor section)	Defective steering circuit wiring	
Questions	Confirm recent repair history									
	Degree of use of machine	Operated for long period	△	△						
	Condition of horn when starting switch is turned ON	Horn does not sound			○		○		○	
		Horn volume is low		○						
Check items	Battery electrolyte is low		○							
	Battery terminal is loose			○						
	When starting switch is turned ON, there is no operating sound from battery relay		○		○					
	When starting switch is turned to START, starting pinion does not move out		○			○			○	
	When starting switch is turned to START, starting pinion moves out, but	Speed of rotation is low		○						
		Makes grating noise		○					○	
		Soon disengages again						○		
Makes rattling noise and does not turn			○				○	○		

Troubleshooting		Carry out troubleshooting on applicable machine								
		Replace	Replace	Correct	Replace	Replace	Replace	Replace	—	
	Inspect flywheel ring gear directly	●								
	When specific gravity of electrolyte and voltage of battery are measured, they are low		●							
	Turn starting switch OFF, connect cord, and carry out troubleshooting at ON	There is not voltage (20 – 30 V) between battery relay terminal B and terminal E				●				
		When terminal B and terminal C of starting switch are connected, engine starts					●			
		When terminal B and terminal C at safety relay outlet are connected, engine starts						●		
		Even if terminal B and terminal C at safety relay outlet are connected, engine does not start							●	
When terminal at safety switch and terminal B at starting motor are connected, engine starts							●			
	Remedy	Replace	Replace	Correct	Replace	Replace	Replace	Replace	—	

S-10 Fuel consumption is excessive

General causes why fuel consumption is excessive

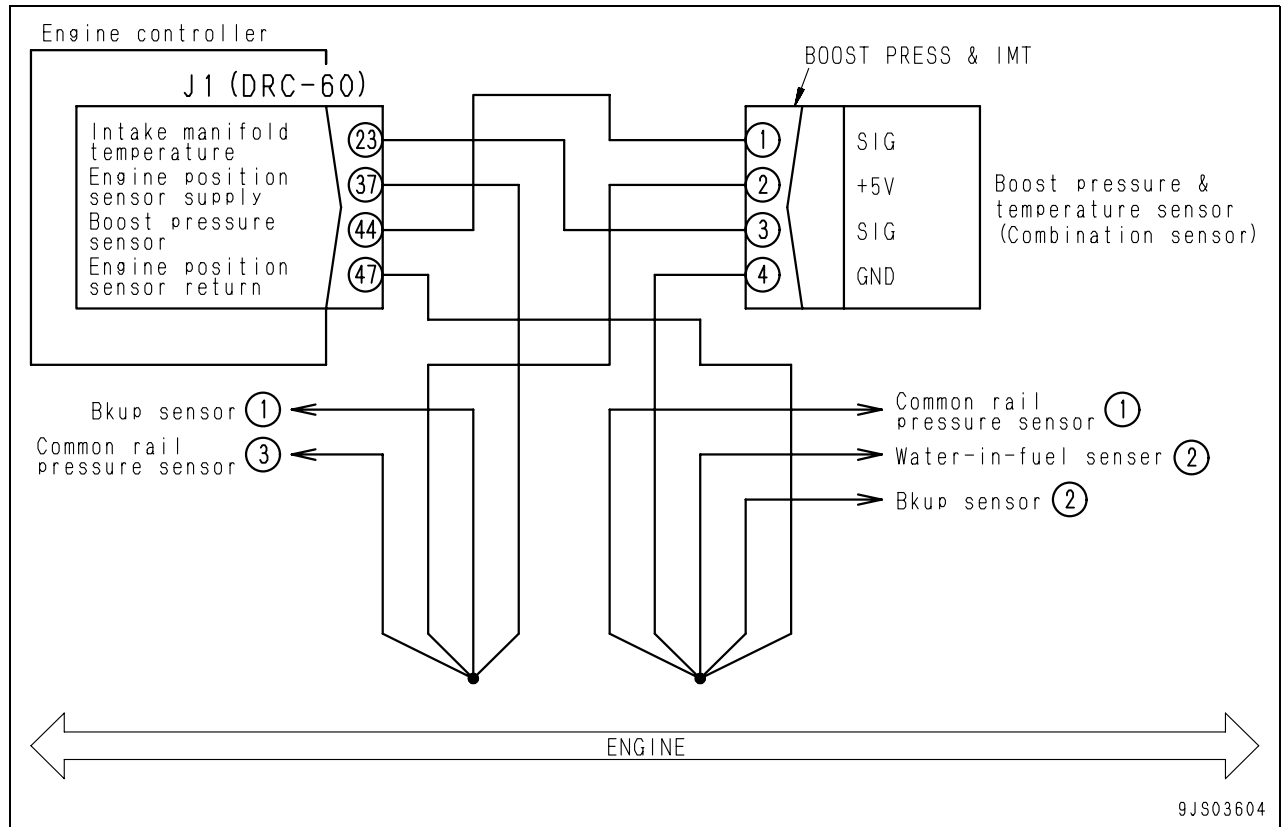
- Leakage of fuel
- Defective condition of fuel injection (fuel pressure, injection timing)
- Excessive injection of fuel

		Causes									
		Fuel leakage inside head cover	Fuel leakage from fuel filter, piping, etc.	Defective fuel supply pump oil seal	Defective supply pump plunger	Defective common rail pressure	Defective spray by injector	Defective operation of injector	Improper injection timing	Defective coolant temperature sensor, wiring harness	
Questions	Confirm recent repair history										
	Degree of use of machine	Operated for long period		△	△		△				
	Condition of fuel consumption	More than for other machines of same model					○		○	○	○
		Gradually increased				○		○			
Suddenly increased		○	○								
Check items	There is external leakage of fuel from engine			○							
	Combustion is irregular							○			
	Engine oil level rises and oil smells of diesel fuel		○	○							
	When exhaust manifold is touched immediately after starting engine, temperature of some cylinders is low							○			
	Low idle speed is high								○		
	Torque converter stall speed or pump relief speed is high								○		
	Color of exhaust gas is	Black					○	○		○	○
		White	○								
Troubleshooting	Remove head cover and inspect directly		●								
	Inspect fuel supply pump oil seal directly				●						
	Carry out troubleshooting according to "No-pressure feed by supply pump (*1)" in E-mode					●					
	When a cylinder is cut out for reduced cylinder mode operation, engine speed does not change							●			
	Much fuel returns from the injector								●		
	Carry out troubleshooting according to "Abnormality in coolant temperature sensor (*2)" in E-mode										●
	Confirm with troubleshooting tool or with monitoring function on applicable machine side						●			●	
Remedy		Correct	Correct	Replace	Replace	Correct	Replace	Replace	Replace	Replace	

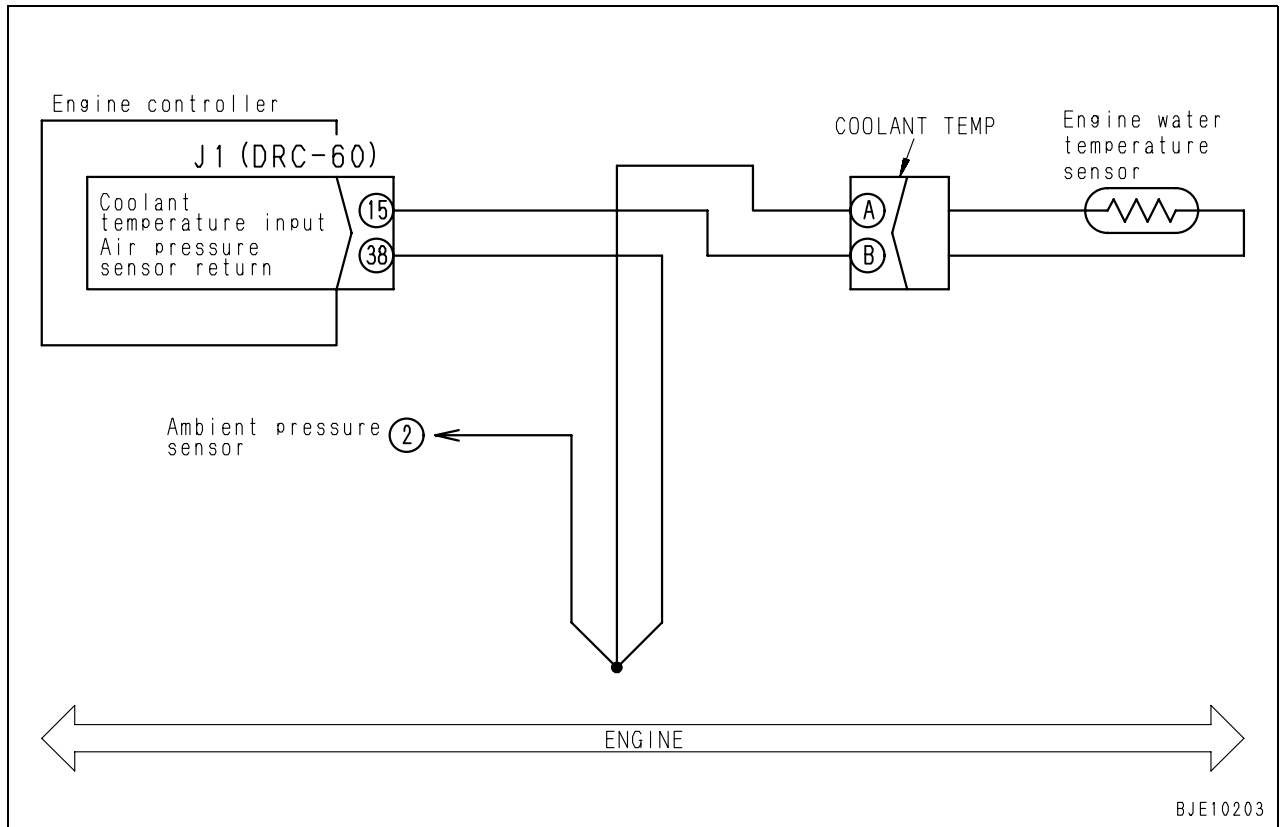
*1: Troubleshooting for failure codes [559] and [2249] in E mode

*2: Troubleshooting for failure codes [144] and [145] in E mode

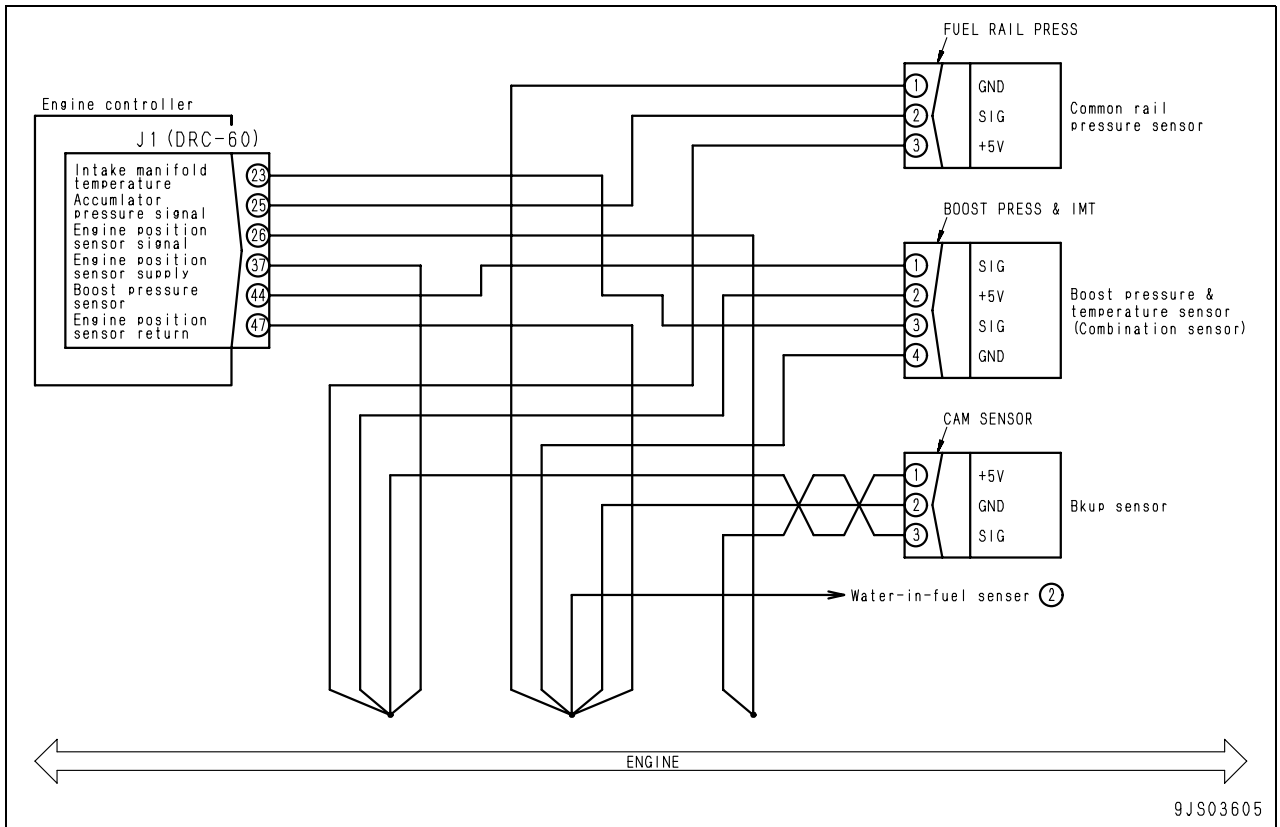
Circuit diagram related to boost pressure, temperature sensor (combination sensor)



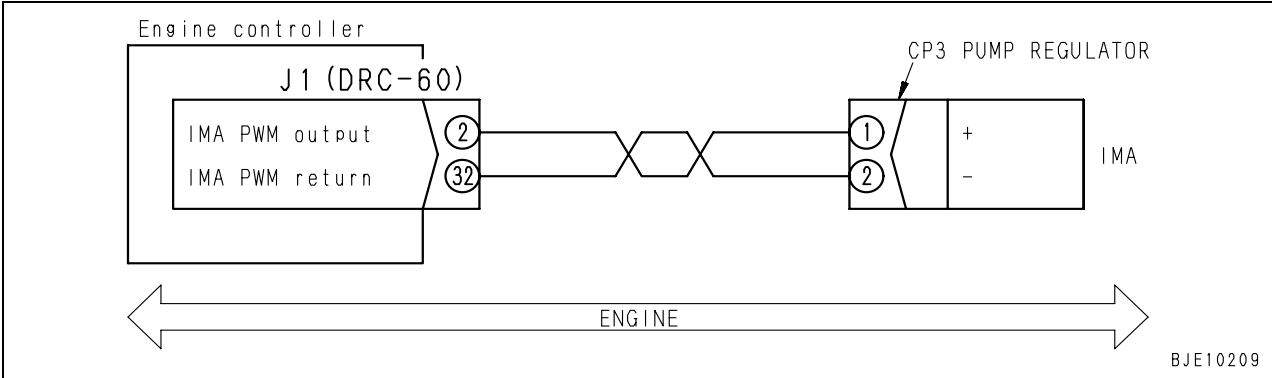
Circuit diagram related to coolant temperature sensor



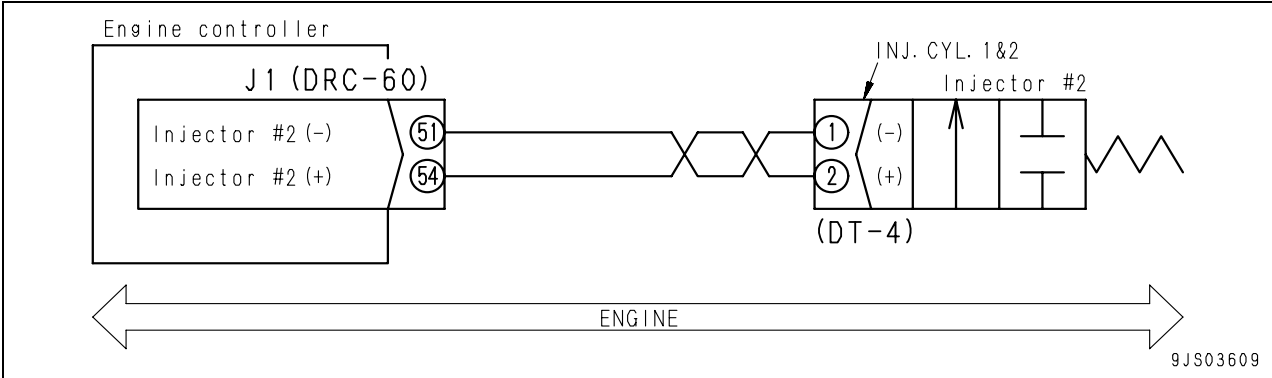
Circuit diagram related to sensor power supply 2



Circuit diagram related to supply pump actuator (metering unit)



Circuit diagram related to injector No. 2



E-31 Failure code [415] (Rotation derating by low engine oil pressure)

Failure code	Trouble	Rotation derating by low engine oil pressure (Engine controller system)	
415			
Contents of trouble	<ul style="list-style-type: none"> While engine is run, engine oil pressure became lower than operating range. 		
Action of controller	<ul style="list-style-type: none"> Limits output and continues operation (Limits fuel injection rate and engine speed). 		
Problem that appears on machine	<ul style="list-style-type: none"> Engine output lowers. 		
Related information	<ul style="list-style-type: none"> Method of reproducing failure code: Start engine. 		
Possible causes and standard value in normal state	Causes	Standard value in normal state/Remarks on troubleshooting	
	Carry out troubleshooting of failure code [143].		

Circuit diagram related to accelerator pedal

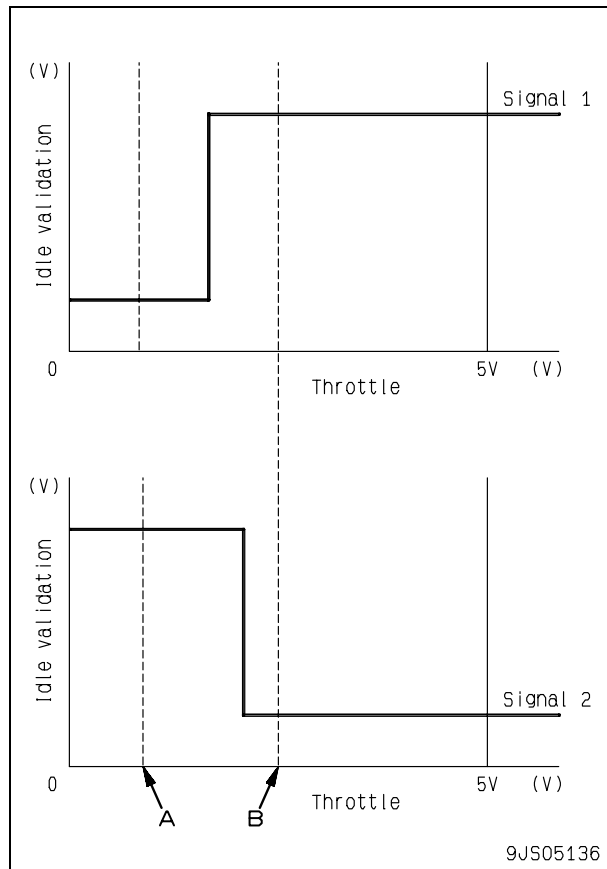
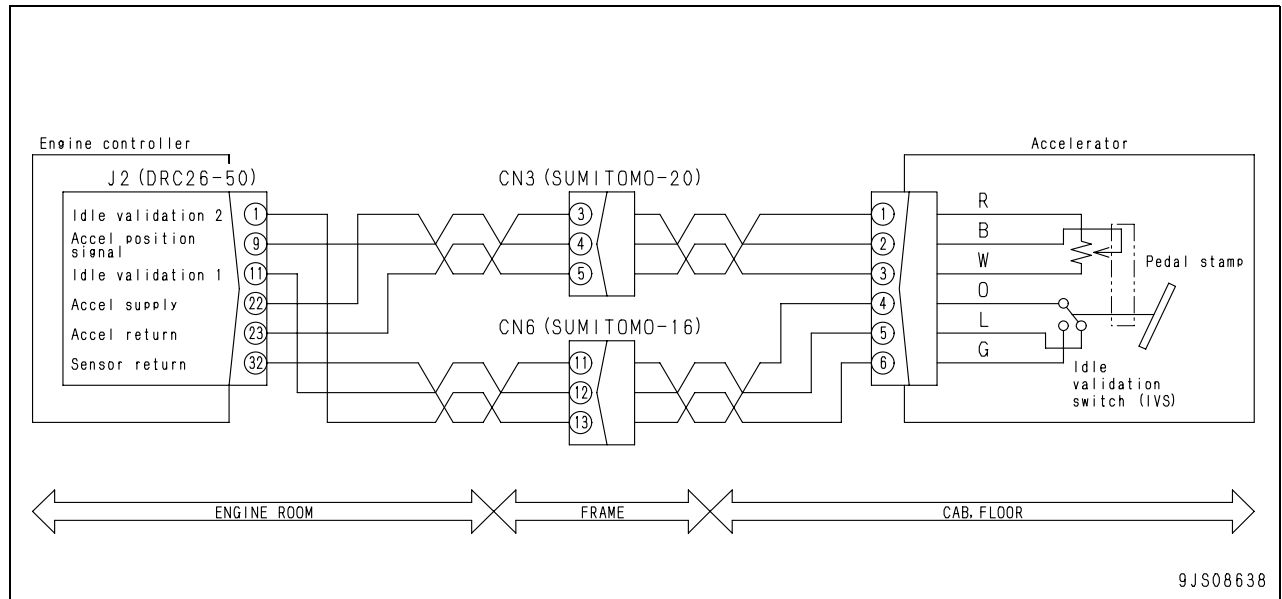
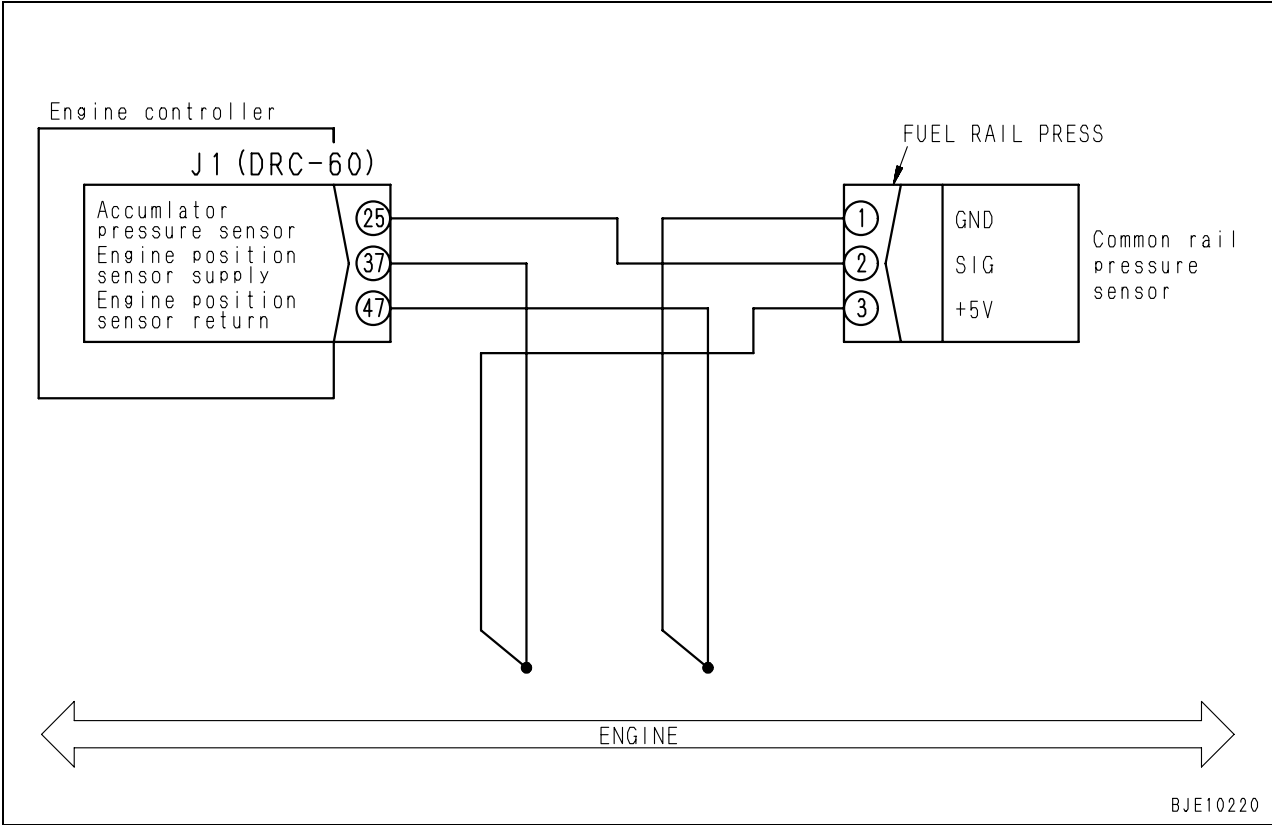
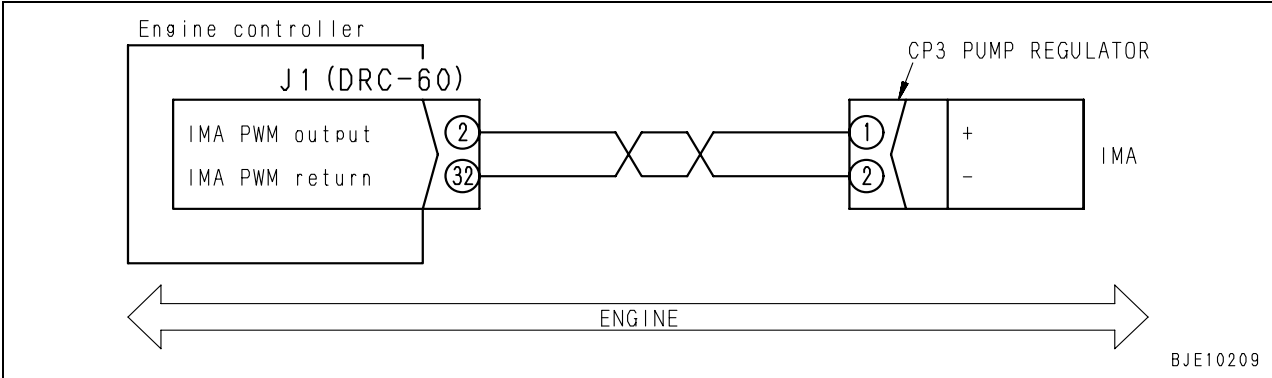


Fig. 1
 Throttle: Throttle sensor signal voltage
 Idle validation: Idle validation switch signal voltage
 A: Voltage when pedal opened + 0.03 x
 (Voltage when pedal pressed – Voltage when pedal opened)
 B: Voltage when pedal opened + 0.1 x
 (Voltage when pedal pressed – Voltage when pedal opened)

Circuit diagram related to common rail pressure sensor

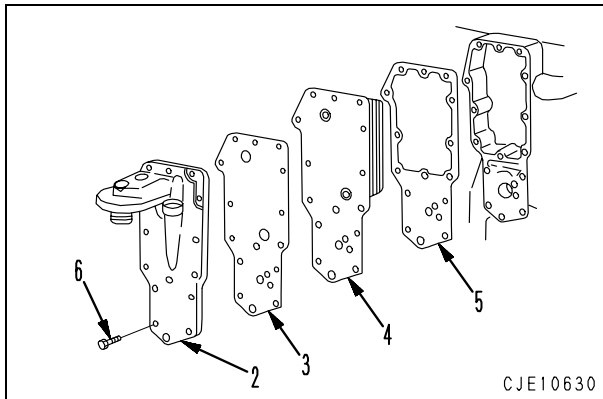


Circuit diagram related to supply pump actuator (metering unit)



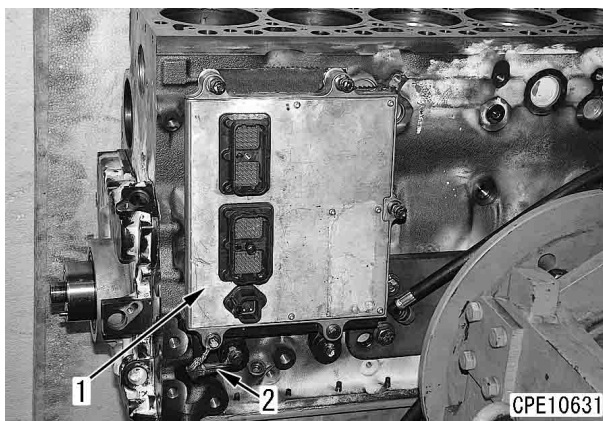
Category	Komatsu code	Part number	Q'ty	Container	Main features and applications
Gasket sealant	LG-9 ThreeBond 1206D	790-129-9310	200 g	Tube	<ul style="list-style-type: none"> Used for rough surfaces such as the circle gear top seal which does not need to be clamped, water resistance of the clearance at the welded area, etc. Can be coated with paint.
	LG-10 ThreeBond 1206E	790-129-9320	200 g	Tube	<ul style="list-style-type: none"> Used as lubricant/sealant when the radiator hoses are inserted. Can be coated with paint.
	LG-11 ThreeBond 1121	790-129-9330	200 g	Tube	<ul style="list-style-type: none"> Feature: Can be used together with gaskets. Used for covers of the transmission case and steering case etc.
	ThreeBond 1211	790-129-9090	100 g	Tube	<ul style="list-style-type: none"> Gasket sealant used to repair engine.
Molybdenum disulfide lubricant	LM-P	09940-00040	200 g	Tube	<ul style="list-style-type: none"> Used to prevent scuffing and seizure of press-fitted portions, shrink-fitted portions, and threaded portions. Used to lubricate linkages, bearings, etc.
Seizure prevention compound	LC-G NEVER-SEEZ	—	—	Can	<ul style="list-style-type: none"> Feature: Seizure and scuffing prevention compound with metallic super-fine-grain, etc. Used for the mounting bolt in the high temperature area of the exhaust manifold and the turbo-charger, etc.
Grease	G2-LI G0-LI *: For cold district	SYG2-400LI SYG2-350LI SYG2-400LI-A SYG2-160LI SYGA-160CNLI SYG0-400LI-A (*) SYG0-160CNLI (*)	Various	Various	<ul style="list-style-type: none"> Feature: Lithium grease with extreme pressure lubrication performance. General purpose type.
	Molybdenum disulfide grease LM-G (G2-M)	SYG2-400M SYG2-400M-A SYGA-16CNM	400 g x 10 400 g x 20 16 kg	Bellows-type container Can	<ul style="list-style-type: none"> Used for parts under heavy load. <p>Caution:</p> <ul style="list-style-type: none"> Do not apply grease to rolling bearings like swing circle bearings, etc. and spline. The grease should be applied to work equipment pins at their assembly only, not applied for greasing afterwards.
	Hyper White Grease G2-T, G0-T (*) *: For cold district	SYG2-400T-A SYG2-16CNT SYG0-400T-A (*) SYG0-16CNT (*)	400 g 16 kg	Bellows-type container Can	<ul style="list-style-type: none"> Seizure resistance, heat resistance and water resistance higher than molybdenum disulfide grease. Not conspicuous on machine since color is white.
	Biogrease G2-B, G2-BT (*) *: For use at high temperature and under high load	SYG2-400B SYGA-16CNB SYG2-400BT (*) SYGA-16CNBT (*)	400 g 16 kg	Bellows-type container Can	<ul style="list-style-type: none"> Since this grease is decomposed by natural bacteria in short period, it has less effects on microorganisms, animals, and plants.
	G2-S ThreeBond 1855	—	200 g	Tube	<ul style="list-style-type: none"> Feature: Silicone grease with wide using temperature range, high resistance to thermal-oxidative degradation and performance to prevent deterioration of rubber and plastic parts. Used for oil seals of the transmission, etc.
	G2-U-S ENS grease	427-12-11871	2 kg	Can	<ul style="list-style-type: none"> Feature: Urea (organic system) grease with heat resistance and long life. Enclosed type. Used for rubber, bearing and oil seal in damper. <p>Caution: Do not mix with lithium grease.</p>

- 2) Remove mounting bolts (6), cover (2) and cover gasket (3).
- 3) Remove oil cooler (4) and cooler gasket (5).

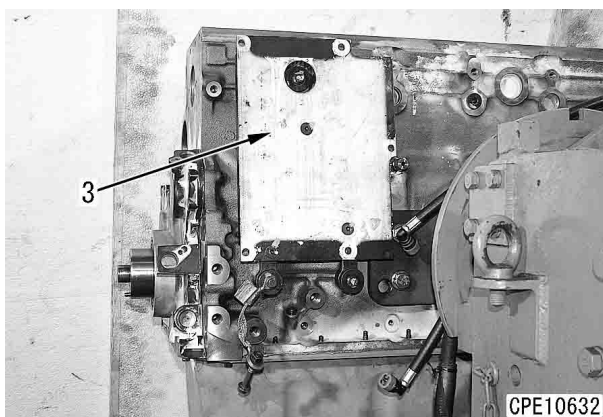


23. Engine controller

- 1) Remove engine controller (1).
- 2) Disconnect ground cable (2).

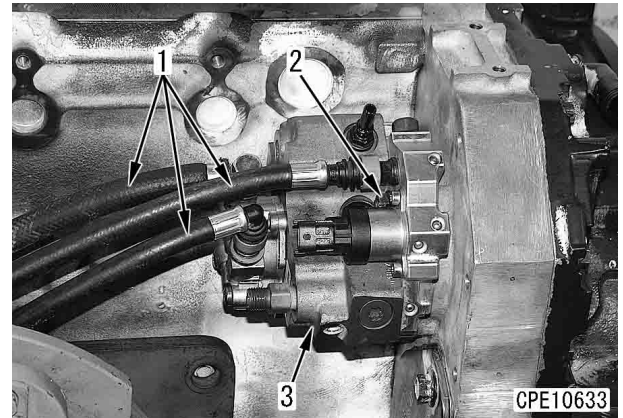


- 3) Remove cooling plate (3).




24. Fuel supply pump

- 1) Remove hose (1).
- 2) Remove 3 nuts (2) and then remove supply pump (3).

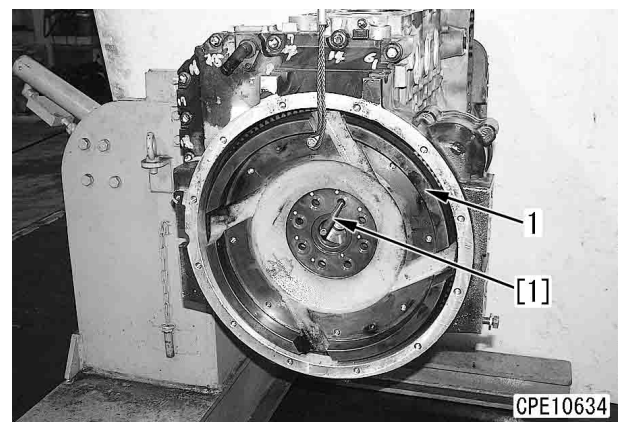


25. Flywheel

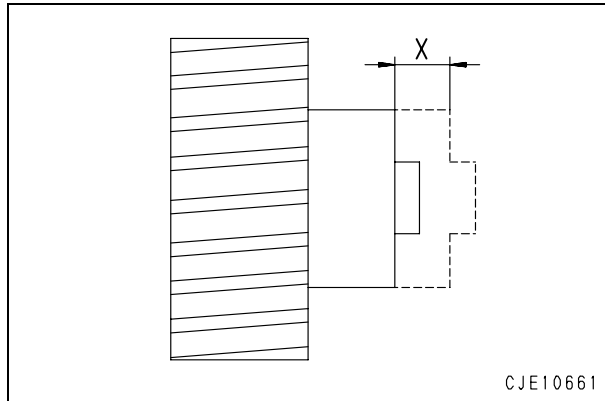
- Install guide bolt [1] and then remove flywheel (1).

 Flywheel: 35 kg

⚠ Take care in this operation so that your fingers may not be damaged by the flywheel that can fall off from the shallow spigot joint.

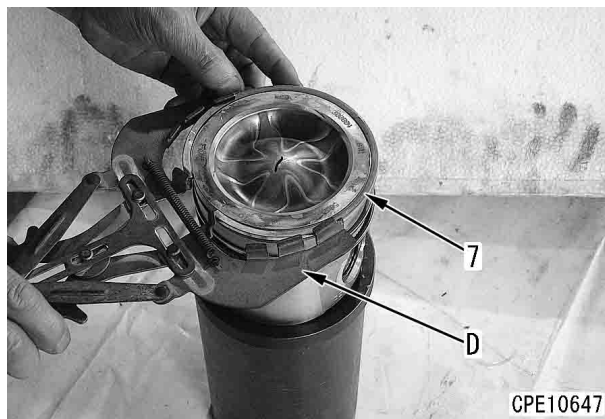


- 8) After tightening the bolts, make sure that the crankshaft turns smoothly.
- 9) Measure the end play of the crankshaft with a dial gauge.
★ End play **X**: 0.24 ± 0.175 mm

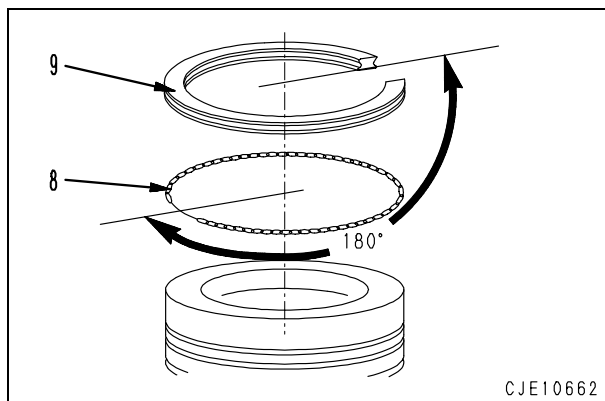


5. Piston and connecting rod assembly

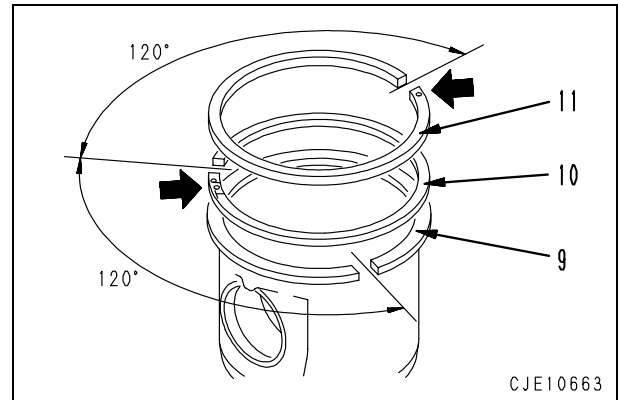
- 1) Using tool **D**, fit piston rings (7) to the piston.



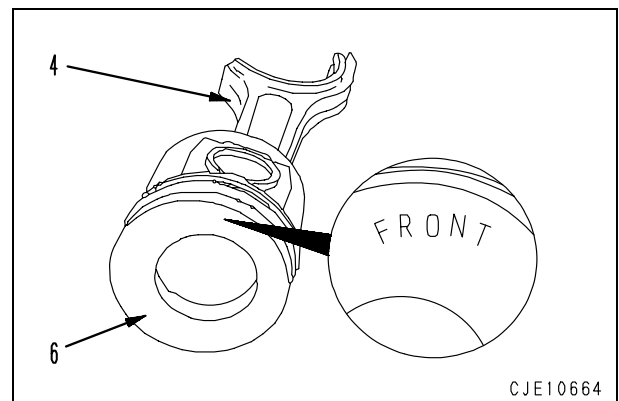
- 2) Installation of oil ring
Set the oil ring (9) so that its abutment joint comes in a position at 180° to the end of expander (8).

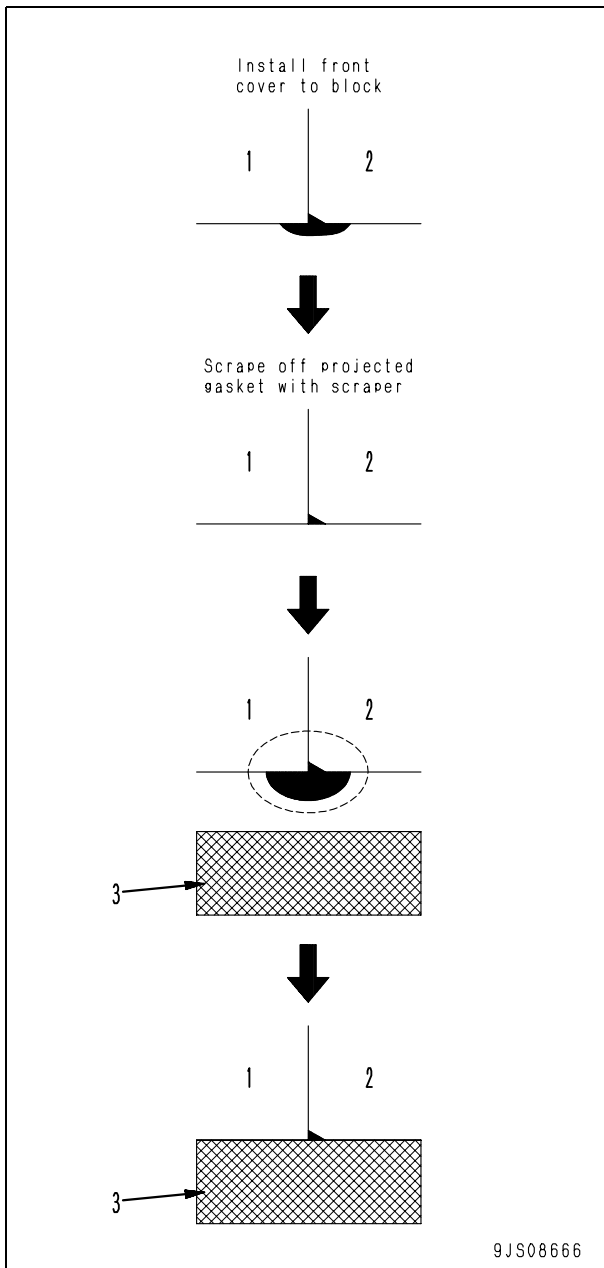
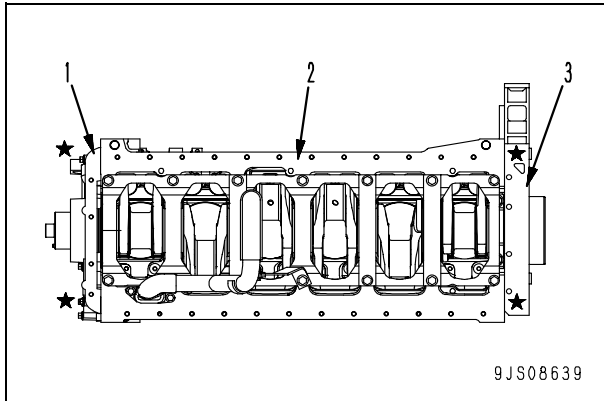


- 3) Fit second ring (10) with the stamp of "TOP" near the abutment joint up.
- 4) Fit top ring (11) with the "dot" mark near the abutment joint up.
- 5) When fitting each ring, set the abutment joint off the thrust, anti-thrust, and piston axis directions.



- 6) Apply engine oil (EO15W-40) to piston ring and piston skirt.
- 7) Set the piston and connecting rod.
 - When "FRONT" mark of piston (6) head is set at the top, connecting rod (4) must be facing to the direction shown in the figure.

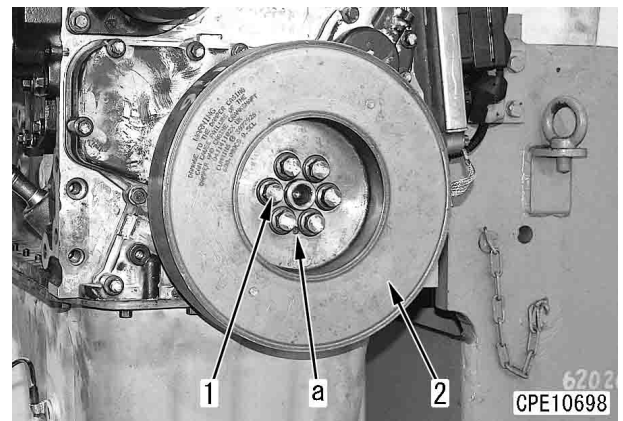




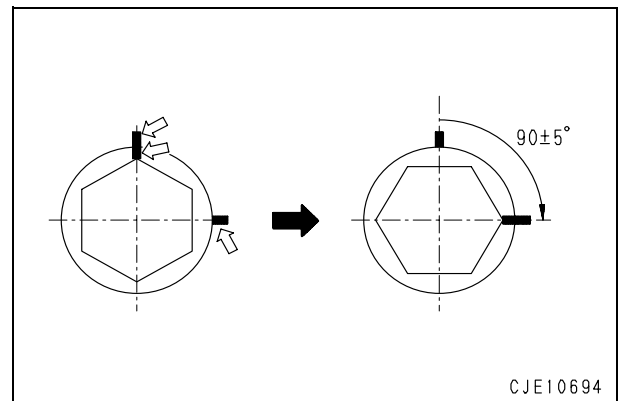
- 1. Cylinder block
- 2. Gear housing
- 3. Oil pan

14. Vibration damper

- 1) Install vibration damper by fitting in their knock holes to dowel pin (a) of the crankshaft.
- 2) Bolt (1) tightening procedure
 - ☞ Mounting bolt:
 - 1] Tighten the bolt's opposing corner sequentially with 55 ± 5 Nm { 5.6 ± 0.5 kgm}.
 - 2] Loosen the bolt by 180° .
 - 3] Tighten the bolt's opposing corner sequentially with 55 ± 5 Nm { 5.6 ± 0.5 kgm}.
 - 4] $90^\circ \pm 5^\circ$ (When angle tightening tool J is used)



- When not using angle tightening tool: Make marks on the crankshaft pulley or vibration damper and each bolt with paint and then tighten the bolt by $90^\circ \pm 5^\circ$.



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