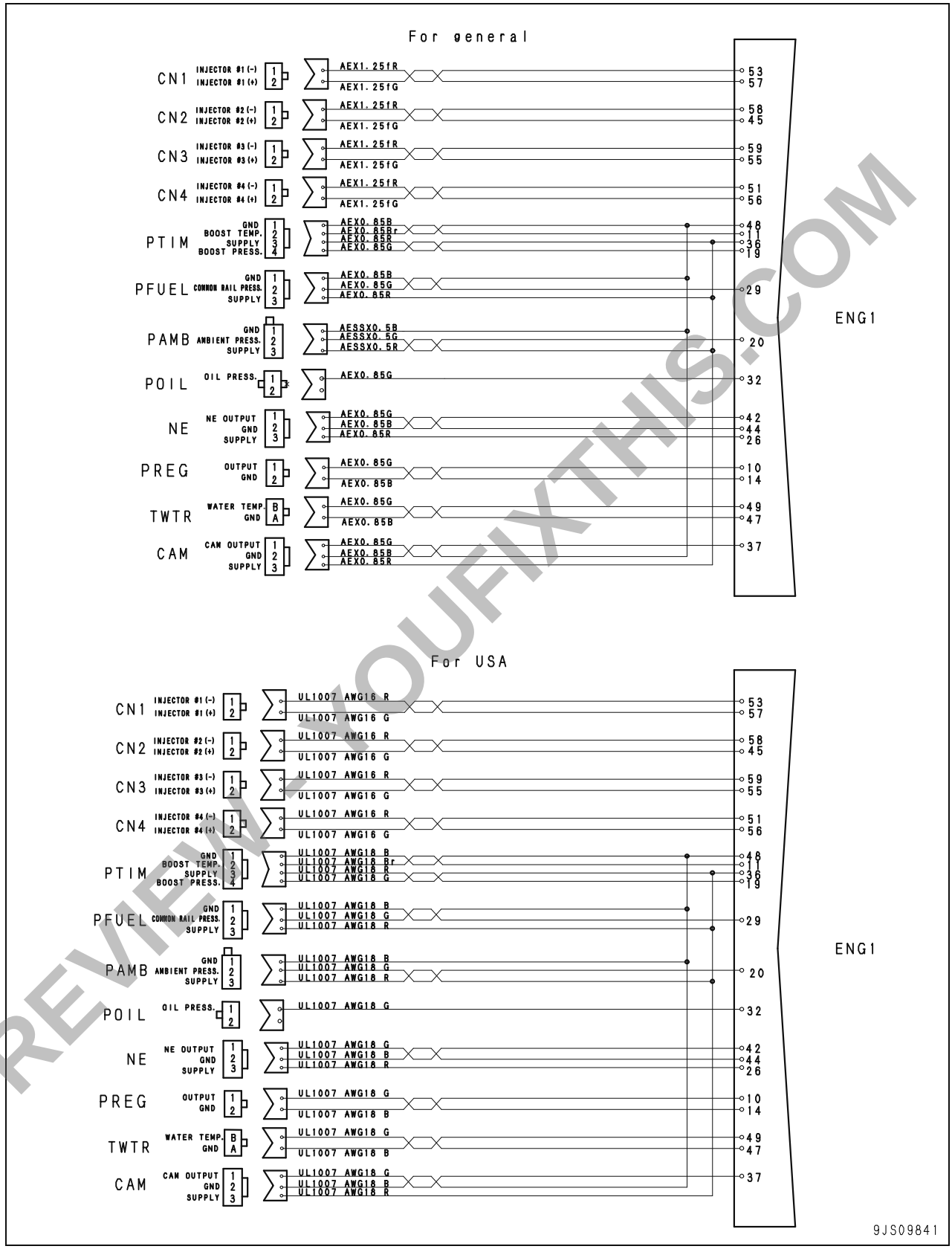
Circuit diagram



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Standard tightening torque table

1. Table of tightening torques for bolts and nuts

★ Unless there are special instructions, tighten metric nuts and bolts to the torque below.

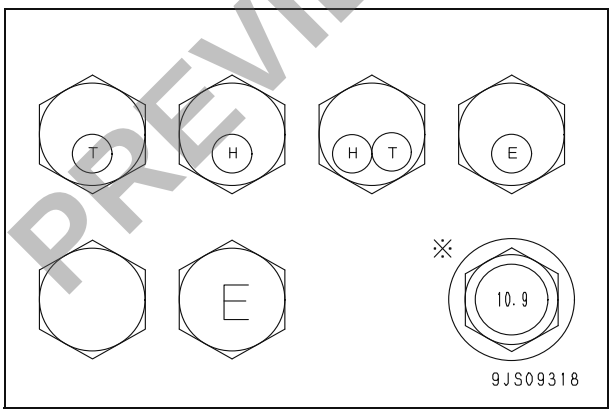
★ The following table applies to the bolts in Fig. A.

Thread diameter of bolt	Width across flats	Tightening torque	
mm	mm	Nm	kgm
6	10	11.8 – 14.7	1.2 – 1.5
8	13	27 – 34	2.8 – 3.5
10	17	59 – 74	6.0 – 7.5
12	19	98 – 123	10.0 – 12.5
14	22	157 – 196	16 – 20
16	24	245 – 309	25 – 31.5
18	27	343 – 427	35 – 43.5
20	30	490 – 608	50 – 62
22	32	662 – 829	67.5 – 84.5
24	36	824 – 1,030	84 – 105
27	41	1,180 – 1,470	120 – 150
30	46	1,520 – 1,910	155 – 195
33	50	1,960 – 2,450	200 – 250
36	55	2,450 – 3,040	250 – 310
39	60	2,890 – 3,630	295 – 370

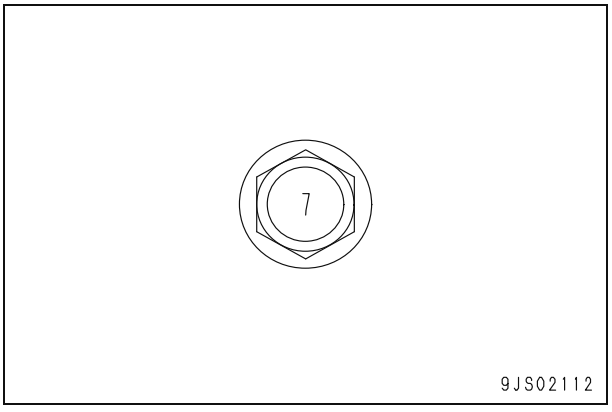
★ The following table applies to the bolts in Fig. B.

Thread diameter of bolt	Width across flats	Tightening torque	
mm	mm	Nm	kgm
6	10	5.9 – 9.8	0.6 – 1.0
8	12	13.7 – 23.5	1.4 – 2.4
10	14	34.3 – 46.1	3.5 – 4.7
12	17	74.5 – 90.2	7.6 – 9.2

★ Fig. A



★ Fig. B



★ Apply the width across flats in the table for Fig. B to the bolt marked with * in Fig. A. (Apply the tightening torque in the table for Fig. A.)

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Failure code table

Failure code of troubleshooting tool	Failure phenomenon	Place of description
111	ECM Critical Internal Failure	Troubleshooting of electrical system (E-mode)
115	Eng. Ne and Bkup Speed Sensor Error	
122	Charge Air Press Sensor High Error	
123	Charge Air Press Sensor Low Error	
131	Throttle Sensor High Error	
132	Throttle Sensor Low Error	
144	Coolant Temp. Sensor High Error	
145	Coolant Temp. Sensor Low Error	
153	Charge Air Temp. Sensor High Error	
154	Charge Air Temp. Sensor Low Error	
187	Sensor Sup. 2 Volt. Low Error	
221	Ambient Air Press. Sensor High Error	
222	Ambient Air Press. Sensor Low Error	
227	Sensor Sup. 2 Volt. High Error	
234	Eng. Overspeed	
238	Ne Speed Sensor Sup. Volt. Error	
271	IMV Short Error	
272	IMV Open Error	
322	Injector #1 System Open/Short Error	
324	Injector #3 System Open/Short Error	
331	Injector #2 System Open/Short Error	
332	Injector #4 System Open/Short Error	
351	INJ. Drive Circuit Error	
352	Sensor Sup. 1 Volt. Low Error	
386	Sensor Sup. 1 Volt. High Error	
415	Rotation derating by low engine oil pressure	
431	Idle Validation SW Low error	
432	Idle Validation Process error	
435	Abnormality in engine oil pressure switch	
441	Battery voltage low error	
442	Battery voltage high error	
449	Rail Press. Very High Error	
451	Rail Press. Sensor High Error	
452	Rail Press. Sensor Low Error	
553	Rail Press. High Error	
559	Rail Press. Low Error	
689	Eng. Ne Speed Sensor Error	
731	Eng. Bkup Speed Sensor Phase Error	
757	All Persistent Data Lost Error	
778	Eng. Bkup Speed Sensor Error	
2185	Throttle Sens. Sup. Volt. High Error	
2186	Throttle Sens. Sup. Volt. Low Error	

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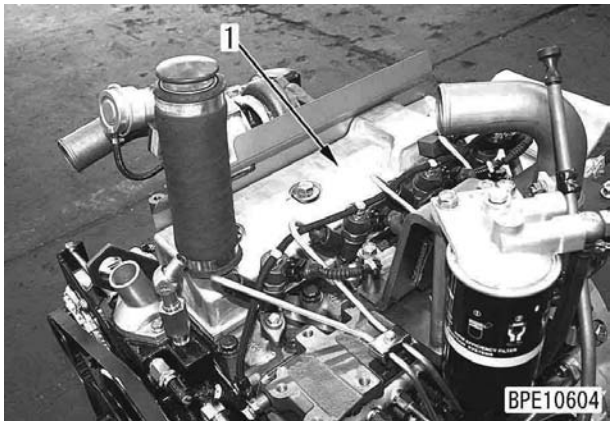
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Adjusting valve clearance

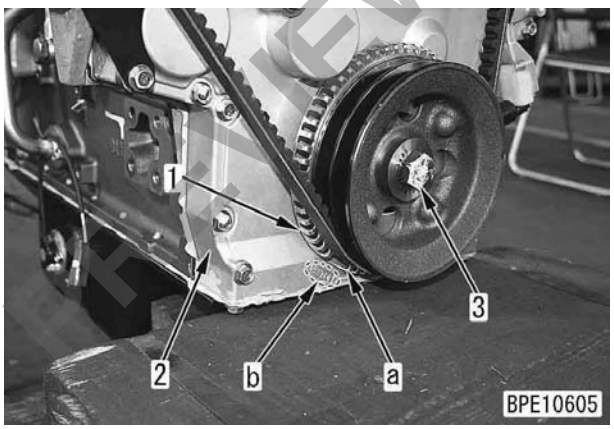
★ Adjusting tools for valve clearance

Symbol	Part No.	Part name
B	Commercially available	Clearance gauge

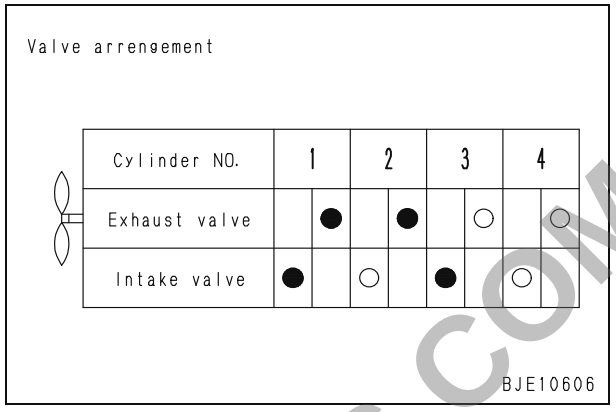
1. Remove cylinder head covers (1).
<The shape in the figure is a little defferent from the actual machine.>



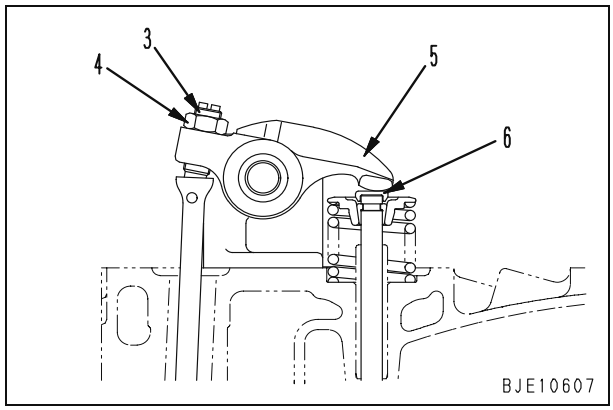
2. Rotate the crankshaft forward (clockwise seen from the front) and set wide notch (a) (Width: 25 mm) of signal plate (1) at the rear of the crankshaft pulley to embossed letters "1.4TOP" (b) of front cover (2).
   Reference: All of the other notches of the signal plate are 5 mm in width.
   ★ Rotate the crankshaft with the crankshaft pulley bolt (3) (Width across flats: 27 mm).
   ★ Always rotate the crankshaft pulley bolt forward to prevent it from being loosened.



3. Adjust the clearances of the valves marked with ● in the valve arrangement drawing according to the following procedure.



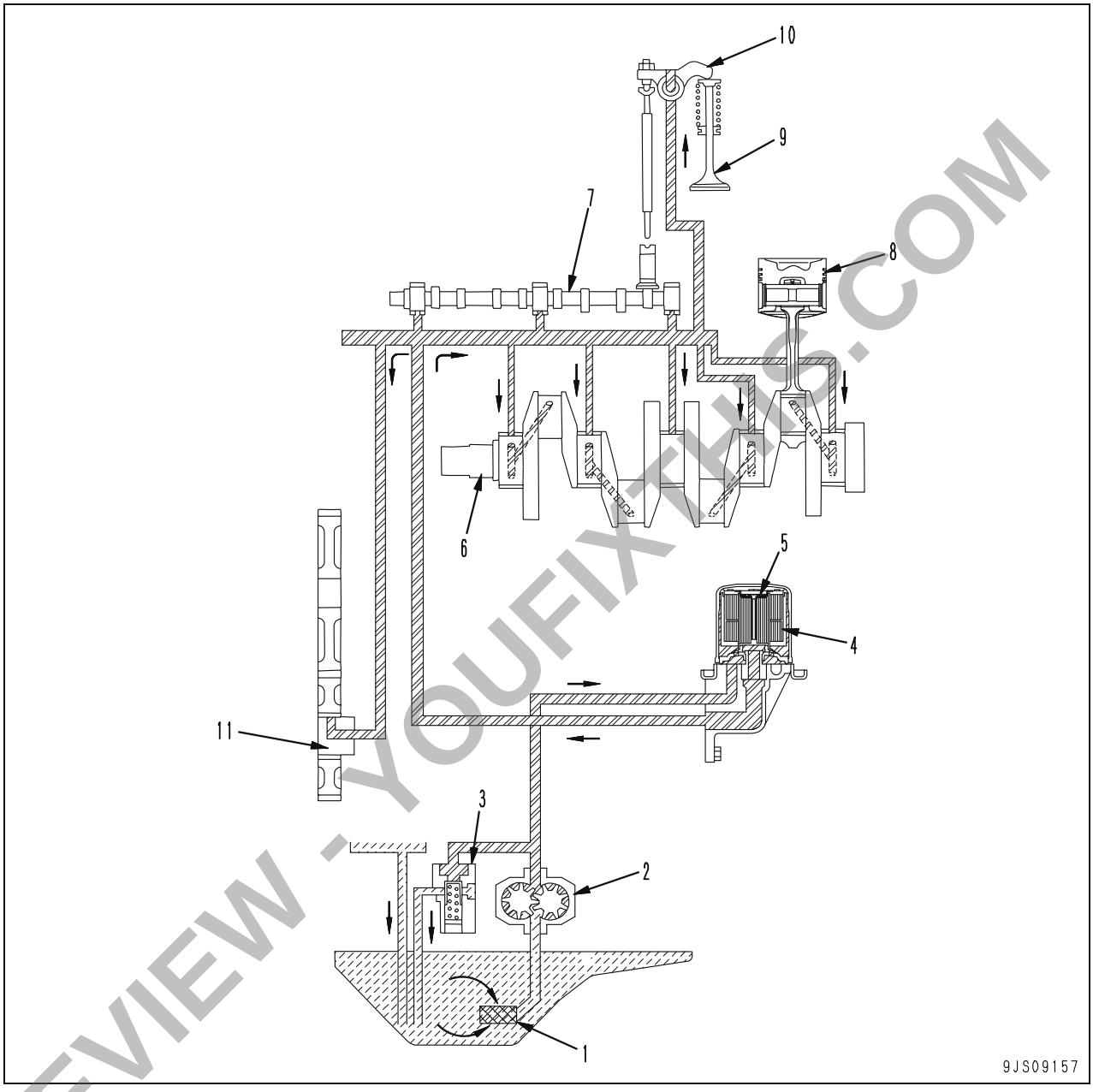
   1) While fixing adjustment screw (3), loosen locknut (4).
   2) Insert clearance gauge **B** in the clearance between rocker arm (5) and valve stem upper end (6) and adjust the valve clearance with adjustment screw (3).
      ★ With the clearance gauge inserted, turn the adjustment screw to a degree that you can move the clearance gauge lightly.
      ★ Valve clearance
      Intake valve: 0.35 ± 0.02 mm
      Exhaust valve: 0.50 ± 0.02 mm
   3) While fixing adjustment screw (3), tighten locknut (4).
      Locknut:
      39.2 – 49 Nm {4 – 5 kgm}
      ★ After tightening the locknut, check the valve clearance again.



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Lubrication system

Lubrication system diagram



1. Oil strainer
2. Oil pump
3. Regulator valve
4. Oil filter
5. Safety valve
6. Crankshaft
7. Camshaft
8. Piston
9. Air intake valve and exhaust valve
10. Rocker arm
11. Timing gear

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Troubleshooting for mechanical system (S-mode)

S-1 Starting performance is poor

General causes why starting performance is poor
- Defective electrical system
- Insufficient supply of fuel
- Insufficient intake of air
- Improper selection of fuel

★ The common rail fuel injection system (CRI) controls the fuel injection timing electrically. Accordingly, even if the starting operation is carried out, the engine may not start until the crankshaft revolves 2 turns at maximum. This phenomenon does not indicate a trouble, however.

			Causes												
			Clogged air cleaner element	Defective contact of valve and valve seat	Worn piston ring, cylinder	Clogged air breather hole of fuel tank cap	Leaking or clogged fuel piping, entry of air	Clogged fuel filter	Stuck, seized supply pump plunger	Defective injector	Defective intake air heater system	Defective alternator (regulator section)	Defective alternator (generator section)	Defective or deteriorated battery
Questions	Confirm recent repair history													
	Degree of use of machine	Operated for long period	△					△						△
	Starting performance	Became worse gradually	○	◎	◎			○						
		Engine starts easily when warm									◎			◎
	Non-specified fuel is being used							○	○	○				
	Replacement of filters has not been carried out according to Operation and Maintenance Manual		◎					◎	○	○				
	Oil must be added more frequently				◎									
	When engine is preheated or when temperature is low, preheating monitor does not indicate normally (if monitor is installed)										◎			
	During operation, charge level monitor indicates abnormal charge (if monitor is installed)											◎	◎	
Check items	Dust indicator is red (if indicator is installed)		◎											
	Air breather hole of fuel tank cap is clogged					◎								
	Fuel is leaking from fuel piping						◎		○					
	When priming pump is operated, it makes no reaction or it is heavy						◎	○						
	Starting motor cranks engine slowly													◎
	While engine is cranked with starting motor,	If air bleeding plug of fuel filter is removed, fuel does not flow out						◎						
		If spill hose from injector is disconnected, little fuel spills							◎					
	When exhaust manifold is touched immediately after starting engine, temperature of some cylinders is low									◎				
	Engine does not pick up smoothly and combustion is irregular			○	○					◎				
	There is hunting from engine (rotation is irregular)					○	◎	○						
	Blow-by gas is excessive				◎									
Troubleshooting	Inspect air cleaner directly		●											
	When compression pressure is measured, it is found to be low			●	●									
	When air is bled from fuel system, air comes out						●							
	Inspect fuel filter 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									●				
	When starting switch is turned to HEAT, intake air heater mount does not become warm										●			
	Does power supply voltage appear between alternator terminals B and E with engine at low idle?	Yes										●		
		No											●	
	When specific gravity of electrolyte and voltage of battery are measured, they are low													●
		Remedy	Clean	Replace	Replace	Clean	Correct	Clean	Replace	Replace	Replace	Replace	Replace	Replace

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

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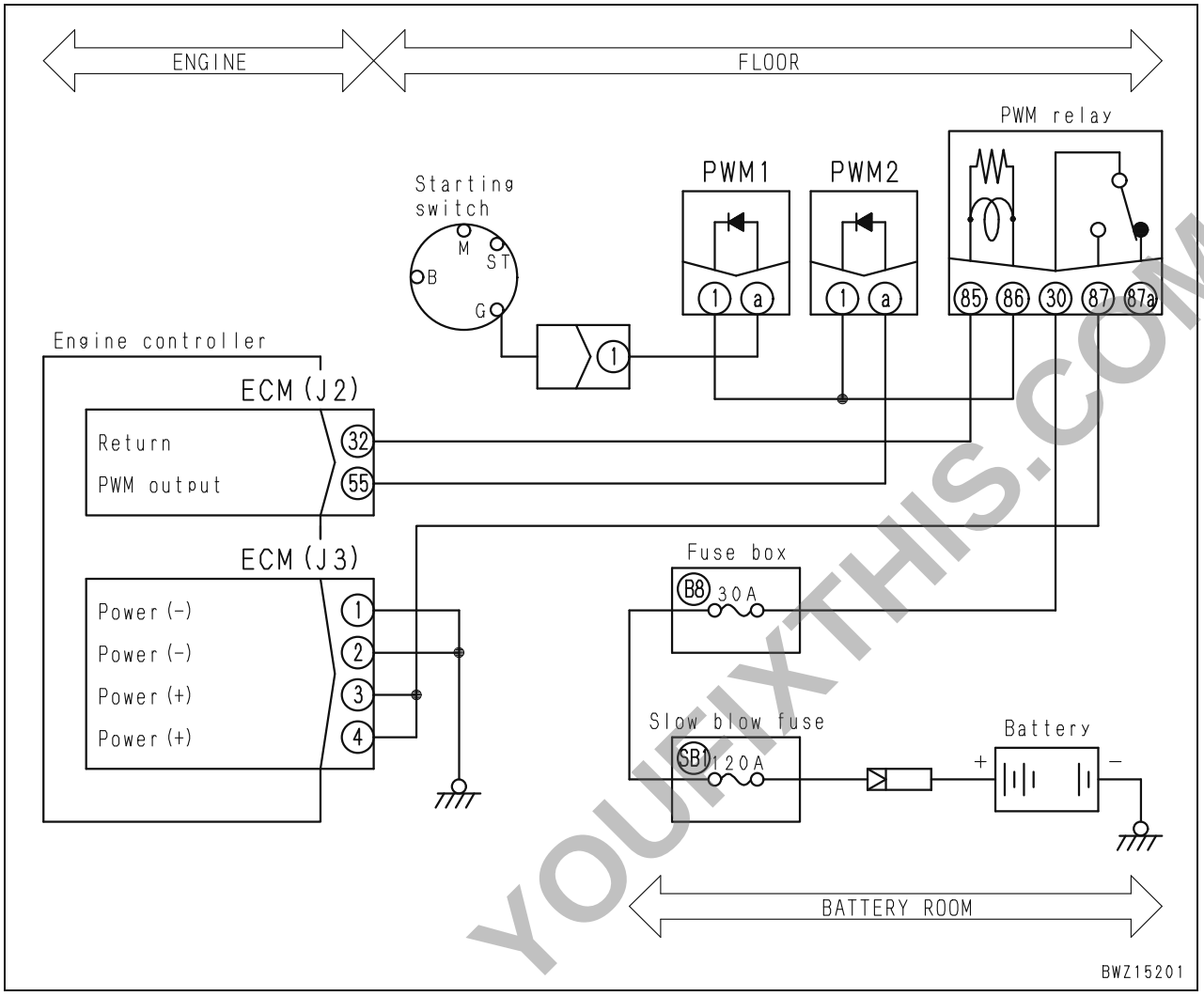
Specifications

Engine name			SAA4D95LE-5-A
Machine models			FD40Z-10, FD35-10, FD40-10, FD45-10, FD50A-10
Number of cylinders – Bore × Stroke		mm	4 – 95 × 115
Total displacement		ℓ{cc}	3.260 {3,260}
Firing order		—	1–2–4–3
Dimensions	Overall length	mm	820
	Overall width	mm	659
	Overall height (excluding exhaust pipe)	mm	893
Performance	Rated output	kW{HP}/rpm	62.5 {84}/2,400 (Gross)
	Max. torque	Nm{kgm}/rpm	323 {33}/1,600 (Gross)
	No-load max. speed (High idle speed)	rpm	2,550 ± 25
	No-load min. speed (Low idle speed)	rpm	800 ± 25
	Fuel consumption ratio at rated point	g/kW·h {g/HP·h}	237 {72}
Dry weight		kg	295
Fuel supply pump		—	Bosch CP1H-OHW (HPCR)
Governor		—	Electronic control type
Quantity of lubricating oil (Refill capacity)		ℓ	11 (12)
Quantity of coolant		ℓ	(Engine side: 4.5)
Alternator		—	12 V, 60 A
Starting motor		—	12 V, 2.5 kW
Turbocharger		—	TD04L
Air compressor		—	—
Others		—	With air-cooled aftercooler

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Circuit diagram related to controller power supply (FD35/50A-10)



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2. Table of tightening torques for split flange bolts

★ Unless there are special instructions, tighten split flange bolts to the torque below.

Thread diameter of bolt	Width across flats	Tightening torque	
mm	mm	Nm	kgm
10	14	59 – 74	6.0 – 7.5
12	17	98 – 123	10.0 – 12.5
16	22	235 – 285	23.5 – 29.5

3. Table of tightening torques for O-ring boss piping joints

★ Unless there are special instructions, tighten O-ring boss piping joints to the torque below.

Nominal No.	Thread diameter	Width across flats	Tightening torque Nm {kgm}	
	mm	mm	Range	Target
02	14	Varies depending on type of connector.	35 – 63 { 3.5 – 6.5}	44 { 4.5}
03,04	20		84 – 132 { 8.5 – 13.5}	103 {10.5}
05,06	24		128 – 186 {13.0 – 19.0}	157 {16.0}
10,12	33		363 – 480 {37.0 – 49.0}	422 {43.0}
14	42		746 – 1,010 {76.0 – 103}	883 {90.0}

4. Table of tightening torques for O-ring boss plugs

★ Unless there are special instructions, tighten O-ring boss plugs to the torque below.

Nominal No.	Thread diameter	Width across flats	Tightening torque Nm {kgm}	
	mm	mm	Range	Target
08	8	14	5.88 – 8.82 {0.6 – 0.9}	7.35 {0.75}
10	10	17	9.81 – 12.74 {1.0 – 1.3}	11.27 {1.15}
12	12	19	14.7 – 19.6 {1.5 – 2.0}	17.64 {1.8}
14	14	22	19.6 – 24.5 {2.0 – 2.5}	22.54 {2.3}
16	16	24	24.5 – 34.3 {2.5 – 3.5}	29.4 {3.0}
18	18	27	34.3 – 44.1 {3.5 – 4.5}	39.2 {4.0}
20	20	30	44.1 – 53.9 {4.5 – 5.5}	49.0 {5.0}
24	24	32	58.8 – 78.4 {6.0 – 8.0}	68.6 {7.0}
30	30	32	93.1 – 122.5 { 9.5 – 12.5}	107.8 {11.0}
33	33	–	107.8 – 147.0 {11.0 – 15.0}	127.4 {13.0}
36	36	36	127.4 – 176.4 {13.0 – 18.0}	151.9 {15.5}
42	42	–	181.3 – 240.1 {18.5 – 24.5}	210.7 {21.5}
52	52	–	274.4 – 367.5 {28.0 – 37.5}	323.4 {33.0}

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Information in troubleshooting table (E-mode)

★ The following information is summarized in the troubleshooting table and the related electrical circuit diagram. Before carrying out troubleshooting, understand that information fully.

Error code	Failure code	Trouble	**Problem that appears on engine**
Display on troubleshooting tool	**Display on applicable machine**		
Contents of trouble	**Contents of trouble detected by engine controller**		
Action of controller	**Action taken by engine controller to protect system or devices when engine controller detects trouble**		
Problem that appears on machine	**Problem that appears on engine as result of action taken by engine controller (shown above)**		
Related information	**Information related to detected trouble or troubleshooting**		

	Causes		Standard value in normal state/Remarks on troubleshooting
Possible causes and standard value in normal state	1 2 3 4	Possible causes of trouble (Given numbers are reference numbers, which do not indicate priority)	**<Contents of description>** **• Standard value in normal state to judge possible causes** **• Remarks on judgment** **<Troubles in wiring harness>** **• Disconnection** **Connector is connected imperfectly or wiring harness is broken.** **• Ground fault** **Wiring harness which is not connected to chassis ground circuit is in contact with chassis ground circuit.** **• Hot short** **Wiring harness which is not connected to power source (24 V) circuit is in contact with power source (24 V) circuit.** **• Short circuit** **Independent wiring harnesses are in contact with each other abnormally.** **<Precautions for troubleshooting>** **(1) Method of indicating connector No. and handling of T-adapter** **Insert or connect T-adapter as explained below for troubleshooting, unless otherwise specified.** **• If connector No. has no marks of "male" and "female", disconnect connector and insert T-adapters in both male side and female side.** **• If connector No. has marks of "male" and "female", disconnect connector and connect T-adapter to only male side or female side.** **(2) Entry order of pin Nos. and handling of tester leads** **Connect positive (+) lead and negative (–) lead of tester as explained below for troubleshooting, unless otherwise specified.** **• Connect positive (+) lead to pin No. or wiring harness entered on front side.** **• Connect negative (–) lead to pin No. or wiring harness entered on rear side.**

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Testing compression pressure

★ Testing tools for compression pressure

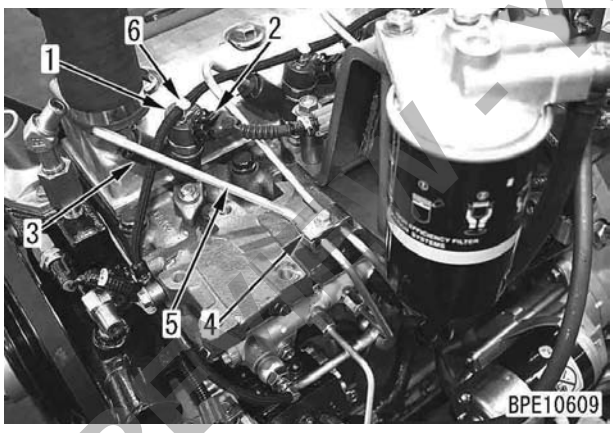
Symbol		Part No.	Part name
C	1	795-502-1590	Compression gauge
	2	795-471-1420	Adapter
		6271-11-3880	Gasket

⚠ **When measuring the compression pressure, take care not to burn yourself on the exhaust manifold, muffler, etc. or get caught in a rotating part.**

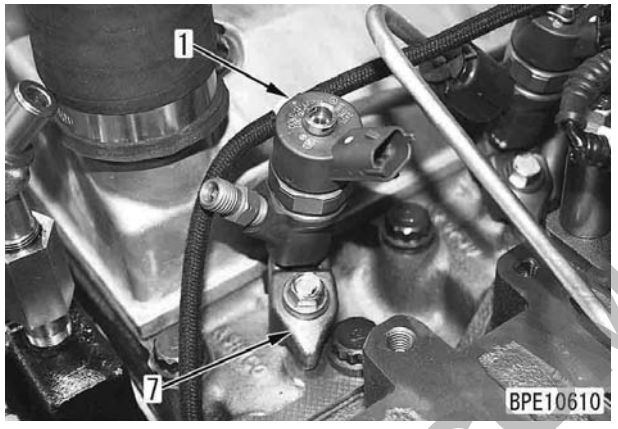
★ Measure the compression pressure after the engine is warmed up
(Engine oil temperature: 40 – 60°C).

1. Remove the injector of the cylinder to be measured.
   ★ Measuring procedure for No. 1 cylinder is described below as an example.
   1) Remove wiring harness connector (2) from injector (1).
   2) Remove fuel scatter prevention cover (3) from the joint.
   3) Remove clamp (4) and high-pressure pipe (5).
   4) Pull out spill hose connector (6) from injector (1).

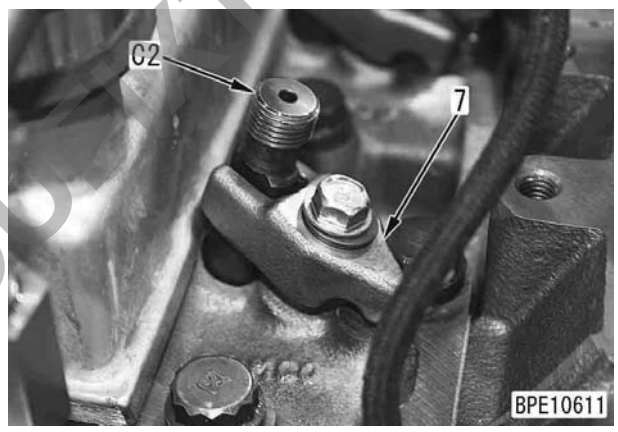
<The shape in the figure is a little defferent from the actual machine.>



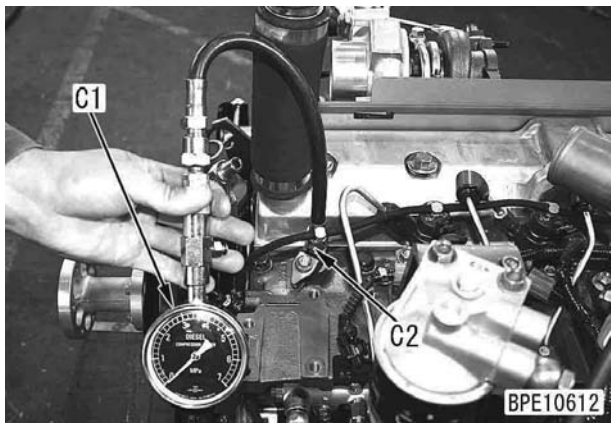
   5) Remove holder (7) and injector (1).
      ★ If injector is stuck and cannot be removed easily, pass a wire under the fuel inlet and pull it up to remove the injector.
      ★ Do not apply an external force to any part other than the injector top terminal.



2. Insert adapter **C2** in the injector mounting hole and fix it with holder (7).
   ★ Fit the gasket to the adapter end.
   Holder mounting bolt:
   27 – 30 Nm {2.8 – 3.1 kgm}
   ★ Seat the fulcrum of the holder perfectly before tightening the mounting bolts.



3. Connect compression gauge **C1** to adapter **C2**.

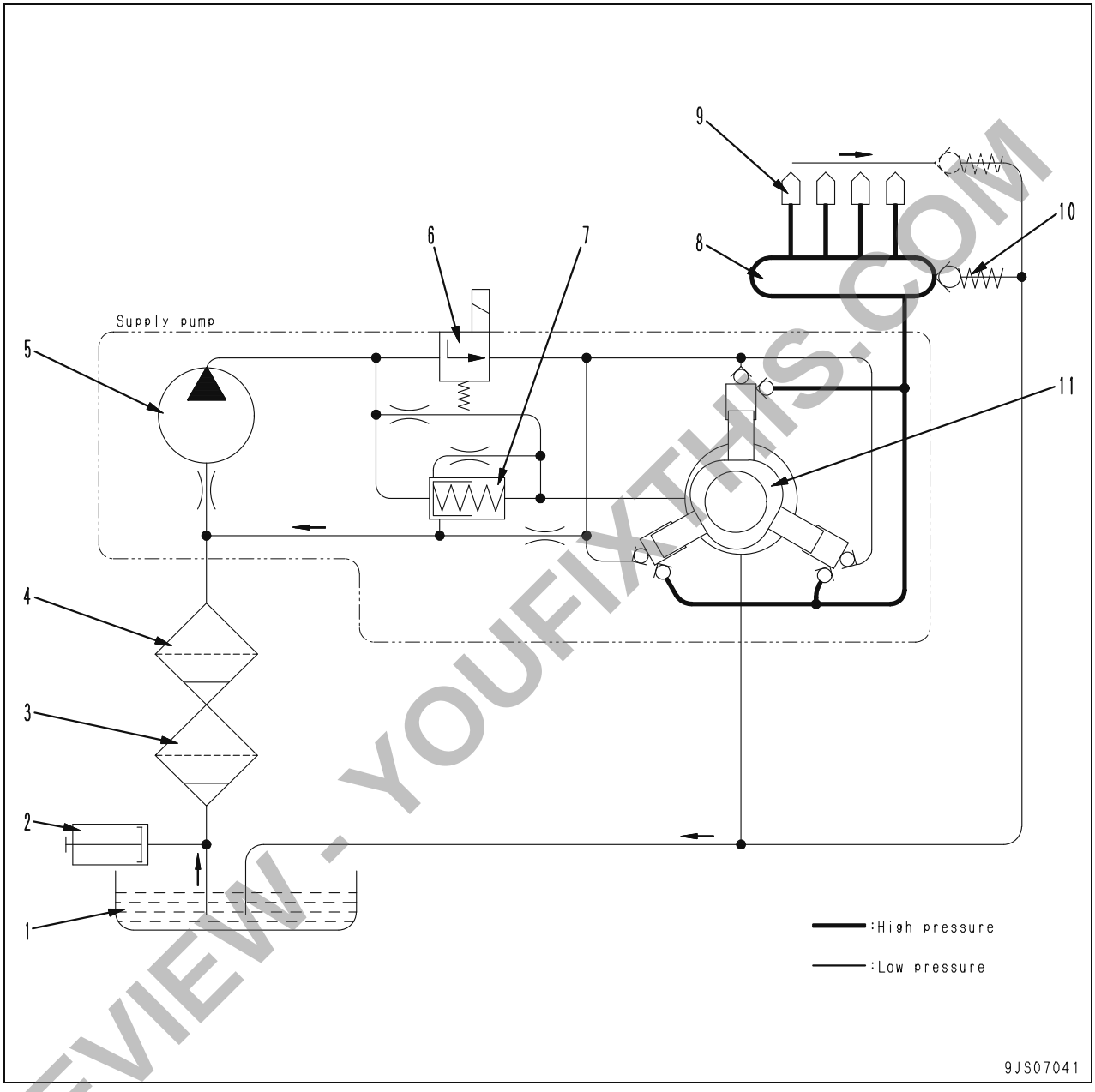


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Fuel system

Fuel system diagram



1. Fuel tank
2. Priming pump
3. Pre-filter with water separator
4. Main filter
5. Feed pump
6. IMV (Inlet Metering Valve)
7. Overflow valve
8. Rail
9. Injector
10. Safety valve
11. High pressure pump

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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	Inspect flywheel ring gear directly		●							Carry out troubleshooting on applicable machine
	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	—

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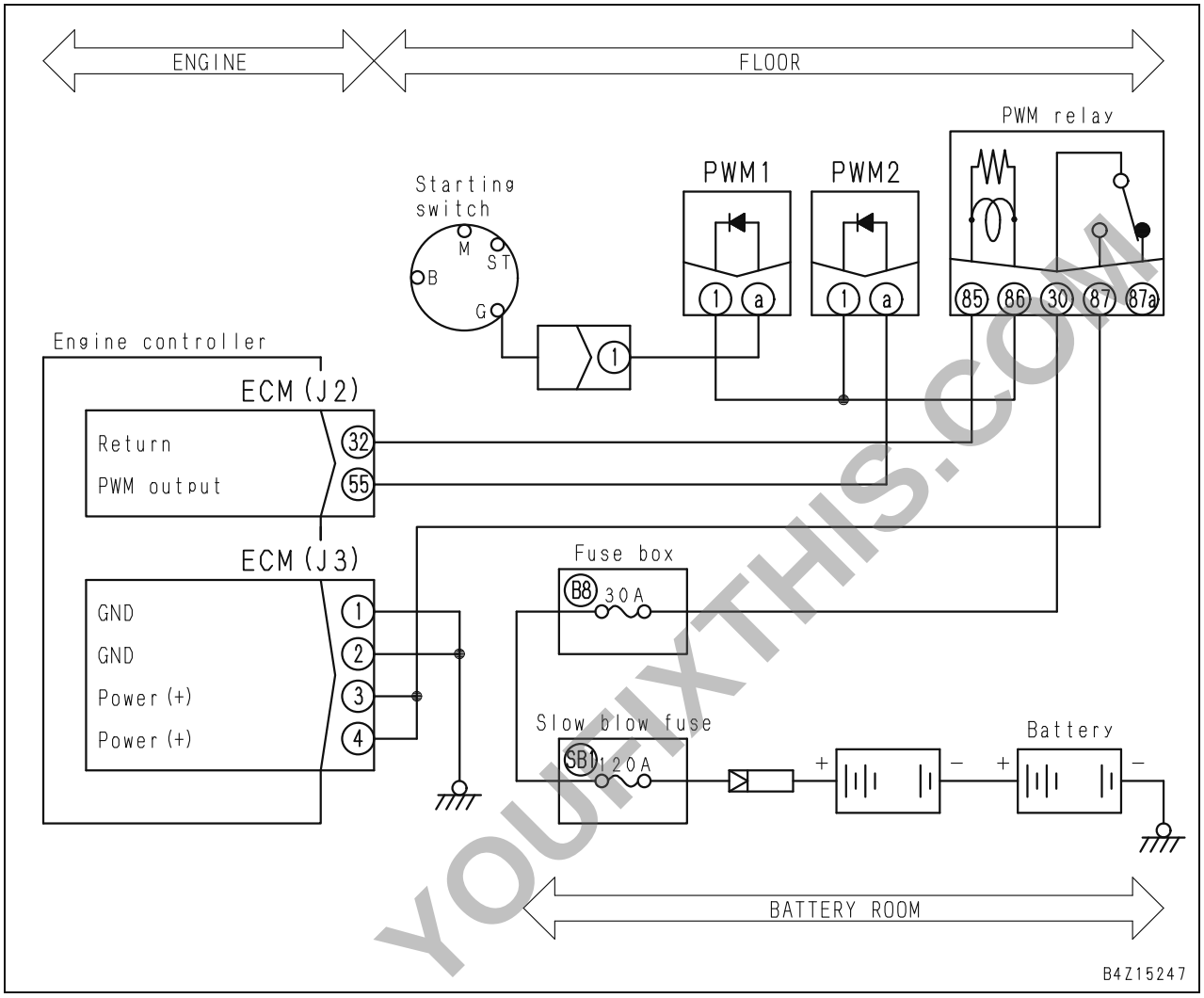
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Engine name			SAA4D95LE-5-A
Machine models			FD60-10, FD70-10, FD80-10
Number of cylinders – Bore × Stroke		mm	4 – 95 × 115
Total displacement		ℓ{cc}	3.260 {3,260}
Firing order		—	1–2–4–3
Dimensions	Overall length	mm	890
	Overall width	mm	661
	Overall height (excluding exhaust pipe)	mm	908
Performance	Rated output	kW{HP}/rpm	71.7 {97.5}/2,250 (Gross)
	Max. torque	Nm{kgm}/rpm	347 {35.4}/1,600 (Gross)
	No-load max. speed (High idle speed)	rpm	2,500 ± 50
	No-load min. speed (Low idle speed)	rpm	800 ± 25
	Fuel consumption ratio at rated point	g/kW·h {g/HP·h}	233 {171}
Dry weight		kg	295
Fuel supply pump		—	Bosch CP1H-OHW (HPCR)
Governor		—	Electronic control type
Quantity of lubricating oil (Refill capacity)		ℓ	11 (12)
Quantity of coolant		ℓ	(Engine side: 4.5)
Alternator		—	24 V, 35 A
Starting motor		—	24 V, 4.5 kW
Turbocharger		—	TD04L
Air compressor		—	—
Others		—	With air-cooled aftercooler

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Circuit diagram related to controller power supply (FD60/80-10)



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5. Table of tightening torques for hoses (taper seal type and face seal type)

★ Unless there are special instructions, tighten the hoses (taper seal type and face seal type) to the torque below.

★ Apply the following torque when the threads are coated (wet) with engine oil.

Nominal No. of hose	Width across flats	Tightening torque Nm {kgm}		Taper seal	Face seal	
		Range	Target	Thread size (mm)	Nominal No. – Number of threads, type of thread	Thread diameter (mm) (Reference)
02	19	34 – 54 { 3.5 – 5.5}	44 { 4.5}	–	9/16-18UN	14.3
		34 – 63 { 3.5 – 6.5}		14	–	–
03	22	54 – 93 { 5.5 – 9.5}	74 { 7.5}	–	11/16-16UN	17.5
	24	59 – 98 { 6.0 – 10.0}	78 { 8.0}	18	–	–
04	27	84 – 132 { 8.5 – 13.5}	103 {10.5}	22	13/16-16UN	20.6
05	32	128 – 186 {13.0 – 19.0}	157 {16.0}	24	1-14UNS	25.4
06	36	177 – 245 {18.0 – 25.0}	216 {22.0}	30	1-3/16-12UN	30.2
(10)	41	177 – 245 {18.0 – 25.0}	216 {22.0}	33	–	–
(12)	46	197 – 294 {20.0 – 30.0}	245 {25.0}	36	–	–
(14)	55	246 – 343 {25.0 – 35.0}	294 {30.0}	42	–	–

6. Table of tightening torques for face seal joints

★ Tighten the face seal joints (sleeve nut type) made of plated steel pipes for low pressure service to be used for engines etc. to the torque shown in the following table.

★ Apply the following torque to the face seal joint while their threaded parts are coated with engine oil (wetted).

Outer diameter of pipe (mm)	Width across flats (mm)	Tightening torque Nm {kgm}		Face seal	
		Range	Target	Nominal No. – Number of threads, type of thread	Thread diameter (mm) (Reference)
8	19	14 – 16 {1.4 – 1.6}	15 {1.5}	9/16-18UN	14.3
10	22	24 – 27 {2.4 – 2.7}	25.5 {2.6}	11/16-16UN	17.5
12	24 (27)	43 – 47 {4.4 – 4.8}	45 {4.6}	13/16-16UN	20.6
15 (16)	30 (32)	60 – 68 {6.1 – 6.8}	64 {6.5}	1-14UN	25.4
22 (20)	36	90 – 95 {9.2 – 9.7}	92.5 {9.4}	1-3/16-12UN	30.2

Reference: The face seal joints of the dimensions in ( ) are also used, depending on the specification.

7. Table of tightening torques for 102, 107 and 114 engine series (Bolts and nuts)

★ Unless there are special instructions, tighten the metric bolts and nuts of the 102, 107 and 114 engine series to the torque below.

Thread size	Tightening torque	
	Bolts and nuts	
mm	Nm	kgm
6	10 ± 2	1.02 ± 0.20
8	24 ± 4	2.45 ± 0.41
10	43 ± 6	4.38 ± 0.61
12	77 ± 12	7.85 ± 1.22
14	—	—

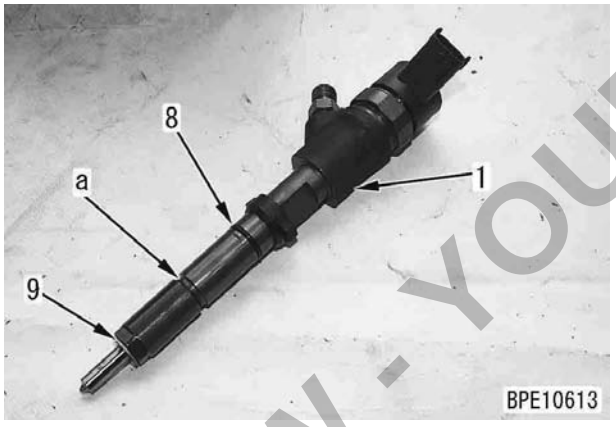
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4. Connect the troubleshooting tool to the engine controller and set it in the no-injection cranking mode.
   - Instead of the above work, you may disconnect the wiring harness connectors from all the injectors so that fuel will not be injected at all.

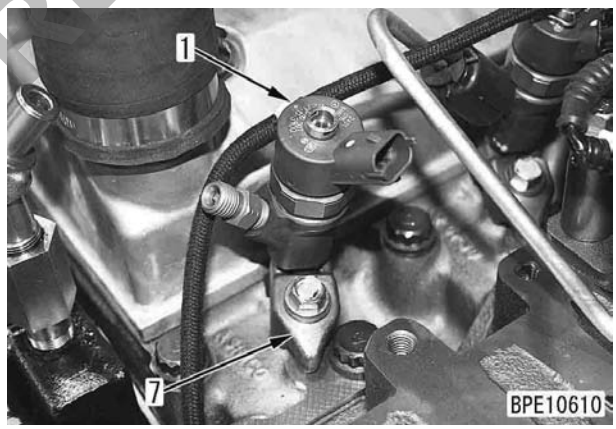
   ⚠ **Since starting of engine is dangerous, be sure to set the injectors so that they will not inject fuel before starting the check.**

5. Crank the engine with the starting motor and measure the compression pressure.
   ★ Read the pressure when the gauge pointer is stabilized.

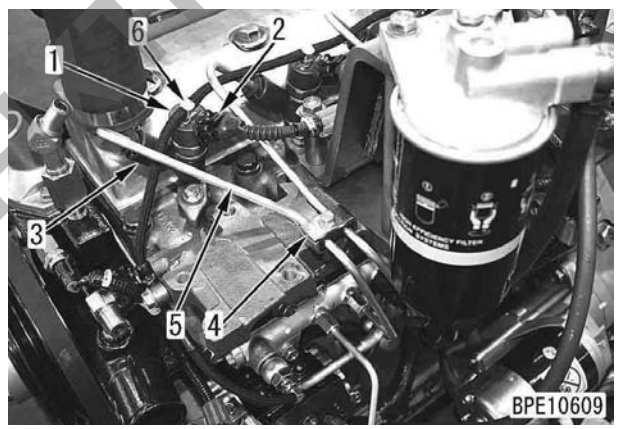
6. After finishing measurement, remove the measuring instruments and return the removed parts according to the following procedure.
   1) Install O-ring (8) and gasket (9) to injector (1).
      ★ Do not install O-ring (8) to groove "a".



   2) Insert injector (1) in the cylinder head and fix it with holder (7).
      Holder mounting bolt:
      27 – 30 Nm {2.8 – 3.1 kgm}
      ★ Seat the fulcrum of the holder perfectly before tightening the mounting bolts.



   3) Connect spill hose connector (6) to injector (1).
   4) Install high-pressure pipe (5).
      High-pressure pipe flare nut (Both ends):
      25.5 – 29.4 Nm {2.6 – 3.0 kgm}
   5) Install fuel scatter prevention cover (3) to the joint of high-pressure pipe (5).
      ★ Install fuel scatter prevention cover (3) with the slit down (on both injector side and common rail side).
   6) Install clamp (4) to high-pressure pipe (5).
      ★ Install the clamp to the position from which it was removed. (The mounting bolt goes through the clamp and enters the bolt hole of the air intake manifold. Accordingly, if the mounting bolt is installed normally, the clamp is installed to its original position.)
   7) Connect wiring harness connector (2) to injector (1).

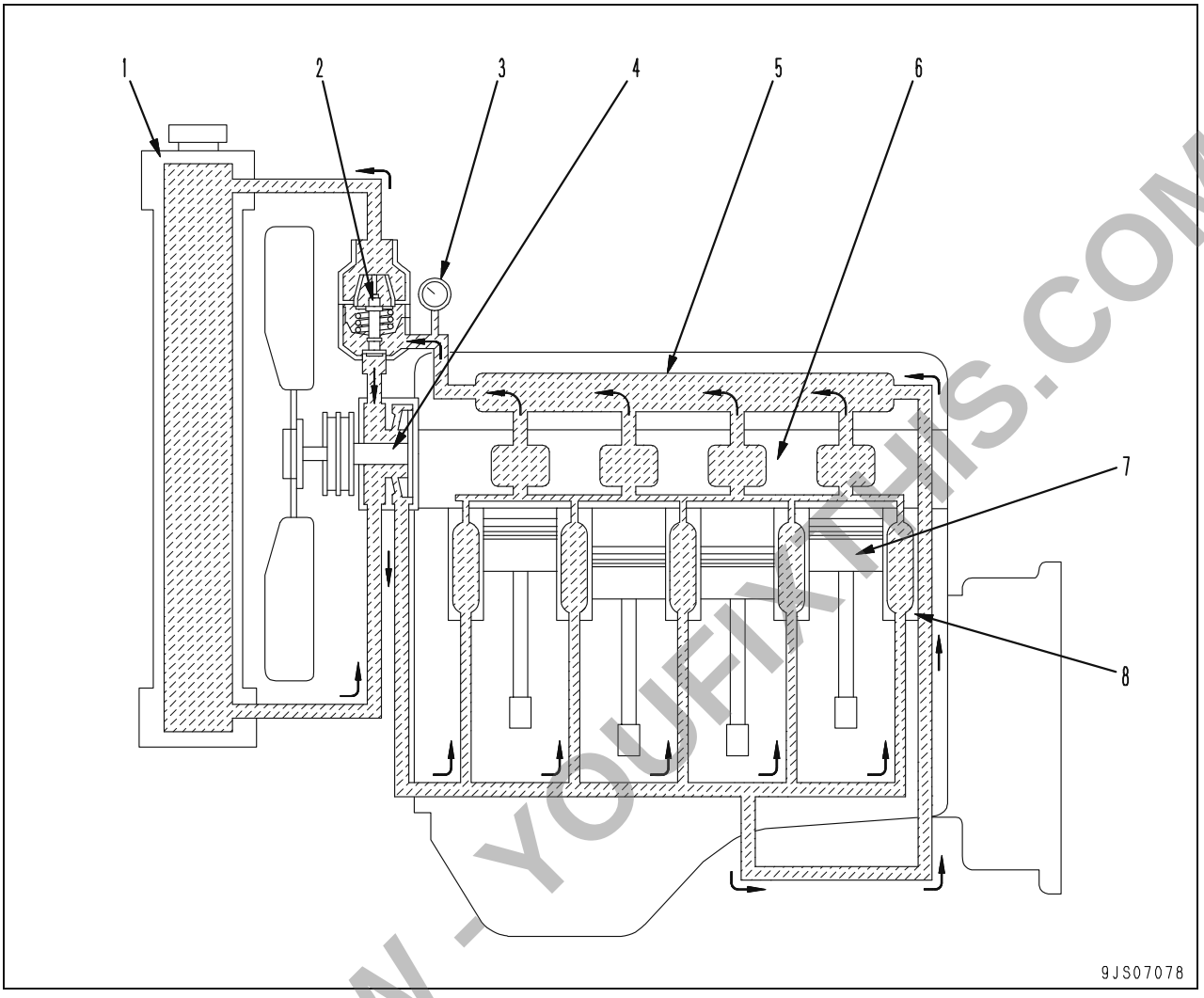


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Cooling system

Cooling system diagram



1. Radiator
2. Thermostat
3. Water temperature sensor
4. Water pump
5. Water manifold
6. Cylinder head
7. Piston
8. Cylinder block

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