4. Engine

4-1 Safety

4-1-1 Safety Statements

Yanmar is concerned for your safety and your machine's condition. Safety statements are one of the primary ways to call your attention to the potential hazards associated with Yanmar TNV engine operation. Follow the precautions listed throughout the manual before operation, during operation and during periodic maintenance procedures for your safety, the safety of others and to protect the performance of your engine. Keep the labels from becoming dirty or torn and replace them if they are lost or damaged. Also, if you need to replace a part that has a label attached to it, make sure you order the new part and label at the same time.



This safety alert symbol appears with most safety statements. It means attention, become alert, your safety is involved! Please read and abide by the message that follows the safety alert symbol.

⚠ DANGER

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

⚠ WARNING

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

⚠ CAUTION

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

NOTICE

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

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2. TECHNICAL DATA

2. Technical Data

2-1 Specifications

Item				Unit	ViO23-6
Main specifications of machine					
Dimensions					
Overall length (Transportation position)				in. (mm)	153.1 (3890)
4-pole canopy	Overall height	Transportation position		in. (mm)	95.3 (2420)
		Traveling position		in. (mm)	95.3 (2420)
	Overall width	Full machine width		in. (mm)	61.0 (1550)
			at minimum track gauge	in. (mm)	54.3 (1380)
Cabin	Overall height	Transportation position		in. (mm)	97.6 (2480)
		Traveling position		in. (mm)	97.6 (2480)
	Overall width	Full machine width		in. (mm)	61.0 (1550)
			at minimum track gauge	in. (mm)	54.3 (1380)
Tumbler center distance				in. (mm)	57.9 (1470)
Track gauge				in. (mm)	51.2 (1300)
Track gauge (at minimum track gauge)				in. (mm)	44.5 (1130)
Minimum ground clearance				in. (mm)	5.91 (150)
Traveling performance					
Travel speed	Rubber track	Low speed (Forward/Reverse)		MPH (km/hr)	1.4 (2.2)
		High speed (Forward/Reverse)		MPH (km/hr)	2.6 (4.2)
Permissible water depth limit				in. (mm)	13.0 (330)
Work performance					
Bucket	Width (Standard) *including side cutter			in. (mm)	19.3 (490)
	[Standard. JIS heaped capacity]			cu.ft. (cu.m)	2.1 (0.06)
	Number of teeth / Installation method			pcs.	3 / Rubber pin lock type
Maximum digging depth	With blade raised			in. (mm)	89.4 (2270)
	With blade on the ground			in. (mm)	96.5 (2450)
Maximum depth of vertically digging				in. (mm)	73.6 (1870)
Maximum dumping height		4-pole canopy		in. (mm)	101.2 (2570)
		Cabin		in. (mm)	101.2 (2570)
Minimum front swing radius (with boom in front center)		4-pole canopy		in. (mm)	71.7 (1820)
		Cabin		in. (mm)	71.7 (1820)
Minimum front swing radius (with boom in full swing)		4-pole canopy		in. (mm)	60.2 (1530)
		Cabin		in. (mm)	60.2 (1530)
Rear end swing radius				in. (mm)	27.2 (690)

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2-6 Periodic Inspection and Servicing

Supply ○ Check/Adjust ◇ Clean □ Oil and grease ■ Replace ● Oil sample ♦

Check & Service items			Daily	Every 50h	Every 100h	Every 250h	Every 500h *	Every 1000h *	Every 2000h **
General	Missing or broken parts		◇						
	Tightening of nuts and bolts		◇						
	Engine condition, exhaust and inlet hoses		◇						
	Machine overall		□						
	Operation manual			◇(1)			◇	◇	◇
Greasing	Greasing points		◇/■						
	Swing gear and crown			■	■	■	■	■	■
	Moving parts of the chassis and track spacing jack.			■	■	■	■	■	■
	Bearing rollers and bearings, idler wheels		◇			■(2)	■	■	■
Engine	Diesel filter			●(1)		●	●	●	●
	Water separator	Drain	◇						
		Bowl (if equipped)					□	□	□
	Oil		◇/○	♦(1)			●	●	●
	Oil filter			●(1)			●	●	●
	Cooling fluid & leakage		◇/○						●
	Radiator fins		◇/□						
	Belt			◇					●
	Fuel hose, coolant hose								◇/●
	Performance of engine control and engine speed			◇(1)			◇	◇	◇
	Governor lever and accelerator device			◇(1)			◇	◇	◇
	Air cleaner	External air cleaner element	□(3)			●(3)	●	●	●
		Safety cartridge element (if equipped)					●	●	●
	Intake and exhaust valves								◇
	Injectors and injection pressure								◇/□
	Crankcase breather system								◇
	Engine silent-bloc & bracket			◇					
Travel	Oil for travel gears			●(1)	◇(2)	◇/●(2)	◇/●	◇/●	◇/●
	Tracks, rubber tracks & pads		◇						
	Track tension		◇						
	Play of travel lever			◇(1)			◇	◇	◇
	Performance of travel			◇(1)			◇	◇	◇
Hydraulic	Oil		◇	♦(1)			♦/●(4)	●	●
	Aspiration filter					●(4)	□	□	□
	Hydraulic oil return filter			●(1)		●(4)	●	●	●
	Accumulator			◇(1)			◇	◇	◇
	Pump pressure			◇(1)			◇	◇	◇
	Play of control lever			◇(1)			◇	◇	◇
	Low pressure			◇(1)			◇	◇	◇
	Blade control			◇(1)			◇	◇	◇
	Boom swing			◇(1)			◇	◇	◇
	Boom			◇(1)			◇	◇	◇
	Arm			◇(1)			◇	◇	◇
	Bucket			◇(1)			◇	◇	◇
	Track spacing			◇(1)			◇	◇	◇
	Options			◇(1)			◇	◇	◇
Electric	Time counter		◇	◇			◇	◇	◇
	Wire breakage, short circuits, loosened terminals		◇	◇			◇	◇	◇
	LCD monitor		◇	◇			◇	◇	◇
	Battery			◇(1)			◇	◇	◇
Final	Sign inspection card and return to YANMAR			◇ (1)		◇	◇	◇	◇

* or annualy first time occurs

** or two years

(1) First time 50-80h visit

(2) If machine does lot of digging line during one day (fiber, drop pipe, drainage…).

(3) If machine is used at dusty worksites.

(4) If a hydraulic hammer is used.

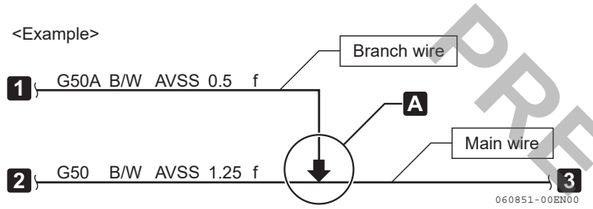
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2-9 Wiring Diagram

■ How to Read Wiring Diagrams

● Intersections and Wire Connections

<Example>

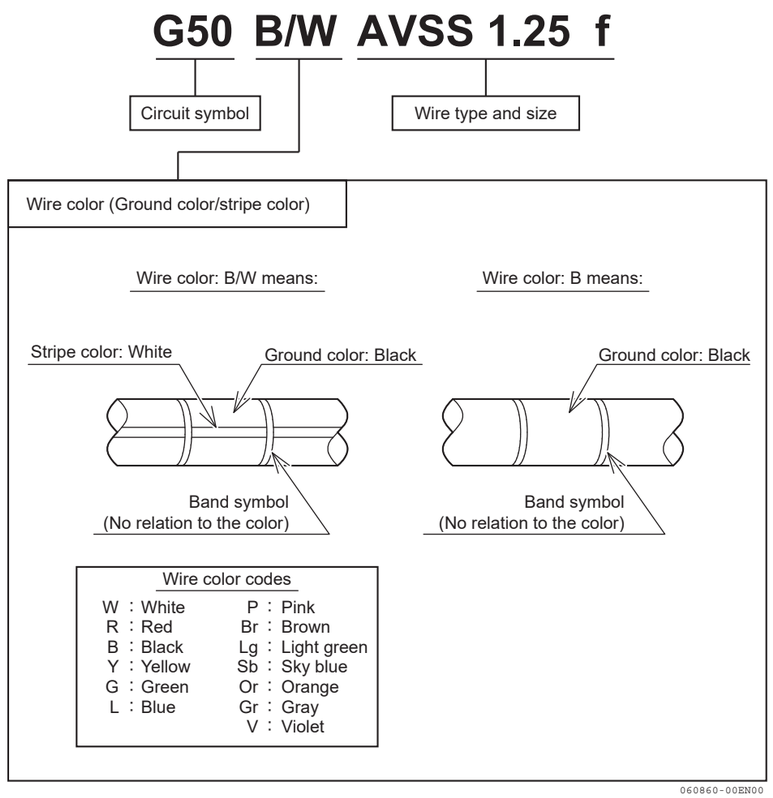


The point of arrow **A** on the main wire shown in the figure above represents an intersection of the branch wire and the main wire.
The direction of the arrow indicates which one is the branch wire (the arrowed line represents the branch wire) and also shows the division between the branch wire and the main wire.

In the example above, the wires are divided as follows.

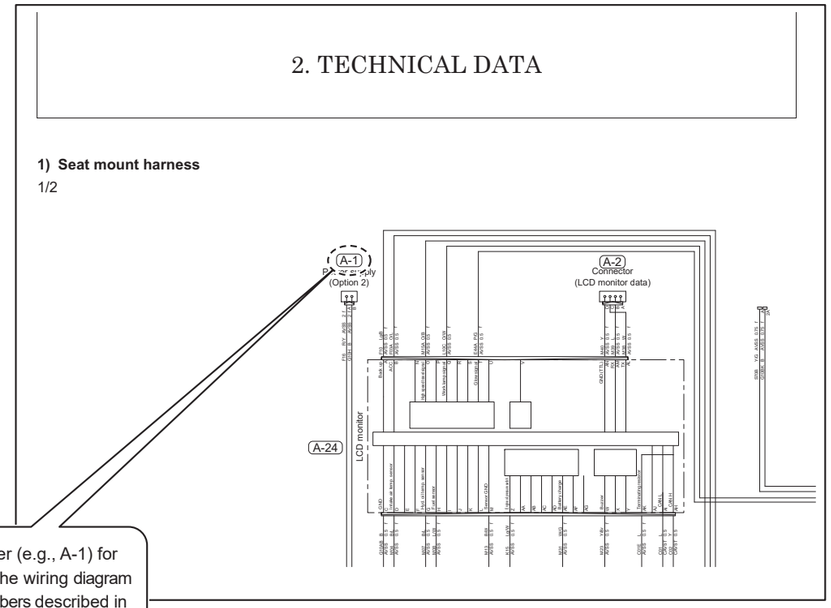
1 to the point of arrow **A** : Branch wire G50A B/W AVSS 0.5 f
2 to **3** : Main wire G50 B/W AVSS 1.25 f

● How to Read Wiring Symbols

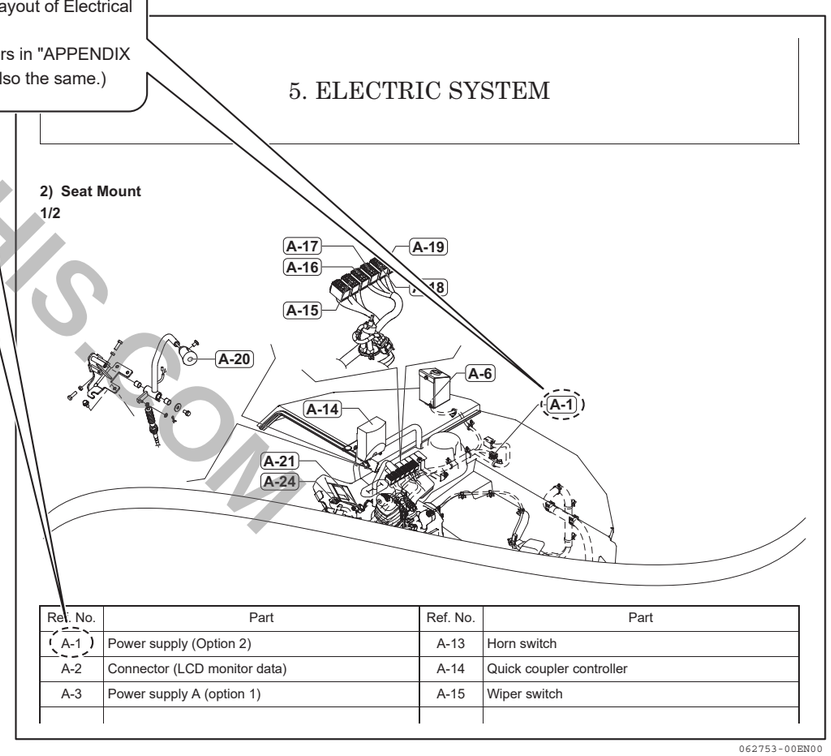


● Reference numbers

<Example>



Each reference number (e.g., A-1) for electric equipment in the wiring diagram corresponds to the numbers described in Section "5-1-1 Parts Layout of Electrical Equipment".
(The reference numbers in "APPENDIX Wiring Diagram" are also the same.)



Ref. No.	Part	Ref. No.	Part
A-1	Power supply (Option 2)	A-13	Horn switch
A-2	Connector (LCD monitor data)	A-14	Quick coupler controller
A-3	Power supply A (option 1)	A-15	Wiper switch

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4-2-8 Crankshaft and Camshaft Components

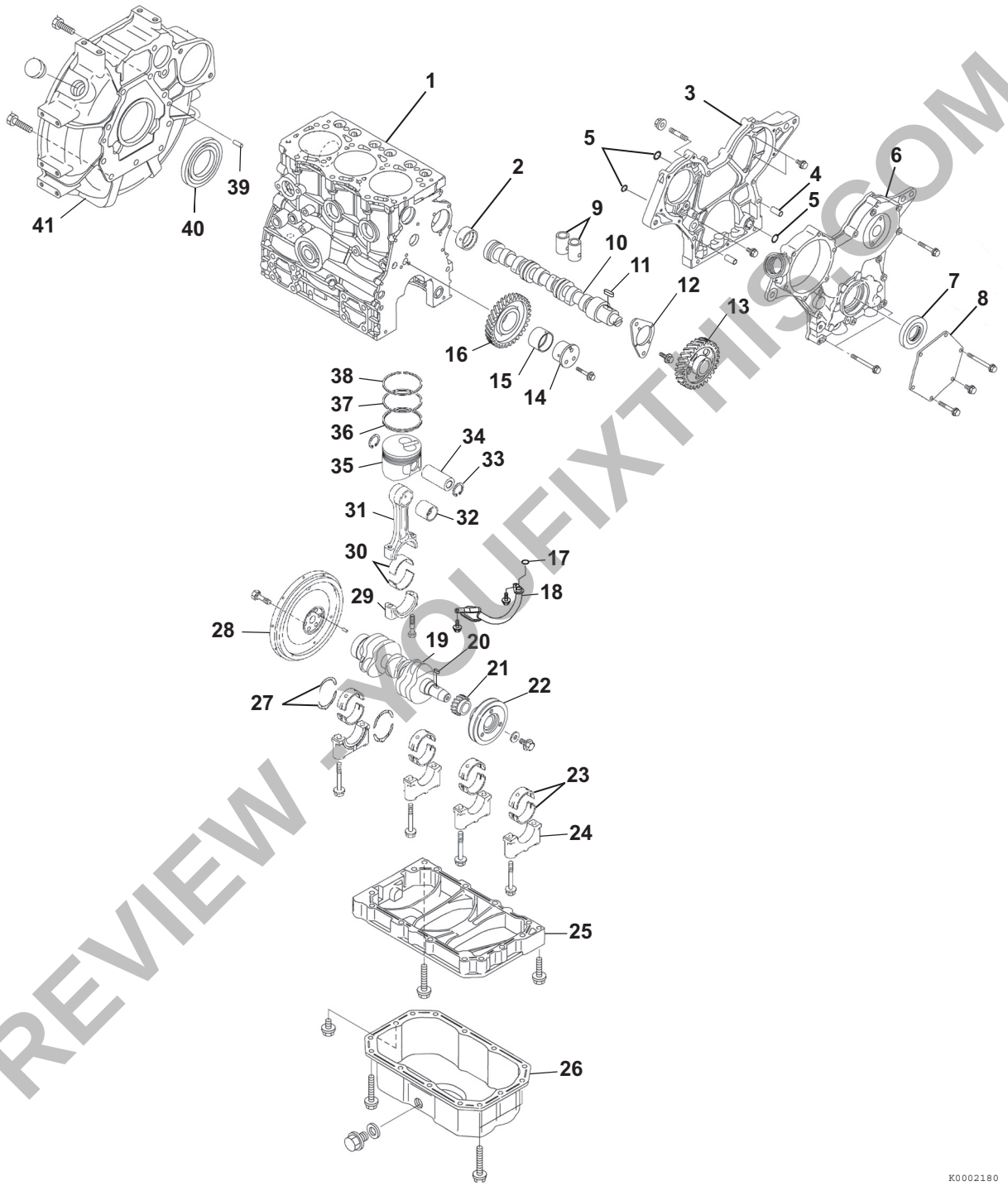


Figure 4-2-38

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1 – Cylinder block
2 – Camshaft bushing
3 – Gear case
4 – Dowel (2 used)
5 – O-ring
6 – Gear case cover
7 – Front crankshaft seal
8 – Fuel injection pump gear cover
9 – Tappets
10 – Camshaft
11 – Camshaft gear key
12 – Camshaft end plate
13 – Camshaft gear
14 – Idler gear shaft
15 – Idler gear bushing
16 – Idler gear
17 – Oil pickup O-ring
18 – Oil pickup
19 – Crankshaft
20 – Crankshaft gear key
21 – Crankshaft gear
22 – Crankshaft pulley
23 – Main bearing inserts
24 – Main bearing cap
25 – Crankcase extension
26 – Oil pan
27 – Thrust bearings
28 – Flywheel
29 – Connecting rod cap
30 – Connecting rod bearing inserts
31 – Connecting rod
32 – Wrist pin bushing
33 – Circlip
34 – Wrist pin
35 – Piston
36 – Oil ring
37 – Second compression ring
38 – Top compression ring
39 – Dowel (2 used)
40 – Crankshaft rear seal
41 – Flywheel housing

Disassembly of Cylinder Block Components

Prepare a clean, flat working surface on a workbench large enough to accommodate the engine components. Discard all used gaskets, O-rings and seals. Use new gaskets, O-rings and seals for reassembly of engine.

NOTICE

- Identify all parts and their location using an appropriate method. It is important that all parts are returned to the same position during the reassembly process.
- Mark all valve train components so they can be installed in their original locations.

Note: Record all measurements taken during disassembly.

If the engine will be completely disassembled, the following preliminary steps should be performed:

1. Disconnect the battery cables at the battery. Always disconnect the negative (-) cable first.
2. Remove the throttle cable, electrical connections, intake and exhaust system connections, and fuel supply lines from the engine.
3. Remove the alternator. *See Removal of Alternator on page 4-7-7.*
4. Drain the engine coolant from the radiator and cylinder block.Remove the cooling system components from the engine.

   NOTICE

   Be sure to secure the engine solidly to prevent injury or damage to parts due to the engine falling during work on the engine.

   ---

5. Remove the engine from the machine. Mount the engine to a suitable engine repair stand having adequate weight capacity.
6. Clean the engine by washing with solvent, air or steam cleaning. Carefully operate to prevent any foreign matter or fluids from entering the engine, fuel system, or electrical components remaining on the engine.

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3-7 List of Tightening Torque

3-7-1 Machine

Applicable model			ViO23-6		
Equipment No		Tightening part	Thread size	Tightening torque ft•lbf (N•m)	Adhesive
Engine / Electrical equipment					
	1	Engine mount vibroisolating rubber	Nut 10	18.1 to 23.8 (24.5 to 32.3)	
	2	Air cleaner intake hose	Hose clip 70	1.8 to 2.5 (2.5 to 3.4)	
	3	Engine mount × Engine stopper L	M10×25	32.5 to 43.4 (44.1 to 58.8)	ThreeBond 1324
	4	Engine mount × Engine stopper	M10×20	32.5 to 43.4 (44.1 to 58.8)	ThreeBond 1324
	5	Engine × Engine mount LR	M10×25	32.5 to 43.4 (44.1 to 58.8)	ThreeBond 1324
	6	Engine × Engine mount RR	M10×25	32.5 to 43.4 (44.1 to 58.8)	ThreeBond 1324
	7	Engine × Engine mount RF	M10×25	32.5 to 43.4 (44.1 to 58.8)	ThreeBond 1324
	8	Engine × Engine mount LF	M10×25	32.5 to 43.4 (44.1 to 58.8)	ThreeBond 1324
	9	Fuel gauge	M5×12 (Pan head screw)	0.87 to 1.08 (1.17 to 1.47)	
	10	Fuel gauge hose	Hose band 13	0.72 to 1.08 (0.98 to 1.47)	
	11	Fuel drain valve	R3/8	14.5 to 21.7 (19.6 to 29.4)	Locktite 577
	12	Drain adapter	R3/8	21.7 to 28.9 (29.4 to 39.2)	
	13	Fuel tank holding band (tank holding side)	Nut 10	1.8 to 2.2 (2.5 to 3.0)	
	14	Fuel tank holding band (lock nut)	Nut 10	18.1 to 23.8 (24.5 to 32.3)	
	15	Alternator B terminal	Nut 6	4.3 to 7.2 (5.9 to 9.8)	
	16	Harness × Starter motor terminal	Nut 8	4.34 to 6.68 (5.88 to 11.77)	
	17	Fuse box × bracket	M8×16	2.89 to 3.62 (3.92 to 4.91)	
	18	LED light (boom)	Nut 8	2.5 to 3.2 (3.4 to 4.4)	
	19	Safety switch (cut-off lever)	M20×1.5 (Lock nut)	14.5 to 18.1 (19.6 to 24.5)	
	20	Safety switch (high speed travel)	M20×1.5 (Lock nut)	14.5 to 18.1 (19.6 to 24.5)	
	21	LCD monitor × Panel stay	M5×20	0.6 to 0.9 (0.8 to 1.2)	
	22	Panel cover × Panel stay	M5×14 (Tapping screw)	0.6 to 0.9 (0.8 to 1.2)	
	23	Engine control dial	Nut (fine thread) M9	0.98 to 1.08 (1.33 to 1.47)	

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5-4 Error Code List

Error code	Classification	Error description	Detection condition	Causes	Corrective measures
28 000096.02	Caution	Short circuit of fuel sensor	Sensor resistance stays at 1 Ω or less for a specific period of time.	• Connection failure of connectors • Harness wiring failure (sensor signal line short circuited to GND or sensor GND line short circuited to power supply) • Defective fuel sensor • Engine ECU internal circuit failure	Check the connectors, harnesses and fuel sensor. Turn the starter switch to the “OFF” position and then the “ON” position. Then check that the error code is displayed again.
28 000096.04	Caution	Disconnection of fuel sensor	Sensor resistance stays at 300 Ω or more for a specific period of time.	• Connection failure of connectors • Harness wiring failure (nearly broken wiring of sensor signal line, sensor 5 V line or sensor GND line) • Defective fuel sensor • Engine ECU internal circuit failure	Check the connectors, harnesses and fuel sensor. Turn the starter switch to the “OFF” position and then the “ON” position. Then check that the error code is displayed again.
28 000100.00	Warning	Abnormal engine oil pressure	Engine oil pressure decrease during engine operation	• Insufficient amount of engine oil • Clogging of engine oil filter • Defective engine oil pressure switch or engine oil pressure decrease	Check the engine oil filter element, engine oil pressure switch and lube oil pump.
28 000110.00	Warning	Abnormal engine coolant temperature: too high	Water temperature alarm switch stays on for a specific period of time.	• Engine overheating • Insufficient amount of engine coolant • Defective engine cooling system • Defective coolant temperature sensor system	Inspect the engine cooling system. Check the connectors, harnesses and coolant temperature sensor. Turn the starter switch to the “OFF” position and then to the “ON” position to check if the error code is displayed again.
28 000110.02	Caution	Short circuit of engine coolant temperature sensor	Sensor resistance stays at 80 Ω or less for a specific period of time.	• Connection failure of connectors • Harness wiring failure (sensor signal line short circuited to GND or sensor GND line short circuited to power supply) • Defective coolant temperature sensor • Engine ECU internal circuit failure	Check the connectors, harnesses and coolant temperature sensor. Turn the starter switch to the “OFF” position and then to the “ON” position to check if the error code is displayed again.
28 000110.04	Caution	Disconnection of engine coolant temperature sensor	Sensor resistance stays at 30 KΩ or more for a specific period of time.	• Connection failure of connectors • Harness wiring failure (nearly broken wiring of sensor signal line, sensor 5 V line or sensor GND line) • Defective coolant temperature sensor • Engine ECU internal circuit failure	Check the connectors, harnesses and coolant temperature sensor. Turn the starter switch to the “OFF” position and then to the “ON” position to check if the error code is displayed again.
28 000167.00	Caution	Low battery charge	Low battery charge signal detected during engine operation	• Connection failure of connectors • Disconnection or short circuit of harness • Defective engine ECU	Check the battery, alternator and harnesses.
28 000639.12	Warning	CAN communication error (Engine ECU)	LCD monitor cannot receive data from engine ECU.	Engine data cannot be obtained due to disconnection of CAN communication line or defective engine ECU.	Check that the connectors, terminals and harnesses for CAN communication are correctly connected. Also, check the engine ECU for blown fuse.
28 520777.02	Caution	Short circuit of hydraulic oil temperature sensor	Sensor resistance stays at 80 Ω or less for a specific period of time.	• Connection failure of connectors • Harness wiring failure (sensor signal line short circuited to GND or sensor GND line short circuited to power supply) • Defective hydraulic oil temperature sensor	Check the connectors, harnesses and hydraulic oil temperature sensor. Turn the starter switch to the “OFF” position and then the “ON” position. Then check that the error code is displayed again.
28 520777.04	Caution	Disconnection of hydraulic oil temperature sensor	Sensor resistance stays at 30 KΩ or more for a specific period of time.	• Connection failure of connectors • Harness wiring failure (nearly broken wiring of sensor signal line, sensor 5 V line or sensor GND line) • Defective hydraulic oil temperature sensor	Check the connectors, harnesses and hydraulic oil temperature sensor. Turn the starter switch to the “OFF” position and then the “ON” position. Then check that the error code is displayed again.
28 520780.00	Caution	Air cleaner clogging	Air cleaner clogging signal is detected continuously for a specific period of time.	• Air cleaner clogged • Short circuit of air cleaner switch connector	Clean the air cleaner. If the error code is still displayed, check if the connectors, terminals and harnesses of the dust indicator are correctly connected. Also, check the installation condition.
28 520805.12	Warning	CAN communication error (Hydraulic ECU)	LCD monitor cannot receive data from hydraulic ECU.	Data cannot be obtained due to disconnection of CAN communication line or defective hydraulic ECU.	Check that the connectors, terminals and harnesses for CAN communication are correctly connected. Also, check the hydraulic ECU for blown fuse.

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13. If necessary, remove the crankshaft gear **(Figure 4-2-61, (1))** and key **(Figure 4-2-61, (2))**. If using a gear puller, be careful not to damage the threads in the end of the crankshaft.

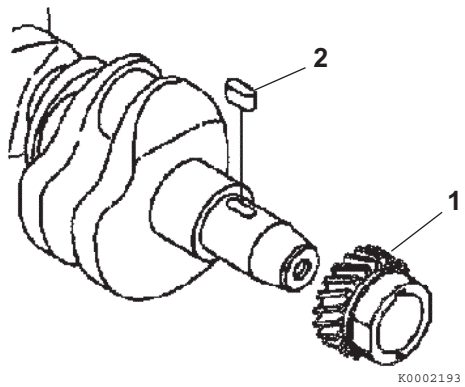


Figure 4-2-61

Inspection of Crankshaft and Camshaft Components

⚠ WARNING

Fume/Burn Hazard



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

Thoroughly clean all components using a brush and appropriate solvent. Each part must be free of carbon, gasket material, metal filings and other debris.

Note: Record all measurements taken during inspection.

■ Replacement of crankshaft oil seals

1. Remove the seal **(Figure 4-2-62, (2))** from the gear case cover **(Figure 4-2-62, (1))**.
2. Apply a continuous bead of ThreeBond Liquid Gasket No. 1212F, YANMAR Part No. 977770-1212F to the outside diameter of a new oil seal **(Figure 4-2-62, (2)).**
3. Install a new seal in the gear case cover with the lip facing in away from the crankshaft pulley. Apply lithium grease to the lip of the seal.

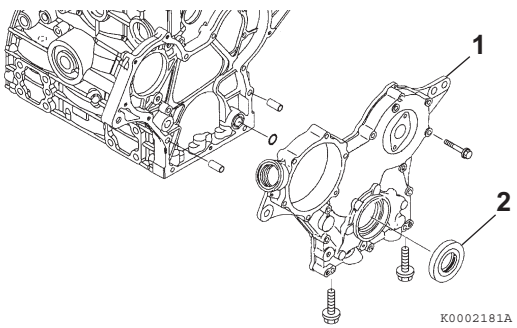


Figure 4-2-62

4. Remove the rear oil seal **(Figure 4-2-63, (1))** from the flywheel housing **(Figure 4-2-63, (2))**.

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1-9 Specifications of Hydraulic Hose

Specifications of the hydraulic hoses can be known by the part descriptions as explained below. (For the parts number, please refer to our Parts Catalog.)

Description ..... Hose P 2 06 AB 075 W —
1 2 3 4 5 6 7 8

1 Part name

2 Hose material
- Rubber hose ..... G
- Wear-resistant high pressure rubber hose ..... H
- Plastic hose ..... P
- Wear-resistant plastic hose ..... F

3 Recommended working pressure psi(Mpa)
- Over 2986 (20.6) 1
- 2489 to 2986 (17.2 to 20.6) 2
- 1991 to 2489 (13.7 to 17.2) 3
- 1564 to 1991 (10.8 to 13.7) 4
- 995 to 1564 (6.9 to 10.8) 5
- 427 to 995 (2.9 to 6.9) 6
- 213 to 427 (1.5 to 2.9) 7
- Below 213 (1.5) 8

4 Nominal dia. (inch)
- 1 / 8" 02
- 3 / 16" 03
- 1 / 4" 04
- 3 / 8" 06
- 1 / 2" 08
- 5 / 8" 10
- 3 / 4" 12
- 1" 16

5 Combination of fitting

Fitting type	Code
R(PT) — Taper pipe thread R (PT)	A
G(PF), 30° — Straight pipe thread G (PF) with male 30 degrees seat	B
90°, G(PF), 30° — 90 degrees bent type. Straight pipe thread G (PF) with male 30 degrees seat	C
Without fitting	Y

*For the combination of fitting, refer to the list on the following page.

6 Total length (Unit : cm)

7 Hose protector
- Coil spring ..... W
- Coil tube ..... S
- Wire braid ..... B
- Tube (Rubber) ..... R
- Tube (Vinyl) V
- Sponge rubber ..... P
- Hose cover ..... K
- No protection ..... Blank

8 Other accessories
- No accessories...Blank
- O-ring 1

List of pipe threads

Symbol	Name
G (PF)	Straight pipe thread
R (PT)	Male taper pipe thread
Rc (PT)	Female taper pipe thread

The example hose, P 2 06 AB 075 W stands for :
2 3 4 5 6 7

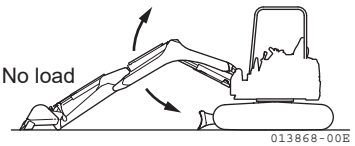
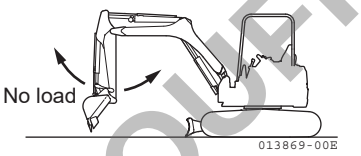
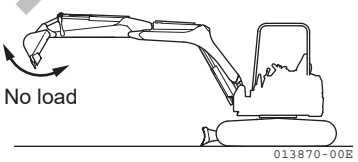
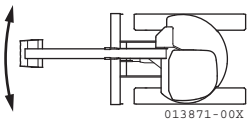
2 Material : Plastic
3 Working pressure : 2489 to 2986 psi (17.2 to 20.6 MPa)
4 Nominal dia. : 3 / 8"
5 Fitting type : Taper pipe thread R (PT) and straight pipe thread G (PF) with male 30 degrees seat.
6 Length : 29.5 in. (75 cm)
7 Hose protector : Coil spring

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3. SERVICING STANDARDS

3. Service Standards

3-1 Machine Performance

Applicable model				ViO23-6	
Item	Measuring condition		Unit	Standard	Allowable
Machine performance					
Working speed					
Boom speed Max. cylinder extension  Bucket teeth grounded	Machine position  • Engine: Rated speed • Hydraulic oil temp.: 122 to 140°F (50 to 60°C) • Excluding cushion • Site: Firm, flat ground	Up	sec.	1.6	1.8
		Down		1.6	1.8
Arm speed Max. cylinder retraction  Max. cylinder extension	Machine position  • Engine: Rated speed • Hydraulic oil temp.:122 to 140°F (50 to 60°C) • Site: Firm, flat ground	Extend	sec.	1.8	2.0
		Retract		2.4	2.6
Bucket speed Max. cylinder retraction  Max. cylinder extension	Machine position  • Engine: Rated speed • Hydraulic oil temp.:122 to 140°F (50 to 60°C) • Site: Firm, flat ground	Dump	sec.	1.8	2.0
		Curl		2.6	2.8
Boom swing speed Max. cylinder retraction  Max. cylinder extension	Machine position  • Engine: Rated speed • Hydraulic oil temp.: 122 to 140 °F (50 to 60 °C) • Site: Firm, flat ground • Full stroke	Right swing	sec.	4.2	4.5
		Left swing		5.1	5.4

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3-2 Engine

1) Nominal and Allowable Values

Applicable model / Item					Unit	3TNV76-PBV1	
						Standard	Limit
Cylinder head							
	Adjustment specifications	Valve clearance			in (mm)	0.006 to 0.010 (0.15 to 0.25)	-
	Cylinder head	Combustion surface distortion (flatness)			in (mm)	0.0020 (0.05) or less	0.0059 (0.15)
		Valve recession		Intake	in (mm)	0.0157 to 0.0236 (0.4 to 0.6)	0.0354 (0.9)
				Exhaust	in (mm)	0.0157 to 0.0236 (0.4 to 0.6)	0.0315 (0.8)
		Valve seat	Seat angle	Intake	degrees (°)	120	-
				Exhaust	degrees (°)	90	-
			Seat correction angle		degrees (°)	40, 150	-
	Intake/exhaust valve and guide	Intake		Guide inside diameter	in (mm)	0.2362 to 0.2367 (6.000 to 6.012)	0.2394 (6.08)
				Valve stem outside diameter	in (mm)	0.2346 to 0.2352 (5.960 to 5.975)	0.2323 (5.90)
				Oil clearance	in (mm)	0.0010 to 0.0020 (0.025 to 0.052)	0.0063 (0.15)
				Valve stem bend	in (mm)	-	0.0004 (0.010)
		Exhaust		Guide inside diameter	in (mm)	0.2362 to 0.2367 (6.000 to 6.012)	0.2394 (6.08)
				Valve stem outside diameter	in (mm)	0.2341 to 0.2346 (5.945 to 5.960)	0.2323 (5.90)
				Oil clearance	in (mm)	0.0016 to 0.0026 (0.040 to 0.067)	0.0067 (0.17)
				Valve stem bend	in (mm)	-	0.0004 (0.010)
		Valve guide projection from cylinder head			in (mm)	0.3858 to 0.3937 (9.8 to 10.0)	-
		Valve stem seal projection from cylinder head			in (mm)	0.429 to 0.441 (10.9 to 11.2)	-
		Valve guide installation method			in (mm)	Cold fitted	-
	Push rod	Push rod bend			in (mm)	Less than 0.0012 (0.03)	0.0012 (0.03)
	Valve spring	Free length			in (mm)	1.4882 (37.8)	-
		Squareness			in (mm)	-	0.0512 (1.3)
	Rocker arm and shaft	Arm shaft hole diameter			in (mm)	0.4724 to 0.4732 (12.000 to 12.020)	0.4752 (12.07)
		Shaft outside diameter			in (mm)	0.4711 to 0.4718 (11.966 to 11.984)	0.4701 (11.94)
		Oil clearance			in (mm)	0.0006 to 0.0021 (0.016 to 0.054)	0.0051 (0.13)

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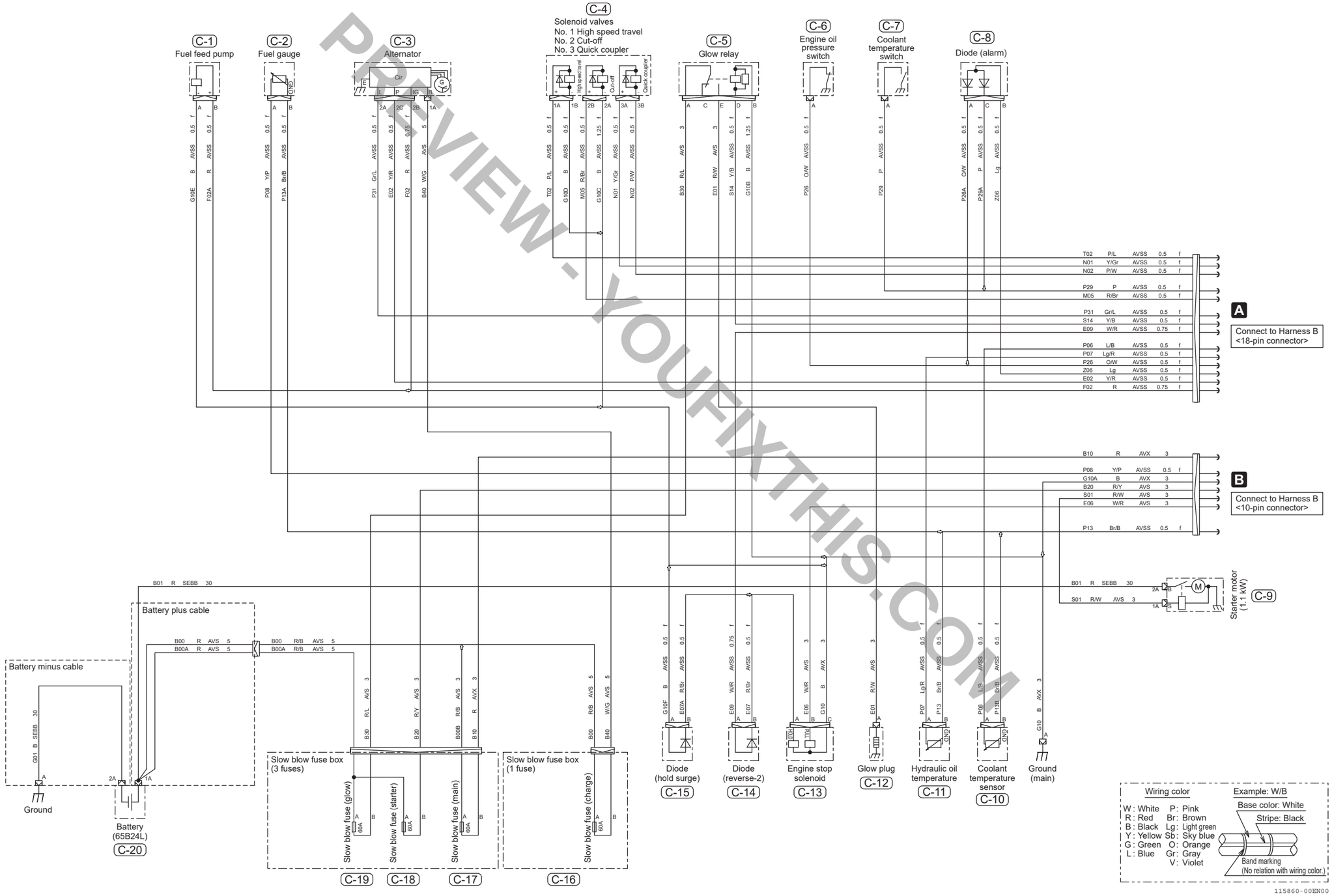
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2) Harness A



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⚠ WARNING

Sever Hazard!



- Keep hands and other body parts away from moving/rotating parts such as the cooling fan, belts or flywheel.
- Wear tight-fitting clothing and keep your hair short or tie it back while the engine is running.
- Remove all jewelry before you operate or service the machine.
- Never start the engine in gear. Sudden movement of the engine and/or machine could cause death or serious personal injury.
- Never operate the engine without the guards in place.
- Before you start the engine make sure that all bystanders are clear of the area.
- Keep children and pets away while the engine is operating.
- Check before starting the engine that any tools or shop rags used during maintenance have been removed from the area.
- Failure to comply could result in death or serious injury.

⚠ WARNING

Exhaust Hazard!



- Never operate the engine in an enclosed area such as a garage, tunnel, underground room, manhole or ship's hold without proper ventilation.
- Never block windows, vents, or other means of ventilation if the engine is operating in an enclosed area. All internal combustion engines create carbon monoxide gas during operation. Accumulation of this gas within an enclosure could cause illness or even death.
- Make sure that all connections are tightened to specifications after repair is made to the exhaust system.
- Failure to comply could result in death or serious injury.

Alcohol and Drug Hazard!



- Never operate the engine while you are under the influence of alcohol or drugs.
- Never operate the engine when you are feeling ill.
- Failure to comply could result in death or serious injury.

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7. Compare the width of the flattened PLASTIGAGE **(Figure 4-2-53, (1))** to the graduation marks on the package. The mark that most closely matches the width of the flattened PLASTIGAGE will indicate the bearing oil clearance. Record the measurements. *See "3-2 Engine Service Standard" section.*
8. Repeat with the remaining connecting rods.

NOTICE

Do not allow the connecting rod to contact the crankshaft journal during piston removal. Damage to the bearing journal may result.

9. Use a wooden dowel against the connecting rod and tap the piston/connecting rod assembly out of the cylinder.
10. Mark the cylinder number on the piston and connecting rod.
11. Remove the bearing inserts **(Figure 4-2-54, (2))**.
12. Remove the compression rings **(Figure 4-2-54, (3))** from the piston using a piston ring expander.
13. Remove the oil ring **(Figure 4-2-54, (4))** from the piston using a piston ring expander.

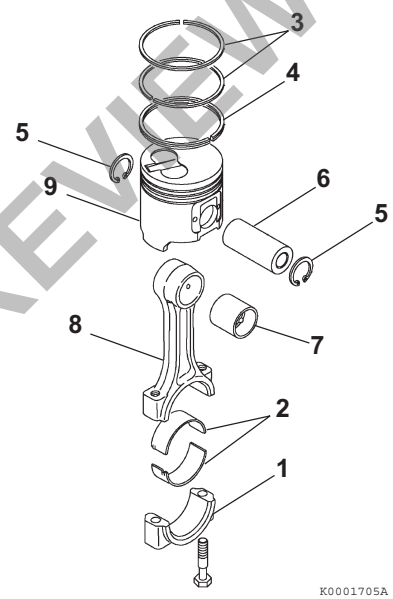


Figure 4-2-54

14. Remove the circlips **(Figure 4-2-54, (5))** from the wrist pin.
15. Remove the wrist pin **(Figure 4-2-54, (6))** and connecting rod **(Figure 4-2-54, (8))** from the piston **(Figure 4-2-54, (9))**.
16. Repeat steps until all pistons are removed and dissembled.

■ Removal of crankshaft

1. Remove the flywheel **(Figure 4-2-55, (1))** from the crankshaft.
2. Remove the bolts **(Figure 4-2-55, (2))** from the flywheel housing assembly. Remove the flywheel housing from the engine.

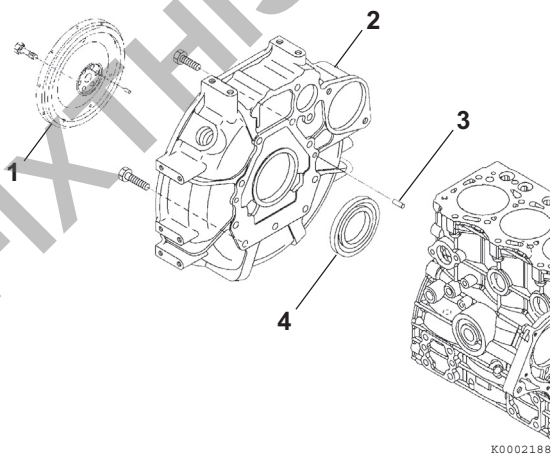


Figure 4-2-55

3. Before removing the main bearing caps, measure the crankshaft end play. Use either of the following two methods:
   - **Method A:** Install a dial gauge **(Figure 4-2-56, (1))** on the cylinder block. Move the crankshaft **(Figure 4-2-56, (2))** in and out to measure the end play. Record the measurement.

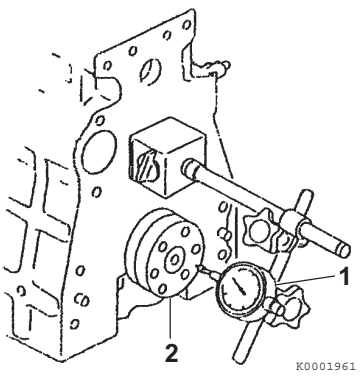


Figure 4-2-56

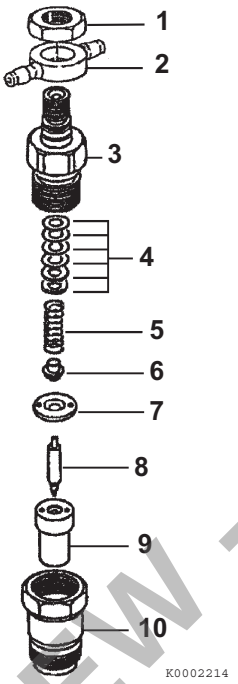
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■ Disassembly and Inspection of Fuel Injectors

NOTICE

Never use a steel wire brush to clean fuel injectors. Damage to the nozzle and other components is likely to result.

1. Clean carbon from used injectors using clean diesel fuel. Hardened deposits or varnish can be cleaned using a brass wire brush.



1 – Return fuel fitting nut
2 – Return fuel fitting
3 – Injector body
4 – Pressure adjusting shims
5 – Spring
6 – Spring seat
7 – Valve stop spacer
8 – Nozzle valve
9 – Nozzle body
10 – Nozzle case nut

Figure 4-3-32

2. Place the fuel injector in a soft-jawed vise with the nozzle pointing up.
3. Remove the nozzle case nut.
4. Carefully remove the injector from the vise.
5. Turn the injector over and remove the nozzle body, nozzle valve, valve stop spacer, nozzle spring seat, nozzle spring, and shims.
6. Inspect the sealing surfaces **(Figure 4-3-33, (2))** between the valve stop spacer and nozzle body for nicks or scratches. Check the contact area between the valve stop spacer and the nozzle valve **(Figure 4-3-33, (1))** for scoring or pitting. Use a magnifying glass to inspect.

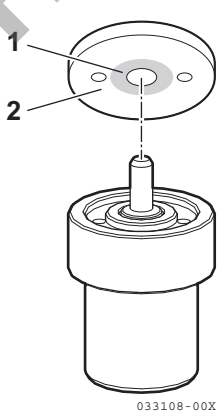


Figure 4-3-33

7. Perform a nozzle valve slide test:
   1- Wash nozzle body and valve in clean diesel fuel.
   2- While holding the nozzle body vertical, pull the nozzle valve about 2/3 of the way out **(Figure 4-3-34)**.
   3- Release the valve. It should fall smoothly to its seat by its own weight.

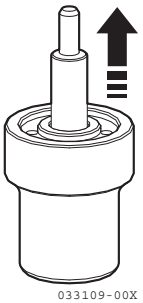


Figure 4-3-34

Replace the fuel injector assembly if it fails any inspection.

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5. Align the front frame housing with the rear frame housing. Reinstall the two bolts **(Figure 4-7-15, (1))** and two nuts **(Figure 4-7-15, (2))**.

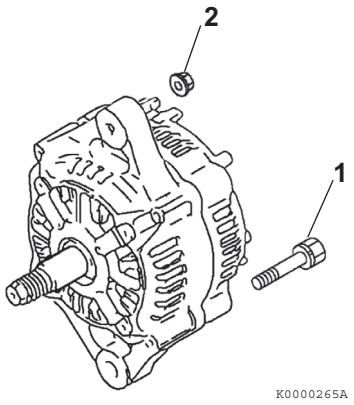


Figure 4-7-15

6. Reinstall the insulation bushing **(Figure 4-7-16, (4))** and nut **(Figure 4-7-16, (3))**.

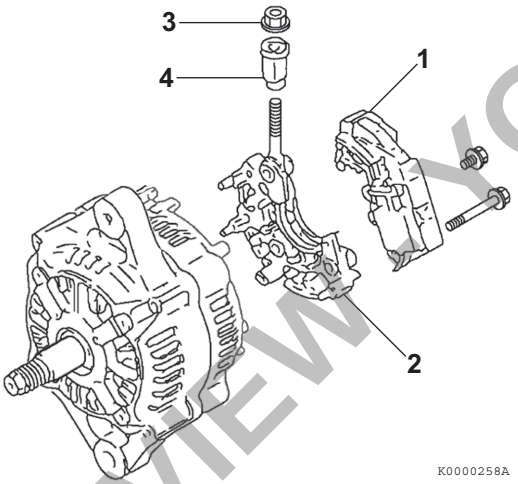


Figure 4-7-16

7. Reassemble the regulator assembly **(Figure 4-7-16, (1))** to the holder **(Figure 4-7-16, (2))**.
8. Reinstall the brush holder **(Figure 4-7-17, (3))**, springs **(Figure 4-7-17, (4))** and brushes **(Figure 4-7-17, (5))**.
9. Reattach the regulator assembly and holder to the rear frame housing.

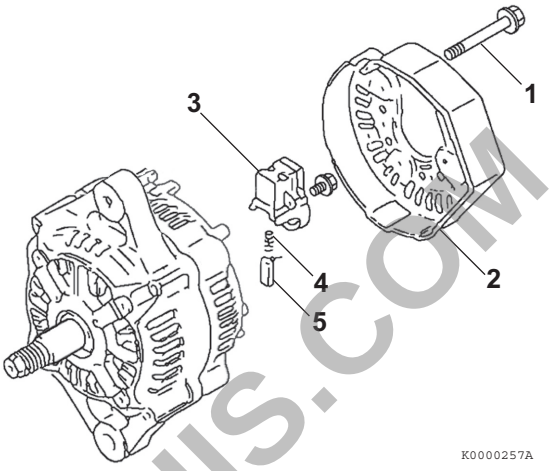


Figure 4-7-17

10. Reinstall the rear cover **(Figure 4-7-17, (2))** to the rear frame housing with three bolts **(Figure 4-7-17, (1))**.

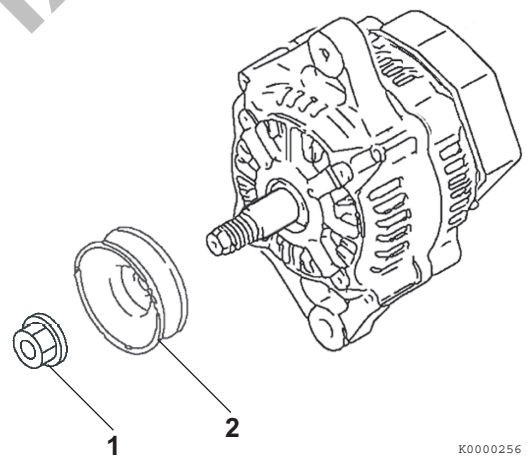
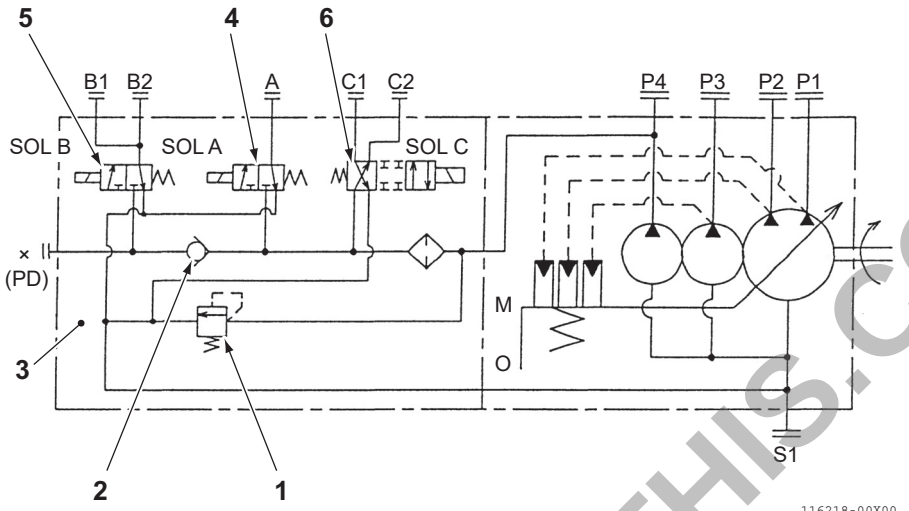


Figure 4-7-18

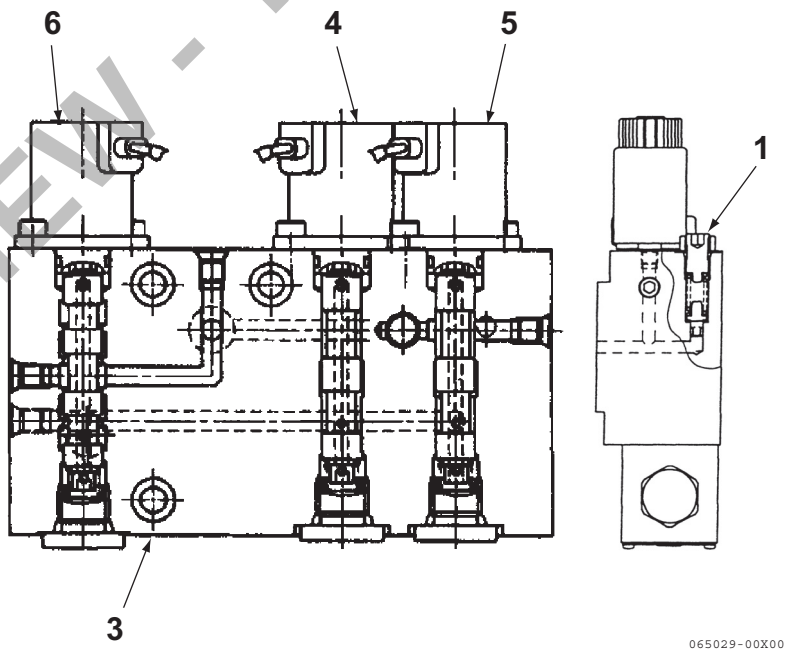
11. Reassemble the pulley **(Figure 4-7-18, (2))** and nut **(Figure 4-7-18, (1))** to the shaft of the rotor assembly. Tighten the nut.

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2) Valve Assembly and Relief Valve



No.	Part
1	Relief valve
2	Check valve
3	Body
4	Solenoid valve A
5	Solenoid valve B
6	Solenoid valve C



The valve assembly comprises a body, solenoid valves A, B and C, a relief valve and a check valve and a filter. It has the flowing functions and is installed on the body H of the piston pump :

[1] Shifting between high-low travel speeds utilizing the gear pump oil for pilot (Solenoid valve A)

[2] Turning on and off the pilot oil for hydraulic joy stick and PI, P2 inlet lock. (Solenoid valve B)

[3] Operating the quick coupler cylinder. (Solenoid valve C)

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9) Swing Operation

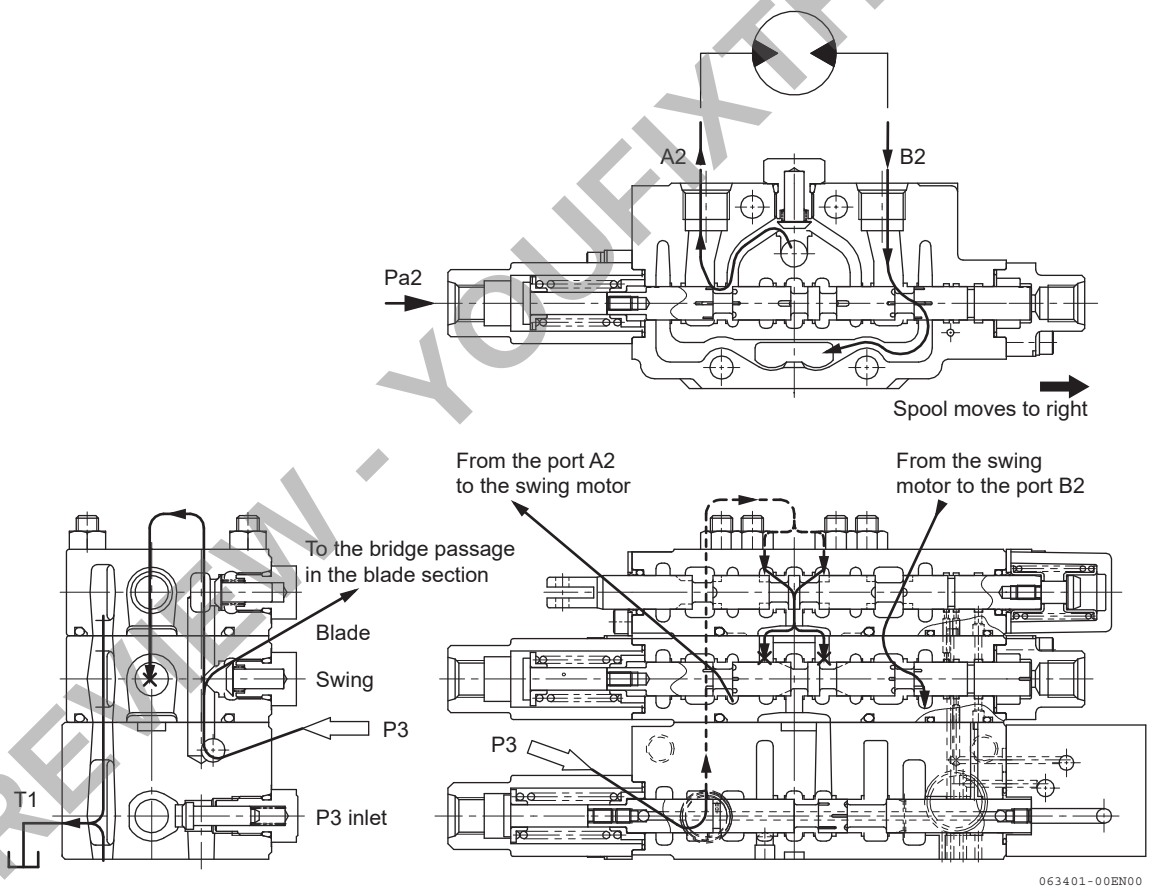
When the swing control lever is moved to the left, the oil from the pilot valve flows to the port Pa2 to move the spool of the swing section.

The P3 by-pass passage is blocked by the spool of the swing section as the spool has been moved.

The passage between the port A2 and the bridge passage is opened as the swing spool has been moved, the oil from the P3 parallel passage flows through the load check valve in the swing section and the bridge passage to the port A2 and is fed to the swing motor.

Meanwhile, the return oil from the swing motor flows to the return oil passage through the port B2 and the notches in the swing spool, which is opened to the return oil passage as the swing spool has been moved. Consequently, the upper structure swings counter clockwise.

When the swing control lever is moved to the right, oil flows to the other way but the valve actuation theory is the same.



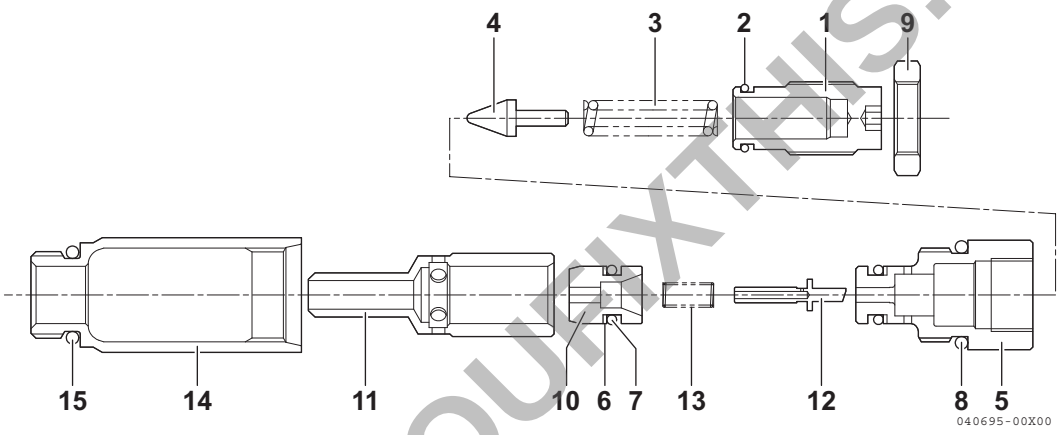
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5) Reassembly of relief valves

WARNING:

Relief valves are the most essential parts in terms of performance and safety. In addition, it is extremely difficult to reset relief valve pressures. If a relief valve failure occurs, replace the whole relief valve assembly.
The reassembly procedure below serves as a reference for performing reassembly after the relief valve is disassembled due to unavoidable circumstances, for example, in failure investigations.
Never use relief valves that have been reassembled according to the procedure below on an actual machine.

(1) Reassembly of system relief valves



Assembly of system relief valve

[1] Check that the O-ring **2** is installed securely in the groove at the end of adjust screw **1**, and then install spring **3** and poppet **4** into the hole in adjust screw **1**.

[2] Check that backup ring **6** and O-rings **7** and **8** are installed securely on poppet guide **5**, and then fit the tapped hole of poppet guide **5** onto the poppet side of the assembly that has been assembled in step [1] and screw the poppet guide onto the assembly.

WARNING:

*Take care to install O-ring **7** and backup ring **6** in their correct positions.*
(Be sure to install the backup ring on the outer threaded side of the poppet guide.)
If installed in the wrong position, the O-ring can protrude, resulting in internal leaks or malfunction of the control valve. In the worst-case scenario, this may lead to damage to other hydraulic equipment.
*Look through the smaller hole in poppet guide **5** to check that poppet **4** is fitted in the seat of poppet guide **5**.*
If it is not fitted, pressure may not build up and control valve malfunction may occur.

[3] Install nut **9** onto the threaded portion of adjust screw **1** protruding from the assembly that has been assembled in step [2].

[4] Check that O-ring **7** and backup ring **6** are installed securely in the groove on the outer face of valve **10**, and then insert valve **10** into socket **11**.

WARNING:

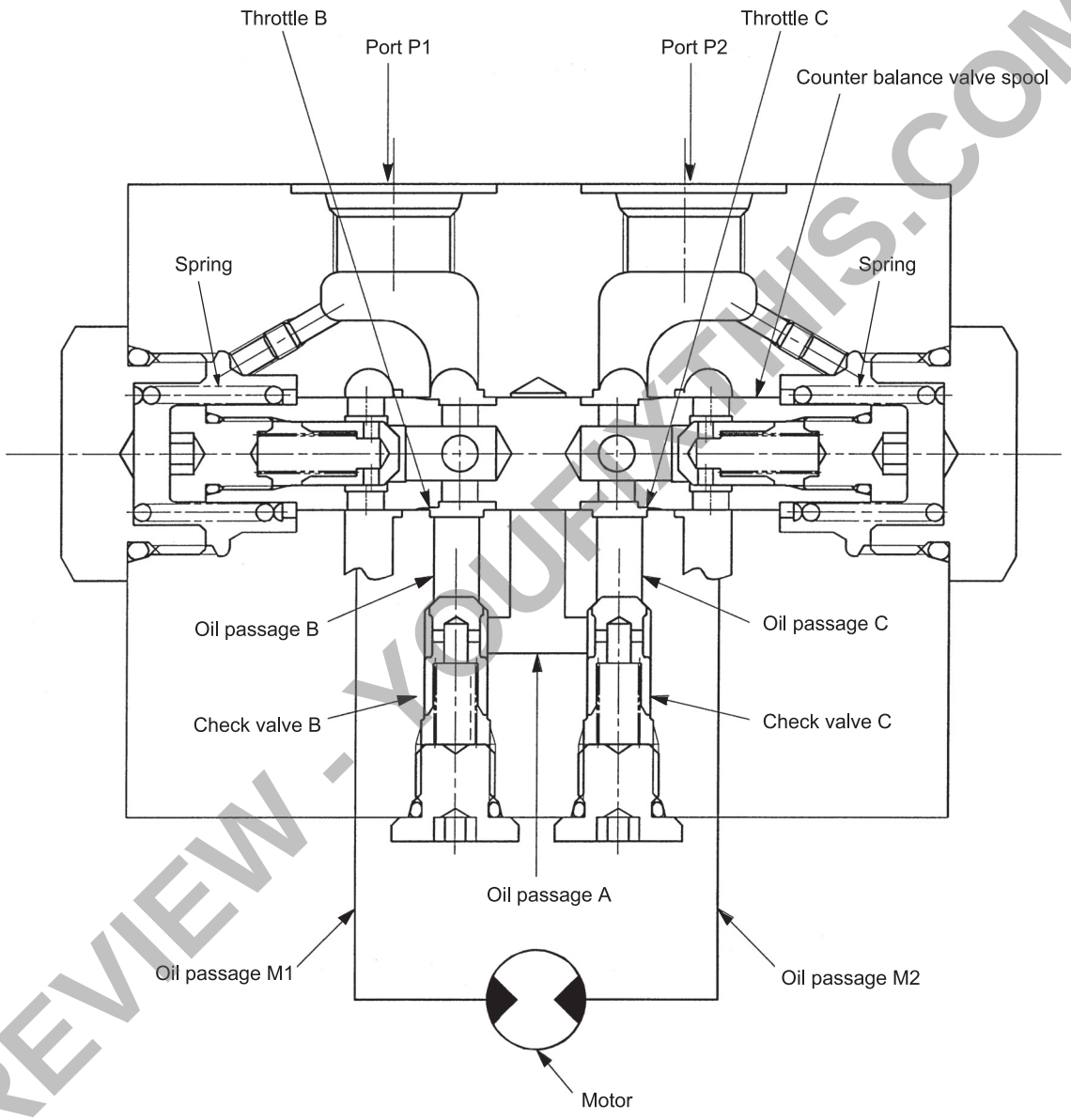
*Take care to install O-ring **7** and backup ring **6** in their correct positions.*
(Be sure to install the backup ring on the seat side of the valve.)
If installed in the wrong position, the same trouble as described in step [2] may occur.

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3) Anti-Cavitation Valve

This anti-cavitation mechanism works together with the counter balance valve.

Compared with conventional counter valance mechanism, this mechanism has oil passages A, B and C and check valves B and C in addition.



Anti-cavitation valve (in neutral state)

117363-00EN00

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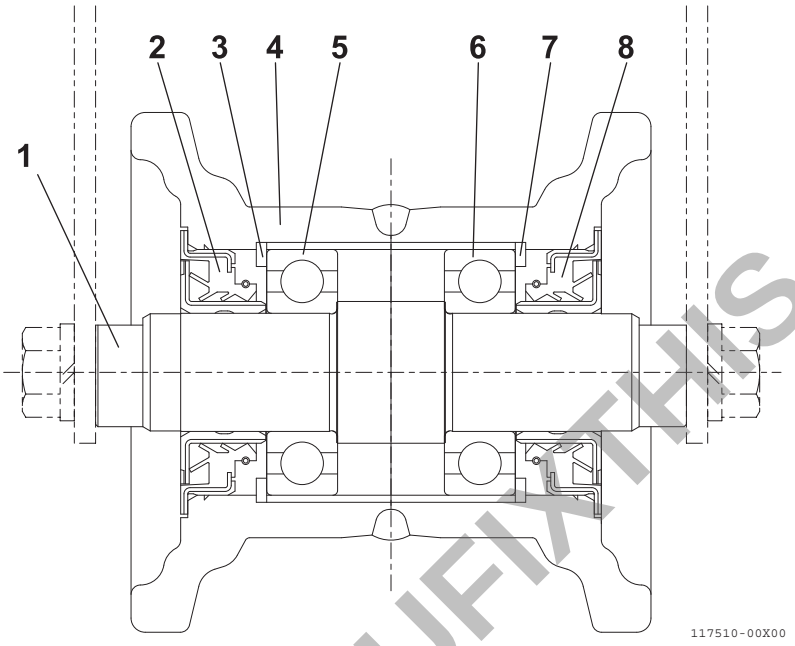
3. Specifications

Maximum allowable working pressure		1015 PSI (7.0 MPa)
Allowable back pressure		145 PSI (1.0 MPa) or less
Maximum flow (per spool)		2.6 GPM (10 L/min)
Amount of leakage (per spool)		12.2 cu.in./min (200 cm^3/min) or less
Waterproof property		JIS D 0203 S2 or equivalent
Earthquake resistance		JIS D 1601-1995 Type-3 Class-B Stage-70
Hydraulic oil		ISO VG32-68 or equivalent
Oil operating temperature range		-4 to 194°F (-20 to 90°C)
Maximum allowable contamination		NAS Class 10 or lower
Port size		JIS B 2351 G1/4
Electrical specifications		
	Solenoid type	Oil immersion type
	Coil insulation class	JIS C 3214 Class-H [356°F (180°C)]
	Connector type	Econoseal J series, Tyco Electronics Cooperation
Proportional solenoid pressure reducing valve		KDRDE5K-31/30D50-122
	Power-supply voltage	12V
	Rated current	1.6A
	Recommended dither	80Hz/600mAp-p
	Coil resistance value	3.2Ω [at 68 °F (20 °C)]

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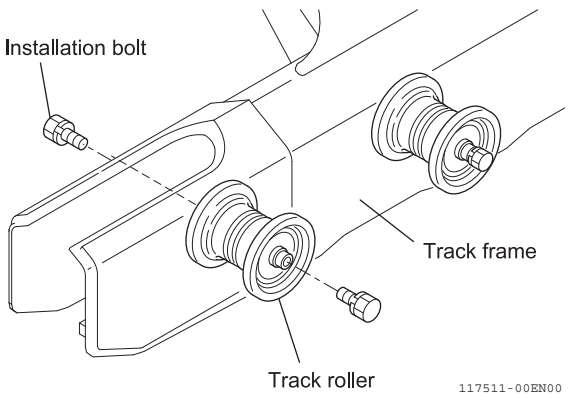
7-2-6 Disassembly and Reassembly of Track Roller

1) Structure

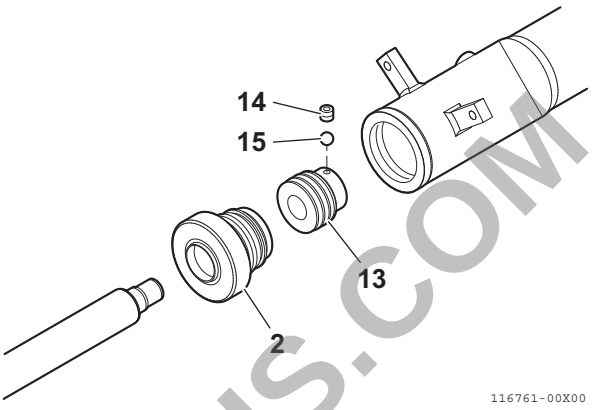


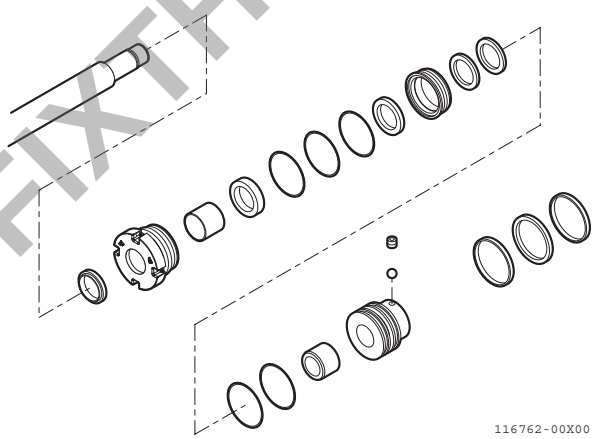
No.	Part	Q'ty	No.	Part	Q'ty
1	Shaft	1	5	Bearing 6205	1
2	Seal TW25 52 18	1	6	Bearing 6205	1
3	Internal snap ring C52	1	7	Internal snap ring C52	1
4	Roller	1	8	Seal TW25 52 18	1

2) Disassembly

Procedure	
(1) Remove the installation bolt to remove the track roller from the track frame.	

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Procedure	
(6) Disassembly of arm, bucket, boom swing and blade cylinders Loosen screw **14** to remove steel ball **15** and then remove piston **13** and head **2** from rod in order.	

(7) Remove all O-rings, back-up rings, piston rings and seal assembly from piston and head. ***Note :*** *Use a sharp tool to raise each O-ring or piston seal, and then insert a spatula to remove it.*	

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