Z25
250Z

Compact Excavator



Form No.
50940346
Revision A
June 2015

Service Manual

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4. Engine

4-1 Safety

4-1-1 Safety Statements

Manitou Americas 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 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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Starting SW

Terminal / Position	B	BR1 (40A)	BR2 (40A)	C2 (40A)	C1 (20A)
OFF					
1					
2					

A-1 Sensor (water temp.)
A-2 Gage,fuel
A-3 Sensor (hydro temp.)
A-6 Driver
A-7 Diode (reverse)
A-8 Relay (power)
A-9 Starter SW
A-10 Feed pump
A-11 SW (light)
A-12 Relay (engine control)
A-13 Relay (safety)
A-42 Fusebox
A-43 Relay(Cab)
A-44 SW (travel signal)
A-45 Diode (P.T.O.)
A-46 Diode (swing)
A-47 SW (P.T.O./swing)
A-48 Resist (R120)
A-49 Diode (selector valve)
A-50 Horn
A-51 Selector valve
A-52 Grip R
A-53 P.T.O. solenoid
A-54 Power outlet
A-55 Relay (travel detection)
A-56 Back buzzer
A-57 Earth (back buzzer)
A-58 Relay (deceleration cancel)
A-59 Service-connector
A-60 Relay (room lamp)
A-41 Pump assy,3sol
SW (cut off) A-4
SW (travel) A-5
A-40 Slow blow fuse (main)
A-39 Slow blow fuse (glow)
A-38 Slow blow fuse (starter)
A-37 Relay (glow)
A-36 Slow blow fuse (charge)
A-35 Starter motor
A-34 Alternator
A-33 SW (water temp.)
A-32 Diode (hold surge)
A-31 Diode (hold)
A-30 Stop solenoid
A-29 Battery 65B24L
A-22 Diode (glow)
A-23 Diode (pulse)
A-24 Diode,1s timer
A-17 Monitor, model setting
Monitor assy A-16
A-14 Diode (buzzer pulse)
A-15 Buzzer
A-18 Timer,3s
A-26 Work lamp (front)
A-25 Solenoid, power cont
A-21 Glow relay (stop sol)
A-20 Timer,1s
A-19 Safety relay
A-28 Pulg, glow
A-27 SW (oil pressure)
A-62 Lamp (cab)
A-61 Quick coupler

A B C

CABIN HARNESS

B-1 Heater unit
B-4 Room light
B-5 Cabin light
B-2 Timer unit
B-7 Window washer pump
B-6 Wiper motor
B-3 Door switch
B-9 Heater switch
B-8 Wiper switch

Cab door	Door switch
Open	ON
Close	OFF

*The wiring diagram in the dashed line shows the cabin wire harness originally installed in a cabin.

SMARTASSIST-Remote HARNESS

Diode (travel signal)
SMARTASSIST-Remote controller

DECEL HARNESS

C-1 Diode (work signal)
C-2 Control unit (decel)
C-3 SW (working signal)
C-7 SW (decel)
C-8 Accel,decel
C-5 Lamp (decel)
C-4 Actuator (decel)

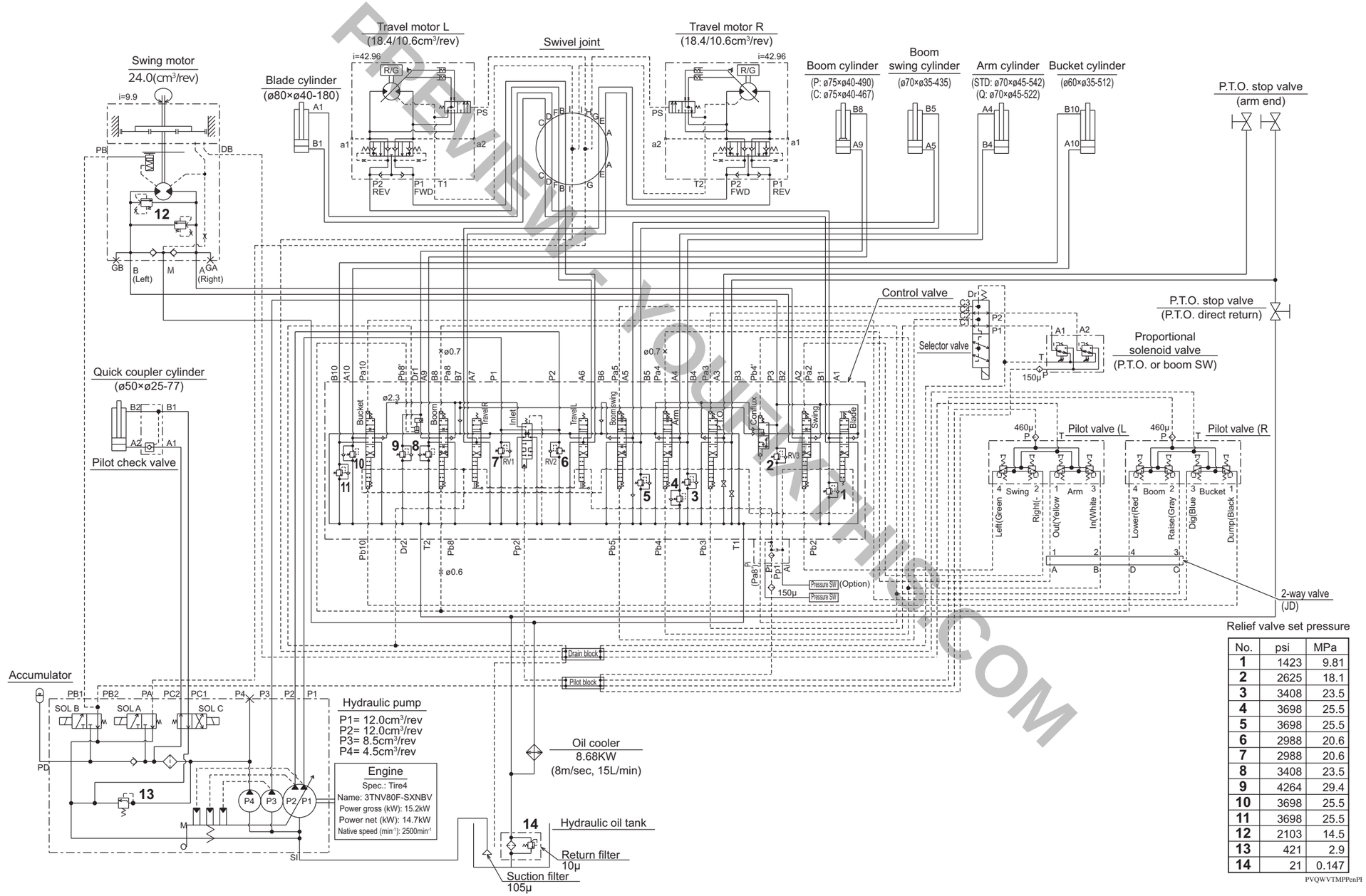
Wiring color

W : White	P : Pink	Example: W/B	
R : Red	Br : Brown	Base color: White	
B : Black	Lg : Light green	Stripe: Black	
Y : Yellow	Sb : Sky blue		
G : Green	Or : Orange		
L : Blue	Gr : Gray		
	V : Violet		

Band marking
No relation with wiring color

2-8 Hydraulic Circuit Schematic

Applicable model :



Relief valve set pressure

No.	psi	MPa
1	1423	9.81
2	2625	18.1
3	3408	23.5
4	3698	25.5
5	3698	25.5
6	2988	20.6
7	2988	20.6
8	3408	23.5
9	4264	29.4
10	3698	25.5
11	3698	25.5
12	2103	14.5
13	421	2.9
14	21	0.147

PVQWVTMPPenPI

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4-2-5 Cylinder Head

Cylinder Head Components

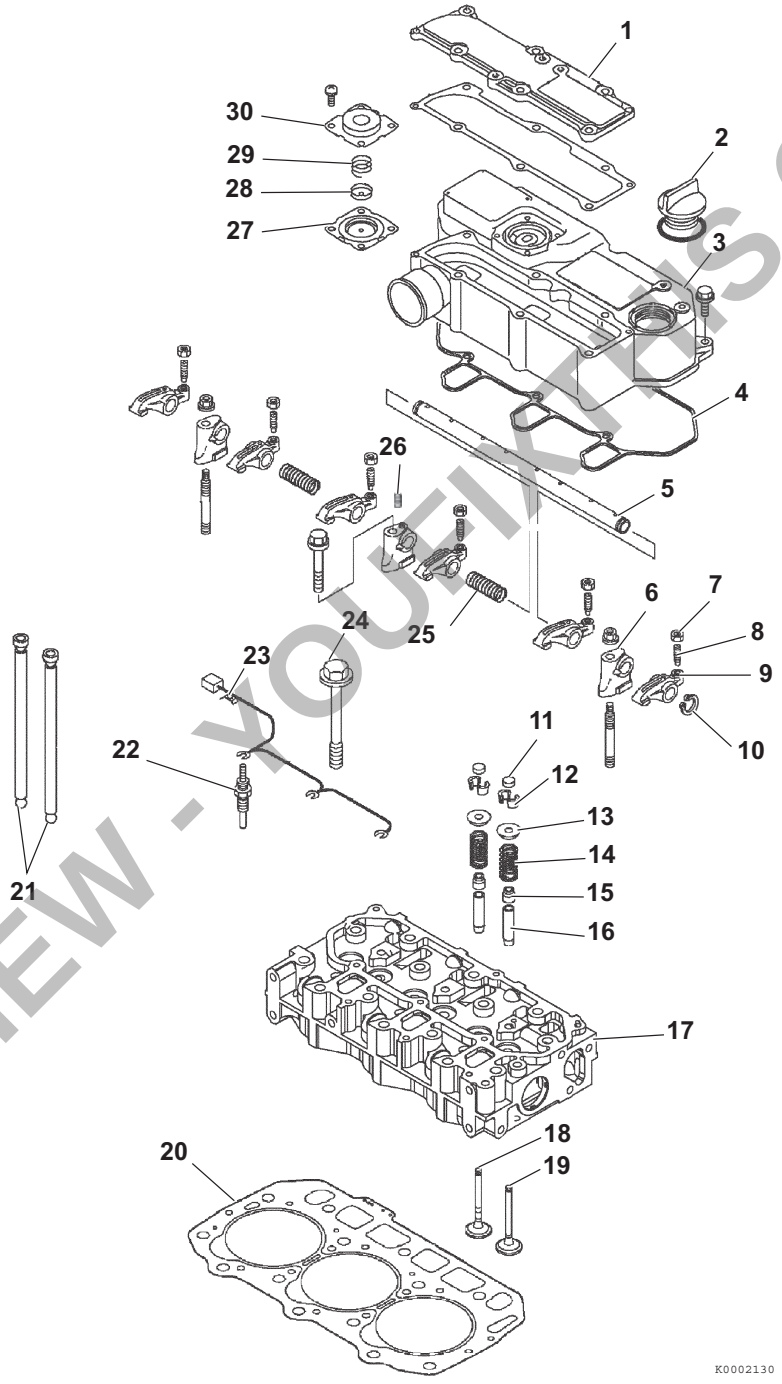


Figure 4-2-1

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No.	Part	Q'ty	No.	Part	Q'ty
1	Body S	1	28	Coned disc spring	4
2	Body H	1	29	Internal snap ring	1
3	Drive shaft	1	30	Internal snap ring	1
4	Cylinder barrel	1	31	External snap ring	1
5	Valve plate	1	32	O-ring	1
6	Piston	10	33	O-ring	3
7	Shoe	10	34	Plug	1
8	Shoe holder	1	35	O-ring	1
9	Barrel holder	1	36	Hexagon socket head bolt	5
10	Swash plate	1	37	Hexagon socket head plug	5
11	Needle	3	38	Plug	1
12	Rocking pin	2	40	Spring pin	1
13	Packing	1	41	Hexagon socket head set screw	1
14	Spring C	1	42	Hexagon nut	1
15	Spring T1	1	43	Seal washer	1
16	Spring holder	1	44	Gear pump kit	1
17	Spring guide	1	45	Coupling	1
18	Pin	1	46	Collar	1
19	Rod	1	47	Hexagon bolt	2
21	Retainer	2	48	O-ring	1
22	Stopper pin A	1	49	Washer	2
23	Stopper pin B	1	50	O-ring	1
24	Pin	1	51	O-ring	2
25	Ball bearing	1	52	Valve assembly	1
26	Needle bearing	1	53	Hexagon socket head bolt	3
27	Oil seal	1	54	Spring washer	3

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5-4 Error Code List

Error code	Classification	Error description	Detection condition	Causes	Corrective measures
00 000091.00	Caution	Accelerator sensor malfunction: above normal operating range (SAEJ1843)	Sensor voltage is 4.6 V or more, or 0.2 V or less.	• Connection failure of connectors • Harness wiring failure (engine control dial wiring disconnected or short circuited to GND) • Defective accelerator sensor • Engine ECU internal circuit failure	Check the connectors, harnesses and engine control dial. Turn the starter switch to the “OFF” position and then to the “ON” position to check if the error code is displayed again.
00 000091.01	Caution	Accelerator sensor failure: below normal operating range (SAEJ1843)	Sensor voltage is 4.6 V or more, or 0.2 V or less.	• Connection failure of connectors • Harness wiring failure (engine control dial wiring disconnected or short circuited to GND) • Defective accelerator sensor • Engine ECU internal circuit failure	Check the connectors, harnesses and engine control dial. Turn the starter switch to the “OFF” position and then to the “ON” position to check if the error code is displayed again.
00 000091.02	Caution	Accelerator sensor malfunction: intermittent failure	Sensor voltage is 4.6 V or more, or 0.2 V or less.	• Connection failure of connectors • Harness wiring failure (nearly broken wiring of sensor signal line, sensor 5 V line or sensor GND line) • Defective accelerator sensor • Engine ECU internal circuit failure	Check the connectors, harnesses and accelerator sensor. Turn the starter switch to the “OFF” position and then to the “ON” position to check if the error code is displayed again.
00 000091.03	Caution	Accelerator sensor malfunction: short circuit to high voltage side	Sensor voltage is 4.6 V or more, or 0.2 V or less.	• Connection failure of connectors • Harness wiring failure (sensor GND line disconnected or sensor signal line short circuited to power supply) • Defective accelerator sensor • Engine ECU internal circuit failure	Check the connectors, harnesses and accelerator sensor. Turn the starter switch to the “OFF” position and then to the “ON” position to check if the error code is displayed again.
00 000091.04	Caution	Accelerator sensor malfunction: short circuit to low voltage side	Sensor voltage is 4.6 V or more, or 0.2 V or less.	• Connection failure of connectors • Harness wiring failure (sensor signal line disconnected or short circuited to GND, or sensor 5V line disconnected or short circuited to GND) • Defective accelerator sensor • Engine ECU internal circuit failure	Check the connectors, harnesses and accelerator sensor. Turn the starter switch to the “OFF” position and then to the “ON” position to check if the error code is displayed again.
00 000091.15	Caution	Accelerator sensor malfunction: disabled (SAEJ1843)	Sensor voltage is 4.6 V or more, or 0.2 V or less.	Engine ECU map data setting fault	Turn the starter switch to the “OFF” position and then to the “ON” position to check if the error code is displayed again.
00 000100.01	Warning	Abnormal engine oil pressure	Engine oil pressure switch is on after engine has started.	• Low engine oil pressure • Defective engine oil system • Harness wiring failure (engine oil pressure switch wiring short circuited to GND) • Defective engine oil pressure switch • Engine ECU internal circuit failure	Inspect the engine oil system. Check the harnesses and engine oil pressure switch. Turn the starter switch to the "OFF" position and then to the "ON" position to check if the error code is displayed again.
00 000100.04	Warning	Engine oil pressure switch failure	Engine oil pressure switch is off while engine is stopped with starter switch in the "ON" position.	• Connection failure of connectors • Harness wiring failure (engine oil pressure switch wiring disconnected or short circuited to power supply) • Defective engine oil pressure switch • Engine ECU internal circuit failure	Check the connectors, harnesses and engine oil pressure switch. Turn the starter switch to the "OFF" position and then to the "ON" position to check if the error code is displayed again.
00 000110.00	Warning	Engine coolant temperature sensor malfunction: too high	Sensor voltage is 4.8 V or more.	• 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.
00 000110.02	Warning	Engine coolant temperature sensor malfunction: intermittent failure	Error undefined is detected 10 times.	• 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.
00 000110.03	Warning	Engine coolant temperature sensor malfunction: short circuit to high voltage side	Sensor voltage is 4.8 V or more.	• Connection failure of connectors • Harness wiring failure (sensor signal line disconnected or short circuited to power supply, or sensor GND line disconnected) • 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.

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Troubleshooting Charts

Cause	Trouble symptom	Starting problem: Engine does not start	Starting problem: Engine starts but stops soon — Exhaust smoke: None	Starting problem: Engine starts but stops soon — Exhaust smoke: Little	Starting problem: Engine starts but stops soon — Exhaust smoke: Much	Insufficient engine output — Exhaust color: Ordinary	Insufficient engine output — Exhaust color: White	Insufficient engine output — Exhaust color: Black	Poor exhaust color — During work: White	Poor exhaust color — During work: Black	High knocking sound during combustion	Abnormal engine sound	Uneven combustion sound	Engine surging: During idling	Engine surging: During work operation	Excessive engine vibration	Difficulty in returning to low speed	Excessive fuel consumption	Engine oil: Excessive oil consumption	Engine oil: Dilution by diesel fuel	Engine oil: Oil with water	Engine oil: Low oil pressure	Excessive blow-by gas	Engine coolant: Overheat	Engine coolant: Low water temperature	Air intake: Pressure drop	Air intake: Pressure rise	Exhaust temperature rise	Corrective action	Reference page
Engine system	Improper intake/exhaust valve clearance	O	O			O						O													O		O	Adjust the valve clearance	*See Measuring and Adjusting Valve Clearance on page 4-2-20.*
	Compression leakage from valve seat					O		O		O		O						O					O		O		O	Lap the valve seat	*See Valve face and valve seat on page 4-2-14.*
	Intake/exhaust valve seizure	O			O	O		O		O		O			O	O			O				O			O		Correct or replace intake/exhaust valve	*See Inspection of intake and exhaust valves on page 4-2-13.*
	Cylinder head gasket blowout					O															O			O					Replace the gasket	*See Disassembly of Cylinder Head on page 4-2-8.*
	Seized or broken piston ring	O			O		O		O			O		O		O			O	O			O	O				O	Replace the piston ring	*See Reassembly of Cylinder Head on page 4-2-16.*
	Worn piston ring, piston or cylinder	O			O		O		O										O	O			O						Perform honing and use oversize parts	*See Honing and Boring on page 4-2-39.*
	Seized crankpin metal or bearing	O	O									O		O	O	O							O						Repair or replace	*See Inspection of Crankshaft and Camshaft Components on page 4-2-32.*
	Improper arrangement of piston ring gaps		O				O												O				O						Correct the ring joint positions	*See Reassembly of pistons on page 4-2-41.*
	Reverse assembly of piston rings						O		O										O				O						Reassemble correctly	*See Reassembly of pistons on page 4-2-41.*
	Worn crankpin and journal bearing					O						O		O	O	O						O							Measure and replace	*See Inspection of Crankshaft and Camshaft Components on page 4-2-32.*
	Loose connecting rod bolt											O				O						O							Tighten to the specified torque.	*See 3-2 Engine Service Standard section.*
	Foreign matter trapped in combustion chamber	O										O							O				O						Disassemble and repair	*See Disassemble of Cylinder Block Components on page 4-2-23.*
	Excessive gear backlash											O																	Adjust gear meshing	*See Checking timing gear backlash on page 4-2-24.*
	Worn intake/exhaust valve guide						O												O				O						Measure and replace	*See Inspection of valve guides on page 4-2-13.*
Engine system	Governor adjusted incorrectly		O											O	O	O	O												Make adjustment	
	Improper open/close timing of intake/exhaust valves	O					O	O	O	O		O																		Adjust the valve clearance	*See Measuring and Adjusting Valve Clearance on page 4-2-20.*

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2-6 Periodic Inspection and Servicing

◇ : Check ○ : Supply ● : Replace □ : Adjust (clean) ■ : Oil & grease

Check & service items			Daily	Every 50 hrs	Every 100 hrs	Every 250 hrs	Every 500 hrs	Every 1000 hrs	Every 1500 hrs	Every 2000 hrs
General	Check falling off, breakage of parts		◇							
	Check loosened bolts & nuts, retighten		◇							
	Check engine condition		◇							
	Clean		□							
Fuel oil	Check & supply of oil to the tank		◇(○)							
	Drain the fuel tank			□						
	Water separator	Check, drain	◇							
		Clean					●			
	Replace the fuel filter element						●			
Lube oil	Engine oil	Check, resupply	◇							
		Replace		● 1st time		●				
	Replace the engine oil filter element			● 1st time		●				
	Travel reduction gear oil	Check, resupply				○				
		Replace			● 1st time			●		
Coolant	Check & supply of coolant		◇							
	Check coolant leakage		◇							
	Check & clean radiator fins					□				
	Check & adjust the fan-belt tension		◇(□)							
	Clean & check the cooling system, and replace the coolant							●within one year		
Rubber hose	Check & replace fuel oil pipe, cooling water pipe		◇							●within two years
Governor lever	Adjust the governor lever and accelerator device					□				
Air cleaner	Clean air cleaner					□				
	Replace air cleaner element						●			
Hydraulic system	Hydraulic oil	Check, resupply	◇							
		Replace						●		
	Clean suction filter					□ 1st time		□		
	Replace return filter					● 1st time	●			
	Check for abnormality of hydraulic pump		◇							
	Check function of accumulator									◇
Grease	Check grease-up positions, grease		■							
	Greasing the swing gears and the swing bearings			■						
Undercarriage	Check, adjust track tension		◇							

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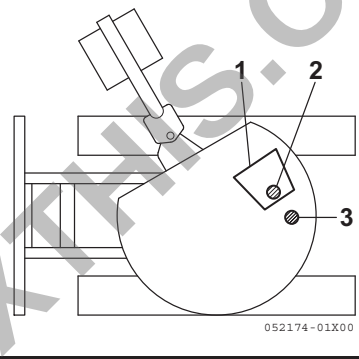
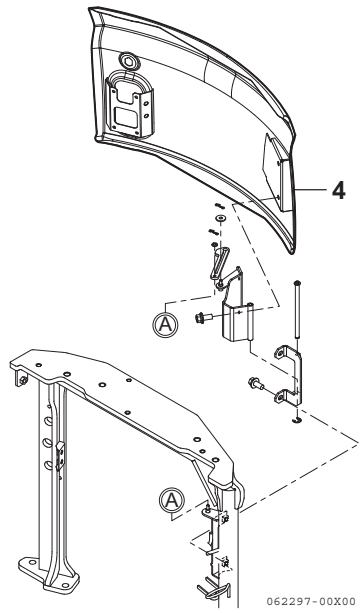
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7. Adjustment and Repair

7-1 Engine and Electric Equipment

7-1-1 Removal and Reinstallation of Engine

1) Removal

Procedure	
(1) Swing upperstructure so that drain plug **2** of hydraulic oil tank **1** and coolant drain plug **3** are positioned halfway between right and left tracks. Then lower bucket to ground and stop engine.	
(2) Remove engine hood rear cover **4**.	

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2. TECHNICAL DATA

2. Technical Data

2-1 Specifications

Item				Unit	
Main specifications of machine					
Dimensions					
Overall length (Transportation position)			Quick coupler spec	in. (mm)	161.0 (4090)
Cabin		Overall height	Transportation position	in. (mm)	99.6 (2530)
			Traveling position	in. (mm)	99.6 (2530)
		Overall width	Full machine width	in. (mm)	59.1 (1500)
Canopy		Overall height	Transportation position	in. (mm)	98.0 (2490)
			Traveling position	in. (mm)	98.0 (2490)
		Overall width	Full machine width	in. (mm)	59.1 (1500)
Tumbler center distance (rubber track)				in. (mm)	62.6 (1590)
Track gauge				in. (mm)	49.2 (1250)
Minimum ground clearance				in. (mm)	12.6 (320)
Traveling performance					
Travel speed		Rubber track	Low speed (Forward/Reverse)	MPH (km/hr)	1.7 (2.8)
			High speed (Forward/Reverse)	MPH (km/hr)	2.8 (4.5)
Permissible water depth limit				in. (mm)	19.7 (500)
Work performance					
Bucket		Width (Standard) *including side cutter		in. (mm)	19.3 (490)
		[Standard. JIS heaped capacity]		cu.ft. (cu.m)	2.83 (0.08)
		Number of teeth / Installation method		pcs.	3 / Rubber pin lock type
Work range (Standard <Quick coupler spec>)					
Maximum digging depth		With blade raised		in. (mm)	116.1 (2950)
		With blade on the ground		in. (mm)	124.0 (3150)
Maximum depth of vertically digging				in. (mm)	93.3 (2370)
Maximum dumping height (Canopy/Cabin)				in. (mm)	109.4 (2780)
Minimum front swing radius (with boom in front)			Cabin	in. (mm)	85.0 (2160)
			Canopy	in. (mm)	
Minimum front swing radius (with boom in front)			Cabin	in. (mm)	72.4 (1840)
			Canopy	in. (mm)	

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3-7 List of Tightening Torque

3-7-1 Machine

Equipment No	Tightening part	Thread size	Tightening torque ft•lbf (N•m)	Adhesive
Engine / Electrical equipment				
1	Engine mount vibroisolating rubber	Nut 10	19 to 23 (24.5 to 32.3)	
2	Engine × Engine mount (Fore Left)	M10×25	32.5 to 43.4 (44.1 to 58.9)	ThreeBond 1324
3	Engine × Engine mount (Fore Right)	M10×25	32.5 to 43.4 (44.1 to 58.9)	ThreeBond 1324
4	Engine × Engine mount (Rear Left)	M10×25	32.5 to 43.4 (44.1 to 58.9)	ThreeBond 1324
5	Engine × Engine mount (Rear Right)	M10×25	32.5 to 43.4 (44.1 to 58.9)	ThreeBond 1324
6	Engine mount × Stopper (Left)	M10×25	32.5 to 43.4 (44.1 to 58.9)	ThreeBond 1324
7	Engine mount × Stopper (Fore Right)	M10×25	32.5 to 43.4 (44.1 to 58.9)	ThreeBond 1324
8	Air cleaner	M8×20	15 to 16 (19.6 to 22.6)	
9	Air cleaner intake hose	Hose clip 70	1.6 to 1.8 (2.16 to 2.45)	
10	Cooling water hose	Hose clip 41	1.8 to 2.2 (2.45 to 2.94)	
11	Oil cooler hose	Hose clip 22	2.9 to 3.6 (3.9 to 4.9)	
12	Fuel level gauge unit	M5×12 (Pan head screw)	0.87 to 1.0 (1.18 to 1.47)	
13	Fuel level gauge hose	Hose band 13	0.75 to 1.0 (0.98 to 1.47)	
14	Fuel oil tank drain valve	R3/8	15 to 21 (19.6 to 29.4)	Loctite 577
15	Fuel oil tank holding band	Nut 10	1.9 to 2.2 (2.45 to 2.94) <Tank holding side>	18.1 to 23.8 (24.5 to 32.3) <Lock nut side>
16	Battery holding rod	Nut 6	1.5 to 2.2 (1.96 to 2.94) (Lower <holding>)	3.6 to 4.3 (4.9 to 5.88) (Upper <Locknut>)
17	Accelerator cable locknut	Nut 6	2.9 to 3.6 (3.92 to 4.90)	
18	Wire harness × Starter motor terminal	Nut 8	4.5 to 8.6 (5.88 to 11.77)	
19	LCD monitor × Panel cover	M6×20	0.75 to 1.0 (1.0 to 1.5)	
20	Panel cover (lower) × Panel cover (upper)	M5×14 (Tapping screw)	1.9 to 2.4 (2.55 to 3.3)	
21	Safety switch (Cut-off lever)	Locknut (Fine thread) 20	22 to 25 (29.4 to 34.3)	
22	Accelerator dial (holding nut)	Nut (Fine thread) M9	1.02 to 1.08 (1.33 to 1.47)	
23	Generator B terminal	Nut 6	4.5 to 7.2 (5.9 to 9.8)	

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3-2 Engine

1) Nominal and Allowable Values

Item		Unit	Standard	Allowable limit
Cylinder head				
Adjustment of valve clearance		in (mm)	0.006 to 0.01 (0.15 to 0.25)	-
Cylinder head distortion (Flatness)		in (mm)	0.0020 (0.05 or less)	0.0059 (0.15)
Valve sink	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 angle	Intake	degrees (°)	120	-
	Exhaust	degrees (°)	90	-
Valve seat correction angle		degrees (°)	40, 150	-
Intake valve	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)
	Valve stem bend	in (mm)	-	0.0004 (0.010)
Exhaust valve	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)
	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)	-
	Installation method	-	Cold fitted	-
Valve stem seal projection from cylinder head		in (mm)	0.429 to 0.441 (10.9 to 11.2)	-
Push rod bend		in (mm)	Less than 0.0012 (0.03)	0.0012 (0.03)
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)
Valve spring	Free length	in (mm)	1.4882 (37.8)	-
	Squareness	in (mm)	-	0.0512 (1.3)

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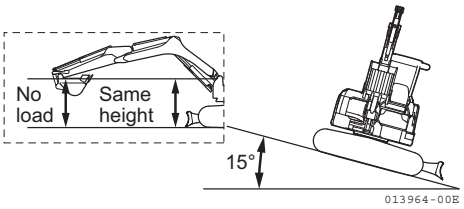
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CHAPTER 4
ENGINE

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Item	Measuring condition	Unit	Standard	Allowable
Machine performance				
Swing drift	Machine position  • Engine: stopped • Hydraulic oil temp.: 122 to 140 °F (50 to 60 °C) • Make the boom and bucket pins the same height. • Park the machine on a slope with an inclination of 15 degrees and turn the upperstructure 90 degrees to the crawler. • Make match marks on the outer race and the inner race of the swing bearing (or the track frame). • Measure shifted distance or angle between both marks after 5 min.	in. (mm)	Engine stop: 0 (0) Engine running: 2.0 (51) or less, 10 degrees or less	-

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Rocker arm shaft outside diameter

Use a micrometer to measure rocker arm shaft diameter. Measure at each rocker arm location in two directions 90° apart **(Figure 4-2-13)**. Record the measurements. *See "3-2 Engine Service Standard" section for the service limit.*

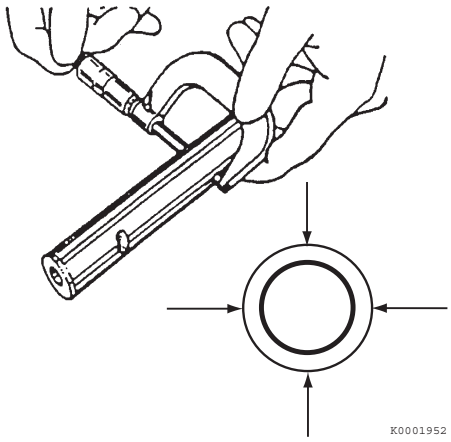


Figure 4-2-13

■ Inspection of valve guides

Visually inspect the valve guides for distortions, scoring or other damage.

Note: Measure valve guides while they are installed in cylinder head.

Use a telescoping gauge and micrometer to measure the inside diameter of the valve guide. Measure in three places and 90° apart **(Figure 4-2-14)**. Record the measurements. *See "3-2 Engine Service Standard" section for the service limit.* Replace valve guides if not within specification.

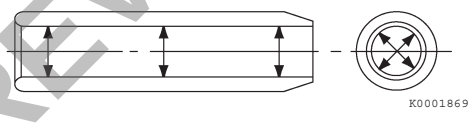


Figure 4-2-14

■ Inspection of cylinder head

Cylinder head distortion

Put the cylinder head flat and inverted (combustion side up) on the bench. Use a straightedge and feeler gauge to measure cylinder head distortion **(Figure 4-2-15)**. Measure diagonally and along each side. Record the measurements. *See "3-2 Engine Service Standard" section for the service limit.*

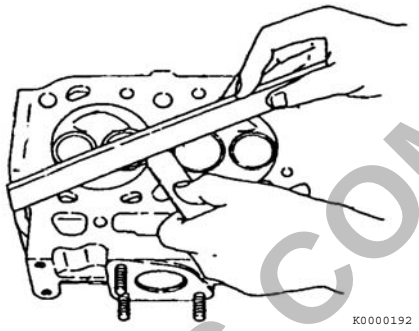


Figure 4-2-15

If distortion exceeds the service limit, resurface or replace the cylinder head. Remove only enough material to make the cylinder head flat, but do not remove more than 0.008 in. (0.20 mm).

■ Inspection of intake and exhaust valves

Visually inspect the intake and exhaust valves. Replace any valves that are obviously discolored, heavily pitted or otherwise damaged.

Valve stem diameter

Use a micrometer to measure the valve stem diameter. Measure the valve stem near the combustion end and near the opposite end **(Figure 4-2-16, (1))**. Record the measurements. *See "3-2 Engine Service Standard" section for the service limit.*

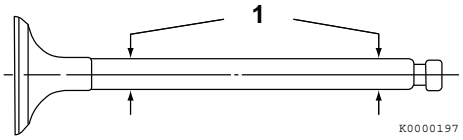


Figure 4-2-16

Valve stem bend

Place the valve stem on a flat inspection block or layout bed. Roll the valve until a gap can be observed between a portion of the valve stem and the surface of the block or bed. Use a feeler gauge to measure the gap **(Figure 4-2-17)**. Record the measurements. *See "3-2 Engine Service Standard" section for the service limit.*

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Checking and Adjusting Fuel Injection Timing

Note: The following procedure is performed on the No. 1 cylinder. While checking and adjusting the timing on only No. 1 cylinder is usually sufficient, the same procedure can be performed on any or all cylinders.

■ Checking Fuel Injection Timing

Note: Some fuel may drain from the fuel injection pump during this process. Make provisions to contain and dispose of any such spillage.

1. Ensure the fuel injection pump is primed with fuel.
2. Clean the area around the fuel injection pump.

   Note: The stop solenoid must be removed to allow fuel to flow through the fuel injection pump.

3. Remove two screws **(Figure 4-3-27, (1))**. Remove the stop solenoid **(Figure 4-3-27, (2))** and O-ring **(Figure 4-3-27, (3))**.

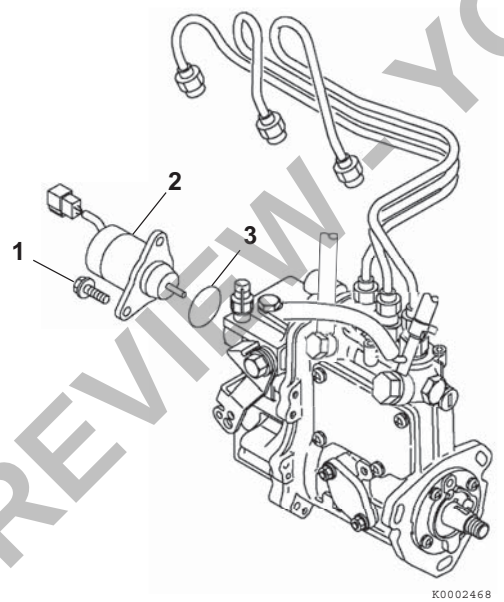


Figure 4-3-27

4. Set the throttle to the HIGH-IDLE position.
5. Using a wrench on the crankshaft pulley bolt, rotate the crankshaft in a clockwise direction while looking through the flywheel inspection port **(Figure 4-3-28, (1))**. Rotate the crankshaft until the injection timing marks on the flywheel are visible for No. 1 cylinder.

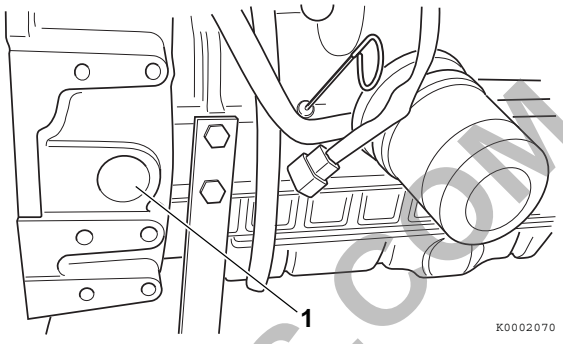
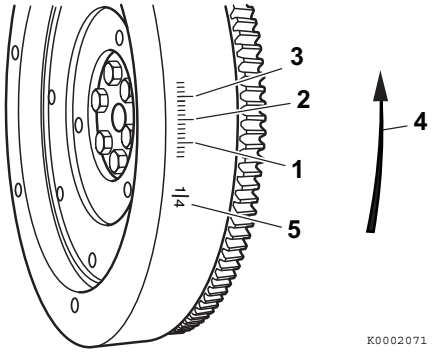


Figure 4-3-28

6. Typical flywheel markings are as shown in **(Figure 4-3-29)**.

   Note: A typical flywheel will have multiple timing grids depending on the number of cylinders. Any grid and its corresponding cylinder can be used to check the fuel injection timing.



1 – 15° BTDC (Before Top Dead Center)
2 – 20° BTDC
3 – 25° BTDC
4 – Direction of rotation
5 – TDC (Top Dead Center)

Figure 4-3-29

7. The flywheel shown in **(Figure 4-3-29)** is for a "Standard Specification" IDI engine. Flywheels used on some "OEM Specific" IDI engines may be marked differently. You should contact that specific OEM for information on the identification of the timing marks.

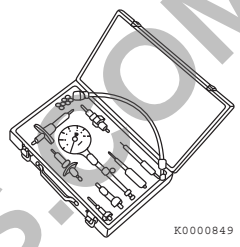
   *Note: The TDC (Top Dead Center) mark can be identified by the cylinder numbers stamped near the TDC mark **(Figure 4-3-29, (5))** on the flywheel.*

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4-9 Failure Diagnosis

4-9-1 Special Service Tools

Compression gauge kit	For measuring compression pressure	 K0000849

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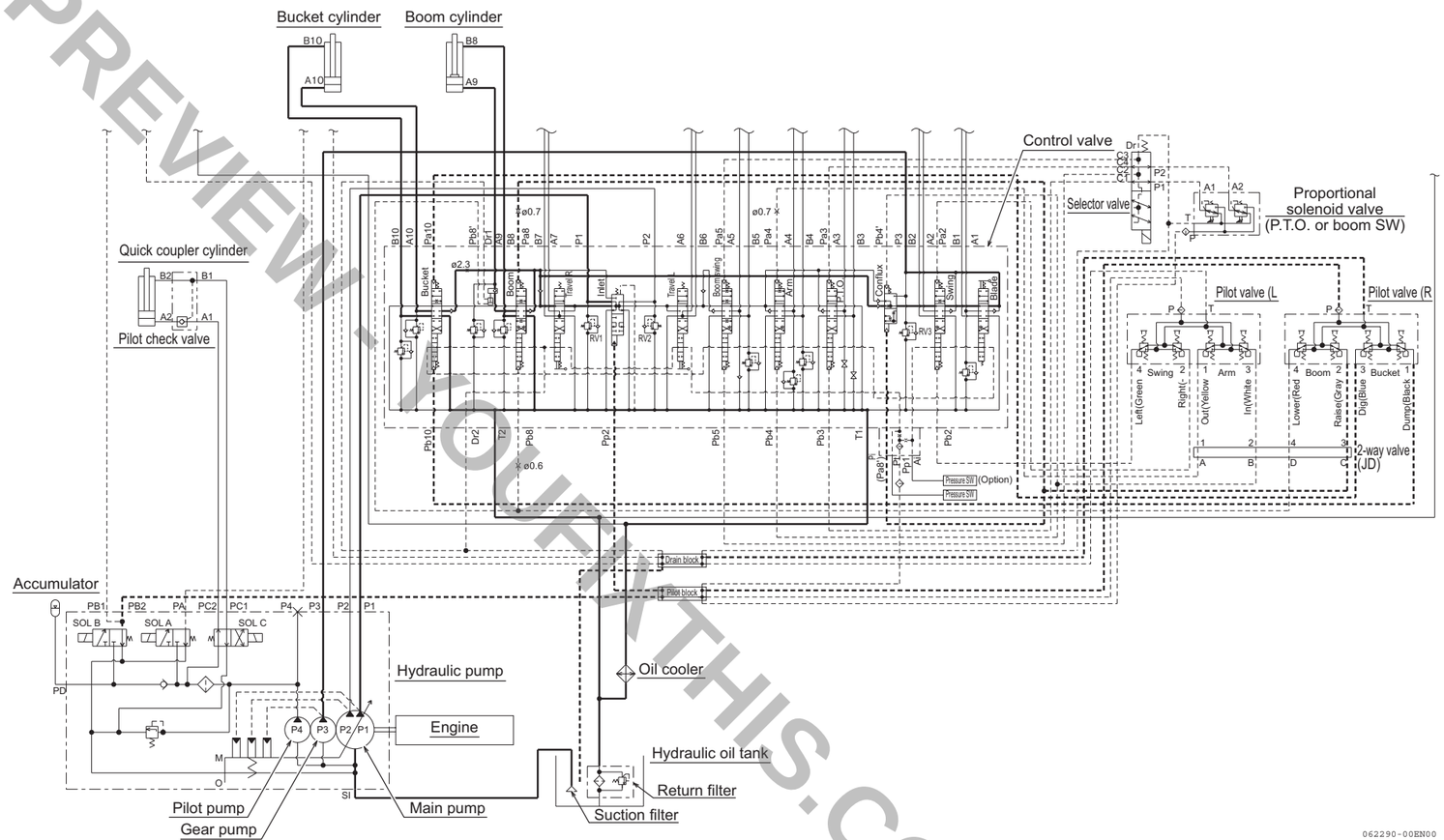
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6-2-10 Simultaneous Operation of Boom Up and Bucket

Oil Flow from Hydraulic Pump

An orifice ([Ø0.09 in. [2.3 mm]]) is installed in the parallel passage to the bucket section so that the oil can flow more smoothly to the boom section when the bucket control lever is moved while the boom with a heavy load is being raised. Therefore, the boom and the bucket can operate simultaneously.

Refer to Section "6-2-1 Boom" and Section "6-2-3 Bucket" for the oil flow with regard to the boom and bucket cylinders.



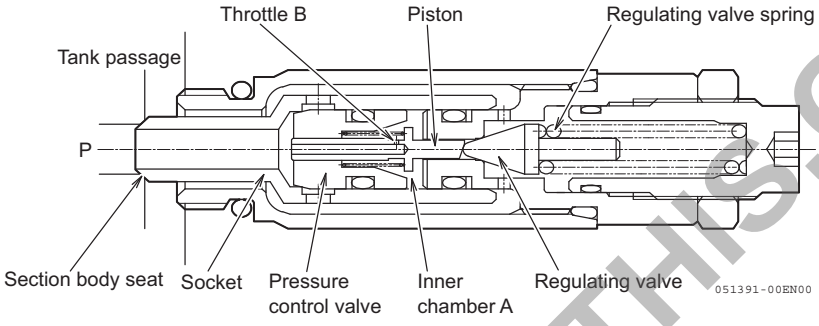
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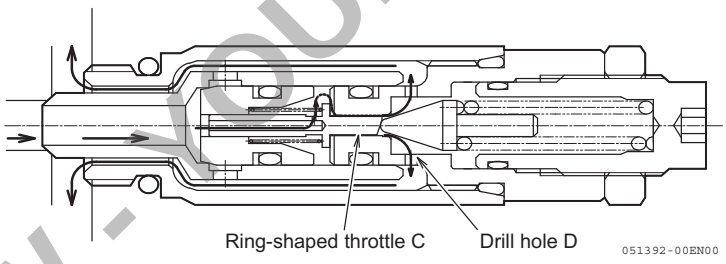
12) System Relief Valves

(1) Relief operation

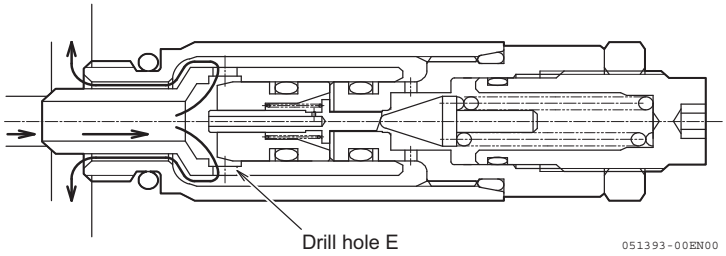
[1] Pressure oil flows through the inside of the piston installed in the pressure control valve (the parent valve) and the throttle B to the inner chamber A, so that it is filled with oil. The pressure control valve and the socket are securely seated, and so are the socket and the section body seat.



[2] When the oil pressure in the port P reaches the set pressure of the regulating valve spring, the pressure oil flows through the piston to the regulating valve to open it.
At this time, the pressure oil passes through the inside of the piston, the throttle B, the inner chamber A, the ring-shaped throttle C and the drill hole D in sequence, and flows outside the socket to the tank passage.



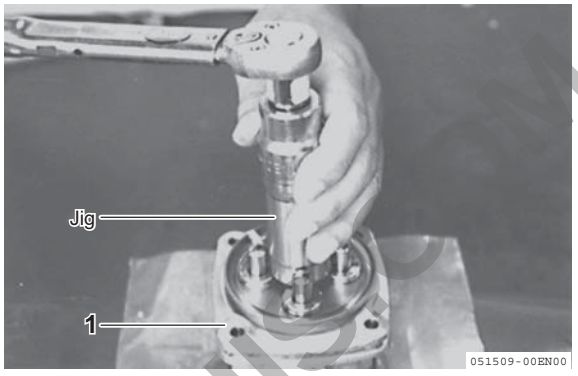
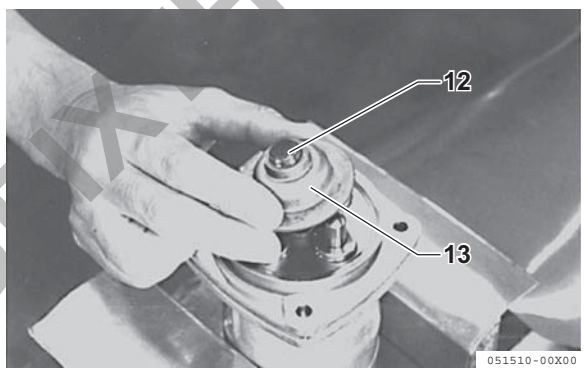
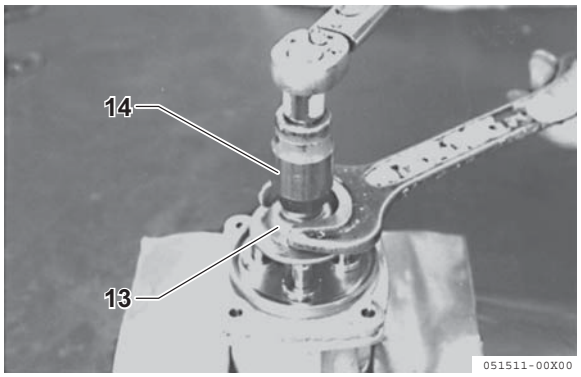
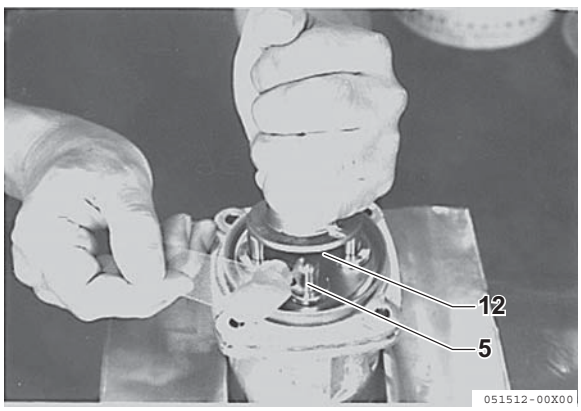
[3] When the regulating valve opens, the pressure in the inner chamber A is lowered, and consequently, the pressure control valve is opened and the pressure oil in the port P flows directly to the tank passage through the drill hole E.



[4] When the pressure in the port P lowers to less than the set pressure of the regulating valve spring, the regulating valve is pressed on the seat with the force of the regulating valve spring and the pressure in the inner chamber A becomes equal to that in the port P. Therefore, the pressure control valve is also pressed on the seat portion of the socket and returned to the original state ([1]).

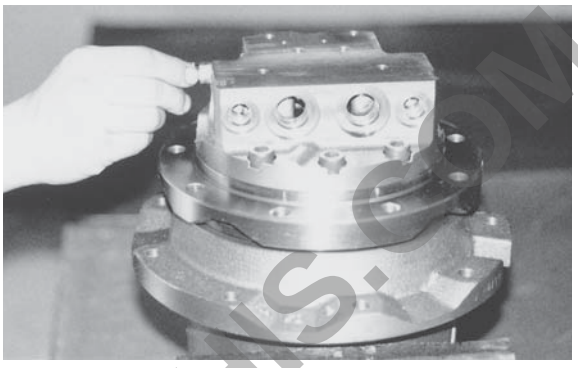
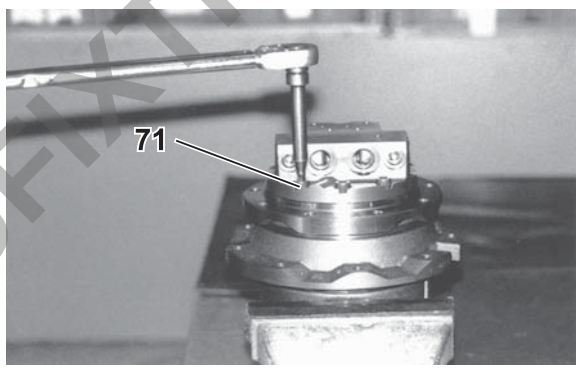
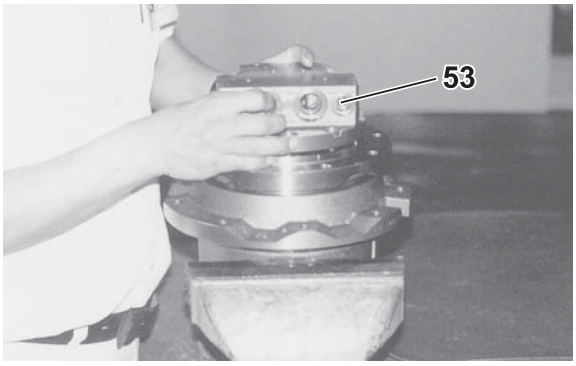
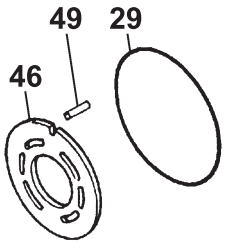
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Procedure	
(10) Using a jig, tighten joint **12** to casing **1** to the specified torque. **Tightening torque:** **32.6 to 36.9 ft•lbf (44.2 to 50.0 N•m)** **Adhesive: Loctite 262**	
(11) Install disc **13** onto joint **12**. ***Notes:*** • *Screw disc **13** onto joint **12** to the point it uniformly contacts four push rods **5**.* • *Screwing disc **13** too much may generate secondary pressure even when the control lever is in neutral, resulting in malfunctions of the machine. To avoid this, be careful not to screw disc **13** beyond the specified point.*	
(12) Install adjusting nut **14**, put a wrench on disc **13** to hold it and tighten adjusting nut **14** to the specified torque. **Tightening torque:** **47.0 to 54.2 ft•lbf (63.7 to 73.5 N•m)** **Adhesive: Loctite 262** ***Note:*** *Make sure that disc **13** is not moved during the tightening of the nut.*	
(13) Apply grease to the rotating portion of joint **12** and the top of push rod **5**.	

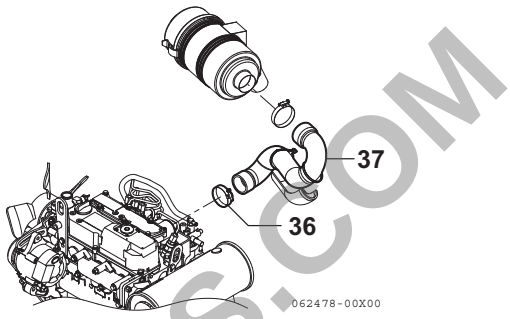
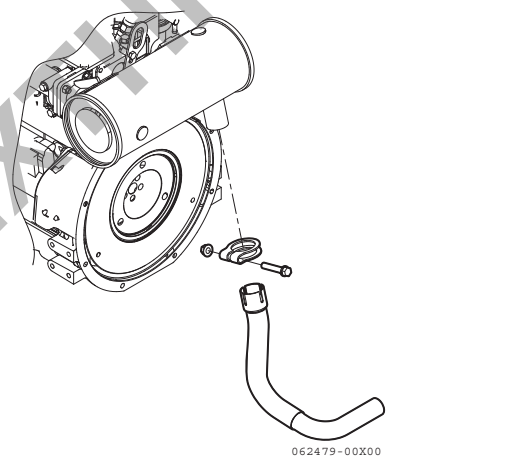
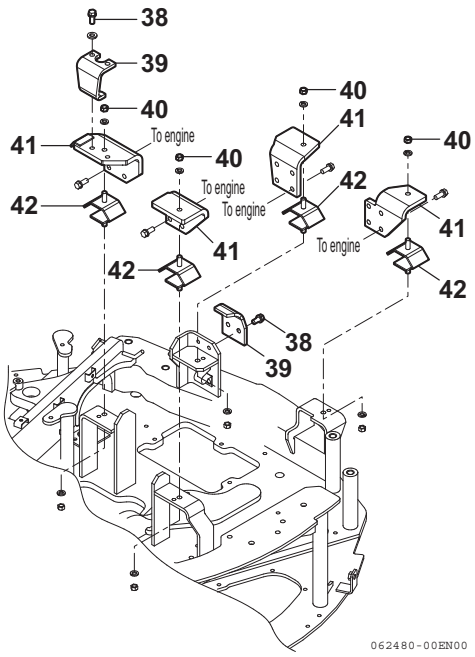
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Procedure	
(9) Remove the spring **68** and the spool **67**. ***Note :*** *Take care not to damage or dent the outside of the spool.*	
(10) Remove the six hexagon socket head bolts **71**. **Tools :** • Torque wrench 3 • Hexagon bit 8	
(11) Remove the base plate **53**. ***Notes :*** • *When the base plate cannot be removed easily, tap it in the pulling-out direction with a plastic hammer. If it is still not be removed, pry it up lightly with a screwdriver.* • *Take care that the cylinder barrel is not pulled out.* **Tools :** • Plastic hammer 13 • Screwdriver 11	
(12) Remove the valve plate **46**, the O-ring **29** and the pin **49**.	

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Procedure	
(27) Loosen hose clamp **36** to disconnect intake hose A **37** from air intake manifold.	
(28) Loosen bolt and nut to remove silencer tail pipe.	
(29) Loosen four bolts **38** to remove two stoppers **39**. (30) Loosen four nuts **40** to separate engine mount plates **41** from anti-vibration rubbers **42**.	

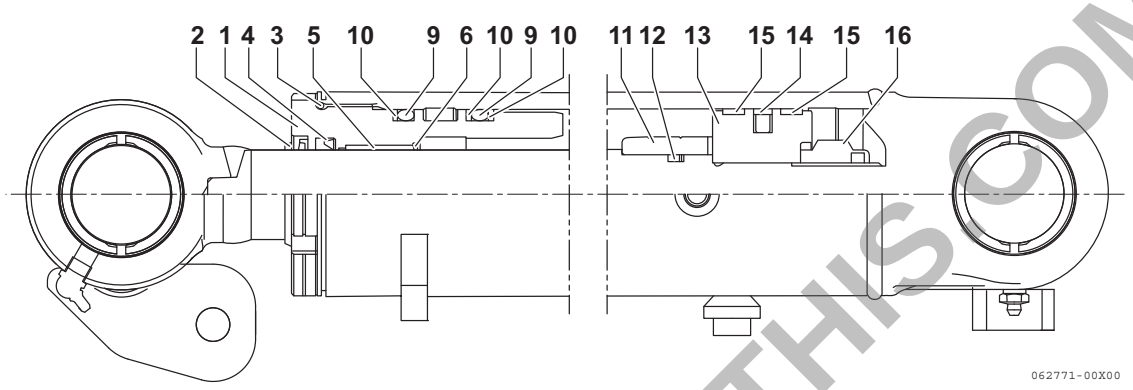
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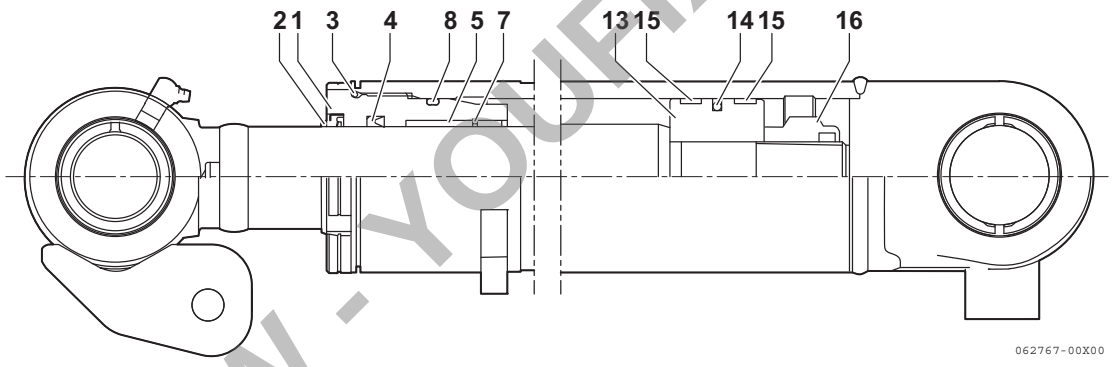
7-5-7 Disassembly and Reassembly of Hydraulic Cylinder

1) Sectional View and Parts

Boom cylinder



Arm, Bucket, Boom swing and Blade cylinders



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