SAFETY PRECAUTIONS

⚠ WARNING

The proper and safe lubrication and maintenance for this machine, recommended by Manufacturer, are outlined in the OPERATOR'S MANUAL for the machine.
Improper performance of lubrication or maintenance procedures are dangerous and could result in injury or death. Read and understand the MANUAL before performing any lubrication or maintenance.

The serviceman or mechanic may be unfamiliar with many of the systems on this machine. This makes it important to use caution when performing service work. A knowledge of the system and or components is important before the removal or disassembly of any component.

Because of the size of some of the machine components, the serviceman or mechanic should check the weights noted in this manual. Use proper lifting procedures when removing any components. Weight of components table is shown in the section ; SPECIFICATIONS.

The following is a list of basic precautions that must always be observed.

(1) Read and understand all Warning plates and decal on the machine before Operating, Maintaining or Repairing this machine.

(2) Always wear protective glasses and protective shoes when working around machines. In particular, wear protective glasses when using hammers, punches or drifts on any part of the machine or attachments. Use welders gloves, hood/goggles, apron and the protective clothing appropriate to the welding job being performed. Do not wear loose fitting or torn clothing. Remove all rings from fingers, loose jewelry, confine long hair and loose clothing before working on this machinery.

(3) Disconnect the battery and hang a "Do Not Operate" tag in the Operators Compartment. Remove ignition keys.

(4) If possible, make all repairs with the machine parked on a firm level surface. Block the machine so it does not roll while working on or under the machine. Hang a "Do Not Operate" tag in the Operators Compartment.

(5) Do not work on any machine that is supported only by lift, jacks or a hoist. Always use blocks or jack stands, capable of supporting the machine, before performing any disassembly.

⚠ WARNING

Do not operate this machine unless you have read and understand the instructions in the OPERATOR'S MANUAL. Improper machine operation is dangerous and could result in injury or death.

(6) Relieve all pressure in air, oil or water systems before any lines, fittings or related items are disconnected or removed. Always make sure all raised components are blocked correctly and be alert for possible pressure when disconnecting any device from a system that utilizes pressure.

(7) Lower the bucket, dozer, or other attachments to the ground before performing any work on the machine. If this cannot be done, make sure the bucket, dozer, ripper or other attachment is blocked correctly to prevent it from dropping unexpectedly.

(8) Use steps and grab handles when mounting or dismounting a machine. Clean any mud or debris from steps, walkways or work platforms before using. Always face to the machine when using steps, ladders and walkways. When it is not possible to use the designed access system, provide ladders, scaffolds, or work platforms to perform safe repair operations.

(9) To avoid back injury, use a hoist when lifting components which weigh 20kg (45lbs) or more. Make sure all chains, hooks, slings, etc., are in good condition and are the correct capacity. Be sure hooks are positioned correctly. Lifting eyes are not to be side loaded during a lifting operation.

(10) To avoid burns, be alert for hot parts on machines which have just been stopped and hot fluids in lines, tubes and compartments.

(11) Be careful when removing cover plates. Gradually back off the last two capscrews or nuts located at opposite ends of the cover or device and carefully pry cover loose to relieve any spring or other pressure, before removing the last two capscrews or nuts completely.

(12) Be careful when removing filler caps, breathers and plugs on the machine. Hold a rag over the cap or plug to prevent being sprayed or splashed by liquids under pressure. The danger is even greater if the machine has just been stopped because fluids can be hot.

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Clearance in thrust direction on arm section

• CX31B

Unit : mm (in)

Sec.	Item		Standard dimensions		Clearance X adjusted with shim (total of both sides)			Remedy	Pin length	
			No.	Dimensions	Standard value	Standard value for repair	Serviceability limit		No.	Dimensions
A-A	Arm point	Arm	L1	140 (5.512)	0.5-2.1 (0.020-0.083)	See "NOTE"		Adjusted with shim	PL1	268 (10.55)
		Bucket		141±0.7 (5.551±0.028)						
B-B	Bucket link	Link side	L2	$140^{-0.2}_{-0.4}$ ($5.512^{-0.008}_{-0.016}$)					PL2	268 (10.55)
		Bucket		141±0.7 (5.551±0.028)						
C-C	Idler link (Connected part of arm)	Arm	L3	140 (5.551)	0.1-0.5 (0.004-0.020)	—			PL3	204.5 (8.05)
		Link side		— (—)						
D-D	Bucket link (Rod side)	Rod side	L4	$55^{0}_{-0.5}$ ($2.165^{0}_{-0.020}$)	Less than 0.5 (0.020)	1.0 (0.039)	1.5 (0.059)		PL5	204.5 (8.05)
		Link side		$56^{0}_{-0.5}$ ($2.205^{0}_{-0.020}$)						
	Bucket link (Idler link side)	Bucket link	L5	$140^{-0.2}_{-0.4}$ ($5.512^{-0.008}_{-0.016}$)	0.1-0.5 (0.004-0.020)	—				
		Idler link		— (—)						
E-E	Bucket cylinder (Head side)	Head side	L6	$55^{0}_{-0.5}$ ($2.165^{0}_{-0.020}$)	0.5-0.9 (0.020-0.035)	1.0 (0.039)	1.5 (0.059)		PL6	153 (6.02)
		Arm		56^{+1}_{0} ($2.205^{+0.039}_{0}$)						
F-F	Arm foot	Arm	L7	$150^{-0.2}_{-0.4}$ ($5.906^{-0.008}_{-0.016}$)	Less than 0.5 (0.020)				PL7	234.5 (9.23)
		Boom		$150^{+0.5}_{0}$ ($5.906)^{+0.020}_{0}$						
G-G	Arm cylinder (Rod side)	Rod side	L8	$60^{0}_{-0.5}$ ($2.362^{0}_{-0.020}$)	0.5-0.9 (0.020-0.035)				PL8	151 (5.94)
		Arm		61^{+1}_{0} ($2.402^{+0.039}_{0}$)						

Note

Clearance X shall be adjusted using shims, if clearance exceeds the standard value for repair.

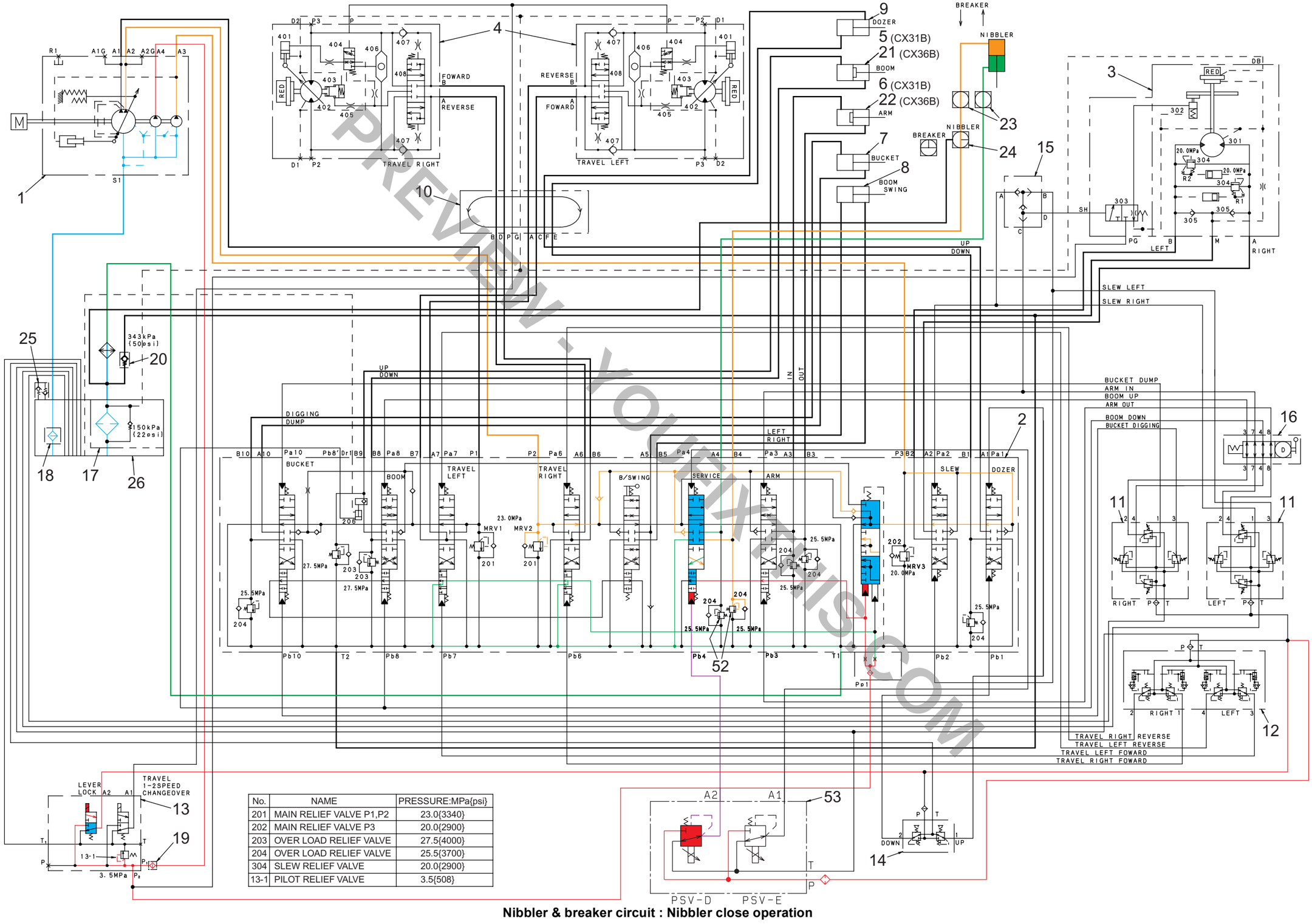
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Model						CX31B		CX36B	
Applicable machines						PW14-46519~		PX15-21105~	
Div.	Item				Unit	Standard value	Repairable value	Standard value	Repairable value
Slew	Slew time per 2–revolution				sec.	13.8±0.7	18	13.8±0.7	18
	Overrun when slewing stops				mm (in)	85^{+10}_{-25}	95	85^{+10}_{-25}	95
	Drift due to gravity					0	—	0	—
Cylinders	Cylinder speed	Boom	Canopy	Ext.	sec.	2.4±0.4	3.1	2.3±0.4	2.9
				Ret.		2.4±0.4	3.1	2.3±0.4	2.9
			Cab	Ext.		2.0±0.4	2.6	2.0±0.4	2.6
				Ret.		2.1±0.4	2.7	2.0±0.4	2.6
		Arm		Ext.		2.6±0.4	3.3	3.1±0.3	4.0
				Ret.		1.6±0.3	2.1	2.0±0.3	2.6
		Bucket		Ext.		2.8±0.4	3.6	2.8±0.4	3.6
				Ret.		1.8±0.3	2.3	1.8±0.3	2.3
		Swing		Ext.		5.4±0.9	6.9	5.4±0.9	6.9
				Ret.		4.0±0.7	5.1	4.0±0.7	5.1
		Dozer		Ext.		3.9±0.5	5.0	3.9±0.5	5.0
				Ret.		3.0±0.4	3.8	3.0±0.4	3.8
	Cylinder Gravity move	(10 min)	Boom		mm (in)	12^{0}_{-12} ($0.47^{0}_{-0.47}$)	24 (0.94)	12^{0}_{-12} ($0.47^{0}_{-0.47}$)	24 (0.94)
			Arm			5^{0}_{-5} ($0.20^{0}_{-0.20}$)	10 (0.39)	5^{0}_{-5} ($0.20^{0}_{-0.20}$)	10 (0.39)
			Bucket			3^{0}_{-3} ($0.12^{0}_{-0.12}$)	6 (0.24)	3^{0}_{-3} ($0.12^{0}_{-0.12}$)	6 (0.24)
			Dozer			3^{0}_{-3} ($0.12^{0}_{-0.12}$)	6 (0.24)	3^{0}_{-3} ($0.12^{0}_{-0.12}$)	6 (0.24)
			Bucket tip			150^{0}_{-150} ($5.9^{0}_{-5.9}$)	300 (12)	150^{0}_{-150} ($5.9^{0}_{-5.9}$)	300 (12)
		(5 min)	Swing			6^{0}_{-6} ($0.24^{0}_{-0.24}$)	12 (0.47)	6^{0}_{-6} ($0.24^{0}_{-0.24}$)	12 (0.47)
Slew bearing	Bucket tip play				mm (in)	60^{+20}_{0} ($2.4^{+0.8}_{0}$)	120 (4.7)	60^{+20}_{0} ($2.4^{+0.8}_{0}$)	120 (4.7)
	Slew bearing play					0.6~1.8 (0.024~0.071)	2.6 (0.10)	0.6~1.8 (0.024~0.071)	2.6 (0.10)
Crawler	Crawler tension		Rubber		mm (in)	70~80 (2.76~3.15)	—	70~80 (2.76~3.15)	—
			Iron			115~130 (4.53~5.12)	—	115~130 (4.53~5.12)	—

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No.	NAME	PRESSURE:MPa{psi}
201	MAIN RELIEF VALVE P1,P2	23.0{3340}
202	MAIN RELIEF VALVE P3	20.0{2900}
203	OVER LOAD RELIEF VALVE	27.5{4000}
204	OVER LOAD RELIEF VALVE	25.5{3700}
304	SLEW RELIEF VALVE	20.0{2900}
13-1	PILOT RELIEF VALVE	3.5{508}

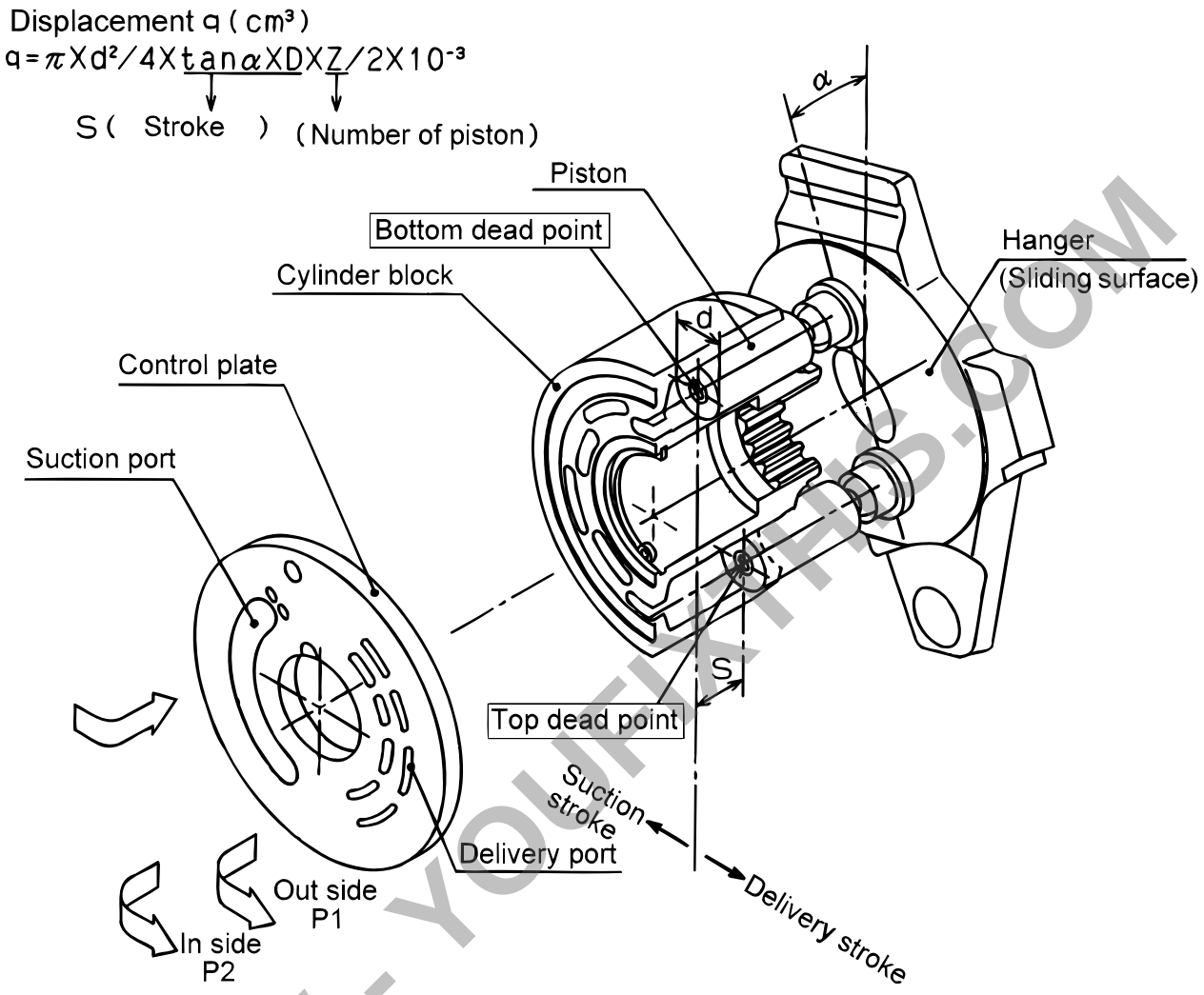
Nibbler & breaker circuit : Nibbler close operation

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(2) Operation

1. Pump operation



a. The cylinder block is fitted on the spline and rotates with the drive shaft.
b. The piston fitted on the cylinder block follows the sliding surface of the hanger and moves back and forth.
c. The piston moves to increase the capacity from the bottom dead point to the top dead point, the pressure oil flows from the inlet port into cylinder block through the control plate. (Suction stroke)
d. But as the piston moves to decrease the capacity from the top dead point to the bottom dead point, the pressure oil is sent out to the delivery port. (Delivery stroke)
e. By changing the tilting angle of the hanger (sliding surface), the displacement varies.
f. The oil sucked from the inside port of the cylinder block is delivered from the delivery port inside of the control valve.
g. The oil sucked from the outside port of the cylinder block is delivered from the delivery port outside of the control plate.

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(4) Operating principle of relief valve

The relief valve is used to decide the driving power and brake force when slewing the hydraulic excavator and each is equipped with main port A and B. And it is constructed so that the relief valve return oil returns in a circuit to the main low pressure line on the other side.

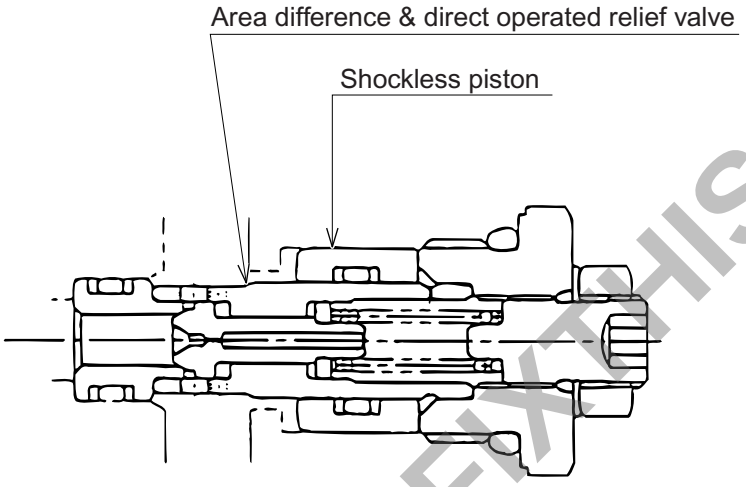
And, it is provided with a shockless function to reduce the shock produced when speeding up or down.

The relief valve is made up of the

a. Area difference & direct operated type relief valve

b. Shockless piston.

The installation of shockless type relief valve is effective for the reduction of the shock, reduction of the stress generated on the structure of the machine.



Construction of relief valve

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Code No. Parts Name Parts No. Use Applicable Machine	Specifications	Description

SW-7

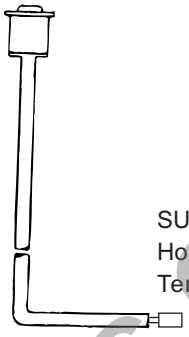
Switch

YN50E01001P2

Horn switch

PW14-45001~
PX15-20001~
PW14-46519~
PX15-21105~

Type	MIYAMA DS-257 OFF-(ON) momentary
Rated	125V 3A (AC)
Insulation resistance	100MΩ or more / 500V Megger



SUMITOMO
Housing 6090-1031
Terminal 8230-4282

SW-9

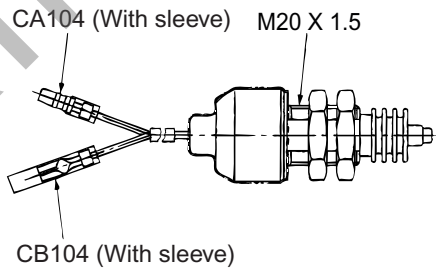
Switch

PA50S00001P1

Lever lock SW.

PW14-45001~
PX15-20001~
PW14-46519~
PX15-21105~

Rated voltage	DC12V
Rated current	15A
Insulation resistance	1MΩ or more
Stroke	Switch ON : 2±1mm, (0.08"±0.04")



SW-10

Switch

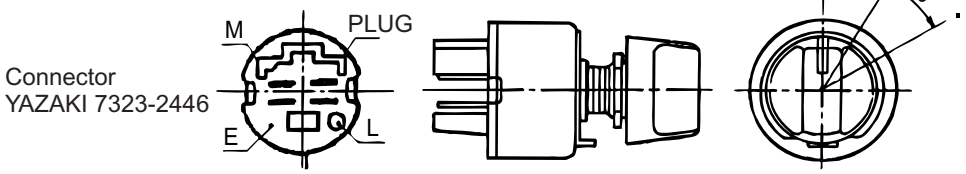
PY50S00003P2

Heater switch
(OPT)

PW14-45001~
PX15-20001~
PW14-46519~
PX15-21105~

Maker's part No.	0850-00595

T / P	E	L	M	Load
OFF	○			
I	○	○		24W
	○	○		
II	○	○	○	24W+80W×3



Connector
YAZAKI 7323-2446

SW-11

Switch

PM50S00005P1

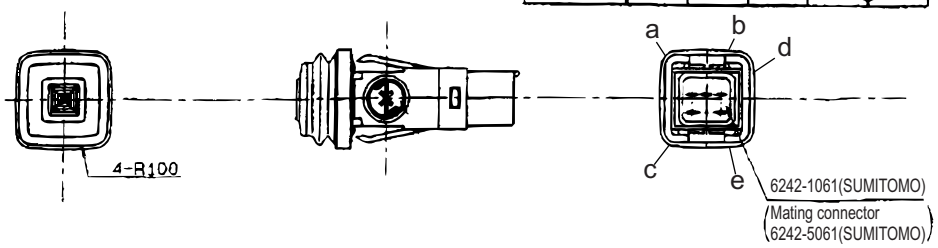
Deceleration switch
(OPT)

PW14-45001~
PX15-20001~
PW14-46519~
PX15-21105~

Rated voltage	DC12V (MAX:DC16V)
Insulation resistance	1MΩ or more(500VMegger)

Connection table

	a	b	c	d	e
FREE		○	○	○	○
PUSH	○	○		○	○



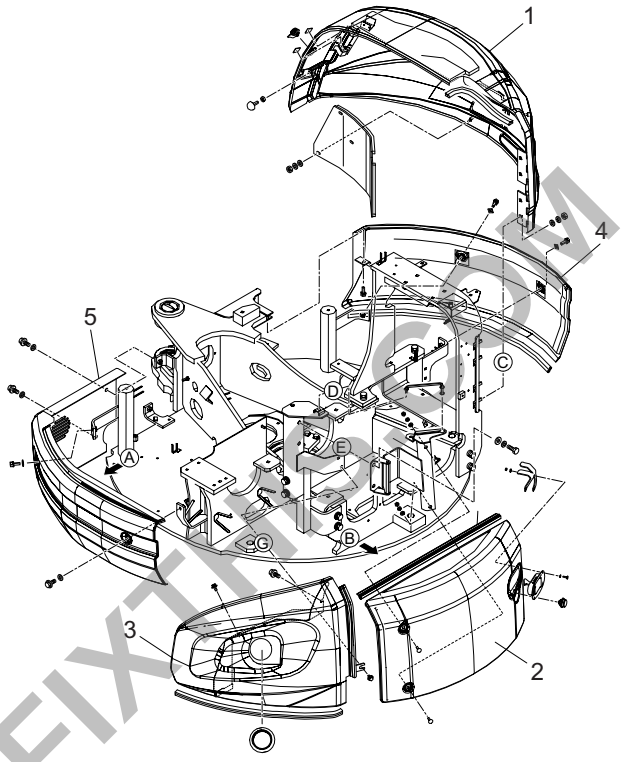
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33.1.2 GUARD (COVER)

33.1.2.1 REMOVAL

- The right figure shows the method for removing the cover of the canopy.

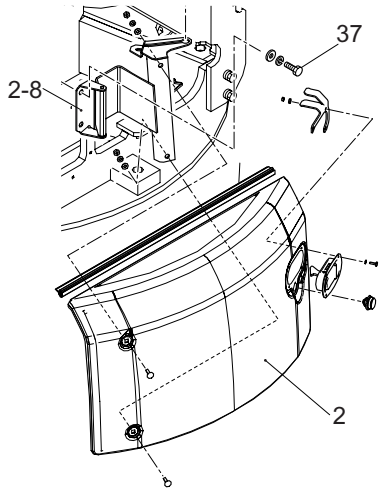


Cover removal

(1) Removing bonnet assembly (2)

Unlock and open the bonnet assembly (2). Loosen two capscrews M12X30 (37) of the hinge section (2-8) to remove the bonnet (2).

Tools: Socket: 19 mm

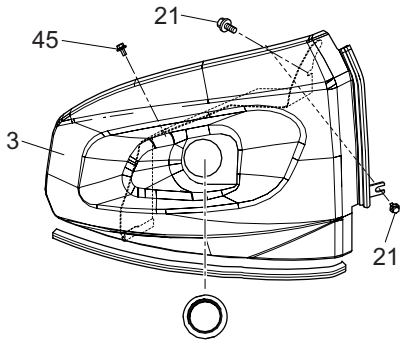


Bonnet assembly (2) removal

(2) Removing cover assembly (3)

Loosen two M8X20 sems-bolts (21) and one M8X25 sems-bolt to remove the cover assembly (3).

Tools: Socket: 13 mm



Cover assembly (3) removal

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33.1.22.3 INSTALLATION

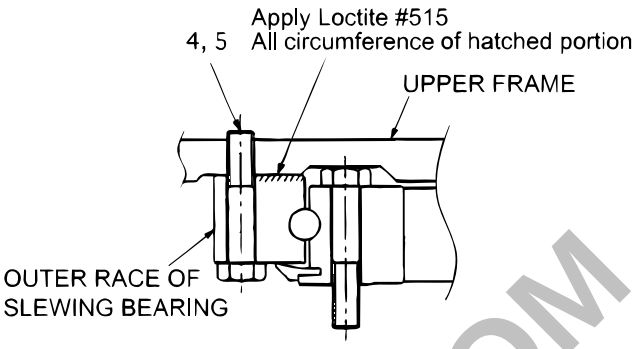
(1) Install the upper frame in reverse order of the removal.

(2) Cleaning contact surface

Clean the bottom surface of the upper frame and the top surface of the slewing bearing.

Fig. "Slewing bearing installation"

-Apply Loctite #515 over the entire circumference of the outer race inside of the capscrew.



Slewing bearing installation

(3) Lifting method

1. Apply wire ropes to the upper frame and lift up horizontally.

2. Check the match marks provided at the disassembly.

3. Slowly lower the upper frame while aligning the match marks and watching the engaging condition between the slewing pinion gear and the internal gear of the inner race of slewing bearing.

(4) Installing slewing bearing and upper frame

1. Apply Loctite #262 on a reamer bolt (5) and fifteen capscrews (4) and temporarily tighten them.

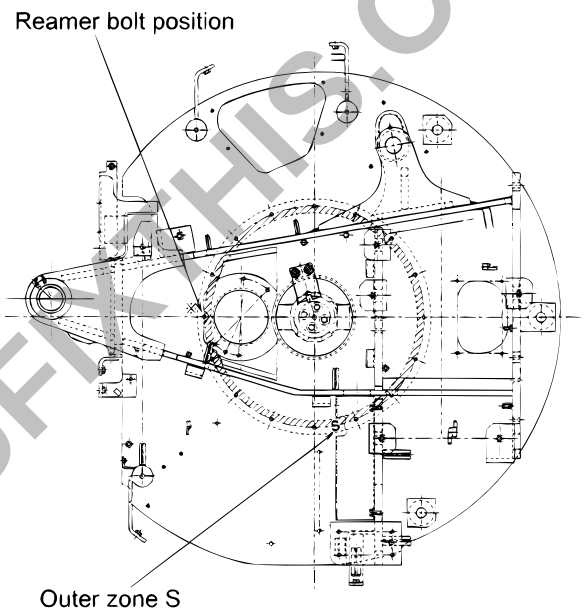
2. Tighten the reamer bolt and capscrews to the specified torque at the front, rear, right and left positions facing each other in order alternately.

Tools: Socket: 19 mm, T=115 N-m (85 lbf-ft)

Apply Loctite #262 to the bolt and capscrews.

3. Fill the grease bath portion surrounding the gear teeth of the slewing bearing with about 2.5 kg (5.5 lbs) of "Lithium grease."

(5) Install the components removed to the original position and check the performance.



Reamer bolt position

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33.2.2.9 Cause of failure and corrective action

(1) When abnormal condition is detected, check on the control valve, pump, cylinder, and motor for abnormality or failure on the circuit.
For that, measure the pilot pressure, delivery pressure of the pump, load pressure, etc. And when a part of them is required to disassemble for checking, follow the procedure of the disassembly and assembly in the above description.

(2) Since dust is very harmful for hydraulic equipment, pay attention to the dust proof.
When a part of them is required to disassemble, before starting the work take a measure for dust protection.

(3) Handle the movable section carefully. Even if there is a slight flaw, repair it with oil stone or replace it. When replaced, clean them.

(4) Handle O-ring, etc. carefully in order not to damage the gasket surface. These flaws will cause oil leakage.

1. Control valve

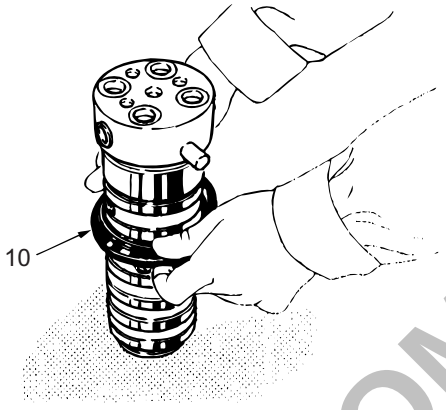
Phenomenon	Cause	Corrective action
1. Each attachment does not function, or the actuation is slow. (Poor power) Or there is no response.section	1. Malfunction of relief valve -Dust caught between pressure regulating valve and seat. * -Dust caught between poppet and seat. * -Pressure regulating valve is stuck. * -Breakage or permanent set in fatigue of spring. * -Loose of adjusting screw 2. Dust caught between the main frame and spool, or stuck	1. Measure the pressure of relief valve -Replace the assembly. * -Replace the assembly. * -Replace the assembly. * -Replace the assembly. * -Readjust it, and tighten the lock nut to the specified torque. 2. Disassemble and clean it. In case of severe flaw, replace the main frame and spool.
2. When spool is placed on the neutral position, the natural drop of the cylinder is large.	1. The space between the main frame of the switching section and the spool is too large. 2. The spool is not returned to the neutral position completely. -Dust caught between the main frame and spool, or stuck -Breakage or permanent set in fatigue of spring 3. Malfunction of ORV Refer to the description marked with *. 4. Malfunction of lock valve -Dust caught in the seat section of the lock valve or needle valve -Stick of the lock valve or needle valve -Dust caught in the throttle of the lock valve	1. Replace spool. 2. Measure pilot secondary pressure. -Disassemble and clean, or when stuck, replace the main frame and spool together. -Replace spring. 3. Measure the pressure of ORV. Refer to the description marked with *. 4. Replace with a new lock valve section assembly (including the lock valve main body).

* In case of abnormality marked with *, do not fail to replace with the new relief valve assembly.

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(4) Remove dust seal (10) from the shaft.



(5) Remove seal, etc. from the inside of the body.
-Be sure of the position of seal, etc. referring to the construction drawing.
-Take out O-ring with the pointed tool like a gimlet.

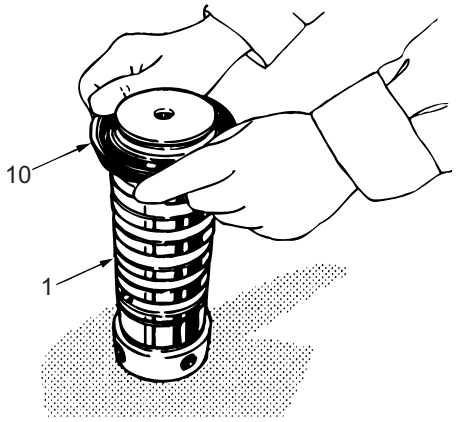


33.2.6.2.3 Assembling

(1) Insert seals in the body.
-Check the seal position referring to the construction drawing.
-Ensure that O-rings are free from twisting.
-Don't deform or bend the slipper seal extremely.



(2) Install dust seal (10) to shaft (1).
-Apply enough grease to the lip section of the dust seal.



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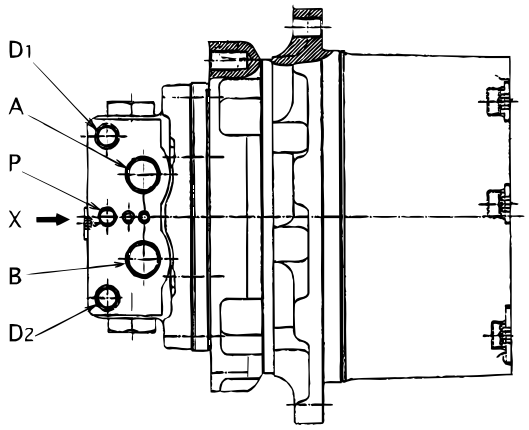
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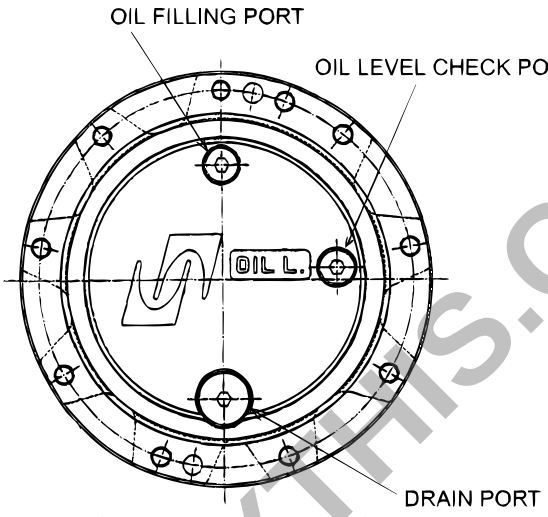
34.2 DISASSEMBLING AND ASSEMBLING

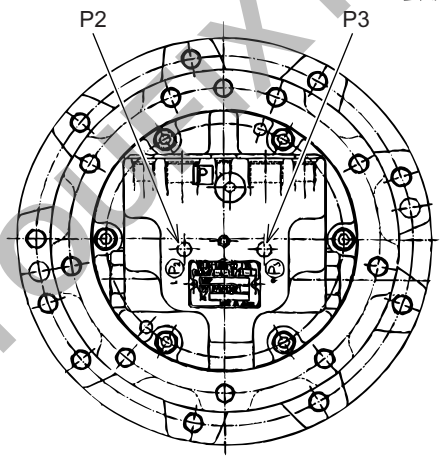
34.2.1 TRAVEL MOTOR

34.2.1.1 SUMMARY

(1) General View





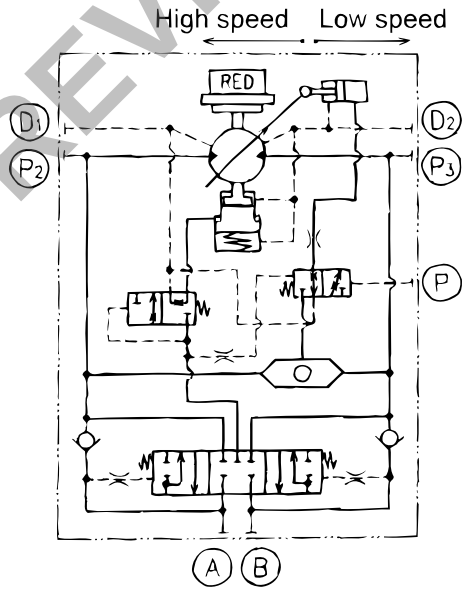


VIEW X

The relation between rotating direction of reduction unit and oil inlet and outlet port (View from X side)

Rotating direction	Oil inlet port	Oil outlet port
Clockwise	A	B
Counterclockwise	B	A

(2) Hydraulic circuit diagram



No.	NAME	SIZE
A	Oil inlet port • Oil outlet port	PF1/2
B		
D1	Drain port	PF1/4
D2		
P	1st/2nd speed select port	PF1/8
P2	Pressure detecting port	PT1/8
P3		

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34.2.1.5 MAINTENANCE STANDARDS

After disassembling GM motor, follow these standards to perform maintenance. Handle every part with care and, in particular, avoid damaging the moving and sliding portions.

(1) Replace any seal (O-ring, oil seal, and floating seal) once used even if no damage is found.

(2) Wear parts maintenance standard

1. Replace any part heavily damaged visually.
2. Replace a part that shows the following abnormalities.

Item No.	Part name	Phenomenon	Standard value(Standard dimension)	Allowable value(Criteria)
(1)	Hub	-Severe visual damage -Pitting recognized on ring gear tooth flank -Abnormal wear such as galling	-	-
(2)	Spindle	-Severe visual damage -Abnormal wear such as galling.	-	-
(3) etc.	Carrier assembly	-Abnormal wear such as galling	-	-
(4) (6) (5) (7)	Sun gear 1 Sun gear 2 Planetary gear 1 Planetary gear 2	-Pitting recognized on tooth flank -Flaking recognized on bearing rolling surface	-	-
(9) (11) (12)	Thrust washer 1 Thrust collar 4 Thrust washer 3	-Sliding surface discolored and/or abnormally worn	-	-
(24)	Main bearing	-Dent recognized -Flaking recognized -Uneven wear recognized	-	-
(27) (28)	Needle roller bearing	-Pitting recognized on roller -Abnormal wear on cage end surface	-	-
(29) (30)	Bearing inner race	-Flaking recognized on bearing rolling surface	-	-
(201)	Rear flange	-Scratch recognized on valve (263) sliding surface	-	-
(102)	Shaft	-Oil seal (132) contacting surface worn -Spline worn	-	-
(103)	Swash plate	-Seizure is recognized	-	-
(104)	Cylinder block	-Spline worn -Bore severely worn -Scratch and uneven wear recognized on timing plate (109) sliding surface	-	-
(105) (106)	Piston assembly Piston Shoe	-Clearance exists between piston (105) and shoe (106) -Abnormal and uneven wear recognized on shoe surface	Clearance 0.05 mm (0.002")	Clearance 0.15 mm (0.006")
(107)	Retainer plate	-Uneven wear recognized on shoe (106) sliding surface -Scratch and uneven wear recognized on thrust ball (108) sliding surface	-	-

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California Proposition 65 Warning

Diesel engine exhaust and some of its constituents are known to the state of California to cause cancer, birth defects, and other reproductive harm.

California Proposition 65 Warning

Battery posts, terminals, and related accessories contain lead and lead compounds, chemicals known to the state of California to cause cancer and reproductive harm.
Wash hands after handling.

PREVIEW - Y

LOCATION OF LABELS

Figure 4-3 shows the location of regulatory and safety labels on Yanmar TNV series engines.

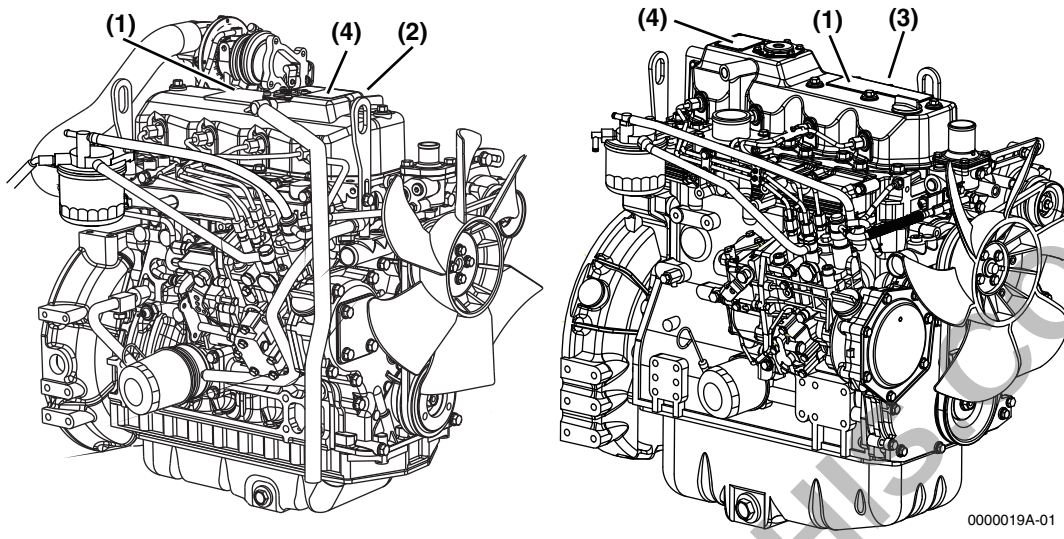


Figure 4-3

Location of labels/nameplates on direct injection model engines

Model	Engine Nameplate	EPA/ARB Certification Label	97/68/EC Emission Control Label
3TNV82A,3TNV84,3TNV84T,3TNV88 3TNV82A-B,3TNV88-B,3TNV88-U 3TNV84T-B	On the top of the locker arm cover(cooling fan end) **Figure 4-3 left, (4)**	On the top of the locker arm cover (flywheel end) **Figure 4-3 left, (1)**	On the exhaust side of the locker arm cover(near the flywheel) **Figure 4-3 left, (2)**
4TNV84,4TNV88,4TNV84T 4TNV88-B,4TNV88-U,4TNV84T-Z	On the top of the locker arm cover(cooling fan end) **Figure 4-3 left, (4)**	On the top of the locker arm cover(flywheel end) **Figure 4-3 left, (1)**	On the exhaust side of the locker arm cover(near the flywheel) **Figure 4-3 left, (1)**
4TNV94L,4TNV98,4TNV98T 4TNV106,4TNV106T 4TNV98-Z,4TNV98-E,4TNV98T-Z	On the top of the locker arm cover(flywheel end) **Figure 4-3 right, (4)**	On the top of the locker arm cover(center) **Figure 4-3 right, (1)**	On the top of the locker arm cover(fan end) **Figure 4-3 right, (3)**

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Item	Nominal Thread Diameter x Pitch	Tightening Torque	Remarks
Pipe Joint Bolt	M8	9 - 12 ft-lb (112 - 148 in.-lb, 12.7 - 16.7 N·m, 1.3 - 1.7 kgf·m)	-
	M10	14 - 19 ft-lb (173 - 225 in.-lb, 19.6 - 18.734 N·m, 2.0 - 3.5 kgf·m)	
	M12	18 - 25 ft-lb (24.5 - 34.3 N·m, 2.5 - 3.5 kgf·m)	
	M14	29 - 36 ft-lb (39.2 - 49.0 N·m, 4.0 - 5.0 kgf·m)	
	M16	36 - 43 ft-lb (49.0 - 58.8 N·m, 5.0 - 6.0 kgf·m)	

Note: Torque values shown in this manual are for clean, non-lubricated fasteners unless otherwise specified.

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Proper operation of the fuel injectors is required to obtain the optimum injection pattern for full engine performance. The EPA / ARB requires that the fuel injectors are inspected, cleaned and tested every 1500 hours. *See Testing of Fuel Injectors on page 7-38*.

This procedure is considered normal maintenance and is performed at the owner's expense. This procedure is not covered by the Yanmar Limited Warranty.

Inspect Turbocharger (Blower Wash as Necessary) - 3TNV84T, 4TNV98T, 4TNV84T, and 4TNV106T, 3TNV84T-Z, 4TNV84T-Z, 4TNV98T-Z

Turbocharger service is required by the EPA / ARB every 1500 hours. Inspect, clean and blower wash the unit if necessary (*see Periodic Inspection on page 10-13*). If you notice that the engine seems sluggish or the exhaust color is abnormal NEVER wait until the next service interval.

Inspect, Clean and Test EGR Valve

4TNV84T-Z, 4TNV98T-E, 4TNV98-Z, 4TNV98T-Z

The EGR valve is a key component for cleaning exhaust gas.

To prevent the valve from deteriorating in exhaust gas recirculation performance due to carbon accumulation, inspect, clean and test the valve at least every 1500 hours.

Consult your local Yanmar dealer for this service.

Inspect and Clean EGR Lead Valve

4TNV84T-Z, 4TNV98T-Z

The EGR lead valve is located in the passage of recirculated gas.

To prevent carbon accumulation in or clogging of the lead valve, inspect and clean the lead valve at regular intervals.

Consult your local Yanmar dealer for this service.

Clean EGR Cooler

4TNV84T-Z, 4TNV98T-Z

The EGR cooler is apt to be contaminated with rust and scale that deteriorate the cooling performance. Carbon accumulation in the exhaust gas passage of the cooler hinders circulation of exhaust gas, resulting in deterioration in exhaust gas cleanup performance.

To prevent such a problem, clean the cooler at least every 1500 hours.

Consult your local Yanmar dealer for this service.

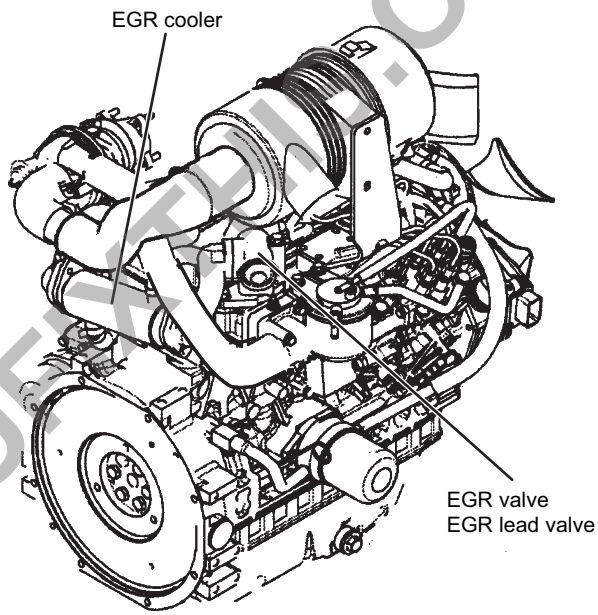


Figure 5-19

Inspect Crankcase Breather System

Proper operation of the crankcase breather system is required to maintain the emission requirements of the engine. The EPA / ARB requires that the crankcase breather system is inspected every 1500 hours.

There are three different crankcase breather systems used on the TNV engines. Only the non-turbo TNV engines crankcase breather system requires periodic maintenance.

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CAUTION

Any part determined to not meet the service standard or limit before the next service, as determined from the state of current rate of wear, should be replaced even though the part currently meets the service standard limit.

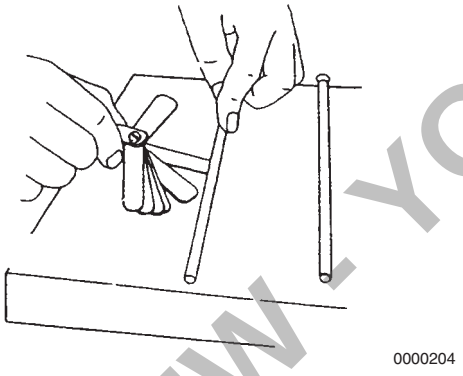
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Inspection of Push Rods

Push Rod Bend

Determine if the bend of the push rods are within the specified limit.

1. Place the push rods on a flat inspection block or layout bed.
2. Roll the push rods until a gap can be observed between a portion of the push rod and the surface of the block or layout bed.
3. Use a feeler gauge to measure the gap **(Figure 6-15)**. *See Push Rod on page 6-9 for the service limit.*



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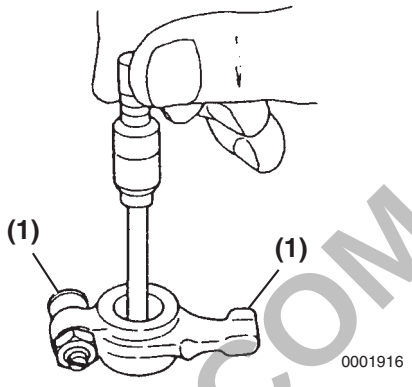
Figure 6-15

Inspection of Rocker Arm Assembly

Rocker Arm Shaft Hole Diameter

Use a test indicator and micrometer to determine if the inside diameter of all the rocker arm support brackets and the rocker arms **(Figure 6-16)** are within the specified limits. *See Rocker Arm and Shaft on page 6-9 for the service limit.*

Inspect the contact areas **(Figure 6-16, (1))** for excessive wear or damage**.**

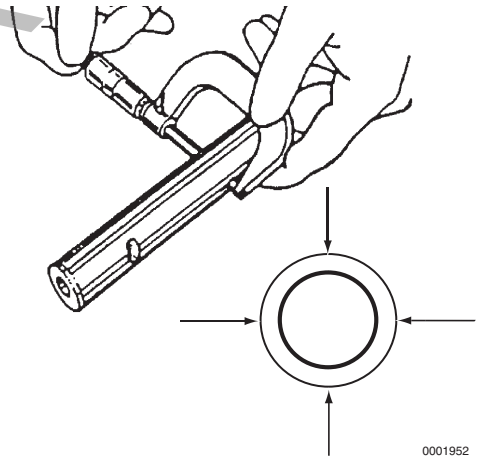


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Figure 6-16

Rocker Arm Shaft Outside Diameter

Use a micrometer to measure the rocker arm shaft diameter. Measure at each rocker arm location in two directions 90° apart **(Figure 6-17)**. *See Rocker Arm and Shaft on page 6-9 for the service limit.*



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Figure 6-17

Inspection of Valve Guides

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

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

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Measure Crankshaft Bearing Oil Clearance

Oil clearance should be checked during disassembly to determine the extent of wear, and during assembly to ensure long engine life. The same procedure is done for both connecting rods and main bearings.

Inspection of Cylinder Block

1. Ensure that oil passages are clear and unobstructed.
2. Check for discoloration or evidence of cracks. If a fracture is suspected, use the color check method or the Magnaflux method to determine if the cylinder block is fractured.
3. Inspect cylinders for roundness, taper, or evidence of scoring. Collect and record the measurements. Consider honing, reboring or replacing the cylinder block if the measurements are not within specification.
   - Take measurements at three places **(Figure 6-113)** (a, b, c), and in two directions (d and e) in each cylinder.

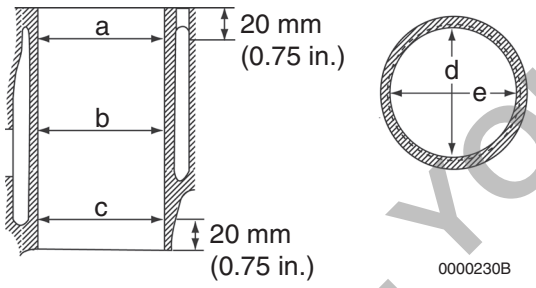


Figure 6-113

Inspection of Pistons, Piston Rings and Wrist Pin

Notes:

- On an engine with low hours, the pistons, piston rings may be reused if they are found to be within specifications. The pistons and piston rings must be reinstalled in the same cylinders from which they were originally removed.
- On an engine with high hours, the pistons rings should be replaced and the cylinder honed *(See Honing and Boring on page 6-88)* or replaced. The piston should be replaced as necessary.

1. Clean piston ring grooves using a piston ring groove cleaning tool. Follow manufacturer's instructions for correct operation.
2. Wash the pistons in an appropriate solvent using a soft brush.
3. Visually inspect each piston for cracks. Pay particular attention to the ring lands between the piston ring grooves.
4. Measure the diameter of the piston skirt at 90° to the wrist pin bore as shown **(Figure 6-114)**. Measurements must be taken at a specified distance **(Figure 6-114, (1))** from the bottom of the piston, based on engine model. Record the measurements. *See Piston on page 6-16 for specifications.*

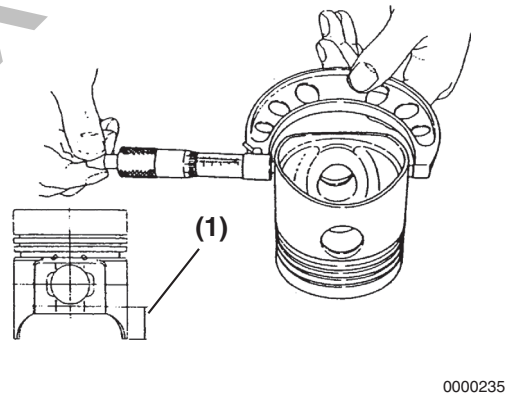


Figure 6-114

5. Subtract the piston measurement from the greatest measurement acquired during cylinder inspection *(see Inspection of Cylinder Block on page 6-83)* to obtain piston-to-cylinder clearance. Record the measurements. *See Piston on page 6-16 for specifications.*
6. Measure the diameter of the wrist pin bore on both sides of the piston **(Figure 6-115)**. *See Piston on page 6-16 for specifications.* Record the measurements.

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1 – High-Pressure Fuel Injection Lines
2 – Fuel Return Line
3 – Return Line-to-Cylinder Head Bolt
4 – Fuel Injector
5 – Injection Line Grommet
6 – Front Plate or Timing Gear Case
7 – Gear Case Cover
8 – Fuel Injection Pump Drive Gear Nut
9 – Lock Washer
10 – Fuel Injection Pump Drive Gear Assembly (DO NOT remove or loosen the four bolts that fasten the injection pump drive gear to the injection pump drive gear hub!)
11 – Coolant Lines for Cold Start Device *
12 – Fuel Injection Pump Insulator
13 – Diesel Fuel Injection Pump
14 – Rear Fuel Injection Pump Support
15 – Fuel Filter / Water Separator
16 – Electric Fuel Supply Pump
17 – Fuel Filter
18 – Fuel Filter Housing
19 – Stop Solenoid *
20 – Cold Start Device (CSD) **
21 – Trochoid Fuel Pump

*: Not used for electronically controlled engines.

**: Electronically controlled engines are equipped with a solenoid valve. As shown in the following figure, electronically controlled engines use an electronically controlled governor combined with a solenoid valve (CSD), rack actuator, engine speed sensor, and other parts.

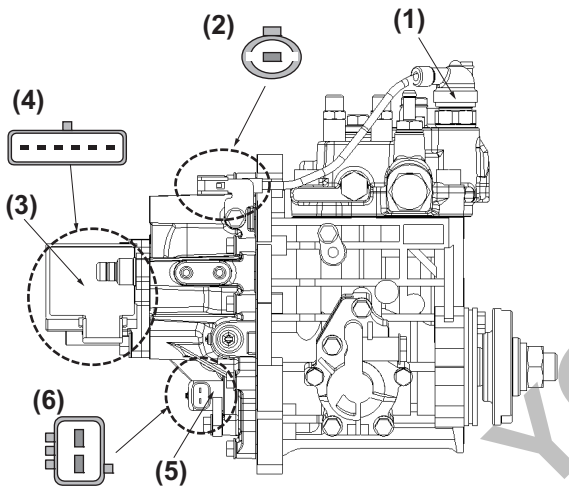


Figure 7-7

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BEFORE YOU BEGIN SERVICING

⚠ WARNING



ENTANGLEMENT HAZARD!

- Stop the engine before you begin to service it.
- NEVER leave the key in the key switch when you are servicing the engine. Someone may accidentally start the engine and not realize you are servicing it. This could result in a serious injury.
- If you must service the engine while it is operating, remove all jewelry, tie back long hair, and keep your hands, other body parts and clothing away from moving / rotating parts.
- Failure to comply could result in death or serious injury.

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⚠ WARNING



BURN HAZARD!

- Keep your hands and other body parts away from hot engine surfaces such as the muffler, exhaust pipe, turbocharger (if equipped) and engine block during operation and shortly after you shut the engine down. These surfaces are extremely hot while the engine is operating and could seriously burn you.
- Failure to comply could result in death or serious injury.

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⚠ 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.

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STARTER MOTOR

⚠ WARNING



SHOCK HAZARD!

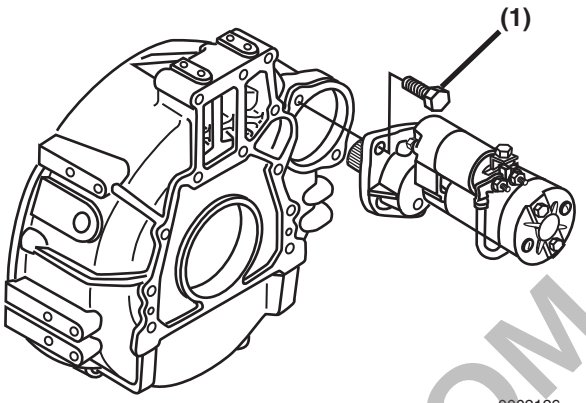
- **Turn off the battery switch (if equipped) or disconnect the negative battery cable before servicing the electrical system.**
- **Check the electrical harnesses for cracks, abrasions, and damaged or corroded connectors. ALWAYS keep the connectors and terminals clean.**
- **Failure to comply could result in death or serious injury.**

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Note: While starter motor design varies between models, the basic repair procedures are the same. The following procedures are typical and may differ from the stater being serviced.

Removal of Starter Motor

1. Disconnect the battery cables at the battery, negative (-) cable first.
2. Remove the electrical wires from the magnetic switch assembly.
3. Remove the starter mounting bolts **(Figure 11-2, (1))**. Remove the starter motor from the flywheel housing.

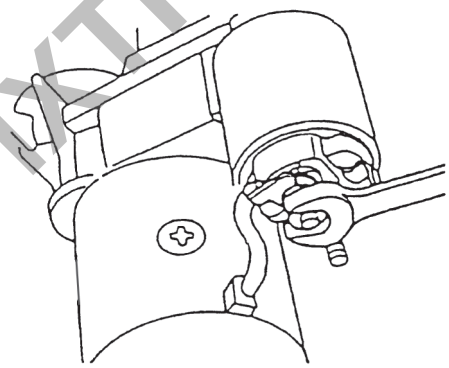


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Figure 11-2

Disassembly of Starter Motor

1. Loosen the M8 nut from the magnetic switch (solenoid) assembly **(Figure 11-3)**. Disconnect the wire from the magnetic switch.



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Figure 11-3

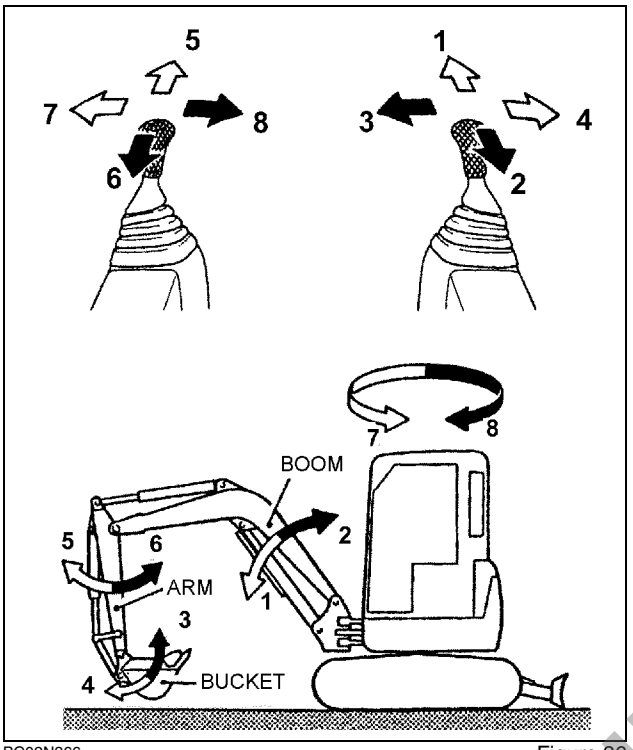
2. Remove the two M4 bolts **(Figure 11-4, (1))** securing the rear cover **(Figure 11-4, (2))** to the brush holder assembly **(Figure 11-4, (3))**.

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Symptoms and conditions of failure / Possible causes		Starting failure					Engine stall after start up			Speed control error						Engine output low			Noise and vibration					Lubricating oil				Cooling water		Intake air		Exhaust gas				Fuel			Electrical parts					Corrective Action	Referenced page number
		Starter does not rotates		Starter rotates			Smoke				No load				Workload	Smoke color																	Workload												
		ECU failure lamp does not go on immediately after turning on the key	ECU failure lamp goes on immediately (within 2 seconds) after turning on the key	Engine does not start up (without initial ignition)	Engine does not start up (it stops immediately after initial ignition)	It takes longer than before to start up engine	None	Slight	Remarkable	Revolution speed cannot be changed with accelerator (stays at a constant speed)	Cannot be set to particular speed	Poor acceleration	Does not smoothly return to low speed	Hunting occurs	Hunting occurs	Normal	White	Black	High knocking sound at combustion time	Uneven combustion sound	Abnormal sound (other than combustion sound) from engine	Engine vibrates heavily	Too much lubricating oil consumed	Lubricating oil diluted with fuel	Lubricating oil mixed with water	Oil pressure low (oil pressure warning lamp lit)	Overheat (water temperature warning lamp lit)	Water temperature low	Pressure low (air cleaner warning lamp lit)	Pressure high	White exhaust gas	Black exhaust gas	Too much blow-bye	Exhaust gas temperature high	Too much fuel consumed	Fuel mixed with water (oil-water separator warning lamp lit)	Fuel filter fouled shortly	Battery charge error (charge lamp lit)	ECU failure lamp flashes	ECU failure lamp stops flashing immediately (within 2 seconds) after turning off the key	Specific ECU control functions fail.	Fuses get blown or broken (repeatedly)		
Electrical system	Fuse blown or broken	○	○				○																																●	Replace the fuse.	
	Starter faulty		○	○																																				Repair or replace the starter.	See "Starter" (on page 11-9).
	Alternator faulty			○																																		○				Repair or replace the alternator.	See "Removing the Alternator" (on page 12-12).
	Wires disconnected	○	○	○			○																															○	○	○	○		Repair or replace the disconnected wire(s) of the harness.	
	Wires short-circuited (sheathing broken); overloaded by the power consumption by additional devices	●																																								●	Inspect, repair, or replace the harnesses and wires as needed. Reexamine the additional devices.	
	Battery voltage low		○	○																																		–				Inspect and charge the battery.	See "Inspecting the Electrolyte Level and Charging the Battery" (on page 5-23).
	Key switch faulty or disconnected	○					○																																	○			Repair or replace the harness. Replace the key switch.	
	Key switch instantly cut off				○		○																																				Replace the key switch.	
	Starter relay faulty, disconnected, or short-circuited		○																																								Repair or replace the harness. Replace the starter relay.	
	Main relay faulty (except for sticking of the contact, which is undetectable by ECU)	○																																							○		Repair or replace the harness. Replace the main relay.	
	Actuator relay faulty (contact failure undetectable by ECU)		?	?			○																																				Replace the actuator relay.	
	Start assist relay faulty (contact failure undetectable by ECU)			○		○													●													△												Replace the start assist relay.	
	Accelerator sensor signal error (an error undetectable by ECU)									○			○	○						○																								Repair or replace the accelerator sensor.	
	Water temperature sensor signal error (an error undetectable by ECU)			○		○							●	●					●																								Replace the water temperature sensor.	
	Speed sensor signal error (an error undetectable by ECU, such as caused by noise)				○	●	○						○	○						○																								Repair or replace the fuel injection pump.	Monitor the engine speed using the diagnosis tool.
	Rack position sensor signal error (an error undetectable by ECU)					●	○					●	○	○						○																								Repair or replace the fuel injection pump.	Monitor the rack position sensor signal using the diagnosis tool.
	Rack actuator malfunctioning (an error undetectable by ECU)					●	○					●	○	○						○																								Repair or replace the fuel injection pump.	Monitor the rack actuator using the diagnosis tool.
	ECU failure lamp disconnected																																								○			Replace the lamp. Repair or replace the harness.	
	ECU faulty (ECU self diagnosis failure)	○	○							○																														○	○		Replace the ECU.	

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2. LEFT-HAND CONTROL LEVER (SAE Pattern)
3. RIGHT-HAND CONTROL LEVER (SAE Pattern)



BC02N366 Figure 36

1. BOOM DOWN (RIGHT-HAND CONTROL LEVER)
2. BOOM UP (RIGHT-HAND CONTROL LEVER)
3. BUCKET IN (RIGHT-HAND CONTROL LEVER)
4. BUCKET OUT (RIGHT-HAND CONTROL LEVER)
5. ARM OUT (LEFT-HAND CONTROL LEVER)
6. ARM IN (LEFT-HAND CONTROL LEVER)
7. ROTATION LEFT (LEFT-HAND CONTROL LEVER)
8. ROTATION RIGHT (LEFT-HAND CONTROL LEVER)

These two levers activate each operation shown in the illustration.

All functions can be activated simultaneously.

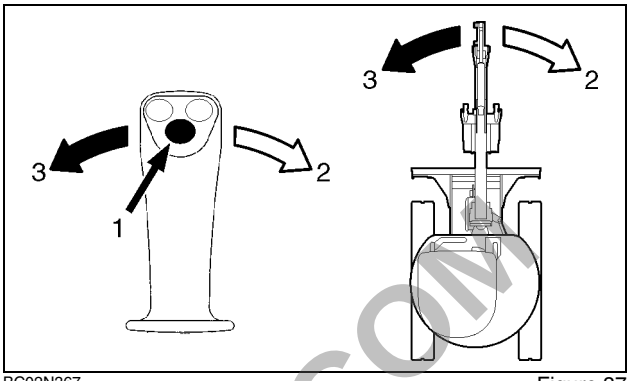
The operator's control levers return to the neutral position when released, and the operation of attachment is stopped.

WARNING: *Confirm for safety around the working area. Also ensure that each lever operation is in accordance with the operating pattern indicated on the labels.*

If labels do not match the operator's control pattern, replace them immediately to avoid accidents and/or injury.

CE-NA000

Boom Swing Function Switch



BC02N367 Figure 37

1. BOOM SWING/REMOTE CONTROL SWITCH
2. RIGHT-HAND SWING
3. LEFT-HAND SWING

Operate the control lever right and left keeping the switch on the grip of the left-hand control lever pressed, and the boom swings right and left

1. Switch . . . . . Pressed (ON)
2. Operate lever right . . . . . Right-hand boom swing
3. Operate lever left . . . . . Left-hand boom swing

IMPORTANT: *The swing operation does not stop even if the switch is turned off during the swing operation. To switch from boom swing to upperstructure swing the left control lever must return to the neutral position.*

WARNING: *Because the boom swing operating range is wide, carefully operate the attachment paying attention to the surrounding conditions.*

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HYDRAULIC SYSTEM

SERVICE SPECIFICATIONS

Capacity of the hydraulic reservoir ..... 38 liters (10 gal)
Total system capacity ..... 48 liters (12.7 gal)
Hydraulic fluid type ..... Case Akcela Hy-Tran Ultra (MS 1209)

Torque Specifications
- Cap screws(4) for hydraulic reservoir air filter ..... 23.5 ± 2 Nm (17.3 ± 1.5 lb-ft)
- Cap screws(4) for hydraulic return filter ..... 23.5 ± 2 Nm (17.3 ± 1.5 lb-ft)

10 hours
- Check the hydraulic reservoir fluid level ..... Every 8 hours or each day
- Check the hydraulic system lines ..... Every 8 hours

500 hours
- Replace the return filter ..... Every 500 hours (After the first 50 hours during the run-in period)

2000 hours
- Clean the filter for the pilot valve ..... Every 2000 hours
- Clean the inline filter for the solenoid valve ..... Every 2000 hours
- Clean the suction strainer ..... Every 2000 hours
- Change the hydraulic fluid ..... Every 2000 hours

4000 hours
- Replace the hoses ..... Every 2 years or every 4000 hours (whichever comes first)

NOTE: *If the machine is new or if a major component has been overhauled or replaced in the hydraulic system, replace the return filter after 50 hours of operation. After that, replace these filters at the regular interval.*

IMPORTANT: *After replacing the hydraulic fluid, it is necessary to bleed all air from the hydraulic components. See Bleeding air from the hydraulic components.*

IMPORTANT: *If metal filings are discovered in the replaced filters, see your Dealer.*

WARNING: *Before carrying out any operation on the hydraulic filters or the hydraulic system, the pressure must be released from the system. Failure to observe this instruction can cause injury. See Releasing Pressure In The Hydraulic System.*

CE-NA000

WARNING: *Before carrying out any service work on the hydraulic system it is necessary to allow it to cool down (the temperature should not be more than 40°C (104°F).*

CE-NA000

WARNING: *Hydraulic fluid or grease injected into your skin can cause severe injury or death. Keep your hands and body away from any pressurized leak. Use cardboard or paper to check for a leak. If fluid is injected into your skin, see a doctor immediately and have the fluid removed.*

CE-NA000

HYDRAULIC BREAKER

When using the hydraulic breaker, hydraulic fluid deteriorates more quickly than during standard digging. Check the hydraulic fluid level more frequently. In addition, when replacing the filters, also check the condition of the hydraulic fluid.

CHECKING HYDRAULIC SYSTEM LINES

Make sure there are no leaks from the hydraulic system hoses, tubes, plugs, connections, and fittings. Make sure all nuts and screws are tightened. Correct any problems discovered.

IMPORTANT: *Release the pressure in the hydraulic system before doing any maintenance work on the hydraulic system (Hydraulic fluid change, filter changes, strainer cleaning, cylinder repair, etc.).*

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