WSM

WORKSHOP MANUAL
KUBOTA EXCAVATOR

U15-3

Kubota

Code No.97899-61270

Record of Revisions

Symbol	Date	Main Revised Points & Corrective Measures	Person-in-charge
1			
2			
3			
4			

CONTENTS

I Product engineering section

A.Developing concept and feature

a. Objective and Concept of Development

1 Objective of Development

Development of products which go ahead of competitive companies in terms of reduced manufacturing costs while reinforcing the performance in horizontal operability, workability, durability, comfort and safety.

2 Product Concept

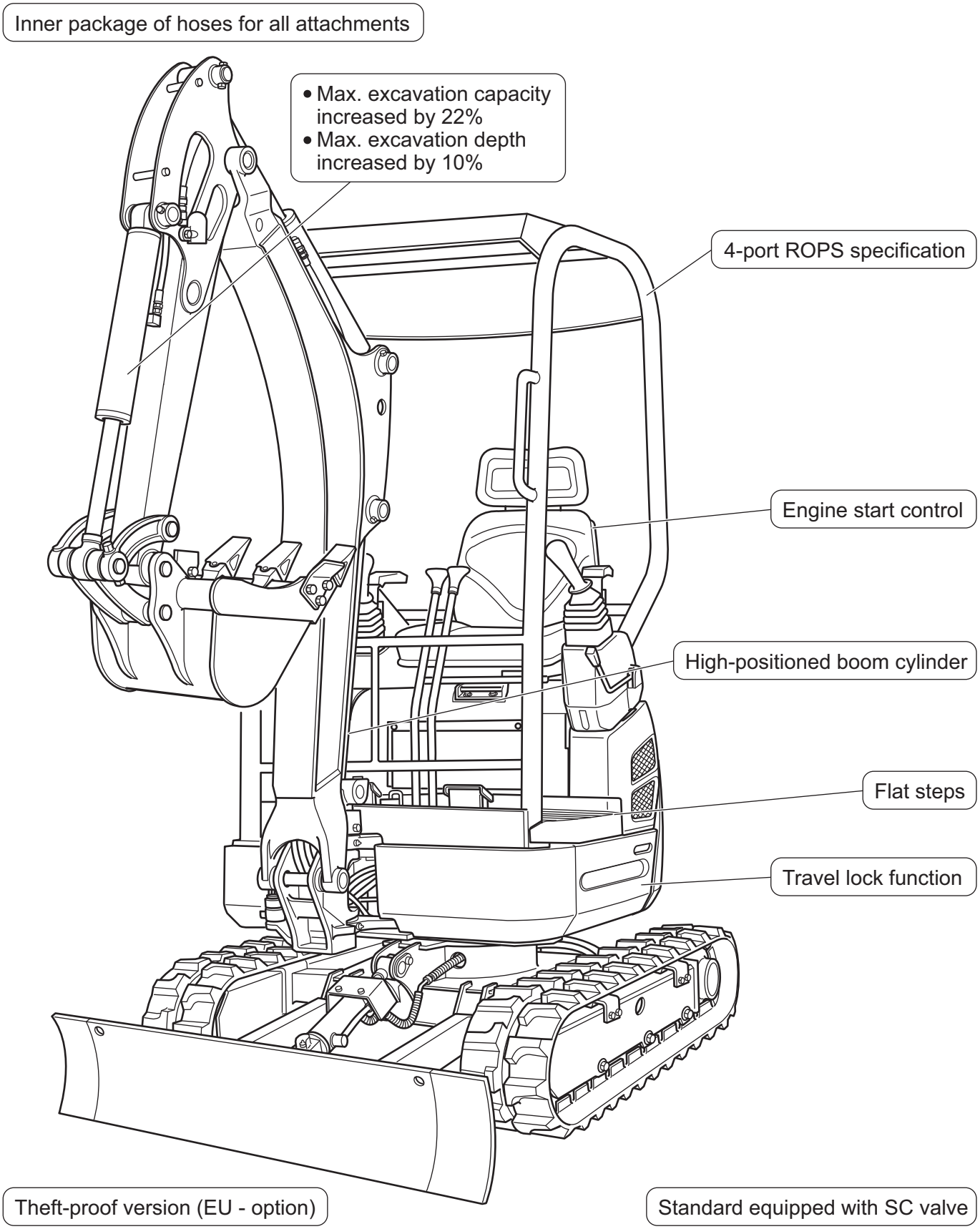
Integration of the world's best actual performance of backhoe and the spirit of innovation.

b. Main Specifications

model			U15-3	U-15
Engine	Brand		KUBOTA	KUBOTA
	Type		D782-EBH-4	D782-BH
	Output	PS/rpm	13/2300	12/2100
		kW/rpm	9.6/2300	8.8/2100
	Displacement	cm^3	778	778
Machine weight		kg	1600	1450
Excavating capacity	Bucket	kN (kgf)	15.2 (1550)	12.5
	Arm	kN (kgf)	8.8 (900)	8.5
Hydraulic pump P1, P2	Relief pressure	kg/cm^2	220	210
	Pump discharge rate	L/min	16.6	15.1
P3	Relief pressure	kg/cm^2	190	210
	Pump discharge rate	L/min	10.4	9.5

c. Major Selling Points and Improvements

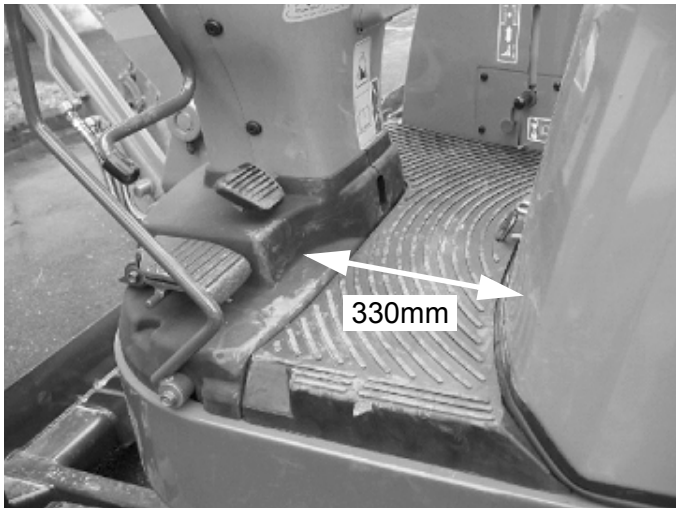
1. Quick chart



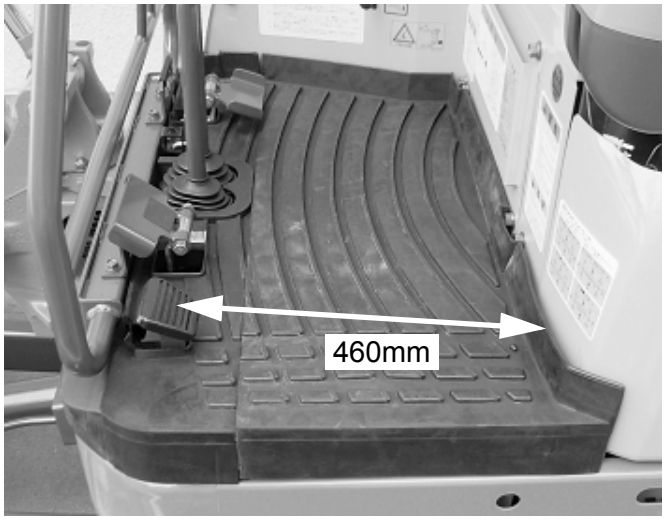
2. Wrist arm control lever

3. Enlarged foot space

U-15 (Previous model)



U15-3 (New model)



4. Upper positioned boom cylinder

5. Inner package of hoses for front attachments

6. Engine start control, Travel lock function

Unloading lever : UP

Engine start	:	○
Front attachment, traveling	:	×

Unloading lever : DOWN

Engine start	:	×
Front attachment, traveling	:	○

7. 4-post ROPS

The equipment is of European specifications.

8. Machine equipped with theft-proof device (Future EU option)

Starter key set

9. Side-opening type full-open hood

U-15 (Previous model)

U15-3 (New model)

Paint color and equipment are of European specifications.

d. Evaluation of Competitive Power with Competitors

1. Workability

Offence	Defense	Item	U15-3	Current U-15	KOMATSU PC15MR	YANMAR Vio15	SCM 301.5CR	Appealing point in sales
	○	Increase in engine output	**9.6**	8.8	11.2	8.5	11.3	We will appeal such a point that the max. excavation capacity and max. excavation depth which are the basic performances of excavating machine take a lead over those of our existing machines as well as competitive companies' machines.
○		Max. excavation capacity increased by 22%	**15.2**	12.5	14.2	13.7	14.4	
○		Max. excavation depth increased by 10%	**2310**	2100	2155	2100	2170	
○		Max. vertical depth increased by 11%	**1900**	1720	1870	1750	1720	
	○	Max. excavation radius increased by 5%	**3900**	3720	3900	3720	3800	
	○	Travel 2-speed traction force increased by 5%		-	-	-	-	
	○	Travel 2-speed speed increased by 8%	**2.2/4.3**	2.0/4.0	2.3/4.3	2.1/4.3	2.3/4.0	
	○	Swiveling force increased by 12%		-	-	-	-	

2. Durability

Offence	Defense	Item	U15-3	Current U-15	KOMATSU PC15MR	YANMAR Vio15	SCM 301.5CR	Appealing point in sales
○		Boom cylinder Protection of cylinder by high-positioning	○	x	x	x	x	As the greatest differentiation from competitive companies' products, we will appeal such a point that loading work can be performed without hassle. This is because the machine can be brought close to a 2-ton dump truck without damage to the boom cylinder during loading work. Such job is found often with machines of this class. We will also appeal such a point that the machine is equipped with the inner package of hoses for all attachments which gives no damage to cylinder.
○		Protection by inner package of hoses for all attachments	○	Δ	Δ	x	x	
	○	Standard equipped with tension spring	○	x	○	○	○	
	○	Double-grouser type iron crawler <For domestic market only>	○	x	-	-	○	
	○	Introduction of high-back and integrated seat	○	x	○	○	○	
	○	Prevention of water entry by enclosed hydraulic oil tank	○	x	-	-	-	
	○	Equipped with starter automatic release function	○	x	-	-	-	
	○	Boom cast steel members	○	x	○	x	x	
	○	High-tensile brass bush	○	x	○	-	-	

3. Operability

Offence	Defense	Item	U15-3	Current U-15	KOMATSU PC15MR	YANMAR Vio15	SCM 301.5CR	Appealing point in sales
	○	Horizontal operation	○	x	○	○	○	We will appeal the comfort and operability of horizontal operation to users of current U-15. We will also appeal to rental users that the starter key can be used also for higher-ranked models.
	○	Starter key used also for higher-ranked models	○	x	-	-	-	
	○	Equipped with auto-glow indicator	○	x	-	-	-	
	○	Right and left pedaling for swing	○	x	○	○	○	

4. Comfort

Offence	Defense	Item	U15-3	Current U-15	KOMATSU PC15MR	YANMAR Vio15	SCM 301.5CR	Appealing point in sales
	○	Ample getting-on/off space	○	Front operation	Δ	Δ	Δ	We will appeal the ampleness of getting-on/off space.
	○	Flat steps	○	x	○	○	○	

5. Maintainability

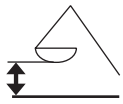
Offence	Defense	Item	U15-3	Current U-15	KOMATSU PC15MR	YANMAR Vio15	SCM 301.5CR	Appealing point in sales
○		Theft-proof specification	○	x	x	x	x	We will appeal to rental uses that the machine can be equipped with a new system theft-proof device as well as the improved operability of SC valve and 4P multi-valve.
○		Standard equipped with SC valve	○	Δ	–	-	-	
	○	Rotary joint O-ring	○	x	-	-	-	
	○	Side-opening full-open hood	○	x	x	x	x	
	○	Split-type dozer hose	○	○	x	○	x	

6. Safety

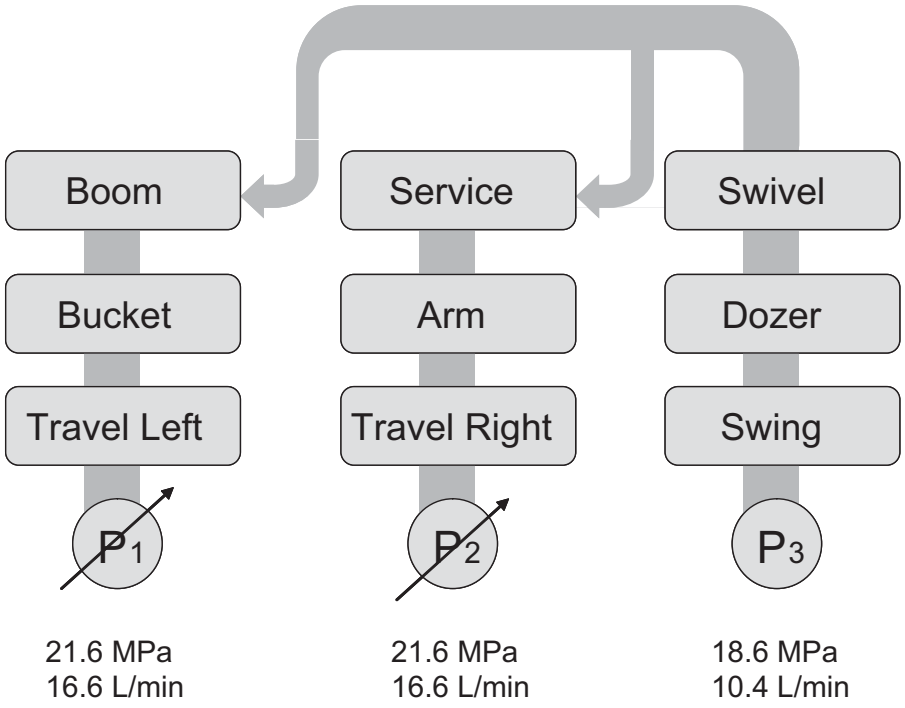
Offence	Defense	Item	U15-3	Current U-15	KOMATSU PC15MR	YANMAR Vio15	SCM 301.5CR	Appealing point in sales
○		Travel lock function, Unlock	○	x	x	x	○	We will appeal such a point that the machine assures the Japan's top-class safety.
○		Engine start control	○	x	x	x	○	
	○	Compatible with ROPS	○	x	x	x	x	

7. Working Range

mm

	U15-3	U-15	Difference
Max. excavation depth	**2310**	2100	+210
Max. vertical excavation depth	**1900**	1720	+180
Max. excavation radius	**3900**	3720	+180
Max. excavation height	**3540**	3740	-200
Max. dumping height	**2440**	2600	-160
Max. floor excavation radius	**3840**	3610	+230
	**1200**	1270	-70

8. Outline of Hydraulic System (Travel straight function)



Travel straight function is possible only together with boom operation.

e. Actual performance comparison

1. On-site Excavation Test

-Test Conditions-
1 m trench excavation, 45-deg. discharge of soil
Excavation work for 10 min., (5-min. rotation)

The equipment is of European specifications.

		U15-3	U-15	Increasing rate	PC15MR-1	Vio15-2	301.5CR
Volume of soil discharged per hour	m^3/h	**31.4**	25.0	+26%	*24.3	*26.3	*25.9
Cycle time	sec	**8.3**	9.8	+15%			
Fuel consumption	cc/10min	**400**	390				
Volume of soil discharged per liter of fuel	m^3/L	**13.1**	10.7	+22%			

* Actual measurement

2. Comparison of Operating Speed

			U15-3	U-15	difference
1. Attachment operated 3 times		sec	**47.3**	48.9	+3.4%
2. Boom (Ground level to top)	UP	sec	**2.3**	2.9	+26.1%
	DOWN		**2.5**	2.4	-4.0%
3. Swiveling speed		rpm	**9.0**	7.8	+13.3%
4. Combined operation		sec	**29.7**	29.9	-0.20

* Actual measurement

3. Comparison of Stability

		U15-3	U-15
Tipping load	Dynamic Front	***148**	*148
	Dynamic Side	***138**	*127
	Static Front	***194**	*213
	Static Side	***181**	*177

* Actual measurement

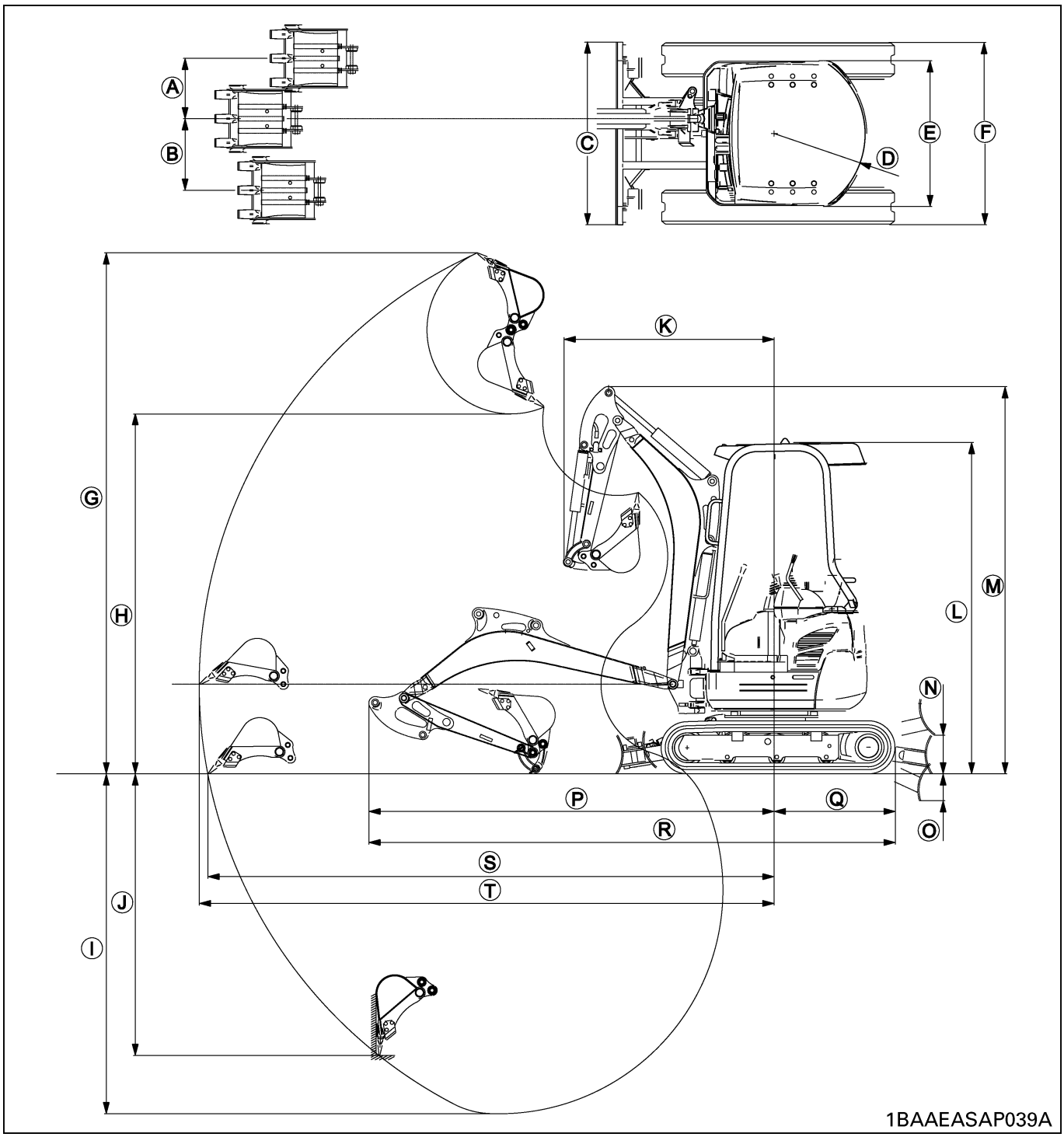
B.Machine specifications

a. Major dimensions and working range (with rubber crawler)

		Unit	U15-3	Remarks
1	Overall length (at transport)	mm	3570	
2	Overall height (at transport)	mm	2250	
3	Overall width	mm	1240/990	
4	Minimum road clearance	mm	145	
5	Dozer outer width x height	mm	1240/990 x 261	
6	Tumbler-to-tumbler distance	mm	1230	
7	Crawler center distance	mm	1010/760	
8	Crawler shoe width	mm	230	
9	Crawler height	mm	360	
10	Swivel structure rear end height	mm	422	
11	Overall crawler length	mm	1587	
12	Approach angle	deg.	30.1	
13	Maximum digging height	mm	3540	
14	Maximum digging radius	mm	3900	
15	Maximum digging depth	mm	2310	
16	Maximum dumping height	mm	2440	
17	Maximum vertical digging depth	mm	1910	
18	Minimum front turning radius	mm	1430/1207	Front/swing
19	Minimum tail turning radius	mm	620	
20	Ground contact pressure	kPa (kgf/cm^2)	25 (0.25)	
21	Swing angle left/right	deg.	63/58	
22	Bucket lift angle	deg.	180	
23	Maximum ground digging radius	mm	3840	
24	Minimum ground finishing radius	mm	1320	
25	Radius at maximum digging height	mm	2015	
26	Radius at maximum dumping height	mm	2012	
27	Maximum bucket bottom height with arm vertical	mm	1200	Arm vertical or fully crowded
28	Overall height with arm crowded and minimum front swivel radius	mm	1430	

from operator's manual

b. Dimensional drawings



from operator's manual

Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	Ⓕ	Ⓖ	Ⓗ	Ⓘ	Ⓙ	Ⓚ	Ⓛ	Ⓜ	Ⓝ	Ⓞ	Ⓟ	Ⓠ	Ⓡ	Ⓢ	Ⓣ
410	485	990 1240	620	980	990 1240	3540	2440	2310	1910	1430	2250	2630	265	180	2750	825	3570	3840	3900

(mm)

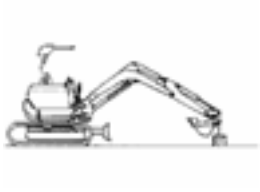
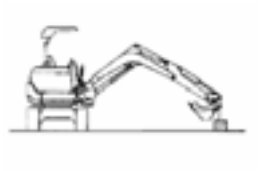
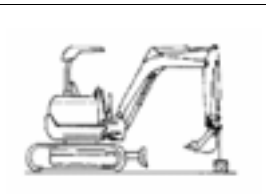
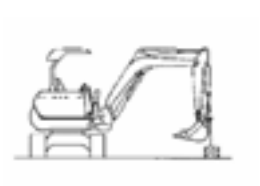
c. Performance and lifting capacity

1. Performance

		Unit	U15-3	Remarks
Standard bucket capacity	heaped	m^3	0.04	CECE
Maximum digging force, arm		KN(kgf)	8.8 (900)	Teeth bottom
Maximum digging force, bucket		KN(kgf)	15.2 (1550)	Teeth bottom
Cycle time		sec/cycle	10.8	
Digging performance		m^3/h	33.4	
Dozer capacity		m^3	0.067	without extention blade

Digging performance, cycle time conditions: Dig 1m depth with Standard bucket and dump soil on the ground after 45° swivel.

2. Lifting capacity

Lifting posture	Dozer	Unit	U15-3		Remarks
Maximum lifting capacity (standard arm)		(kgf)	Crawler extended	crawler retracted	
			60		
	Up	kgf	215 (T)	215 (T)	
	Down	kgf	280 (R)	280 (R)	
	Up	kgf	100 (T)	185 (T)	
	Down	kgf	135 (T)	195 (T)	
	Up	kgf	475 (R)	475 (R)	
	Down	kgf	475 (R)	475 (R)	
	Up	kgf	275 (T)	475 (R)	
	Down	kgf	315 (T)	475 (R)	

Lifting capacity
The machine can lift the loads listed above when the hydraulic pressure is as specified. But the actual measurements are based on "n = 1", which means some fluctuations are expected.
Measuring conditions:
(1) Hydraulic oil temperature: 50 ± 5 °C, riding operator (about 60 kg), engine at maximum rpm.
(2) The boom is inched until the other end of the machine comes off the ground or the boom circuit gets relieved. Then the loads are measured.
Note: The loads also vary depending on the ground surface condition, dozer's ground-contact status, operator's weight, remaining fuel and other factors.
(3) The boom swing position is set at the center.
(The machine may turn over if it is set off the center.)
*The above figures show the machine that is about to life a load.

In the above table, (T) means that the machine may turn over if the load is heavier. And (R) means that the boom circuit gets relieved if the load is heavier.

II Service engineering section

A.Maintenance specifications

a. List of oil and water quantities

	Unit	U15-3	Remarks
Radiator soft water	L	2.7	Kubota LLC-N-50F
Reserve tank soft water	L	0.6	
Crankcase engine oil (at filter replacement)	L	3.5	Class CC 10W30
Hydraulic tank oil	L	13	ISO 46
Total hydraulic oil	L	22	ISO 46
Wheel motor gear oil	L	0.25	SAE 90 (API, GL-4)
Swivel reducer gear oil	L	-	
Track roller gear oil	cc	40	Engine Oil SAE 30 Class CD
Carrier roller (upper track roller)	cc	-	Grease EP2
Front idler	cc	30	Engine Oil SAE 30 Class CD
Fuel tank light oil (full)	L	18	Diesel light oil No. 3

b. Tightening torque

1. Machine

Unit: N·m (kgf·m)

	Loctite	U15-3	Remarks
Travel wheel motor	O	60.8 ~ 70.6 (6.2 ~ 7.2)	
Control valve	O		
Sprocket	O	60.8 ~ 70.6 (6.2 ~ 7.2)	
Track roller	O	103 ~ 117.7 (10.5 ~ 12)	
Carrier roller		48.1 ~ 55.9 (4.9 ~ 5.7)	Slide plate
Plate (idler)		77.5 ~ 90.2 (7.9 ~ 9.2)	
Grease cylinder nipple		98.0 ~ 108.0 (9.0 ~ 11.0)	
Swivel bearing	O	103 ~ 117.7 (10.5 ~ 12)	
Swivel motor	O	367.7 ~ 431.5 (37.5 ~ 44.0)	
Return filter		19.6 ~ 29.4 (2.0 ~ 3.0)	
Engine bracket/engine support	O		
Engine anti-vibration rubber	O	39.2 ~ 45.1 (4.0 ~ 4.6)	Nut
Engine anti-vibration rubber		39.2 ~ 45.1 (4.0 ~ 4.6)	
Counterweight	O	107.9 ~ 125.5 (11.0 ~ 12.8)	Oil tank
Coupling		48.1 ~ 55.9 (4.9 ~ 5.7)	
Main pump		77.5 ~ 90.2 (7.9 ~ 9.2)	
Rotary joint		48.1 ~ 55.9 (4.9 ~ 5.7)	
Rotary joint stopper	O	48.1 ~ 55.9 (4.9 ~ 5.7)	
Muffler flange		23.5 ~ 27.5 (2.4 ~ 2.8)	
Control valve through bolt		13.7 ~ 14.7 (1.4 ~ 1.5)	

2. General bolt/nut tightening torque

Unit: N·m (kgf·m)

	4T	7T	9T
M6	7.8 ~ 9.3 (0.8 ~ 0.95)	9.8 ~ 11.3 (1.0 ~ 1.15)	12.3 ~ 14.2 (1.25 ~ 1.45)
M8	17.7 ~ 20.6 (1.8 ~ 2.1)	23.5 ~ 27.5 (2.4 ~ 2.8)	29.4 ~ 34.3 (3.0 ~ 3.5)
M10	39.2 ~ 45.1 (4.0 ~ 4.6)	48.1 ~ 55.9 (4.9 ~ 5.7)	60.8 ~ 70.6 (6.2 ~ 7.2)
M12	62.8 ~ 72.6 (6.4 ~ 7.4)	77.5 ~ 90.2 (7.9 ~ 9.2)	103.0 ~ 117.7 (10.5 ~ 12.0)
M14	107.9 ~ 125.5 (11.0 ~ 12.8)	123.6 ~ 147.1 (12.6 ~ 15.0)	166.7 ~ 196.1 (17.0 ~ 20.0)
M16	166.7 ~ 191.2 (17.0 ~ 19.5)	196.1 ~ 225.4 (20.0 ~ 23.0)	259.7 ~ 304 (26.5 ~ 31.0)
M18	245.2 ~ 284.4 (25.0 ~ 29.0)	274.6 ~ 318.7 (28.0 ~ 32.5)	343.2 ~ 402.1 (35.0 ~ 41.0)
M20	333.4 ~ 392.3 (34.0 ~ 40.0)	367.7 ~ 431.5 (37.5 ~ 44.0)	519.8 ~ 568.8 (53.0 ~ 58.0)

3. Hydraulic pipe tightening torque

Steel pipe size (mm) (O.D. x I.D. x Thickness)	Tightening torque N·m (kgf·m)	Wrench width (mm) [Reference]	Remarks
ϕ8 x 6 x t1	29.4 ~ 39.2 (3.0 ~ 4.0)	*17	* Ihara-made sleeve nuts
ϕ10 x 7 x t1.5	39.2 ~ 44.1 (4.0 ~ 4.5)	*19	
ϕ12 x 9 x t1.5	53.9 ~ 63.7 (5.5 ~ 6.5)	*21	
ϕ16 x 12 x t2	88.3 ~ 98.1 (9.0 ~ 10.0)	*29	
ϕ18 x 14 x t2	127.5 ~ 137.3(13.0 ~ 14.0)	*32	
ϕ27.2 x 21.6 x t2.8	235.4 ~ 255.0(24.0 ~ 26.0)	*41	

4. Hydraulic hose tightening torque

Thread size (piping thread)	Tightening torque N·m (kgf·m)		Wrench width [Reference]	Remarks
	Union nut	Taper thread		
1/8”	7.8 ~ 11.8 (0.8 ~ 1.2)	19.6 ~ 29.4 (2.0 ~ 3.0)	*17	
1/4”	24.5 ~ 29.4 (2.5 ~ 3.0)	36.3 ~ 44.1 (3.7 ~ 4.5)	*19	
3/8”	37.2 ~ 42.1 (3.8 ~ 4.3)	68.6 ~ 73.5 (7.0 ~ 7.5)	*22	
1/2”	58.8 ~ 63.7 (6.0 ~ 6.5)	83.4 ~ 88.3 (8.5 ~ 9.0)	*27	
3/4”	117.7 ~ 127.5 (12.0 ~ 13.0)	166.6 ~ 181.3 (17.0 ~ 18.5)	*36	

Note: * Wrench width may vary depending on the manufacturer, thread diameter and other factors.

5. Engine

N·m (kgf·m)

Engine model	D782
Cylinder head cover	4.9 (0.5)
Nozzle holder	58.8 (6.0)
Rocker arm bracket nut	10.8 (1.1)
Cylinder head cover	40.2 (4.1)
Connecting rod bolt	28.4 (2.9)
Flywheel	56.9 (5.8)
Bg case bolt 1	14.7 (1.5)
Bg case bolt 2	28.4 (2.9)
Bearing case cover bolt	10.8 (1.1)

Hose clamp (threaded type) N·m (kgf·cm)

Part code	Applicable diameter (mm)	Tightening torque	
09318-89016	12 ~ 16	2.5 ~ 3.4	(25 ~ 35)
09318-89039	31 ~ 40	2.5 ~ 3.4	(25 ~ 35)
09318-89045	36 ~ 46	2.5 ~ 3.4	(25 ~ 35)
RB101-63631	13 ~ 20	3.4 ~ 4.4	(35 ~ 45)
RC101-64581	15 ~ 25	4.9 ~ 5.9	(50 ~ 60)
68311-72821	26 ~ 38	4.9 ~ 5.9	(50 ~ 60)
RC411-63181	40 ~ 55	4.9 ~ 5.9	(50 ~ 60)
RC401-63191	50 ~ 60	4.9 ~ 5.9	(50 ~ 60)
69284-63171	77 ~ 95	4.9 ~ 5.9	(50 ~ 60)
RD411-63821	32 ~ 44	4.9 ~ 5.9	(50 ~ 60)

c. Quality specifications

No		Specificatios Items			Unit	U15-3	Remarks
Q1		Main Speed JIS A8404					
1	1	Machine size	Total length (Transport)		mm	3575 ± 71	
	2		Total width		mm	1240/990 ± 12	
	3		Total height (Canopy)		mm	2300 ± 23	
	4		Total height (Cabin)		mm	-	
2	1	Weight	Machine weight (Canopy)		kg	1600 ± 32	Fuel tank
	2		Machine weight (Cabin)		kg	-	
3	1	Performance	Swivel speed		rpm	8.7 ± 0.9	Rated engine RPM, η=100%
	2		Travel speed	F1	km/h	2.2 ± 0.2	
	3			F2	km/h	4.0 ± 0.4	
	4			R1	km/h	2.2 ± 0.2	
	5			R2	km/h	4.0 ± 0.4	
	6		Gradeability		deg	30 <	
4	1	Rear end min. turning radius			mm	620 ± 12	
	2	Swivel frame rear ground clearance			mm	422 ± 8	
	3	Tambler center distance			mm	1230 ± 37	
	4	Crawler total length			mm	1587 ± 48	
	5	Crawler total width			mm	1240/990 ± 26	
	6	Crawler shoe width			mm	230 ± 5	
	7	Min. ground clearance			mm	145 ± 4	
5	1	Engine,	Model name			D782-BH-4	
	2		Rated output DIN 70020		kw	9.6 ± 0.2	
					ps	13.0 ± 0.3	
	3		Rated speed		rpm	2300	
	4		Displacement		L	0.778	
					cc	778	
6	1	Hydraulic pump type				Variable x2 +gear	
	2	Pump delivery			L	16.6 x 2, 10.4, 6.2	
	3	Main relief pressure (Bench set)	P1,P2		Mpa	$21.6^{+1.0}_{-0.5}$	
					kgf/cm^2	220^{+10}_{-5}	
					Bar	$216^{+9.8}_{-4.9}$	
			P3		Mpa	$18.6^{+1.0}_{-0.5}$	
					kgf/cm^2	190^{+10}_{-5}	
					Bar	$186^{+9.8}_{-4.9}$	
			P4		Mpa	$3.9^{+1.0}_{-0.5}$	
					kgf/cm^2	40^{+10}_{-5}	
					Bar	$39^{+9.8}_{-4.9}$	
7	1	Swivel motor type					
8	1	Under carrage	Travel motor type			Variable displace-ment pump	
	3		Crawler shoe type			Rubber	

No		Specificatios Items			Unit	U15-3	Remarks
9	1	Front attachment	Bucket heaped capacity	CECE	m^3	0.04 ± 0.002	
	2						
	3		Bucket width		mm	456 ± 10	Without side cutter
	4		Swing angle	L	deg	63 ± 2	
	5			R	deg	58 ± 2	
	6		Max. digging radius		mm	3901 ± 59	
	7		Ground level Max. digging radius		mm	3843 ± 58	
	8		Ground level Min. finish radius		mm	1320 ± 26	Bucket bottom horizontal
	9		Max. digging depth		mm	2306 ± 46	
	10		Max. vertical digging depth		mm	1911 ± 38	
	11		Max. digging height		mm	3536 ± 71	
	12		Max. dump height		mm	2443 ± 49	
	14		Mini. turning radius		mm	1426 ± 43	
	15		Mini. turning radius (Left swing)		mm	1207 ± 36	
	16		Off-set amount	L	mm	510 ± 15	
	17			R	mm	385 ± 12	
	18		Max. digging force		kgf	1.55	
					N	15.2	
10	1	Dozer	Width		mm	1244/990 ± 5	
	2		Height		mm	261 ± 5	
	4		Max. lift above GL		mm	263 ± 13	
	5		Max. below GL		mm	182 ± 9	
11	4	Water & oil	Fuel	Tank	L	17.5 ± 0.9	
	5		Hydraulic oil	Tank	L	13 ± 0.7	
Q2		Main Specs JIS A8404					
1	1	Bucket tooth slaggish			mm	73 ± 93	
	2	Decline of front attachment			mm	0 ± 10	
	3	Dozer's declination			mm	0 ± 10	
3	3	Min. clearance of bucket teeth to boom cylinder protector			mm	37 $^{+34}_{-16}$	
4	1	Approach angle			deg	30.1 ± 3.0	
5	1	Crawler height			mm	360 ± 7	Include grouser on the sprocket
	2	Max. crawler height			mm	360 ± 7	
Q3		Engine performance					
1	1	Max. engine torque			kgf•m/rpm	4.52/1750	
					N•m/rpm	44.3/1750	
2	1	Max, engine rpm	no load		rpm	2600 >	
	2		1 pump relief		rpm		
	3		2 pump relief		rpm	2300 <	
	4		3 pump relief		rpm	2300 <	
3	1	Idling rpm			rpm	1200 + 150/-0	

No		Specificatios Items		Unit	U15-3	Remarks
Q4		Travelling performance				
1	1	Travel motor block performance, L/R		mm	300 >	20 deg, 10 min
2	1	Max, Traction force	F1	kgf•m	1255 ± 126	η=65%
				kN•m	12.8 ± 1.3	
	2		F2	kgf•m	637 ± 64	
				kN•m	6.5 ± 0.7	
3	1	Travel straightness	F1	mm	600 >	10m distance
	2		F2	mm	600 >	
	3		Dozer F1	mm	600 >	Dozer up & down 10m distance
	4		Dozer R1	mm	600 >	
4	1	Track shoe sag distance	Iron	mm	25 ~ 30	
	2		Rubber	mm	10 ~ 15	
Q5		Work performance				
4	2	Arm digging force		kgf	824<	Bucket tooth root
				kN	8.4<	
	3	Bucket digging force		kgf	1412<	Machine stance to JIS bucket tooth root
				kN	14.4<	
5	1	Boom speed	up	sec	2.2 ± 0.3	Oil temp. 50 ± 5°C Max. heiht to ground
	3		down	sec	2.5 ± 0.3	Oil temp. 50 ± 5°C
6	1	Arm speed	crowd	sec	3.5 ± 0.3	Oil temp. 50 ± 5°C
	2		extend	sec	2.4 ± 0.3	Oil temp. 50 ± 5°C
7	1	Bucket speed	crowd	sec	2.8 ± 0.3	Oil temp. 50 ± 5°C
	2		dump	sec	1.9 ± 0.3	Oil temp. 50 ± 5°C
8	1	Dozer speed	up	sec	1.4 ± 0.3	Max. down to max. up
	2		down	sec	1.9 ± 0.3	Max. up to max. down
13	1	Max. digging height radius		mm	2015 ± 202	
	2	Max. dump height radius		mm	2012 ± 121	at bucket pin
	4	Bucket bottom height at arm vertical		mm	1200 ± 36	Bucket horizontal
	5	Bucket wrist angle		degree	180 ± 3	
Q6		Swivel, swing performance				
1	1	Swivel torque	L	kgf•m	217 <	Arm extend,show/Quick
				kN•m	2.1 <	
	2		R	kgf•m	217 <	
				kN•m	2.1 <	
2	1	Swivel capable angle at slope		deg	18 <	Bucket load=JIS heaped x 1.8
3	1	Swivel block performance	L/R	deg	30 >	
5	1	Swivel start-up speed		sec	2.1 ± 0.2	0 ~ 90 deg swivel
7	1	Swing speed	Left	sec	4.6 ± 0.3	
	2		Right	sec	3.7 ± 0.3	
8	1	Swing Lock	Swivel R&L	mm	6 >	90 deg-swivel, 100 times actual digging cylinder dislocation

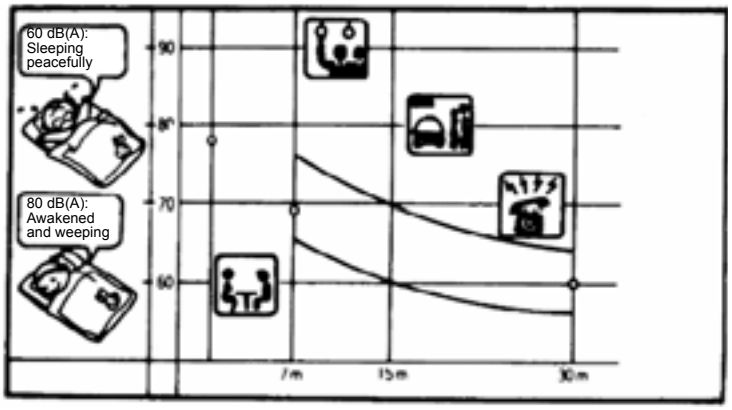
No		Specificatios Items		Unit	U15-3	Remarks
Q7		Hydraulic performance				
1	1	Relief pressure setting	P1	kgf/cm^2	220^{+10}_{-5}	
				MPa	$21.6^{+1.0}_{-0.5}$	
				bar	$215.8^{+9.8}_{-4.9}$	
	2		P2	kgf/cm^2	220^{+10}_{-5}	
				MPa	$21.6^{+1.0}_{-0.5}$	
				bar	$215.8^{+9.8}_{-4.9}$	
	3		P3	kgf/cm^2	190^{+10}_{-5}	
				MPa	$18.6^{+1.0}_{-0.5}$	
				bar	$186.3^{+9.8}_{-4.9}$	
	4		P4	kgf/cm^2	40^{+10}_{-5}	
				MPa	$3.9^{+1.0}_{-0.5}$	
				bar	$39.2^{+9.8}_{-4.9}$	
5	1	Cylinder block performance	Boom	mm	25 >	Arm extend, bucket Hydraulic oil temp. 50 ± 5°C height 1m, 10 min. Bucket load : Heaped Soil gravity : 1.8
	2		Arm	mm	15 >	
	3		Bucket	mm	10 >	
	4		Dozer	mm	25 >	
6	1	Boom cushioning performance	30°C	sec	3 >	
	2		50°C	sec	0.5 to 1.5	
	3		80°C	sec	0.3 <	
8	1	Service port flow	No load/load	L	27	
Q8		Lever operating force & stroke				
1	1	Boom lever operating force		kgf	1.4 ± 0.5	Measured 20 mm below the grip end.
				kN	13.7 ± 4.9	
	4	Arm lever		kgf	1.4 ± 0.5	
				N	13.7 ± 4.9	
	5	Bucket lever		kgf	1.4 ± 0.5	
				N	13.7 ± 4.9	
	6	Swivel (Swing) lever		kgf	1.4 ± 0.5	
				N	13.7 ± 4.9	
	7	Dozer lever		kgf	3.1 ± 0.5	
				N	30.0 ± 4.9	
	8	Travel lever	L/R	kgf	1.5 ± 0.5	
				N	15.0 ± 4.9	
	9	Accelerator lever (up/down)		kgf	3.4 ± 1.5	Measured 30 mm below the grip end.
				N	35.0 ± 14.7	
	10	Swing pedal		kgf	10.0 ± 1.0	Measured Step end.
				N	98.0 ± 9.8	
	11	Safety lock lever, L&R	up	kgf	2.0 ± 1.0	
				N	20.0 ± 9.8	
			down	kgf	3.0 ± 1.0	
				N	30.0 ± 9.8	

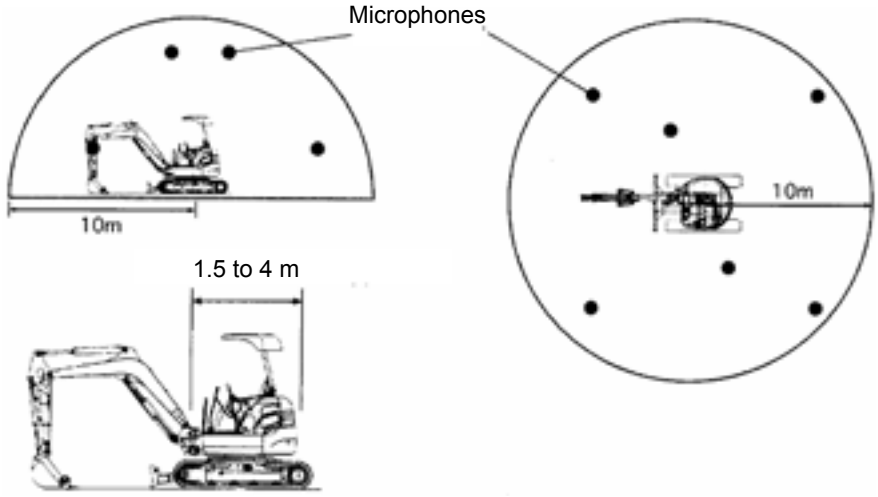
No		Specificatios Items			Unit	U15-3	Remarks
1	13	Service port pedal			kgf	5.0 ± 1.0	L / R
					N	51.0 ± 10	
2	1	Boom lever stroke		up	mm	72 ± 10	Measured grip end
	2			down	mm	72 ± 10	
	3	Arm lever stroke (crowd/dump)			mm	72 ± 10	
	4	Bucket lever stroke (crowd/dump)			mm	74 ± 10	
	5	Swivel lever stroke			mm	74 ± 10	
	6	Dozer lever up & down			mm	80 ± 10	
	7	Travel lever, L & R, F & R		L	mm	75 ± 10	
				R	mm	75 ± 10	
	9	Swing pedal stroke			mm	6 ± 10	Measured Step end
	10	Service port pedal stroke (LH & RH)			mm	12 ± 10	
Q9		Stability					
1	1	Standard arm, Dynamic operation load limit	Bucket load to 10 degrees tipping	Side, dozer up	kgf	-	arm extended, bucket crowd, swing 0 degree, exclude bucket weight 37Kg.
					N	-	
				Over end, dozer up	kgf	-	
					N	-	
	2		Bucket load to tipping, track frame extended	Side, dozer up	kgf	121 <	
					N	1187 <	
				Over end, dozer up	kgf	130 <	
					N	1275 <	
	3		Bucket load to tipping, track frame retracked	Side, dozer up	kgf	63 <	
					N	618 <	
				Over end, dozer up	kgf	130 <	
					N	1275 <	
2	1	Standard arm, Static operation load limit	Bucket load to tipping, track frame extended	Side, dozer up	kgf	162 <	front level crowd, swing 0 degree, exclude bucket weight 37Kg. Load is added at the top of arm.
					N	1589 <	
				Over end, dozer up	kgf	175 <	
					N	1716 <	
	2		Bucket load to tipping, track frame retracked	Side, dozer up	kgf	95 <	
					N	932 <	
				Over end, dozer up	kgf	175 <	
					N	1716 <	
Q10		Comfortability					
1	1	Noise level	At operator's ear LPA	Canopy	db(A)	78 >	
	2			Cab	db(A)	-	Cab door close
	3		Noise source; LWA		db(A)	92 >	

d. Operating noise

	Unit	U15-3	Remarks
At ear level (Canopy)	db(A)	78 >	
Around the machine	db(A)		
Acoustic power level	db(A)	92 >	
Low-noise specified number			
Ultra-low noise specified number			
Emission control specified			
Standard operation			
Energy tax system			

(The noise at ear level is measured with the average energy output under no load at maximum rpm.)





Simulated digging is made at maximum engine rpm, and the then operating noise is measured within 10 m in radius from the machine (imaginary hemispherical space with the machine length from 1.5 to 4 m).

e. Machine weight and parts weight

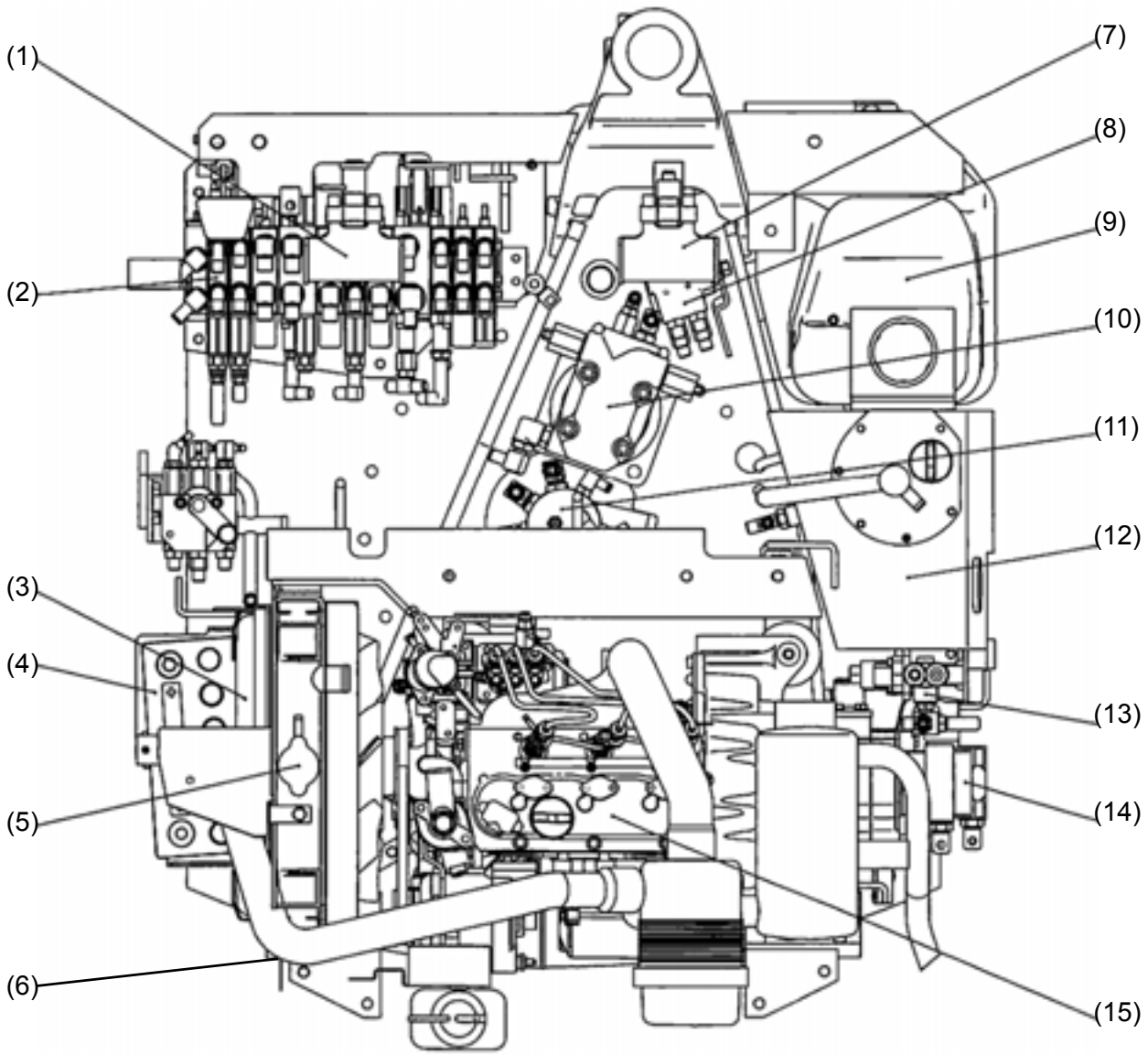
* The weights in the table below are approximate.

	Unit	U15-3	Remarks
Machine weight	kg	1600	
Body weight	kg	1340	
Maximum breaker weight	kg	90	
Backhoe overall	kg	177	Swing bracket and boom cylinder not included
Upper swivel structure	kg	816	Canopy/cabin
Lower travel structure	kg	577	Rubber crawler
Track frame	kg	61/83/61	Left/center/right
Swivel frame	kg	150	
Swing bracket	kg	28	
Boom	kg	67	
Arm	kg	30	
Bucket	kg	29	450-400
Dozer	kg	67	
Counterweight	kg	205	
Iron crawler	kg	89	
Rubber crawler	kg	56	

	Unit	U15-3	Remarks
Engine	kg	64	Dry weight
Hydraulic tank	kg	13	With filter
Fuel tank	kg	1.6	
Swivel bearing	kg	17	
Battery	kg	13	
Track roller	kg	4	
Upper track roller	kg	-	
Sprocket	kg	5	
Idler	kg	18	Sprocket included
Canopy roof	kg	9	
Post (support)	kg	21	
Pump assembly	kg	14	
Wheel motor	kg	17	
Swivel motor	kg	15	
Control valve	kg	14	Without joint
Boom cylinder	kg	15	
Arm cylinder	kg	12	
Bucket cylinder	kg	11	
Swing cylinder	kg	9	Offset
Dozer cylinder	kg	7	
Rotary joint	kg	13	
Radiator	kg	2	

B.Machine body structure and function

a. Overall Arrangement

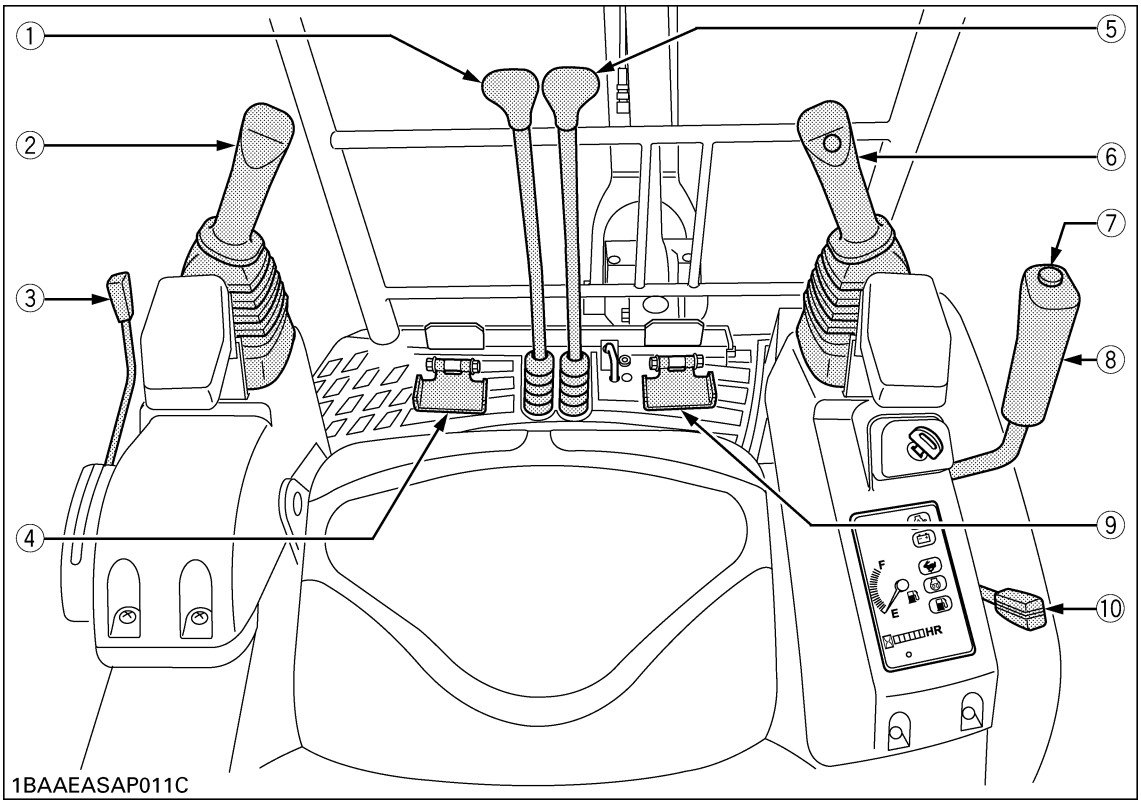


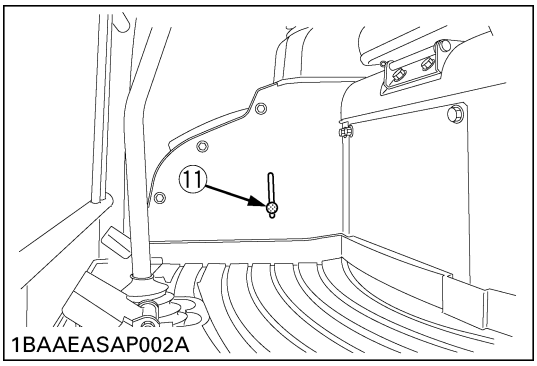
Vertical Operation

(1) Service port pedal
(2) Control valve
(3) Oil cooler
(4) Battery
(5) Radiator
(6) Suction pipe
(7) Swing pedal
(8) Selector valve
(9) Fuel tank
(10) Swivel motor
(11) Swivel joint
(12) Oil tank
(13) Unloading valve
(14) Pump
(15) Engine

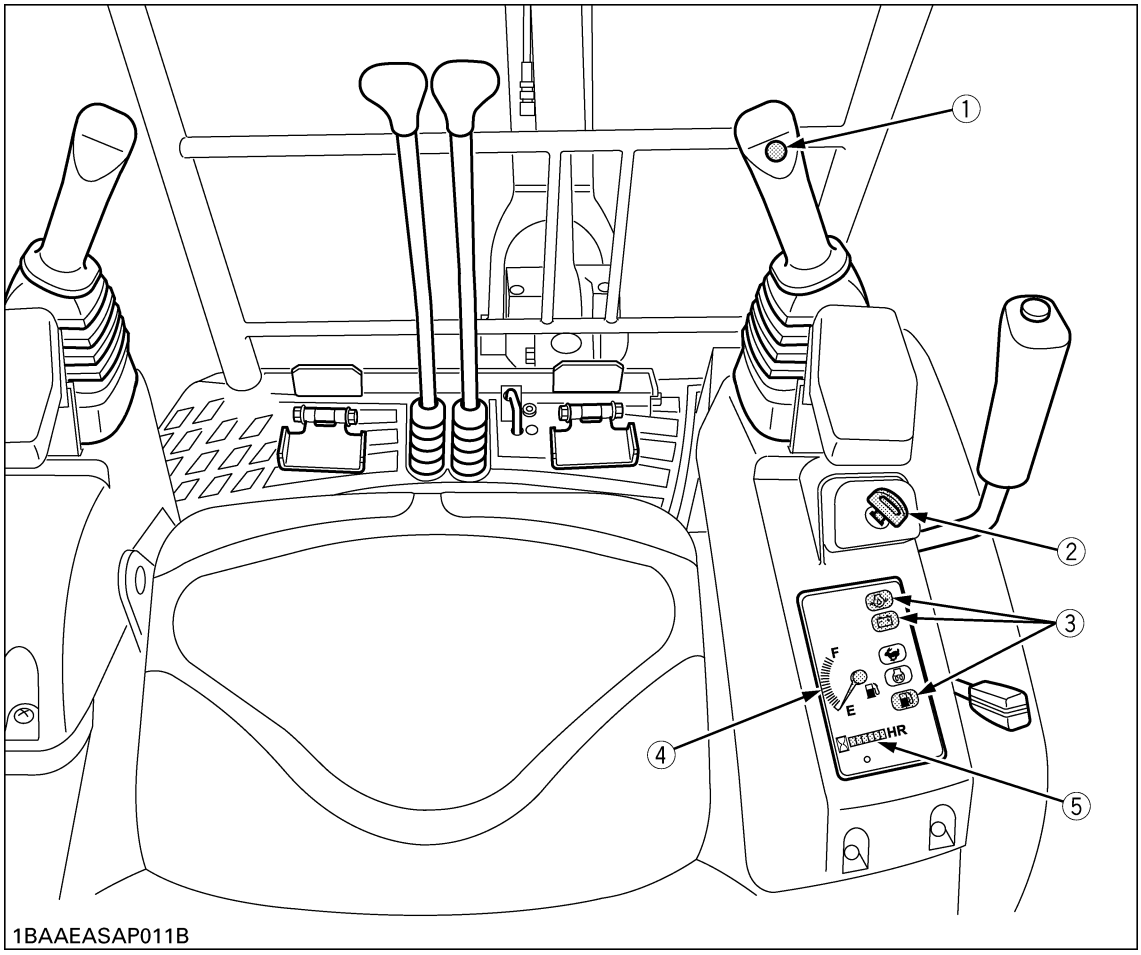
Note : For the export model, the travel Hi - Low control switch is located on the dozer lever grip.

2. Arrangement of Control Levers



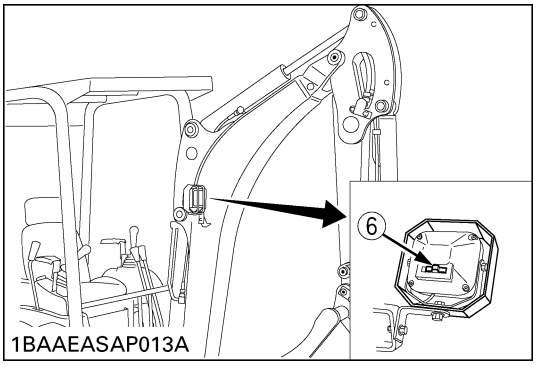


(1) Travel lever (left)
(2) Control lever for front attachments (left)
(3) Lock lever for attachment control
(4) Service port pedal
(5) Travel lever (right)
(6) Control lever for front attachments (right)
(7) Two travel speed switch
(8) Control lever for dozer or track width
(9) Boom swing pedal
(10) Throttle lever
(11) Track width change / dozer select lever



1BAAEASAP011B

(1) Horn switch
(2) Starter switch
(3) Malfunction indicator (Quick Diagnosis)
(4) Fuel meter
(5) Hour meter
(6) Working light switch



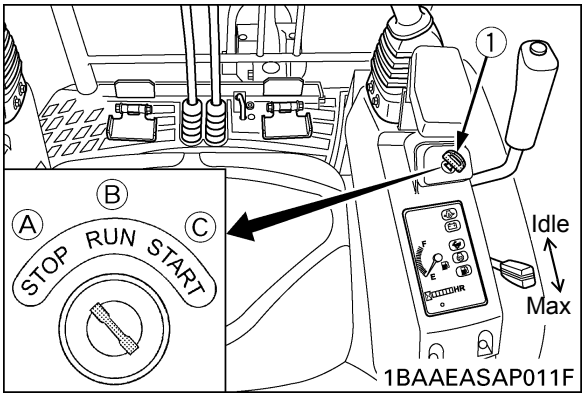
1BAAEASAP013A

Adoption of Meters

Hour meter, oil level gauge and Easy checker (oil lamp, charge lamp, glow lamp and fuel level alarm lamp) for various indications.

Direction of accel lever : EU - version

(Machine front)

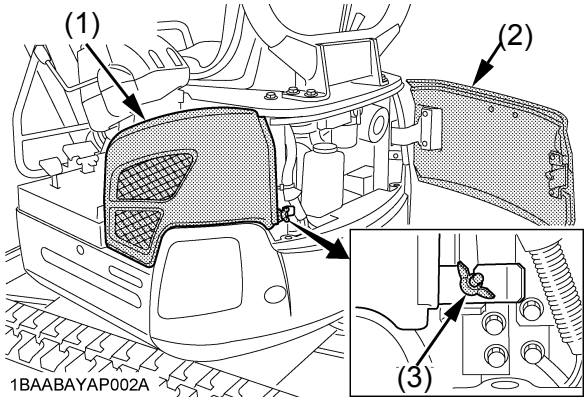


(1) Starter Switch

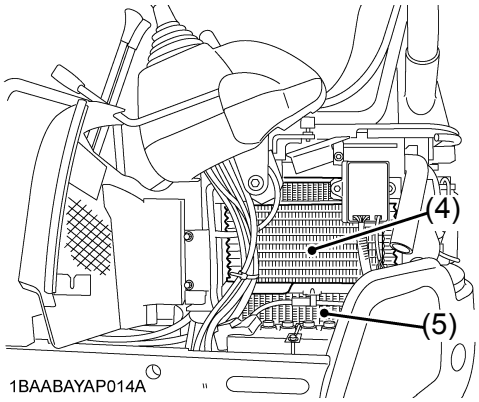
(A) "STOP"
(B) "RUN"
(C) "START"

PP - version

(Machine front →)

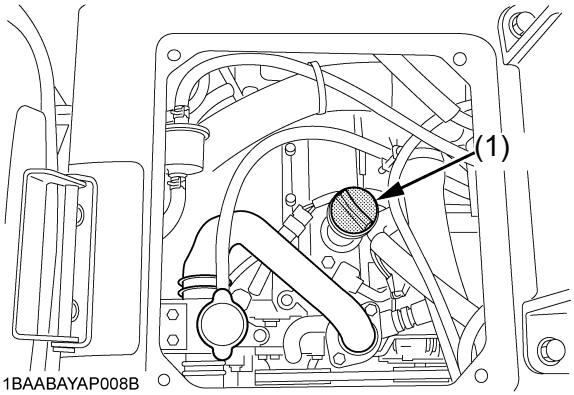


(1) Hood Left
(2) Hood Rear
(3) Wing nut



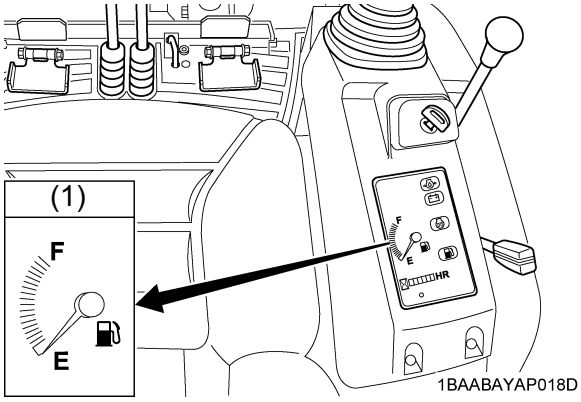
(4) Oil cooler
(5) Radiator

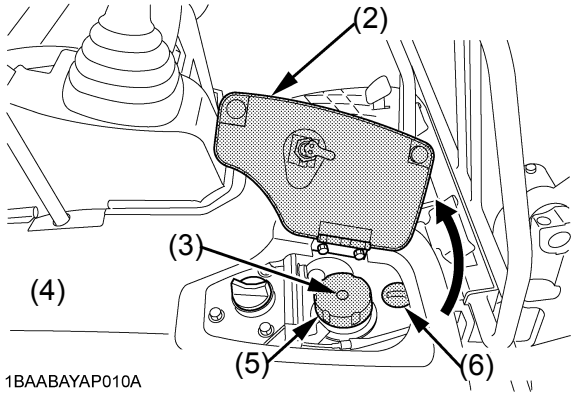
The oil cooler and the radiator can be checked and cleaned by opening the left hood.



(1) Oil filler port

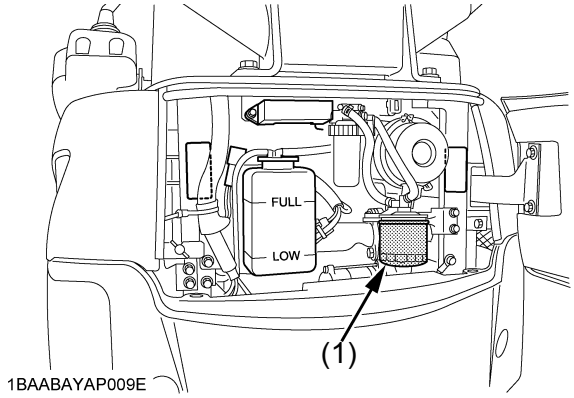
Engine oil can be refilled by opening the inspection door after lifting up the seat.

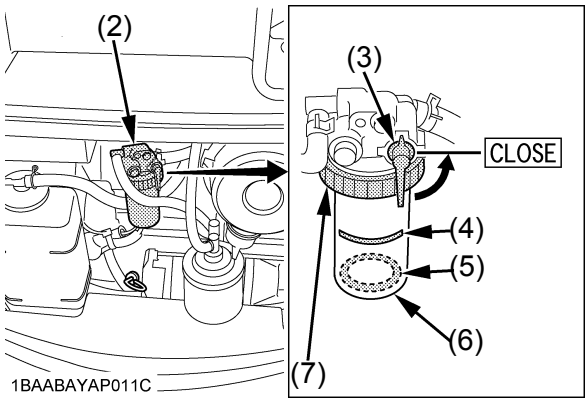




(1) Fuel level gauge
(2) Fuel cap cover
(3) Air vent
(4) Hydraulic oil filler port
(5) Cap
(6) Gauge

- Adoption of fuel level gauge makes it possible to check the remaining oil amount.
- A gauge is mounted at the side of the fuel filler port. When fuel is nearly filled up, the pointer of the gauge starts moving and about 2 liters of fuel oil is filled up.
- A hydraulic oil filler port is provided also at the side of the fuel filler port.



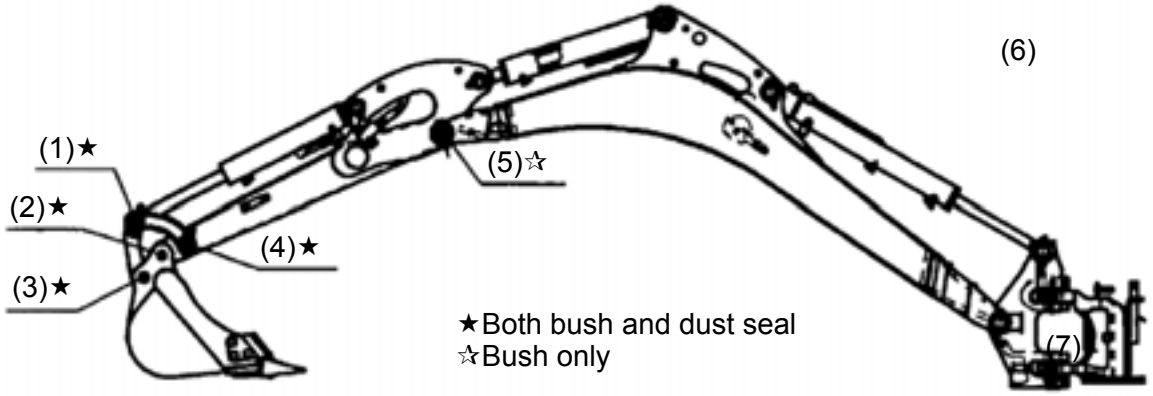


(1) Fuel filter cartridge
(2) Water separator
(3) Water separator handle
(4) Indication line
(5) Float (Red)
(6) Cup
(7) Retainer ring

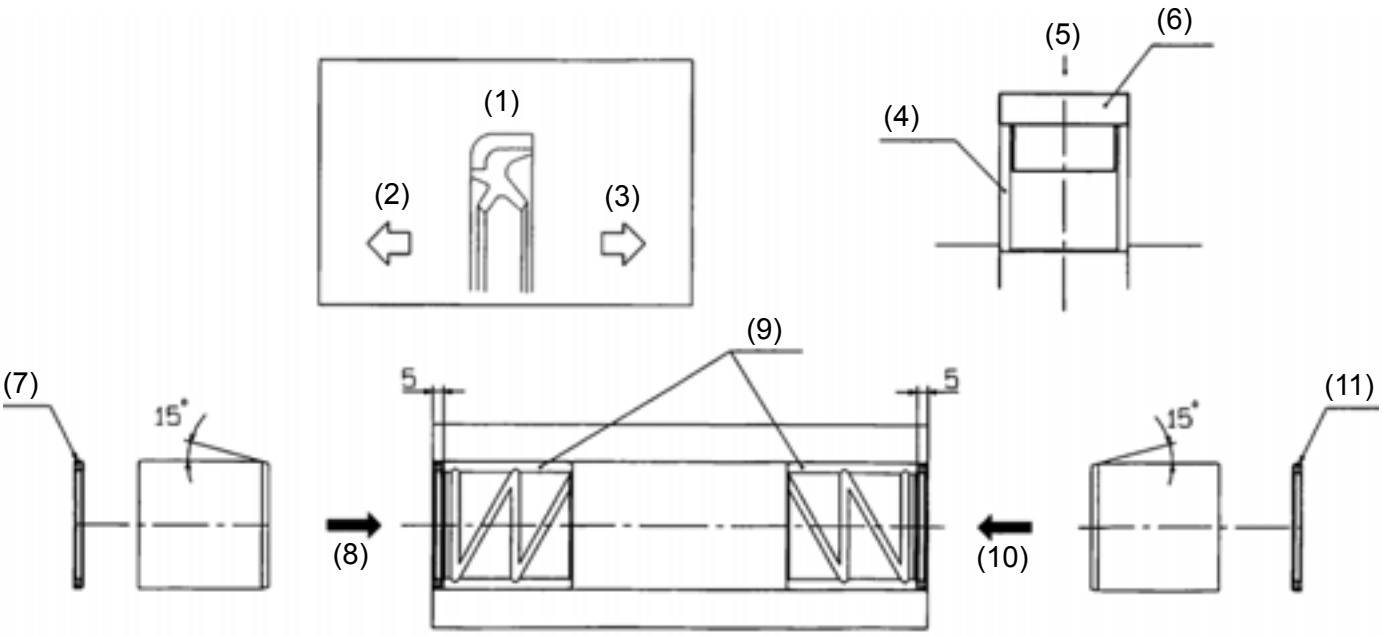
Like in the models of KX91-3S·α and KX121-3S·α Series, the fuel filter has been separated from the water separator.

3. Press-fitting of Bushes

Positions where bushes and dust seals are inserted (except for the parts finished with bush insertion).



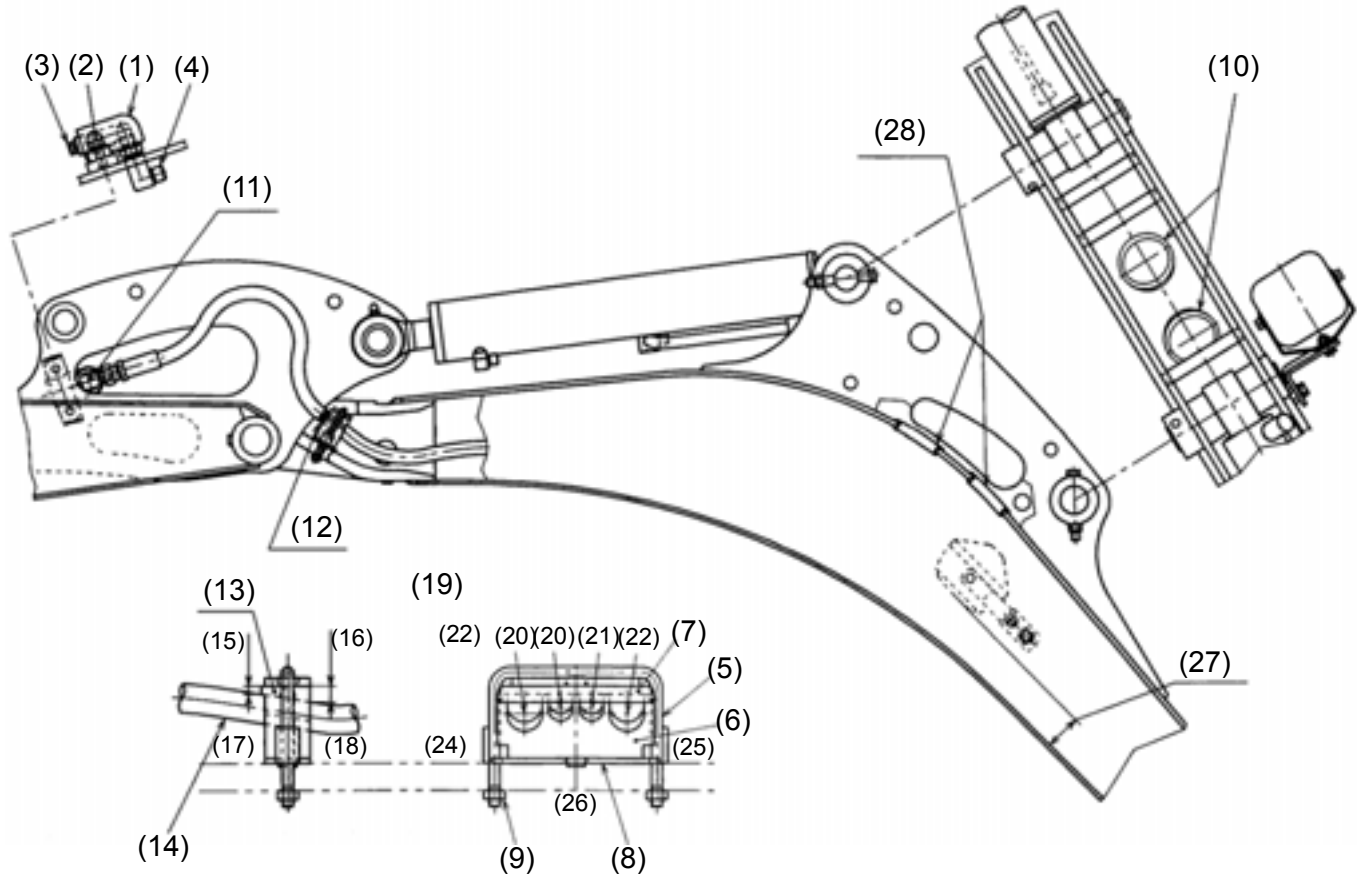
(1) Bucket link 1 side
(2) Arm end
(3) Bucket link 1 side
(4) Arm boss side
(5) Arm boss side
(6) Tensile brass



(1) (Dust seal magnified view)
(2) Bush side
(3) Outside
(4) Bush
(5) Insert
(6) Reinforcing plate
(7) Dust seal
(8) Bush inserting direction
(9) Bush
(10) Bush inserting direction
(11) Dust seal

4. Front Equipment

Rectify the boom inside.



No.	Part Name	Q'ty	No.	Part Name	Q'ty	Part No.
(1)	Bracket (SP)	2	(6)	Cushion (1)	1	
(2)	Bolt	4	(7)	Cushion (2)	1	
(3)	Plug	2	(8)	Plate (lower)	1	
(4)	Pipe joint	2	(9)	Jam nut	2	
(5)	Clamp	1	(10)	Grommet (boom)	2	RB237-6652Δ

(11) Assemble the pipe joint (4) and the bracket (SP) (1) in parallel.

(12) Put the marking (tape) to the front (for both bucket and SP).

(13) Pay attention to the direction of the cushion (6).

(14) Fix the hoses (for both bucket and SP) so that they should face up forwards.

(15) Thin

(16) Thick

(17) Front

(18) Rear

(19) Magnified view of the clamp

(20) White

(21) Red

(22) Black

(23) Color of hose tape

(24) Left side

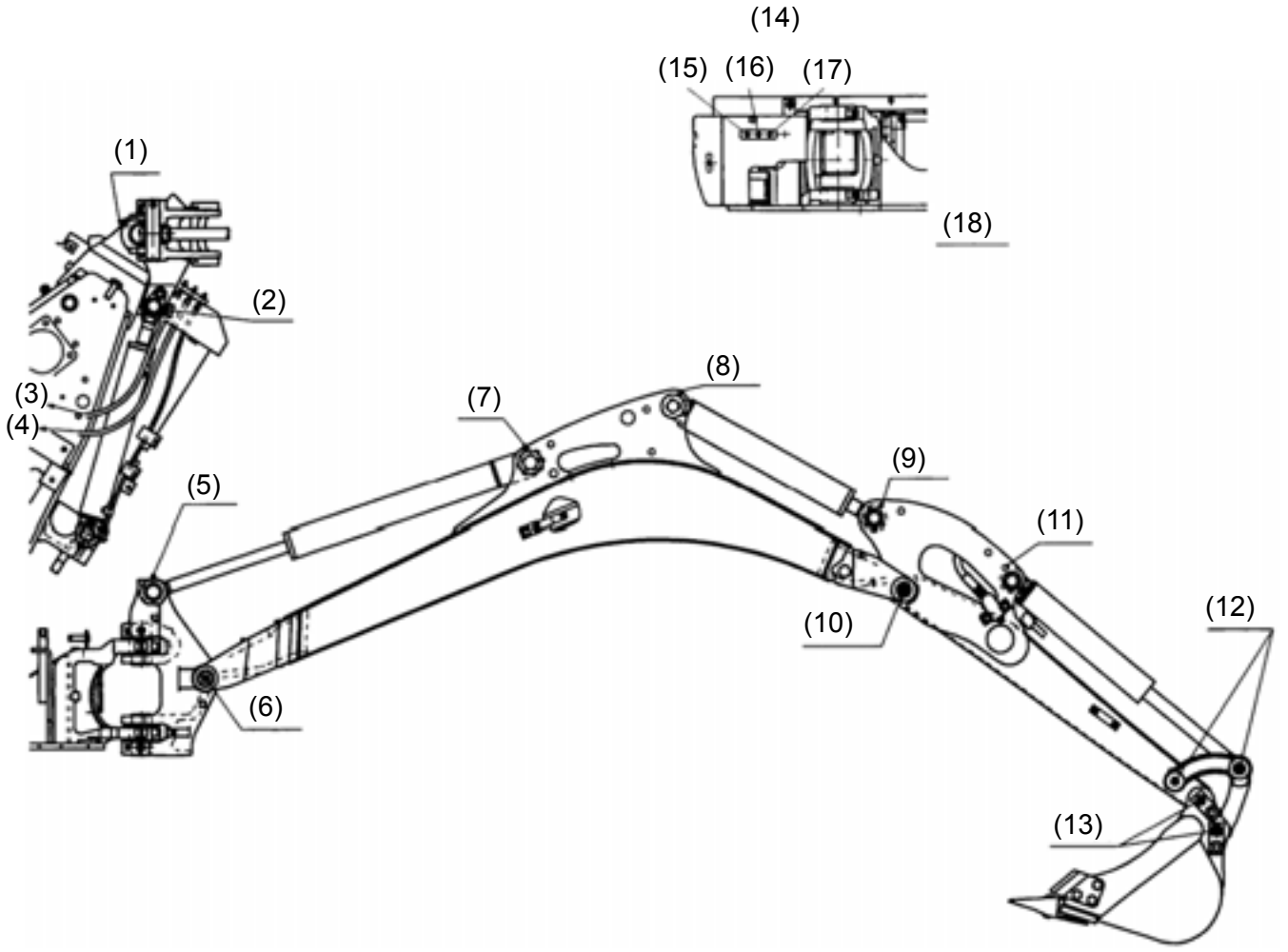
(25) Right side

(26) As viewed from rear

(27) Working light should be in parallel with the bottom plate.

(28) Pay attention to the direction of the bracket (10).
Apply adhesive to the grommet.

5. Greasing (1)



(1) Type A (Boss greasing)
Swing supporting points (upper and lower)

(2) Type A (Boss greasing)

(3) To swivel bearing balls

(4) To swivel bearing teeth

(5) Type A (Boss greasing)

(6) Type A (Pin greasing)

(7) Type A (Boss greasing)

(8) Type A (Boss greasing)

(9) Type A (Boss greasing)

(10) Type A (Pin greasing)

(11) Type C (Boss greasing)

(12) Type A (Pin greasing)

(13) Type A (Pin greasing)

(14) As viewed from front of the swivel frame

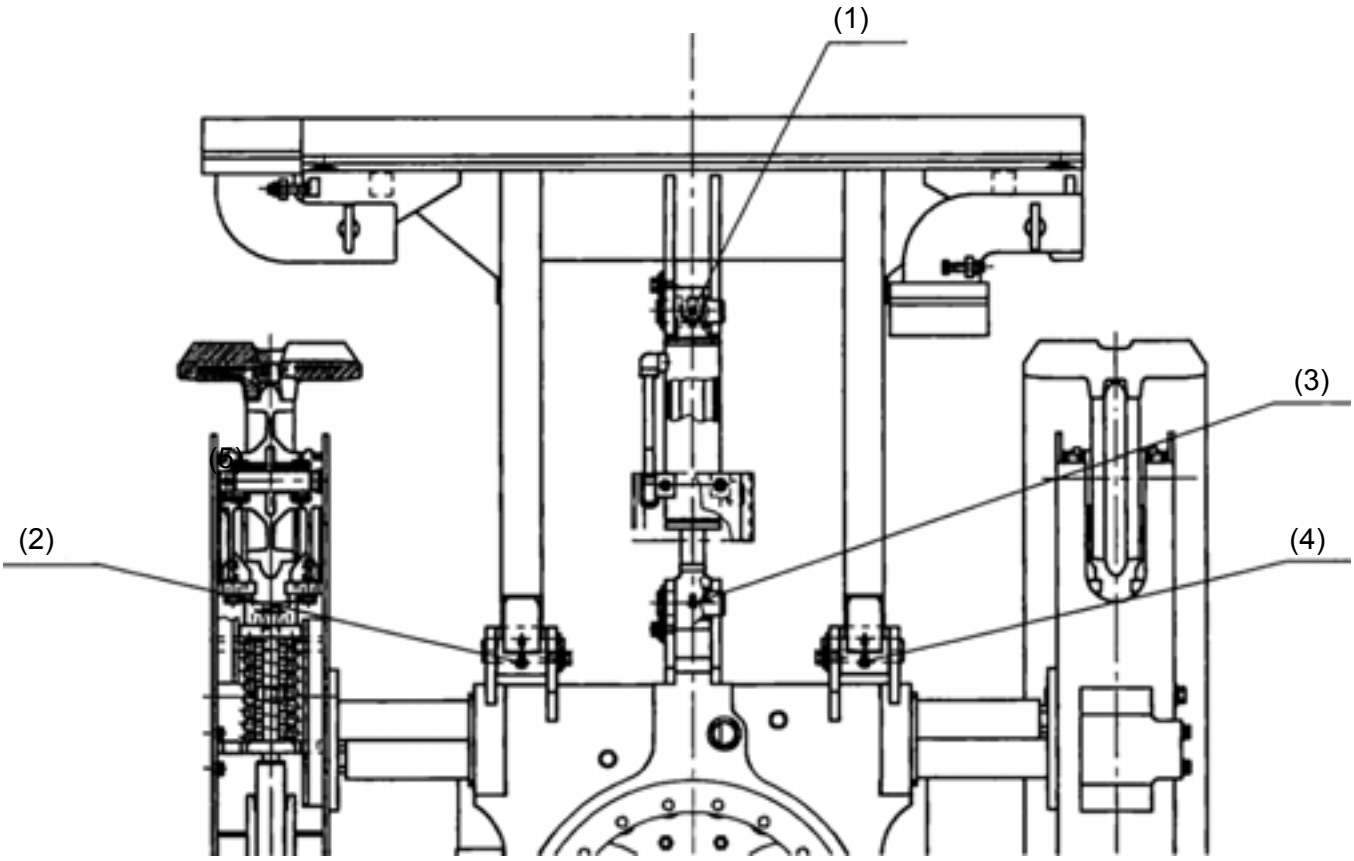
(15) Swing cylinder bottom

(16) Swivel bearing (teeth)

(17) Swivel bearing balls

(18) Grease the swivel bearing balls and teeth respectively at 6 positions while turning the bearing by 90 deg. each.
The balls and teeth may be greased before assembling.

6. Greasing (2)



(1) Type A (Boss greasing)
(2) Type B (Boss greasing)
(3) Type B (Boss greasing)
(4) Type B (Boss greasing)

A-type: Straight type
(06611-15010)

B-type: 67°C
(06616-25010)

C-type: 90°C
(06616-35010)

7. Cleaning and greasing the Track Frame Slide Pipes

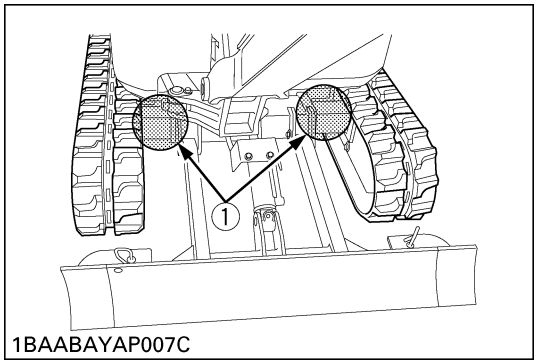
When the slide pipes of the track frame are clogged or adhered with soil or sand, clean the slide pipes in the following manner according to need.

WARNING

To avoid the personal injury or death:

- Place the machine on even ground when cleaning the track frame slide pipes.

1. First lift the machine off the ground using the dozer blade and boom functions.
2. Switch the track width change / dozer select lever to the “Track width change” position.
3. Push the control lever forward, and expand the track width to 1240 mm.
4. Remove soil and sand adhered to the slide pipes, then put grease evenly around the pipes. Make sure all 4 slide pipes are greased.
5. Retract and expand the track width repeatedly for a few times by moving the control lever, so that the grease is spread adequately.
6. Switch the track width change / dozer select lever to the “Dozer” position.
7. Place the machine down on the ground carefully by moving the dozer blade and the boom.

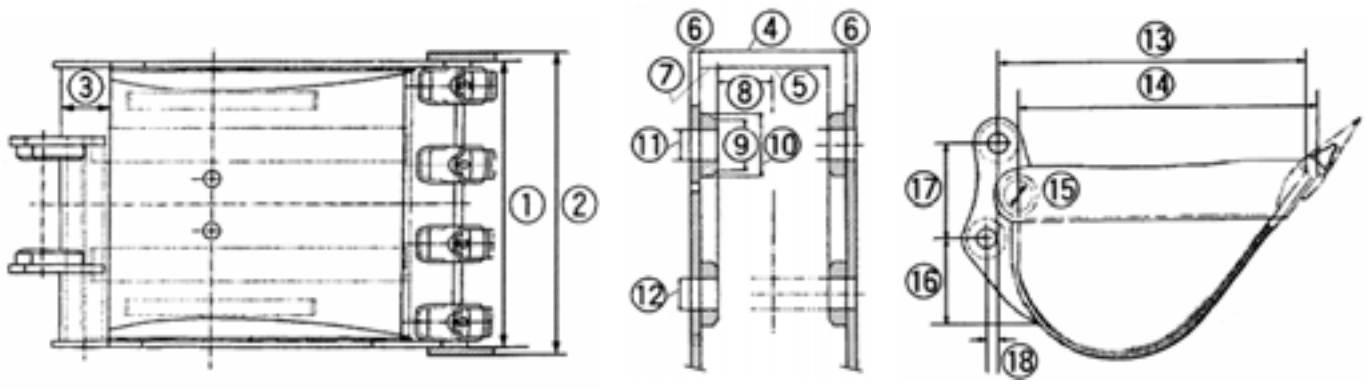


(1) Track frame slide pipes

b. Front attachment

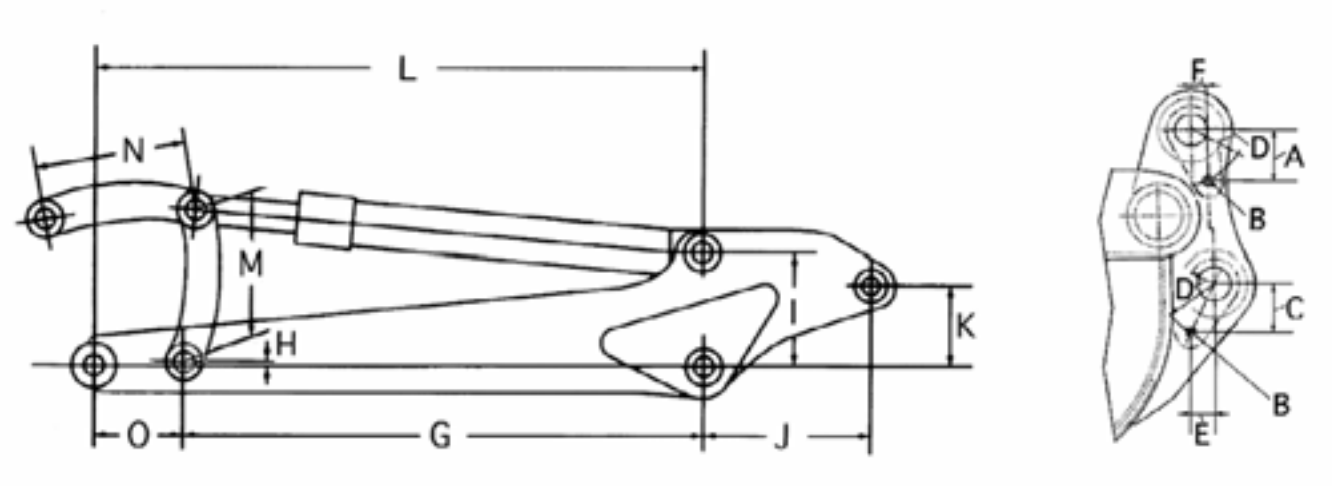
1. Bucket dimensions

	Unit	U15-3	Remarks
(1)	mm	400	Lip outside width
(2)	mm	456	Side cutter outside width
(3)	mm	60.5 x 6	ϕ x t
(4)	mm	139.5	
(5)	mm	95.5	Arm end width
(6)	mm	16	
(7)	mm	22	
(8)	mm	47.75	
(9)	mm	ϕ49	
(10)	mm	ϕ60	
(11)	mm	ϕ30	
(12)	mm	ϕ30	
(13)	mm	457	
(14)	mm	380.5	
(15)	mm	ϕ48.5	
(16)	mm	126.5	
(17)	mm	88.5	
(18)	mm	16.5	

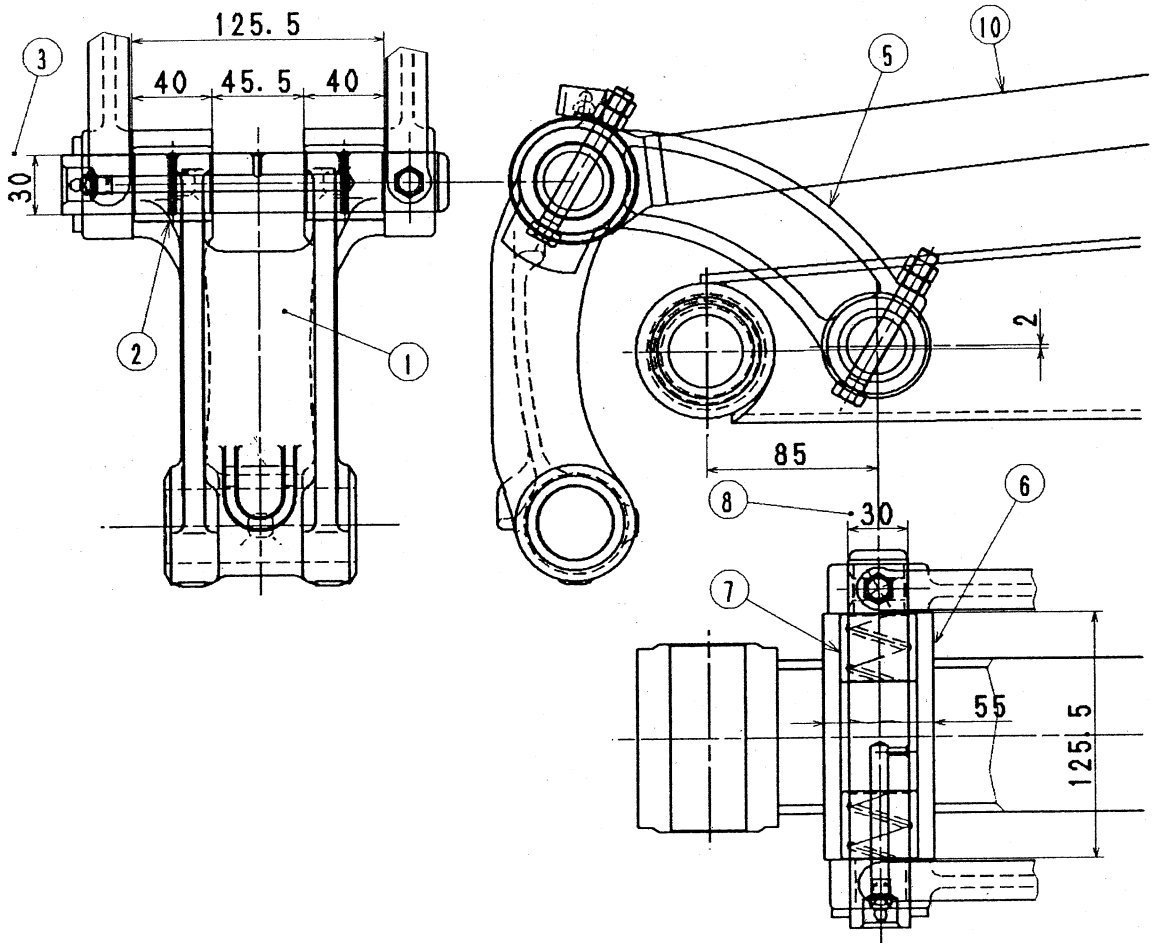


2. Bucket fixture dimensions

	Unit	U15-3	Remarks
A	mm	45.3	
B	mm	2 x M12 x 1.25	
C	mm	45.3	
D	mm	45.3	
E	mm	16.5	
F	mm	3.95	
G	mm	865	
H	mm	2	
I	mm	180	
J	mm	167.5	
K	mm	104.5	
L	mm	735	
M	mm	173	
N	mm	175	
O	mm	85	



3. Bucket link pin



[Unit : mm]

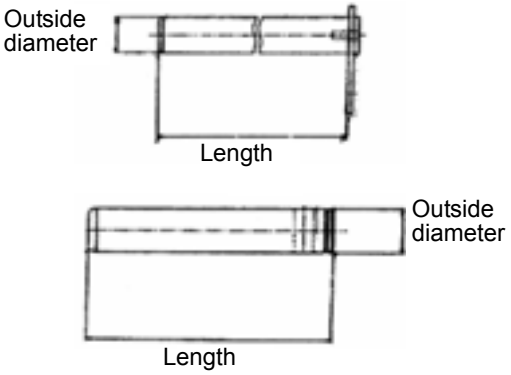
Parts name		Specifications
(1)	Bucket link 1	ϕ30 x 95.5
(2)	Bush A	ϕ30 x ϕ38 x W35
(3)	Pin A dia	ϕ30 x 192.5
(5)	Bucket link 2, 3	ϕ30 - ϕ30
(6)	Arm boss	ϕ55 x ϕ38 x L125.5
(7)	Bush B	ϕ30 x ϕ38 x W35
(8)	Pin B dia	ϕ30 x 192.5
(10)	Bucket cylinder L/S (stroke)	529 / 802 (269)

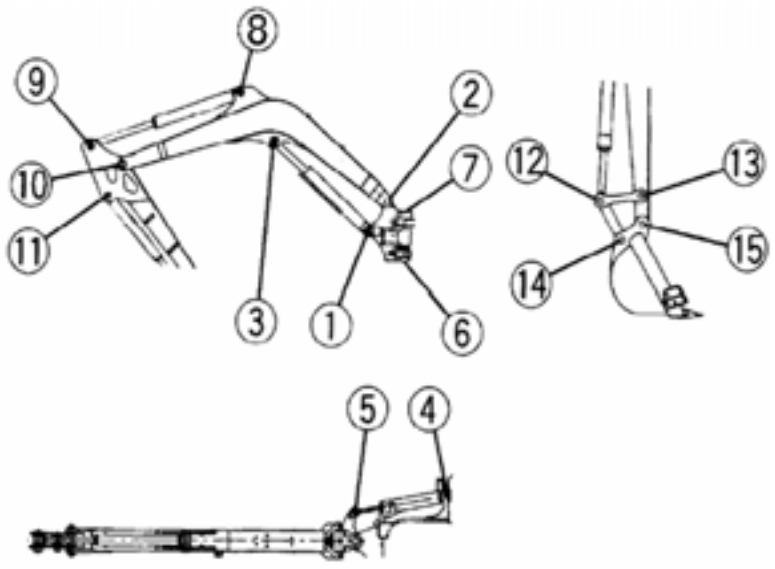
4. Front pins and bush

[Unit : mm]

Location No.	Pin diameter x length	Bush inner dia. x outer dia. x length	Remarks
(1)	ϕ35 x 257	ϕ35 x ϕ45 x 45	
(2)	ϕ35 x 160	ϕ35 x ϕ45 x 35, 44	
(3)	ϕ35 x 160	ϕ35 x ϕ45 x 45	
(4)	ϕ30 x 112.5	ϕ30 x ϕ40 x 35	
(5)	ϕ30 x 96	ϕ30 x ϕ40 x 35	
(6)	ϕ50 x 109	ϕ50 x ϕ60 x 37, 28, 40	
(7)	ϕ50 x 109	ϕ50 x ϕ60 x 37, 28, 40	
(8)	ϕ30 x 160	ϕ30 x ϕ40 x 35	
(9)	ϕ30 x 142	ϕ30 x ϕ40 x 35	
(10)	ϕ30 x 191	ϕ30 x ϕ38 x 35	
(11)	ϕ30 x 142	ϕ30 x ϕ40 x 45	
(12)	ϕ30 x 192.5	ϕ30 x ϕ40 x 35	
(13)	ϕ30 x 192.5	ϕ30 x ϕ38 x 35	
(14)	ϕ30 x 182	ϕ30 x ϕ38 x 35	
(15)	ϕ30 x 182	ϕ30 x ϕ38 x 35	

* The working limits of the pins are 1.0 shorter than the reference on new vehicle.





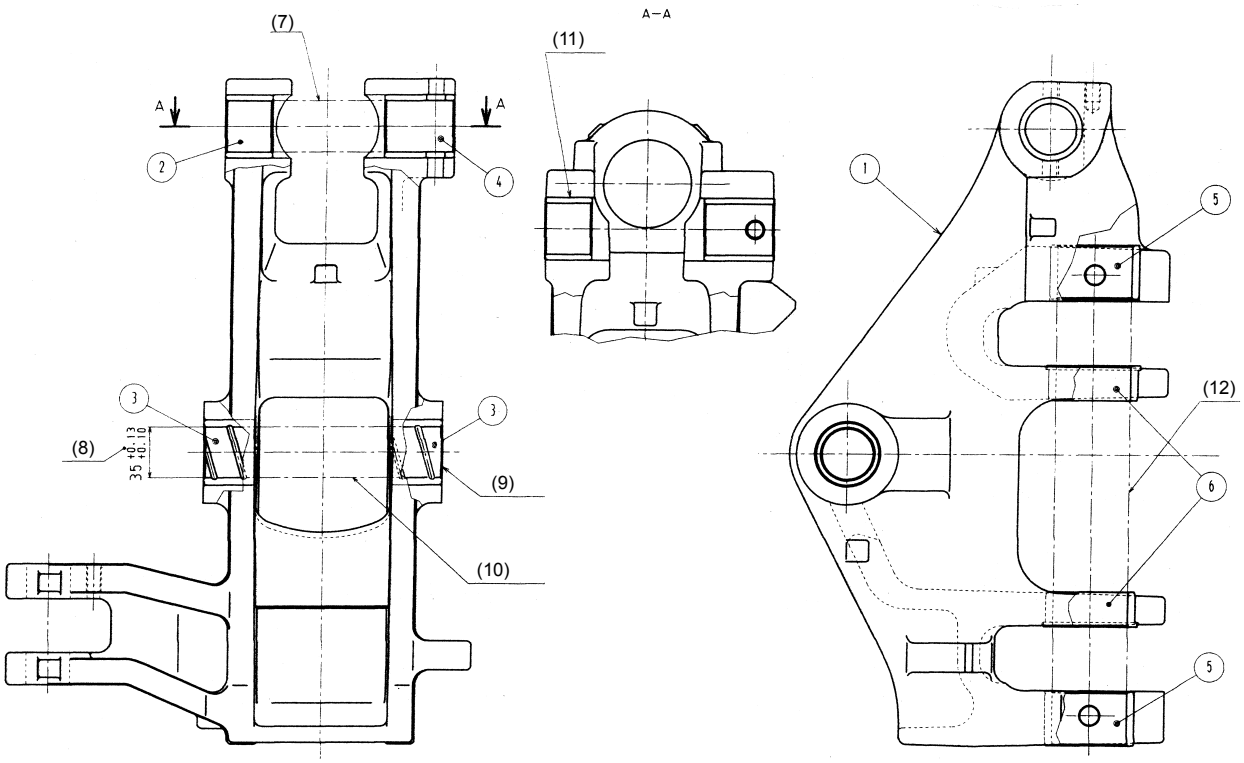
(New pin and bush tolerance)

pin : $\phi 25^{-0.05}_{-0.08}$, $\phi 30^{-0.05}_{-0.07}$, $\phi 35^{-0.05}_{-0.07}$, $\phi 50^{-0.05}_{-0.07}$

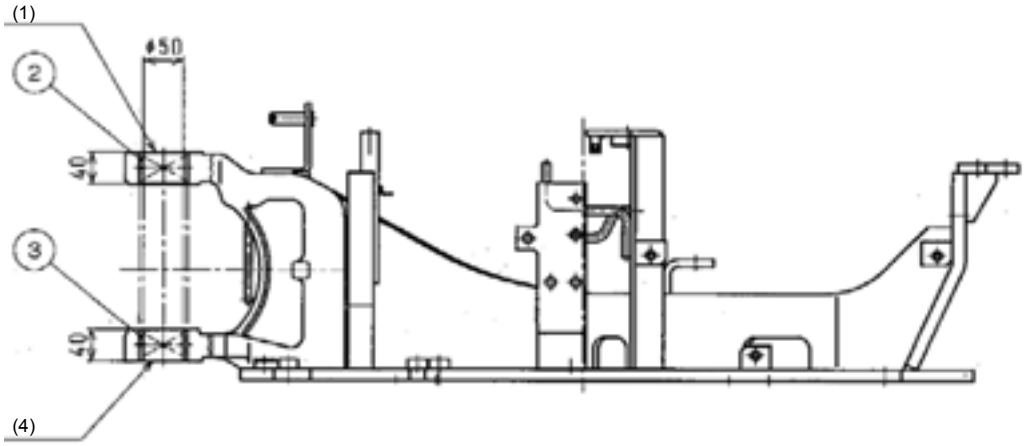
bush : Inner dia. $\phi 25^{+0.130}_{+0.100}$, $\phi 30^{+0.130}_{+0.100}$, $\phi 35^{+0.130}_{+0.100}$, $\phi 50^{+0.090}_{+0.060}$

Outer dia. $\phi 38^{+0.070}_{+0.040}$, $\phi 40^{+0.100}_{+0.070}$, $\phi 45^{+0.100}_{+0.070}$, $\phi 60^{+0.100}_{+0.070}$

5. Swing bracket



(1) Swing bracket
(2) ~ (6) Bushing
(7) After installing the bush, pin of ϕ34.9 goes through smoothy.
(8) Dimension before bushing.
(9) Side of the bush (3) should flash the face.
(10) After installing the bush, pin of ϕ34.9 goes through smoothy.
(11) Side of the bush (2) should behind the surface.
(12) After installing the bush, pin of ϕ49.95 goes through smoothy.



(1) Bushing end to be fitted to boss end
(2) Bush (506040)
(3) Bush (506040)
(4) Bushing end to be fitted to boss end

c. Control levers and linkage

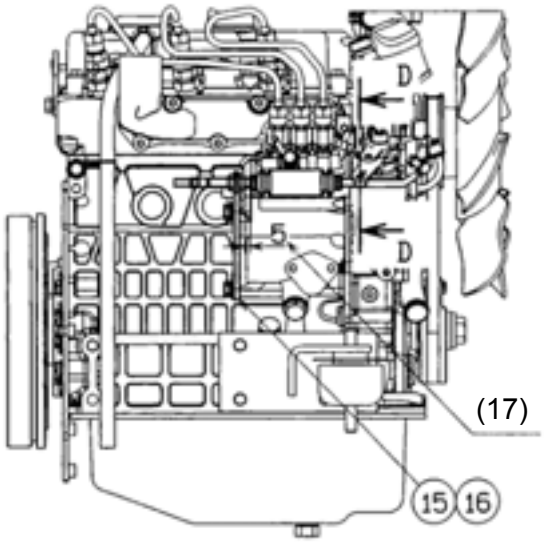
1. Lever strokes and operating forces

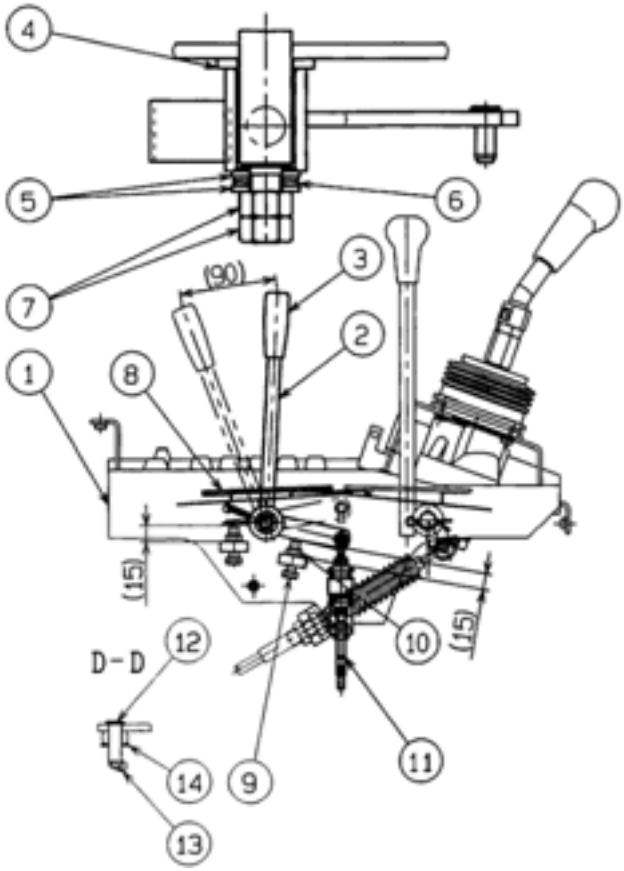
Reference on new vehicle

		Unit	U15-3	Remarks
Boom lever	Stroke	mm	72	Measured at the grip end
	Operating force	N(kgf)	13.7 (1.4)	Measured 20 mm below the grip end
	Play	mm	2≧	
Arm lever	Stroke	mm	72	Measured at the grip end
	Operating force	N(kgf)	13.7 (1.4)	Measured 20 mm below the grip end
	Play	mm	2≧	
Bucket lever	Stroke	mm	74	Measured at the grip end
	Operating force	N(kgf)	13.7 (1.4)	Measured 20 mm below the grip end
	Play	mm	2≧	
Swivel lever	Stroke	mm	74	Measured at the grip end
	Operating force	N(kgf)	13.7 (1.4)	Measured 20 mm below the grip end
	Play	mm	2≧	
Travel lever	Stroke	mm	75	Measured at the grip end
	Operating force	N(kgf)	15.0 (1.5)	Measured 20 mm below the grip end
	Clearance LH/RH lever at neutral position.	mm	5	Longitudinal direction
	Clearance LH/RH lever at most forward and backward position.	mm	10	Longitudinal direction
	Clearance LH/RH lever	mm	2 ~ 5	Lateral direction
Acceleration lever	Operating force	N(kgf)	35.0 (3.4)	Measured 30 mm below the grip top
Dozer lever	Stroke	mm	80	Measured at the grip end
	Operating force	N(kgf)	30.0 (3.1)	Measured 20 mm below the grip end
Lock lever, up	Operating force		20 (2.0)	
Lock lever, down	Operating force		30 (3.0)	
Swing pedal	Operating force	N(kgf)	98.0 (10.0)	Measured at the grip end
Travel high SW	Operating force	N(kgf)	-	

2. Accelerator Lever

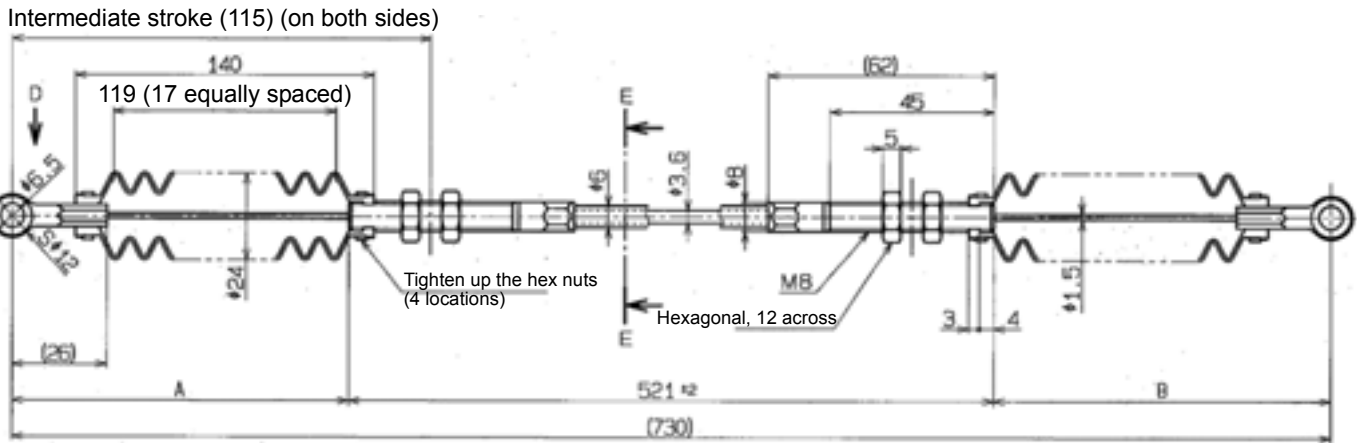
Set the automatic release function at more than 1200 rpm by idling.



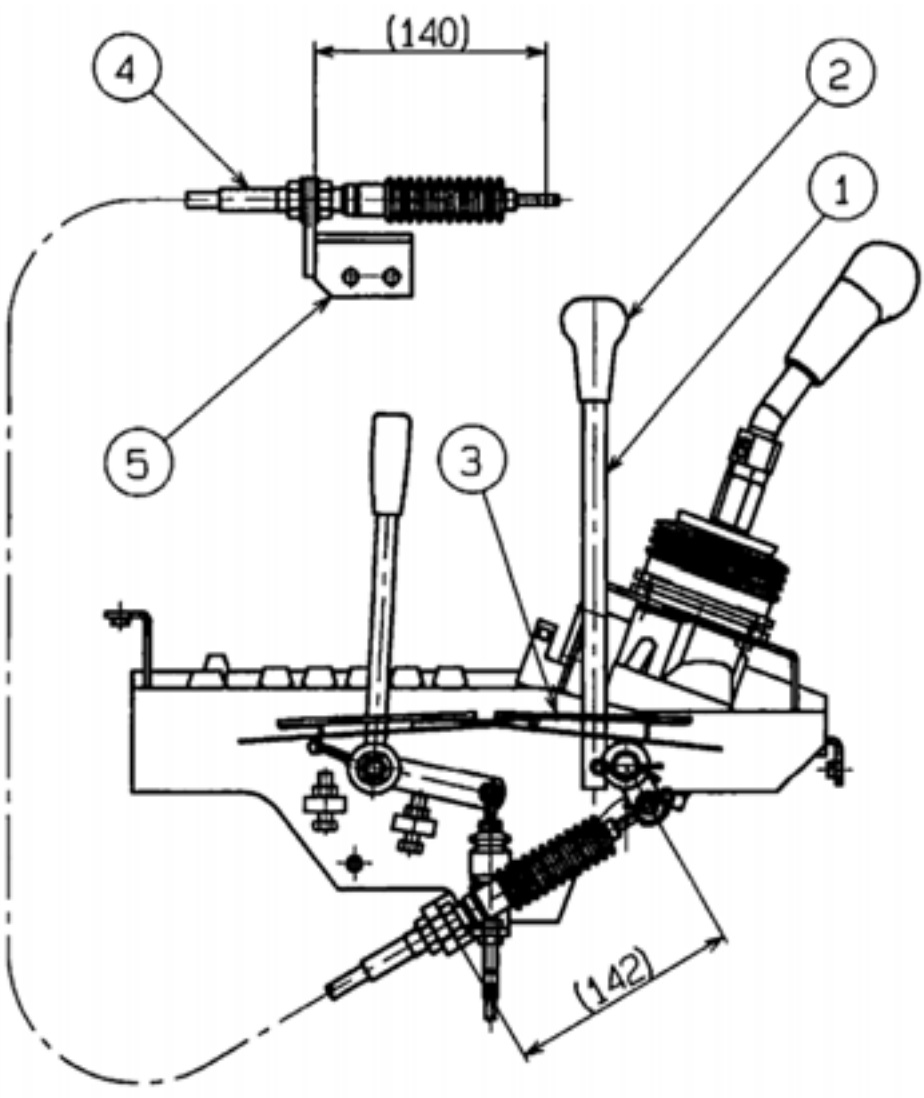


(18)

No.	Part Name	Q'ty	No.	Part Name	Q'ty	Remarks
(1)	Bracket (Operation, R)	1	(9)	Bolt	2	
(2)	Lever assembly (Accelerator)	1	(10)	Nut	2	
	Lever (Accelerator)	1	(11)	Cable (Accelerator)	1	
	Bush	2	(12)	Headed pin	1	
(3)	Lever grip 2	1	(13)	Snap pin 6	1	
(4)	Plain washer	1	(14)	Plain washer	1	
(5)	Plain washer	2	(15)	Support (Accelerator)	1	
(6)	Disc spring	2	(16)	Bolt	2	M8 7T
(7)	Nut	2	(17)	Put them together and assemble beforehand.		
(8)	Seal (Lever, blade)	1	(18)	Dimensions in the parenthesis show the design values.		



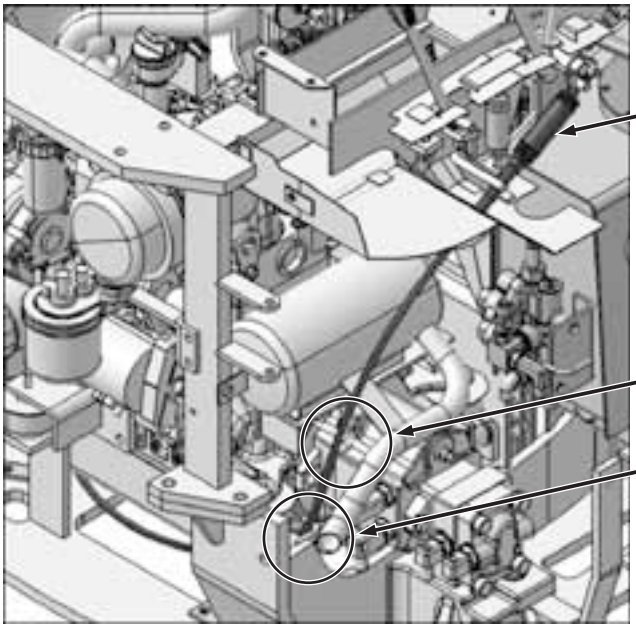
3. Dozer Lever



(6)

No.	Part Name	Q'ty	Remarks
(1)	Lever assembly (Blade)	1	
	Lever (Blade)	1	
	Bush	2	
(2)	Grip	1	
(3)	Seal (Lever, blade)	1	
(4)	Cable (Blade)	1	
	Plain washer	1	
	Snap pin	1	
(5)	Bracket (Cable, blade)	1	
(6)	Dimensions in the parentheses show the design values.	1	

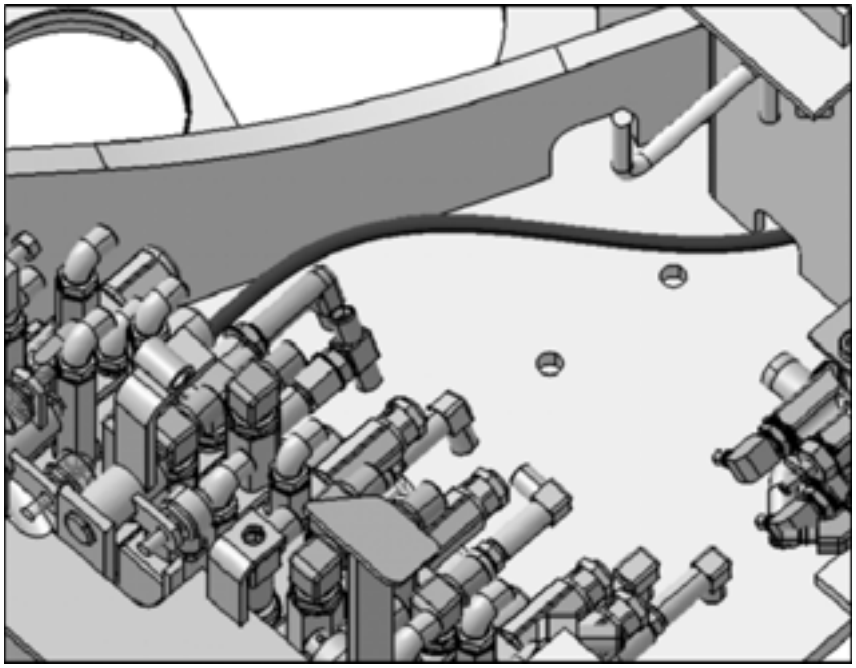
4. Dozer Cables (Route)



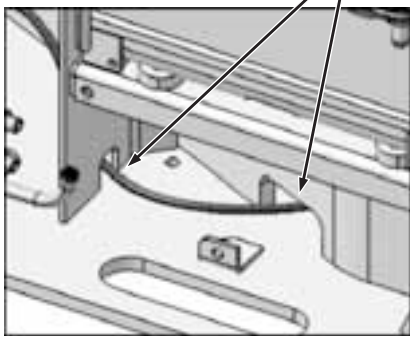
RA221-6573Δ
Cable (Blade)

Pass the cable behind the welded member of the bracket (muffler).

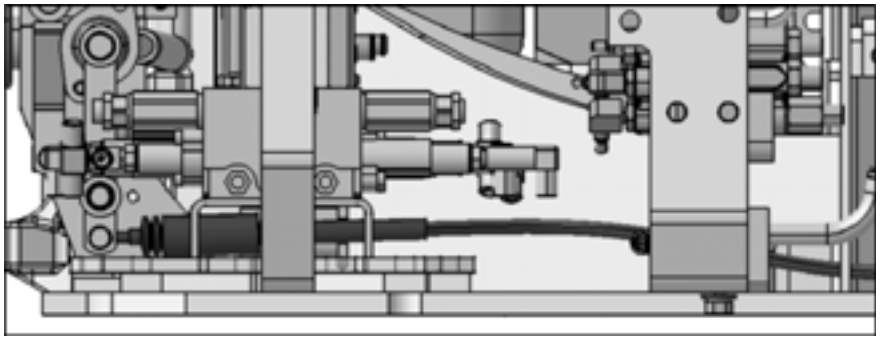
Pass the cable along the inside of the welded member of the swivel frame.



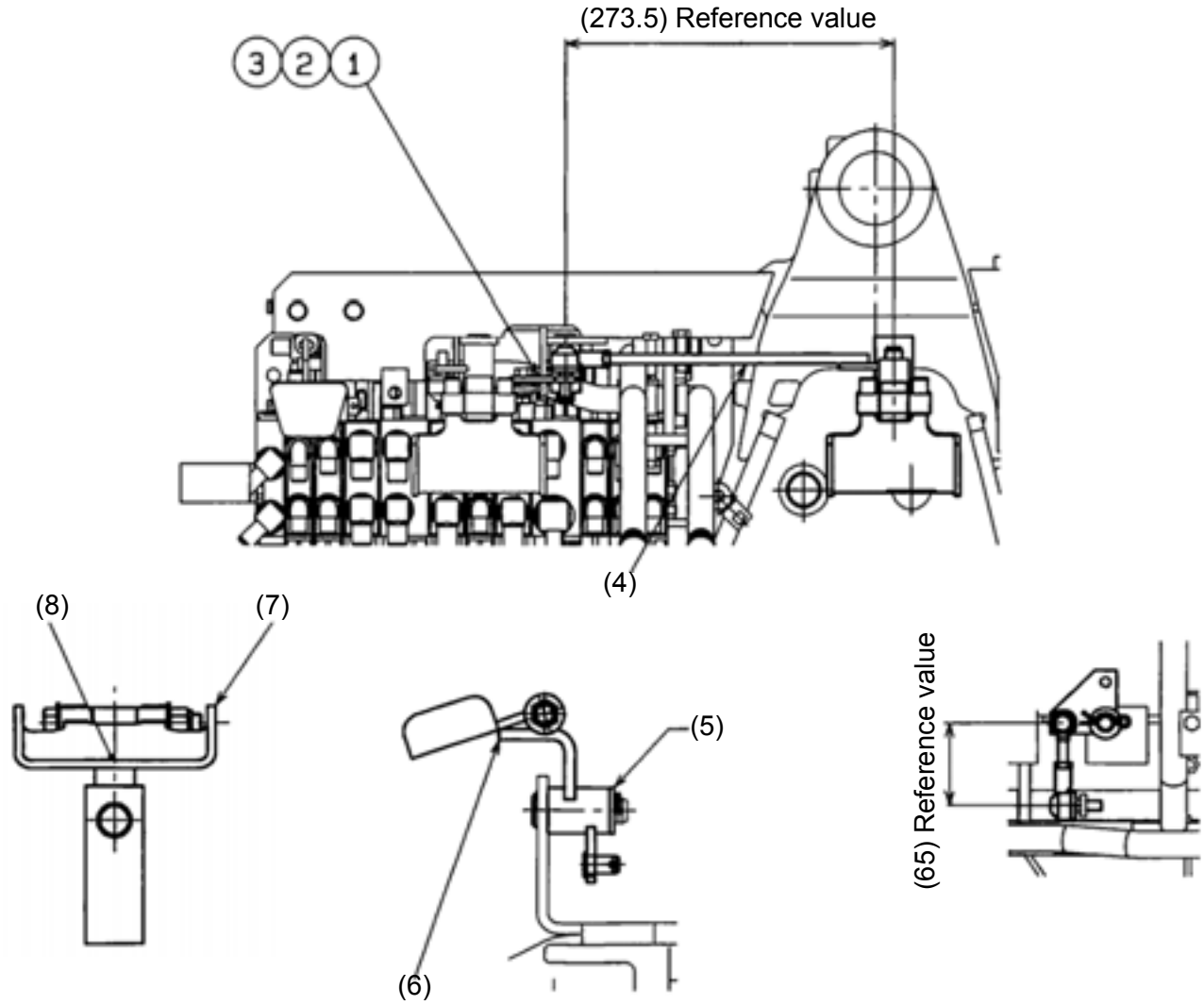
Pass the cable through the 2 holes of the vertical ribs at the left side of the swivel frame.



Pass the cable under the control valve.

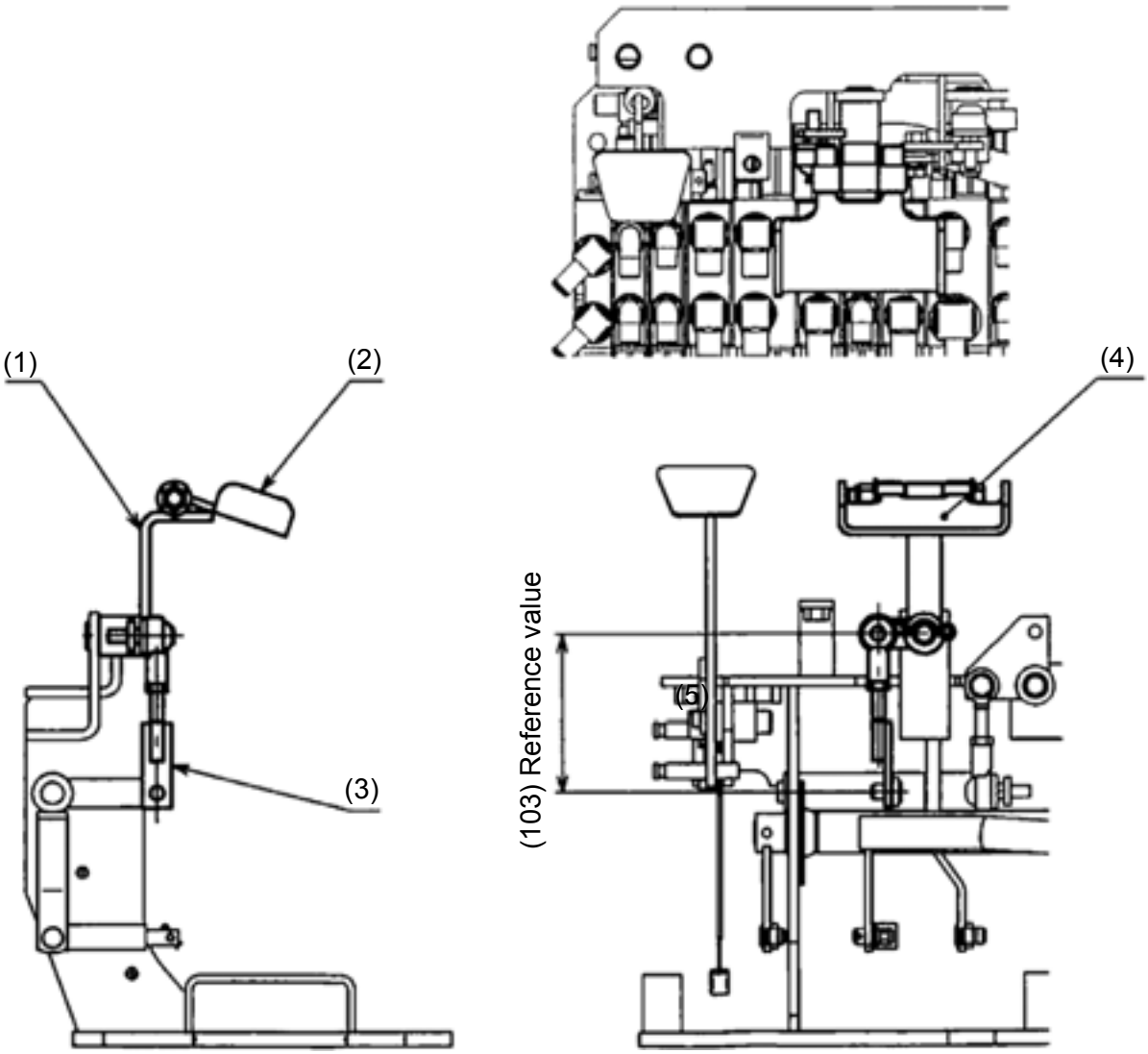


5. Swing Pedal



No.	Part Name	Q'ty	No.	Part Name	Q'ty
(1)	Lever assembly (Swing)	1	(5)	Plain washer	1
	Lever (Swing)	1		Snap pin	1
	Bush	2	(6)	Lever assembly (Swing pedal)	1
(2)	Plain washer	1		Lever (Swing pedal)	1
(3)	Snap pin	1		Bush	2
(4)	Rod (Swing)	1	(7)	Pedal	1
	Rod end right-hand screw	1		Bolt	1
	Nut	2		Plain washer	2
	Spring washer	1		Jam nut	1
	Plain washer	1	(8)	Assemble so that the pedal upper side should be level at neutral.	
	Snap pin	1			

6. Swing Pedal

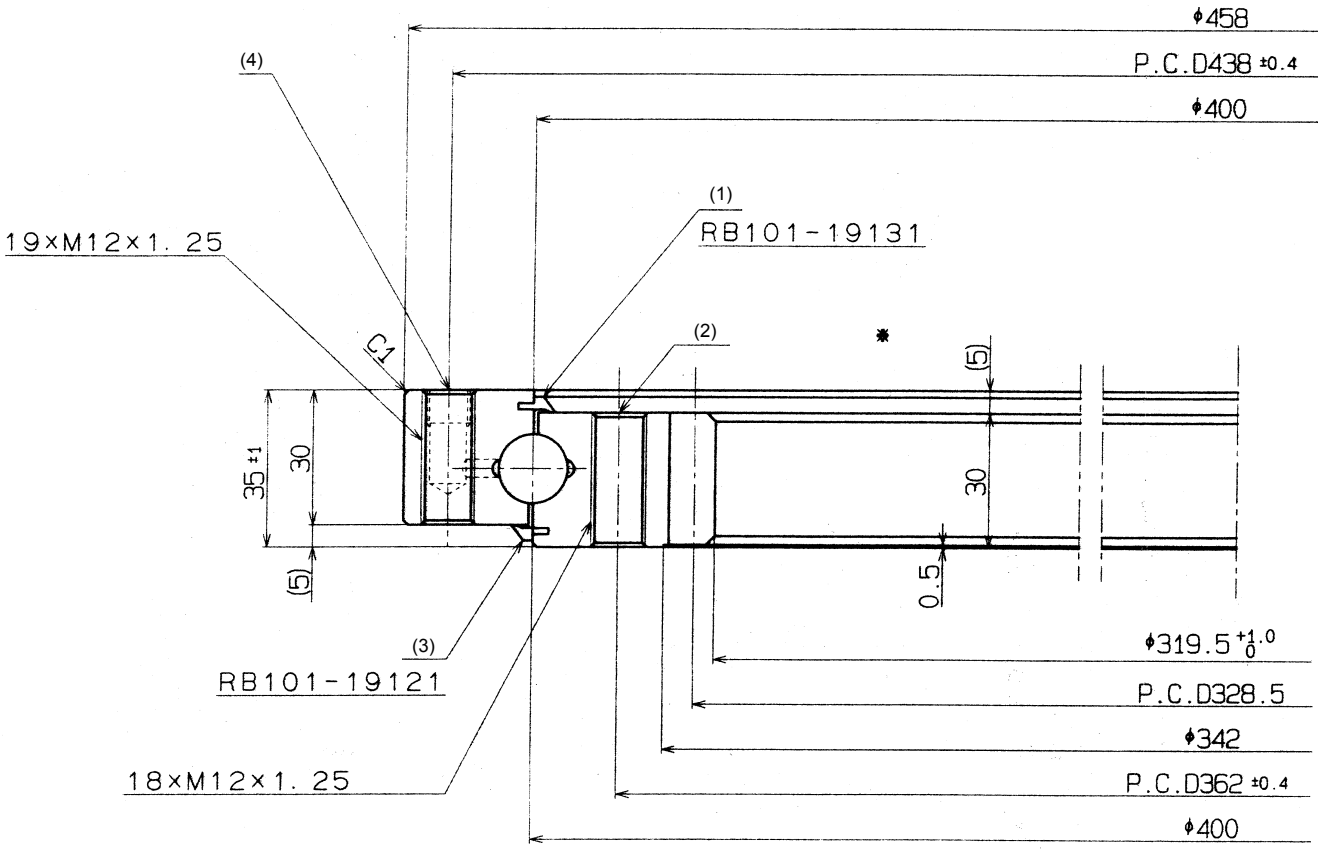


No.	Part Name	Q'ty
(1)	Lever assembly (SP pedal)	1
	Lever (SP pedal)	1
	Bush	2
(2)	Pedal	1
	Bolt	1
	Plain washer	1
	Jam nut	1
(3)	Rod (SP)	2
	Rod end right-hand screw	1
	Nut	
	Spring washer	1
	Plain washer	1
	Snap pin	

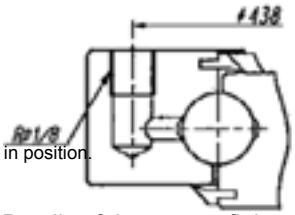
(4) Assemble so that the pedal upper side should be level at neutral.

d. Under carriage components

1. Swivel bearing

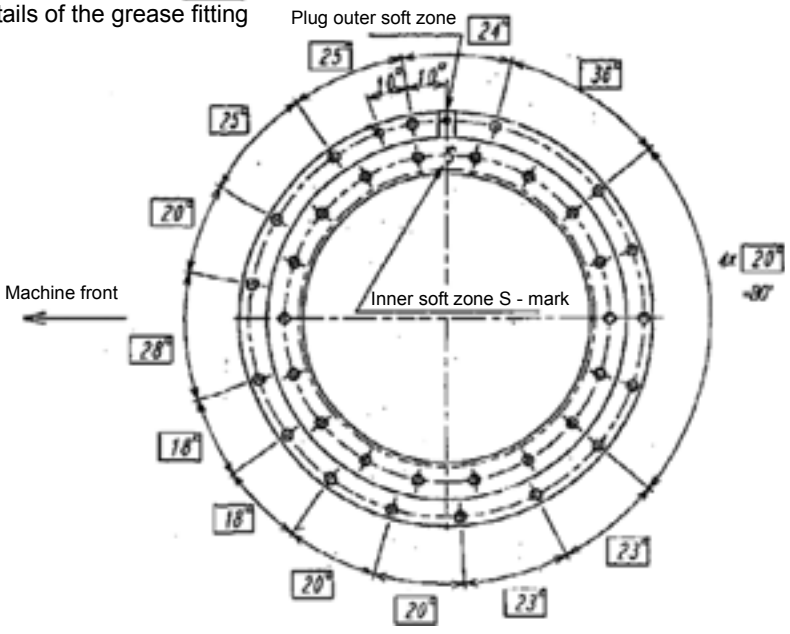


(1) Seal B
(2) S-mark
(3) Seal A
(4) R_p 1/8, for grease nipple

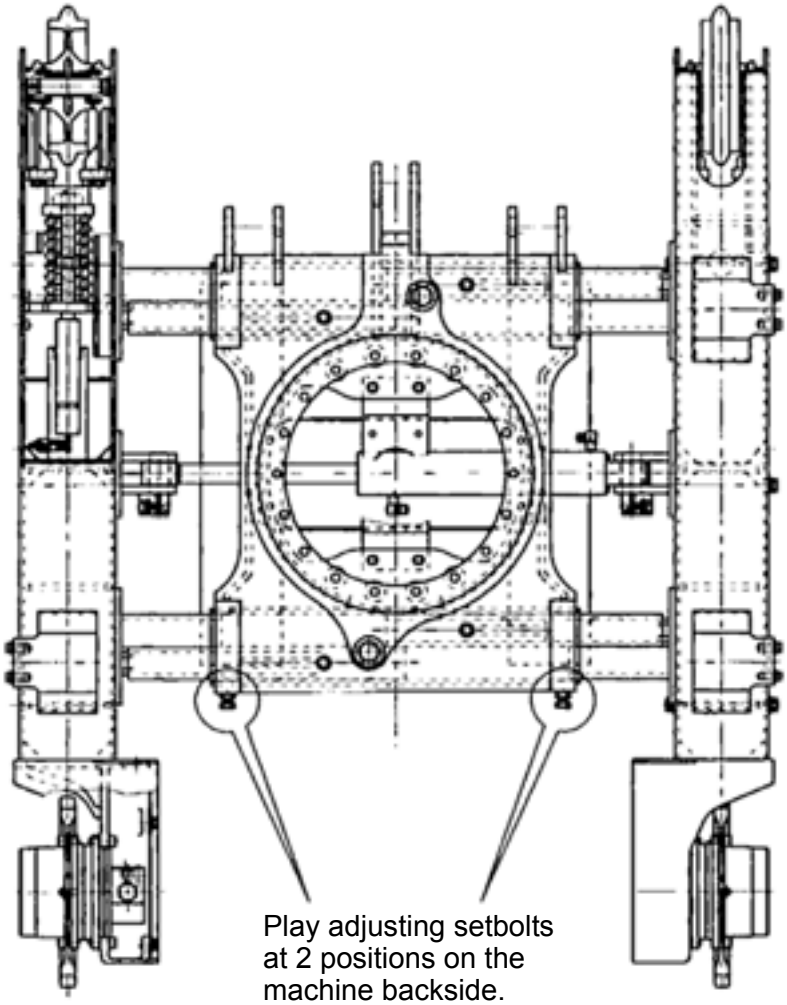


Details of the grease fitting

1) Number of teeth = 73
2) Backlash = 0.05 ~ 0.35 mm
   (0.002 ~ 0.014 inch)
3) P.C.D. = ϕ 328.5
4) Induction-harden the inner and outer ring raceways as well as the tooth flank and bottom.
   Raceway surface hardness: 50 ~ 60 HRC
   Tooth flank and bottom surface hardness: 52 ~ 60 HRC
   (See the Gear Specifications for gear hardening details.)
5) Inner ring' "S" marking and outer ring's stopper on the soft zone.
   When installing the bearing, position the soft zone where there is the least load.
6) Radial clearance (Measuring load) (0.03 ~ 0.25)
   Axial clearance (Measuring load) (0.03 ~ 0.15)

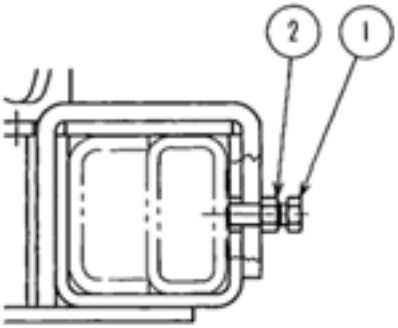


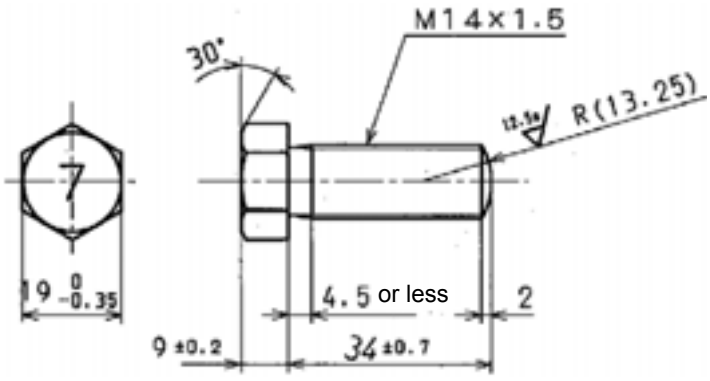
2. Truck Frame (Adjustment of Play)



Play adjusting setbolts at 2 positions on the machine backside.

Magnified view of adjusting portion



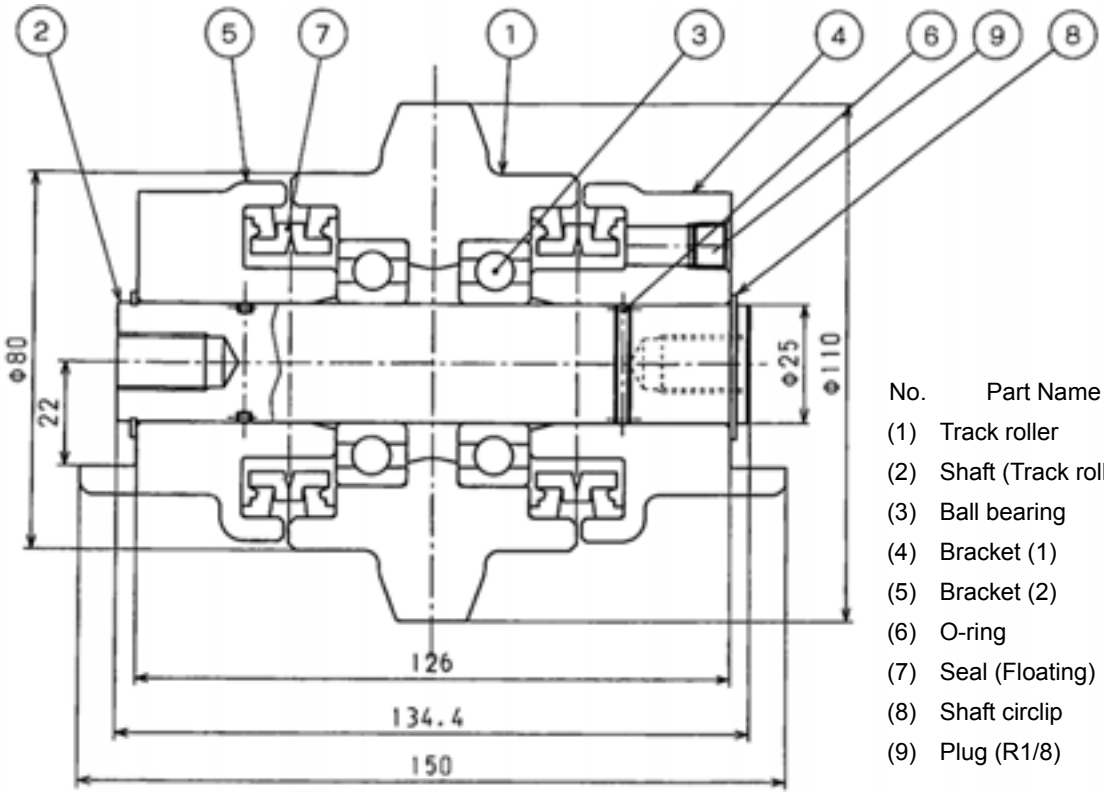


(Set bolt)

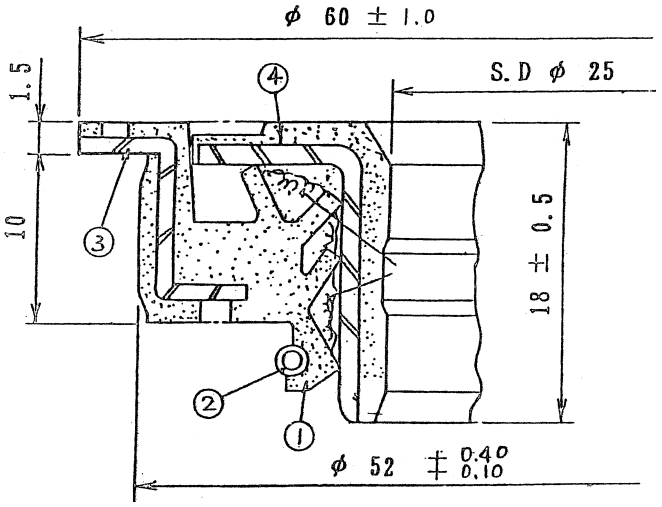
No.	Part Name	Q'ty
(1)	Set bolt (RA221-21161)	2
(2)	Nut	1

Play adjusting procedure
1. Tighten the play adjusting setbolts until they reach the left and right sides of the frame.
2. Loosen the play adjusting setbolts by 1/4 turns when they have reached the frame.
3. Lock the adjusting setbolts by nuts.

3. Structure of Track Roller



No.	Part Name	Q'ty	Remarks
(1)	Track roller	1	FCD600
(2)	Shaft (Track roller)	1	S45C-D
(3)	Ball bearing	2	
(4)	Bracket (1)	1	FCD450-10
(5)	Bracket (2)	1	FCD450-10
(6)	O-ring	2	
(7)	Seal (Floating)	2	
(8)	Shaft circlip	2	
(9)	Plug (R1/8)	1	



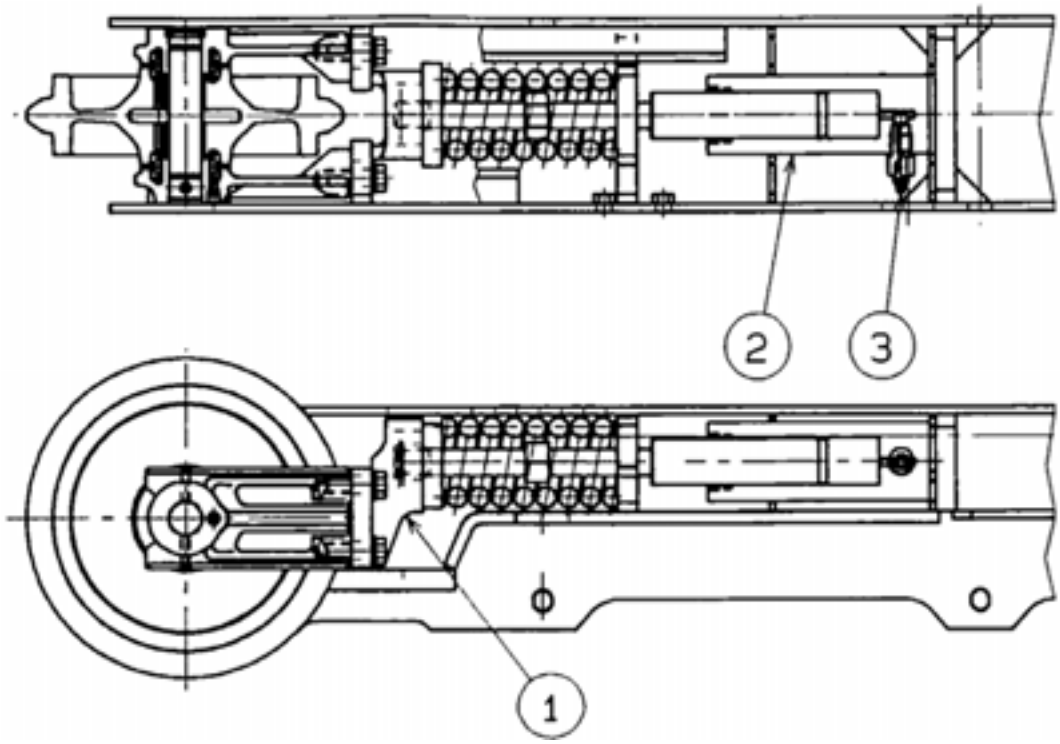
(1) Packing, NBR
(2) Spring
(3) Reinforce, ring
(4) Sleeve
(5) Fill grease

Lub oil :Engine oil SAE #30CD class 40 cc
Plug :Apply screw lock agent and tightening torque, 0.8 kg·m

Notes:

1. Fill the bearing with oil (40 cm^3).
2. Use Engine genuine oil SAE30 class CD or equivalent.
3. Use care not to confuse the sides of the shaft circlip.
   (Rolled-over side to be fitted in the groove is inner side, while the burred (sharp) side is the outer side)
4. The roller should be turned smoothly after it has been assembled completely.
5. Dimensions of assembling jigs for seal etc. and the assembling procedure are equivalent to those of RA211-2170Δ.

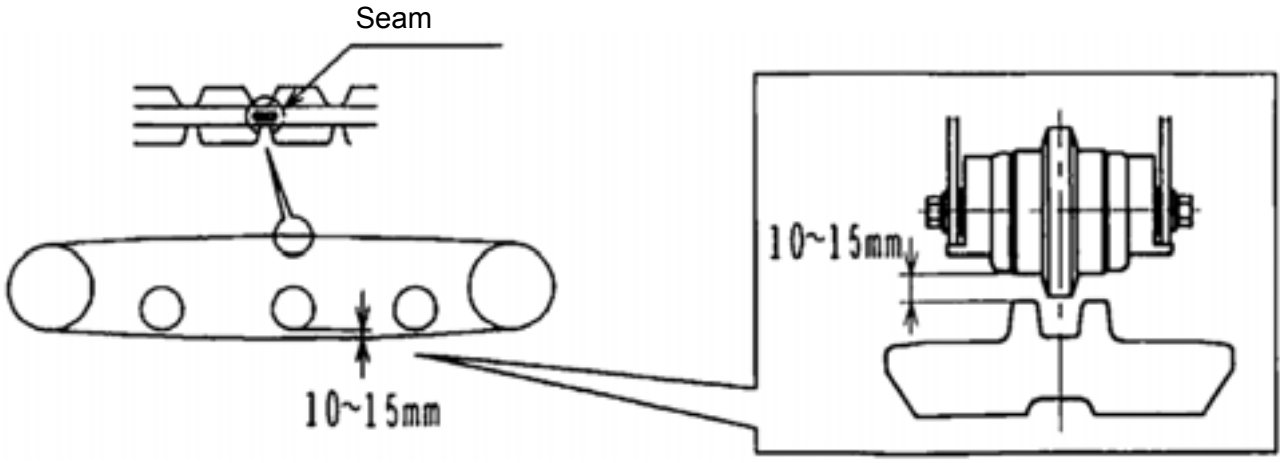
4. Tension Device



Both iron and rubber springs can be used compatively.

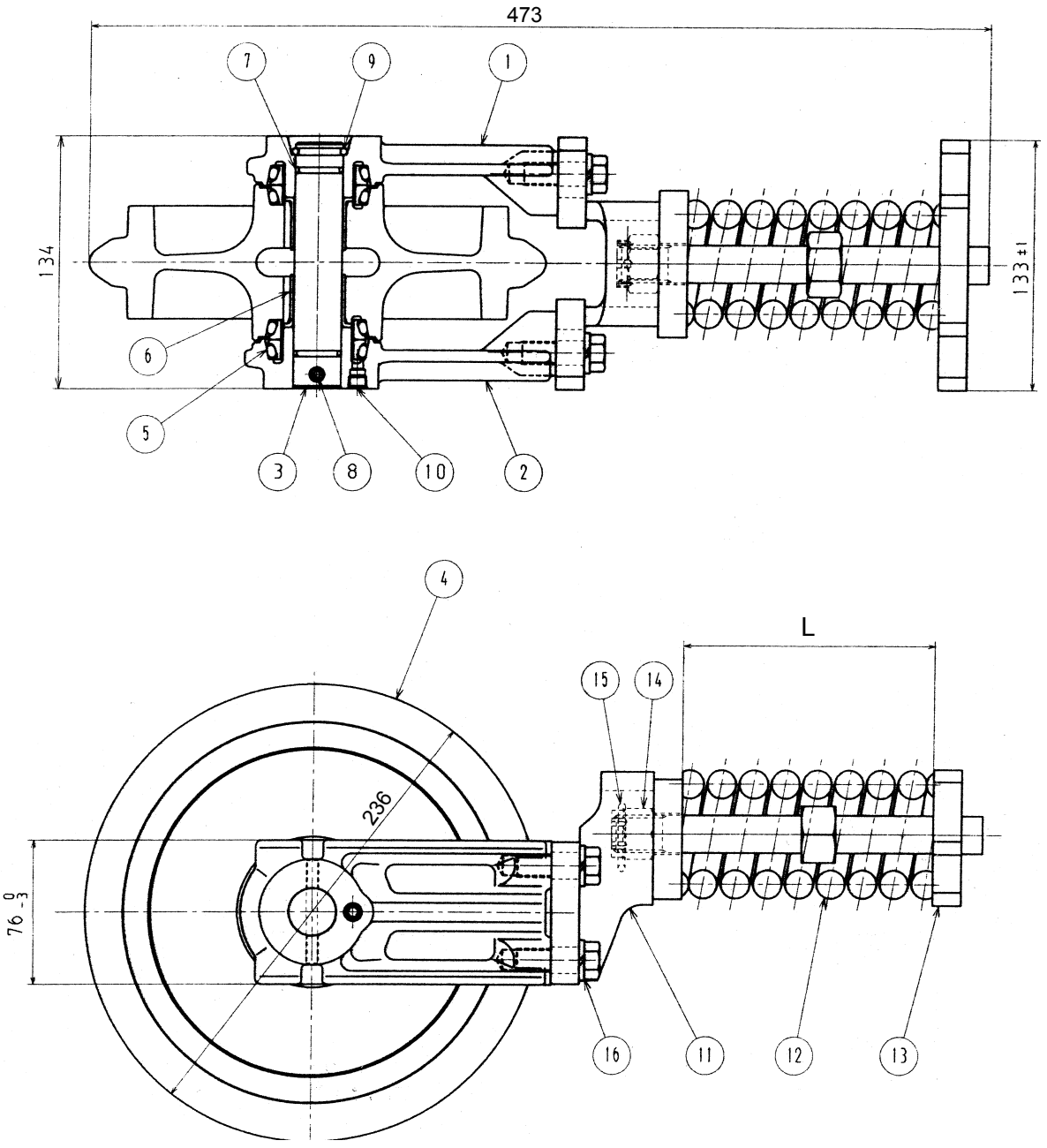
No.	Part Name	Q'ty
(1)	Idler assembly	2
(2)	Cylinder assembly (Left)	1
	Cylinder assembly (Right)	1
(3)	Nipple (Grease cylinder)	2

In the case of rubber roller, adjust it so that the joint mark (∞) should come to the upper center position (as shown in the figure below).

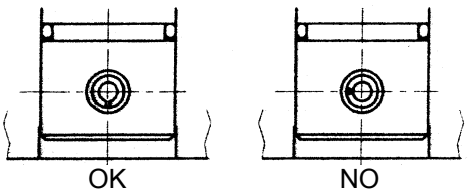


5. Idler and tension spring

[mm]



(1) Support 1	(5) Floating seal	(9) Wire	(13) Retainer
(2) Support 2	(6) Bushing	(10) Plug, R 1/8	(14) Nut
(3) shaft	(7) O-ring	(11) Yoke	(15) Split pin
(4) Idler	(8) Spring pin	(12) Spring	(16) Bolt



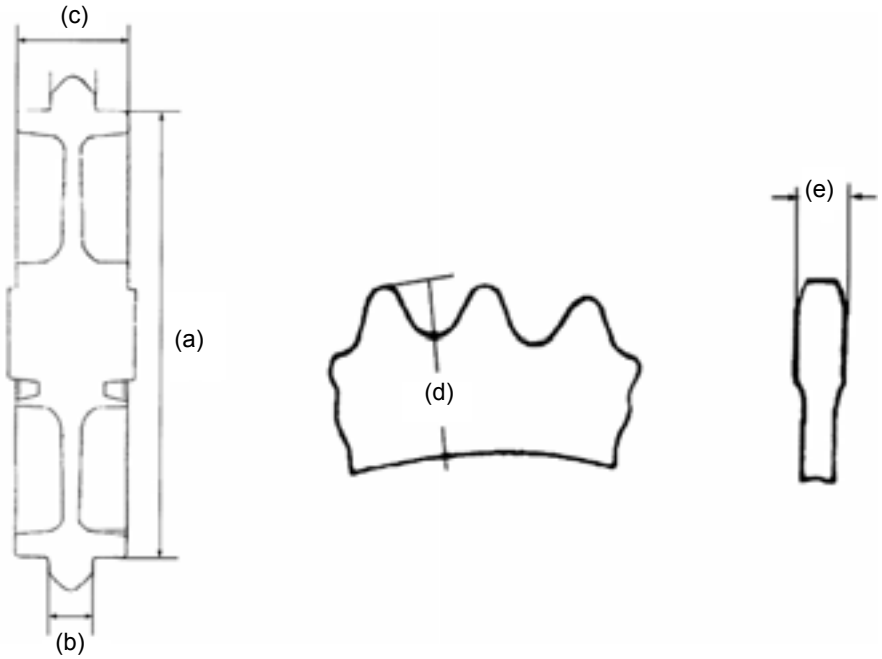
(Spring roll pin direction)

1) Pre-set length of spring : L=130 mm (5.12 inch)
2) Bolt(16) tightening torque : 77.5 ~ 90.2 N·m (7.9 ~ 9.2 kgf·m)
3) Lub oil : Engine oil SAE30 CD. Apply screw lock agent. (Locktite 271).
   30cc

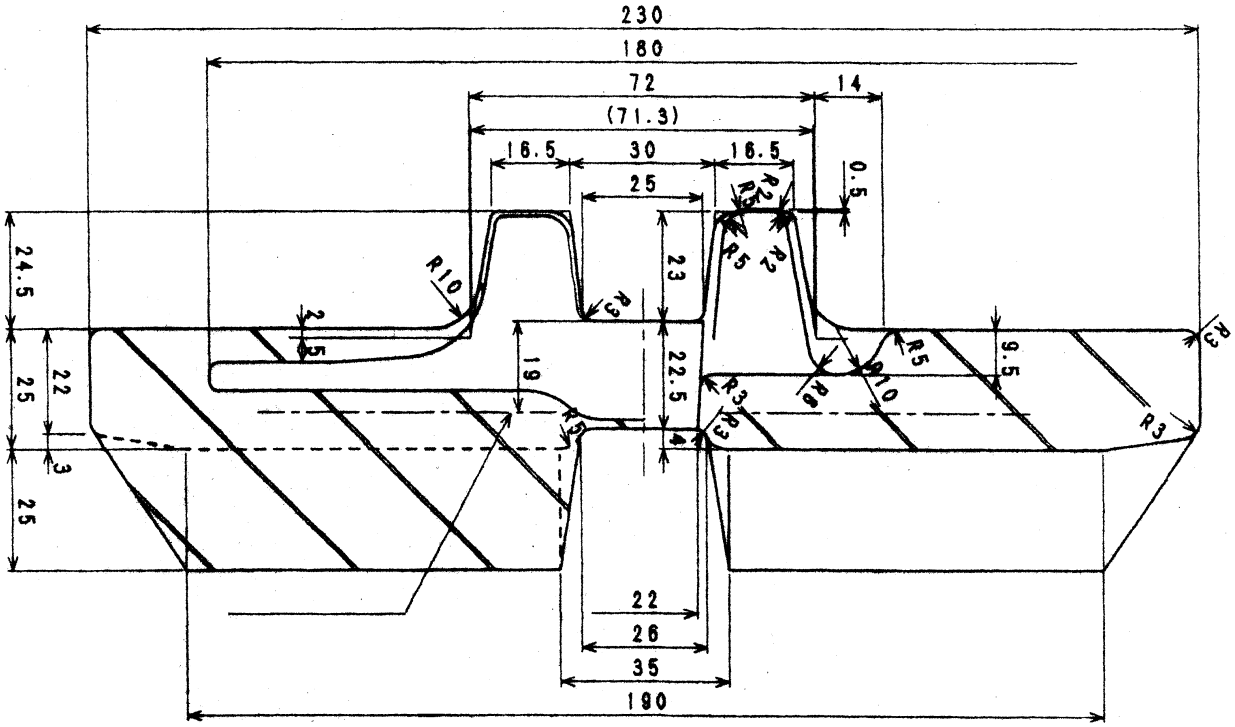
6. Idler and sprocket

(A) Reference on new vehicle
(B) Allowable limit

		Unit	U15-3	Remarks
Idler (a) Outside diameter	(A)/(B)	mm	202/196	Rubber Crawler
			196/190	Steel Crawler
(b) Guide width	(A)/(B)	mm	27/23	
(c) Idler width	(A)/(B)	mm	60/55	
Sprocket (d) Outside diameter	(A)/(B)	mm	290/284	
Sprocket (e) Wheel width	(A)/(B)	mm	23/18	



7. Rubber track

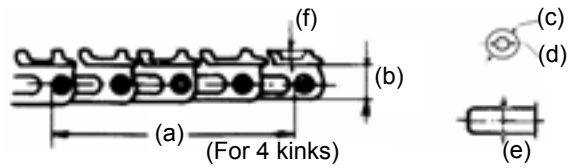


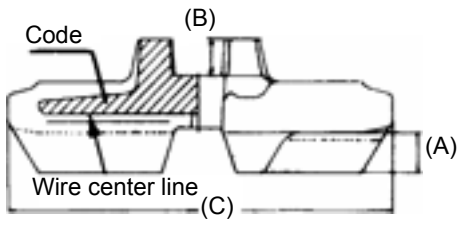
Spec items	
Type	230 x 35 x 96
Lug height	23.0 mm
Iron core pitch	96.0 mm
Circunference	3360 ± 10 mm
Number of steel cords	48 ± 4
Steel cords lap length	260 mm
Steel cords strength	3.92 KN (400 kgf) or more
Thickness of crawler main part	23.0 mm
Ditto joint parts	26.5 mm
Core metal	FCD450 (Equiv.)
Number of core metal (Links)	35

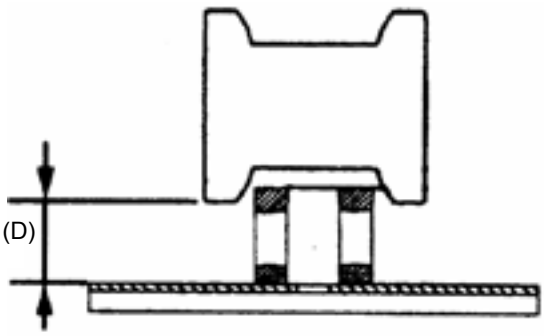
8. Track shoe

(A) Reference on new machine
(B) Allowable limit

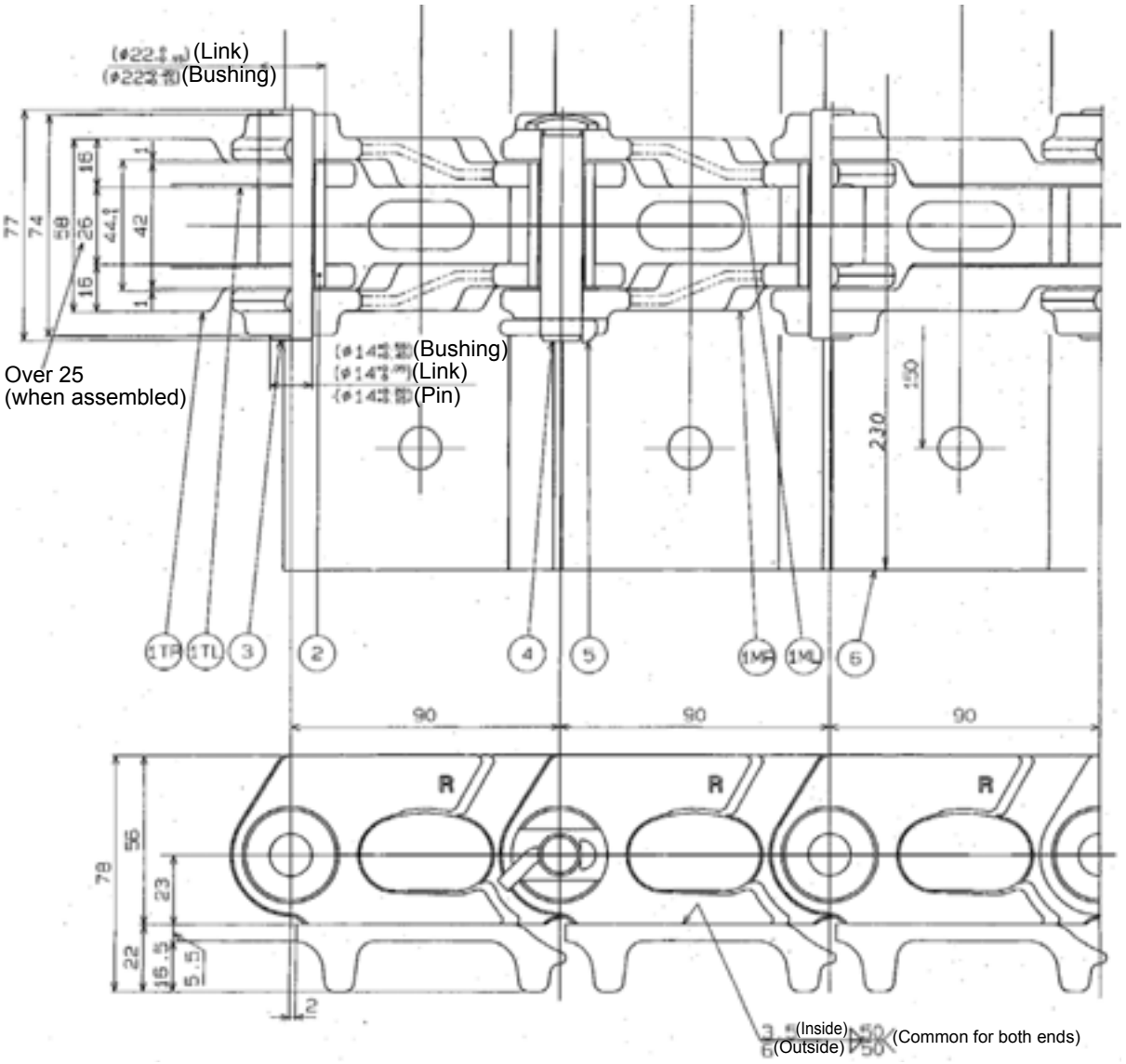
Crawler width		Unit	U15-3	Remarks
(a)	Length (A)/(B)	mm	360/370	
(b)	Wheel tread height (A)/(B)	mm	56/51	
(c)	Collar outside diameter	mm	22/20.5	
(d)	Collar inside diameter	mm	14/16	
(e)	Master pin outside diameter	mm	14/12.5	
(f)	Grouser height (A)/(B)	mm	16.5/8	Including plate
	Crawler width x No. of links	mm	230 x 37	
(D)	Crawler tension	mm	25 ~ 30	Roller outer collar to plate



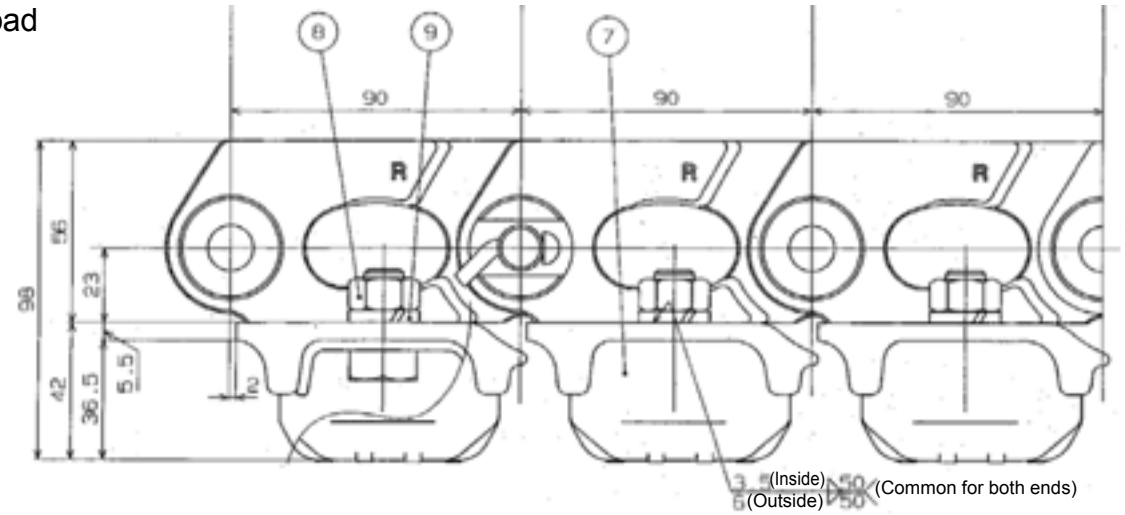




9. Iron track shoe



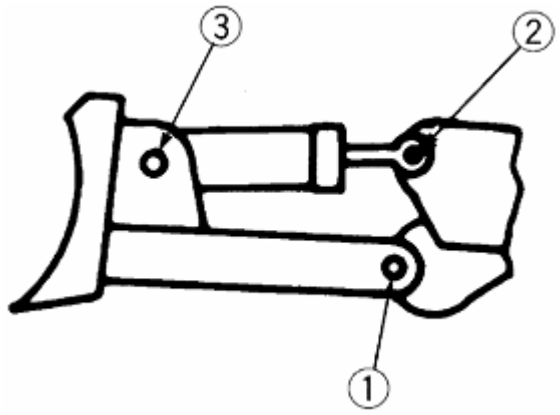
Rubber pad

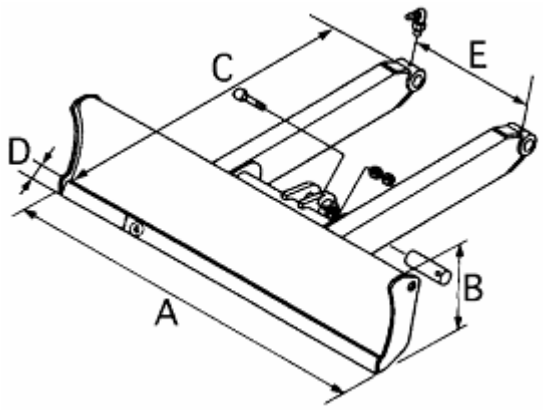


Tighten hex nuts to torque of 70-100 N·m.

9. Dozer

		Unit	U15-3	Remarks
(1)	Pin outside dia. - Length	mm	ϕ30-102.5	
(2)	Outside diameter - Length	mm	ϕ30-84.5	
(3)	Outside diameter - Length	mm	ϕ30-84.5	
(4)	Outside diameter - Length	mm	ϕ30-95	Track cylinder mounting pin
(5)	Outside diameter - Length	mm	ϕ25-133	Extension blade mounting pin
A	Width	mm	1244/990	
B	Height	mm	261	
C	Length	mm	710	
D	Tip wear thickness	mm	t 9	
E	Distance between supports	mm	434	
	Movement above ground/below ground	mm	263/182	
	Dozer capacity	m^3	0.067	w/o Extention blade





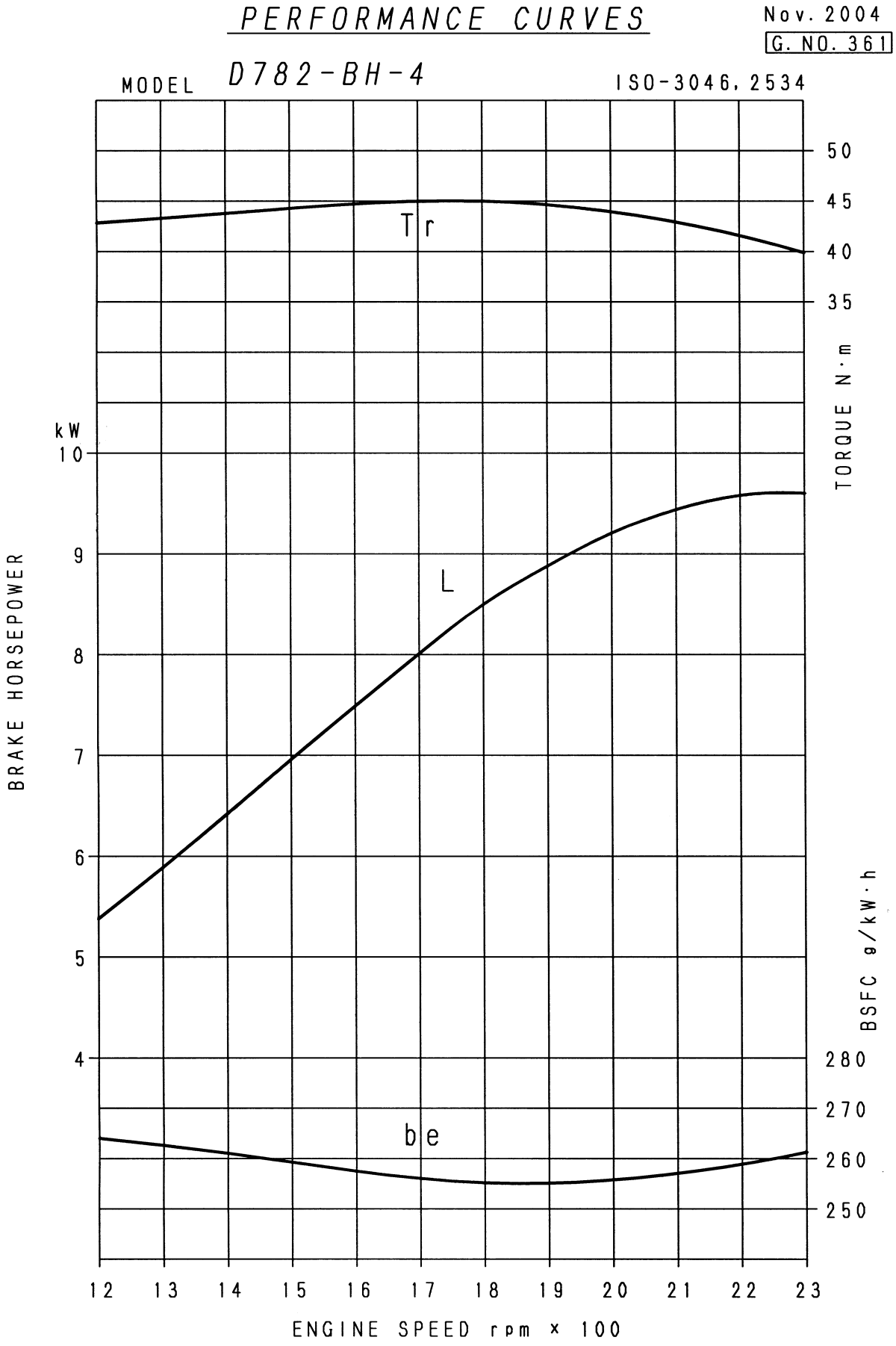
C.Engine

a. Main specification

Main specifications of the D782-BH-4 high-speed diesel engine

Type		4-cycle, vertical, 3-cylinder, water-cooled diesel engine
No. of cylinders - Cylinder bore x Stroke	mm	3 - ϕ67 x L73.6
Piston displacement	l	0.778
Rated net output/rpm	kW / rpm	9.6 (13.1PS) / 2300
Maximum engine speed	rpm	2600 ≧
Engine idling speed	rpm	1200 +150 / -0
Type of combustion chamber		E-TVCS
Type of fuel injection pump		Bosch MD mini-pump
Type of governor		Centrifugal mechanical governor
Type of injection nozzle		DN4PD52 mini-nozzle
Fuel injection timing	deg	BTDC14 ~ 16 (15p ~ 17p : pressure feed type)
Fuel injection pressure	MPa	13.7 (140 kgf/cm^2)
Compression ratio		24
Cooling system		Pressure radiator type, 0.088 MPa (0.9 kgf/cm^2) Forced circulation by cooling water pump
Starting system	V, kW	Self-starter (12,1.2)
Charging system	V, W	Alternator type (12,480)
Fuel used		Diesel light oil
Battery used		50B24 R or equivalent
Weight	kg	About 64
Application		Mini-excavator U15-3

b. Performance curves



c. Engine electrical data

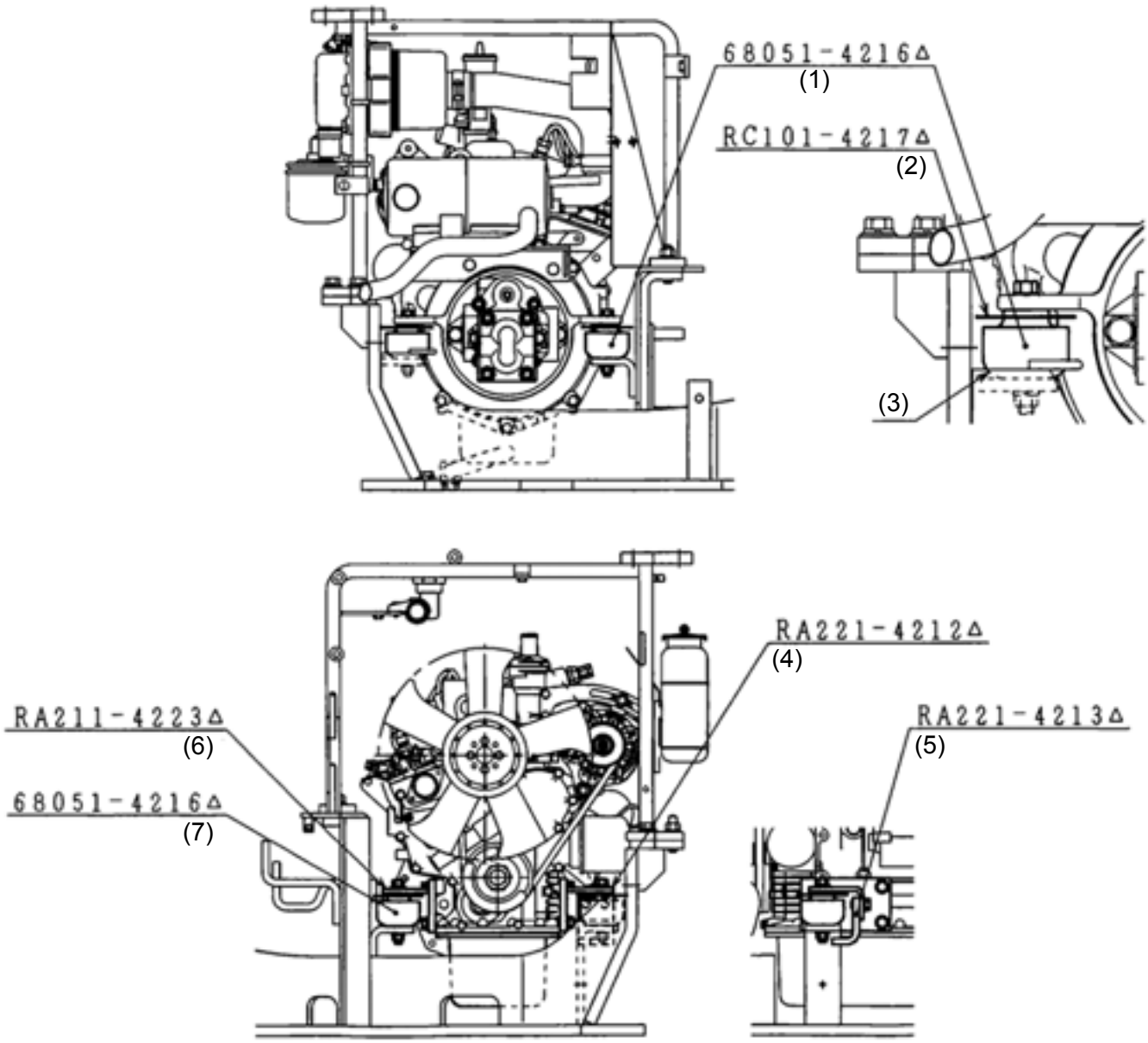
	Unit	U15-3	Remarks
Fuel system Injection P type		Bosch MD (NC), Mini-Pump	
Fuel tank capacity	L	18	
Fuel consumption rate	g/kWh	286	
Fuel consumption	L/hr	19.3 (2.0)	Calculated 0.85, 0.6(actual measurement)
Type of nozzle		DN4PD62	Denso
Injection pressure	Mpa (kgf/cm^2)	13.8 ~ 14.7 (140 ~ 150)	
Electrical system Charging generator	V-W	12-480	
Denso-specified type	Part code/ electricals	V10505-B-AEBI-1	
Charging current	A	40	
Regulator-adjusted voltage	V	14.2 ~ 14.8	5000 rpm, 10A, 25 °C
Type of battery		55B24R	Yuasa
5-hour rated capacity	Ah	36	
Electrolyte specific gravity		1.28 ± 0.01	20 °C
Self-strat motor	V-W	12-1.2	
Maker-specified type		228000-0951	Denso
Glow plug		1.5 ± 0.15 (DC11V applied for 6 seconds)	Cold resistance 0.9 Ω

d. Engine servicing data

(A) Reference on new vehicle
(B) Allowable limit

		Unit	U15-3	Remarks
Engine model			D782-BH-4	
Cylinder head distortion limit		mm	0.05	
Top clearance		mm	0.50 ~ 0.65	
Cylinder bore (A)/(B)		mm	67.000 ~ 67.019 / +0.15	
Cylinder liner wear limit		mm	+0.15	
Clearance with piston ring groove	Oil ring (A)/(B)	mm	0.02 ~ 0.06 / 0.15	
	Compression ring (A)/(B)	mm	0.085 ~ 0.115 / 0.15	
Piston ring fitting clearance	Oil ring (A)/(B)	mm	0.15 ~ 0.30 / 1.2	
	Compression ring (A)/(B)	mm	0.15 ~ 0.30 / 1.2	Top
	Compression ring (A)/(B)	mm	0.30 ~ 0.45 / 1.2	Second
Piston outside diameter		mm	ϕ67	
Timing gear backlash (A)/(B)		mm	0.041 ~ 0.124 / 0.15	
Compression pressure (A)/(B)		Mpa (kgf/cm^2)	3.0 ~ 3.4 (31~35) / 2.5 (25)	
Difference among compression pressure cylinders		%	10 ≧	
Crankshaft	Crank pin out. diameter	mm	33.959 ~ 33.975	
	Side clearance (A)/(B)	mm	0.15 ~ 0.31/0.5	
Valve guide inside diameter		mm	6.010 ~ 6.025	
Valve stem outside diameter		mm	5.968 ~ 5.980	
Clearance between valve stem and valve guide (A)/(B)		mm	0.030 ~ 0.057 / 0.1	
Pressure at radiator water pressure test		kPa (kgf/cm^2)	137 (1.4)	
Cap opening valve pressure		kPa (kgf/cm^2)	88 (0.9) → 59 (0.6)	In 10 seconds
Thermostat	Working temperature	°C	69.5 ~ 72.5	71°C

e. Engine Mount

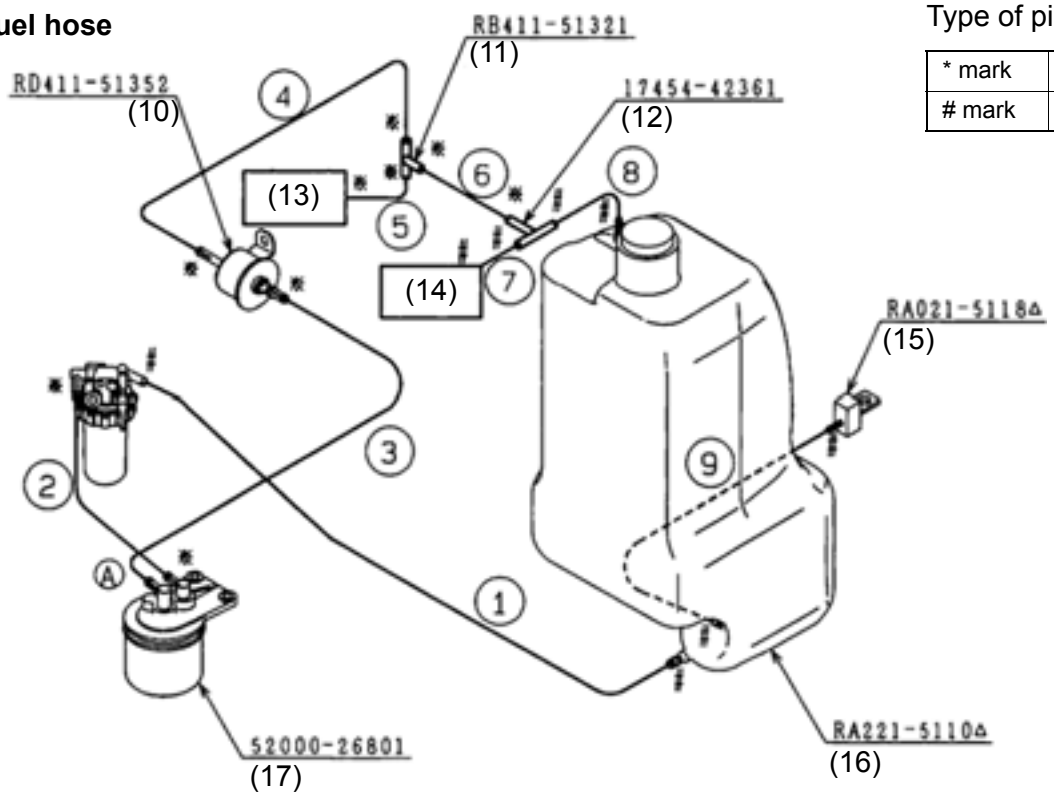


(1) Vibration-proof rubber
(2) Cover (Rubber sheet)
(3) Rounded part
(4) Bracket (Engine, rear)
(5) Stopper (Engine)
(6) Bracket (Engine, rear)
(7) Vibration-proof rubber

f. Fuel System

1. Fuel System (1)

Route of fuel hose

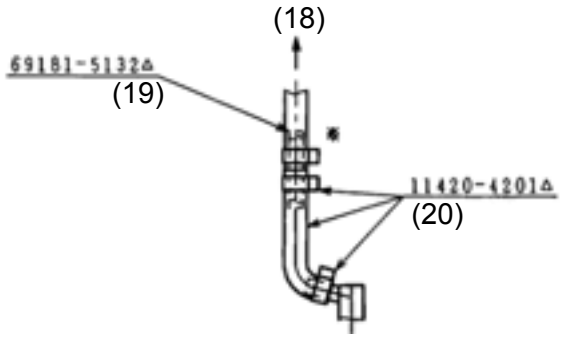


Type of pipe clip

* mark	14911-42751
# mark	14971-42751

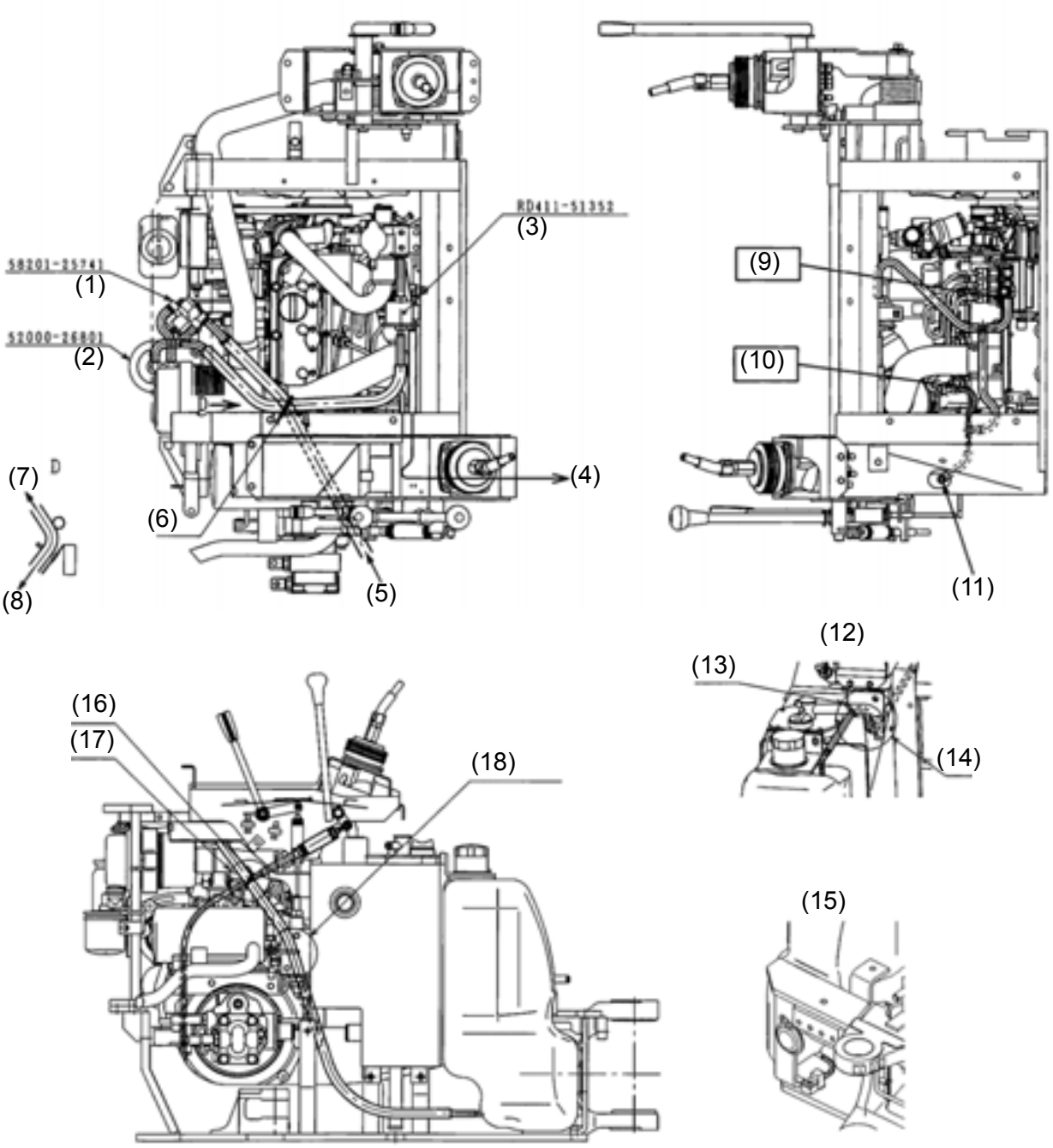
Can be operated for 8 hours by 18 liters of fuel oil.

Details of A



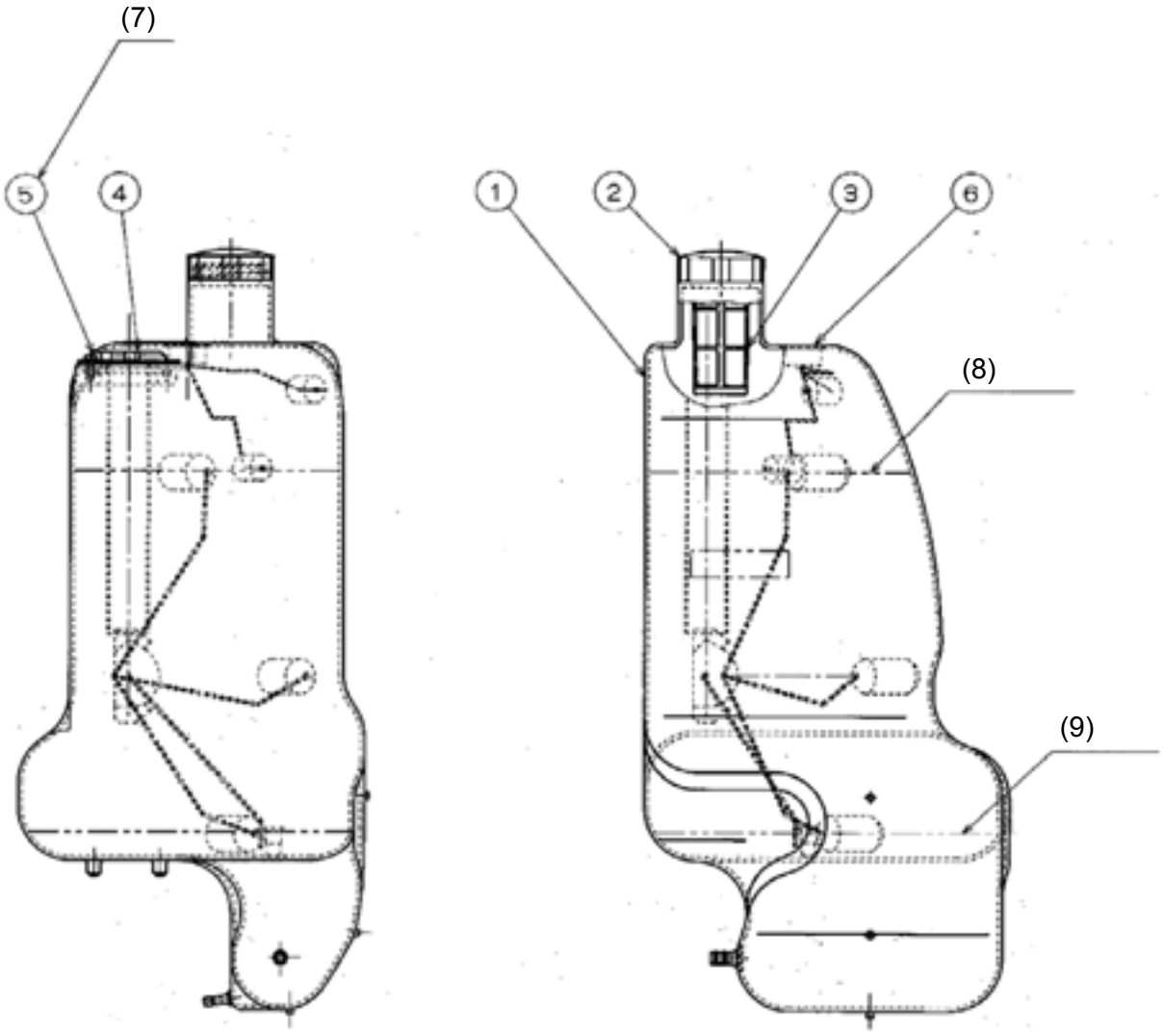
No.	Part Name	Q'ty	Tube length (mm)		
(1)	Fuel tube	1	L = 1280	(10)	Pump assembly (Fuel)
	Tube (1)	1	L = 1150	(11)	Pipe joint (T-S)
(2)	Fuel tube	1	L = 220	(12)	T-pipe joint
(3)	Fuel tube	1	L = 520	(13)	Engine fuel injection pump
	Tube (420)	1	L = 420	(14)	Engine fuel return port
(4)	Fuel tube	1	L = 280	(15)	Joint (Fuel drain)
(5)	Fuel tube	1	L = 140	(16)	Fuel tank assembly
(6)	Fuel tube	1	L = 140	(17)	Filter assembly (Fuel)
(7)	Fuel tube	1	L = 150	(18)	Pump assembly (Fuel)
(8)	Fuel tube	1	L = 550	(19)	Straight pipe joint
	Tube (470)	1	L = 470	(20)	Fuel pipe assembly
(9)	Fuel tube	1	L = 80		

2. Fuel System (2)



(1) Water separator
(2) Filter assembly (Fuel)
(3) Pump assembly (Fuel)
(4) Fuel tank (Upper)
(5) Fuel tank (Lower)
(6) Clamp
(7) Water separator
(8) Fuel tank
(9) Engine fuel injection pump
(10) Engine fuel return port
(11) Pass it through this hole.
(12) Fuel tank upper part
(13) Clamp
(14) Pass it under the cover (tank, return).
(15) Fuel tank lower part
(16) Clamp
(17) Pass it over the dozer cable.
(18) Pass it along inner side of fuel tank L member.

3. Fuel tank

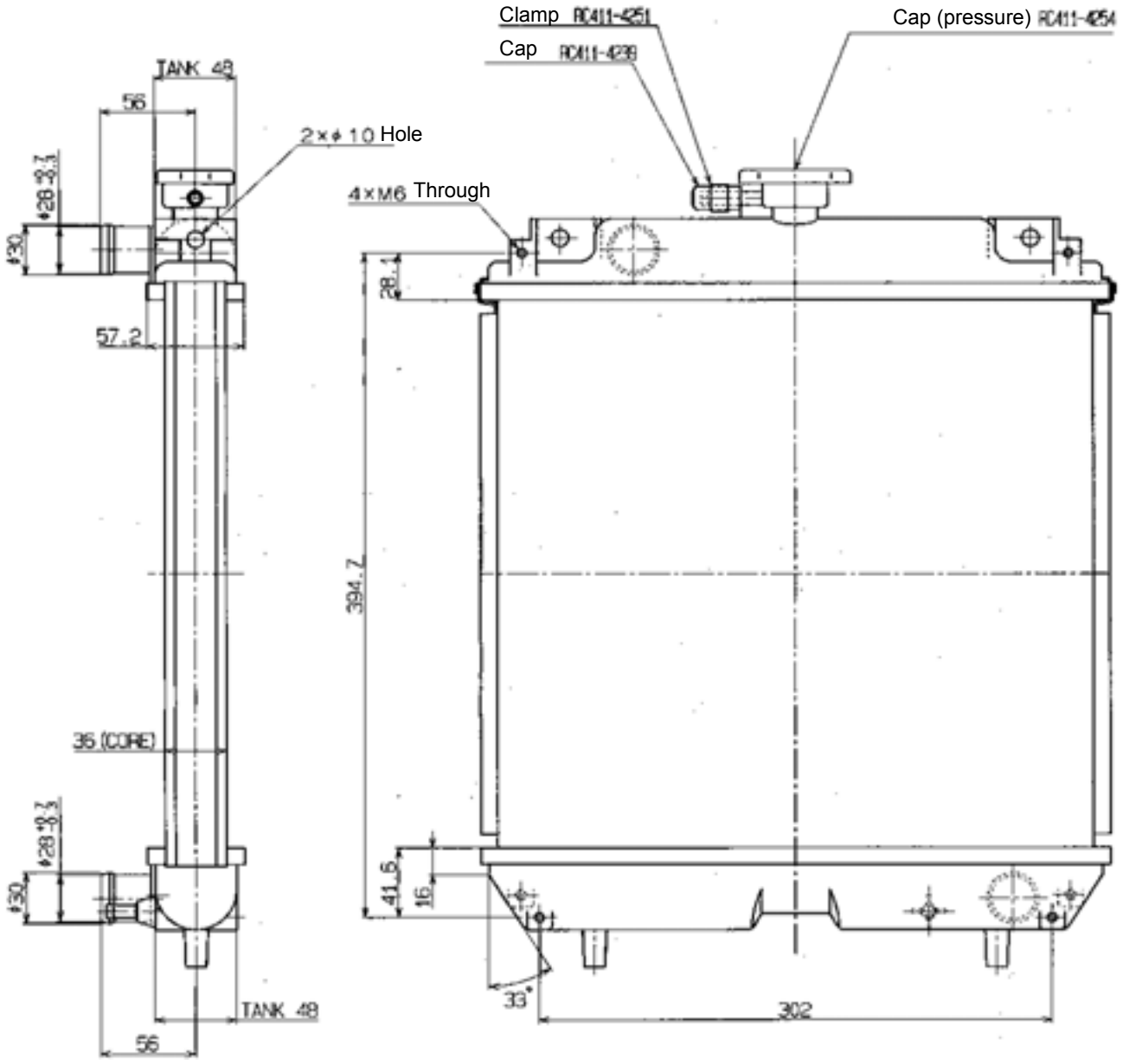


(1) Fuel tank
(2) Cap assembly (fuel)
Cap (fuel)
Sponge
Packing
(3) Fuel filter assembly
Fuel filter
Packing
(4) Sensor (fuel)
(5) Machine screw with spring
(6) Fuel level gauge assembly
(7) Tightening torque
(8) Fuel level 15.2L
(9) Fuel level 2.2L

S Note:
No leak is allowed under air pressure of 29.4 kPa (0.3 kg/cm^2) in following conditions.
Fluid in use: Light oil
Ambient operating temperature: -17 to 70 °C

g. Cooling system

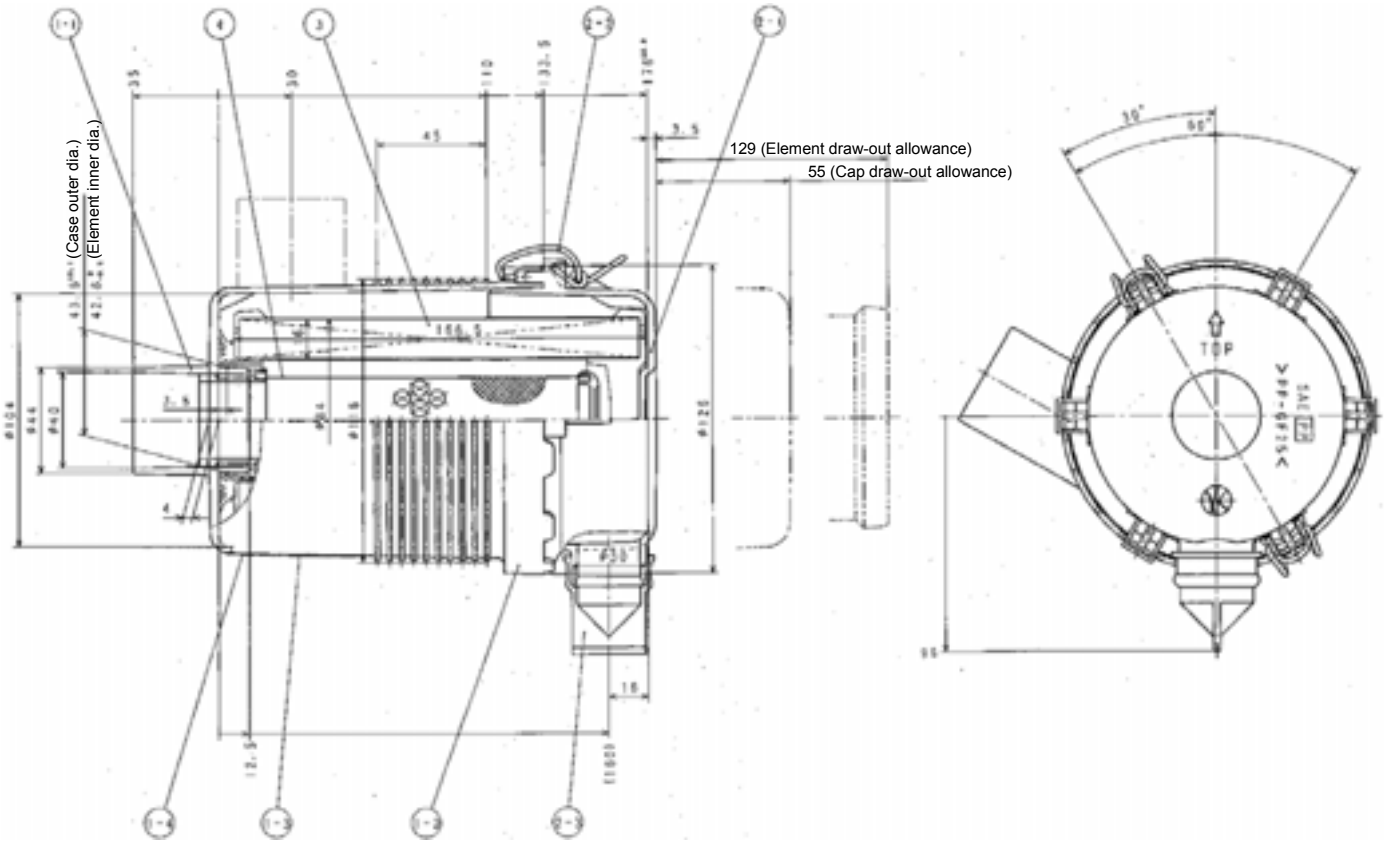
1. Structure



2. Radiator specifications

Diy	Heading		Unit	(Conventional unit)
Performance specifications	Condition	Air flow	m/s	8
		Vater flow	L/min	40
		Temp difference	°C	60
	Radiator capacity		kW	20.7 (17853 kcal/h)
	Air resisyance		Pa	132.3 (13.5 mmAg)
	Water resistance		kPa	(mmHg)
	Valve opening pressure	Press	kPa	147 (1.5 kgf/cm^2)
		Vacuum	kPa	
	Test pressure		kPa	147 (1.5 kgf/cm^2)
	Vibration durability	Acceleration		6 G
		Direct		Up/down
		Cycle		22.3 Hz
		Cycle		10°
Structural specifications	Core type			CF29-2
	Core size	Wide	mm	351
		Height	mm	325
		Thickness	mm	36
	Fin pitch		mm	4.5/2
	Radiation area	Fin	m^2	3.78
		Tube	m^2	0.89
		Total	m^2	4.67
	Front area		m^2	0.132
	Water passage area		cm^2	12.7
	Water duantity		L	1.3
	Dry weight		kar	2.4
	Surface treatment			
Remarks	Louver-less			

h. Air cleaner

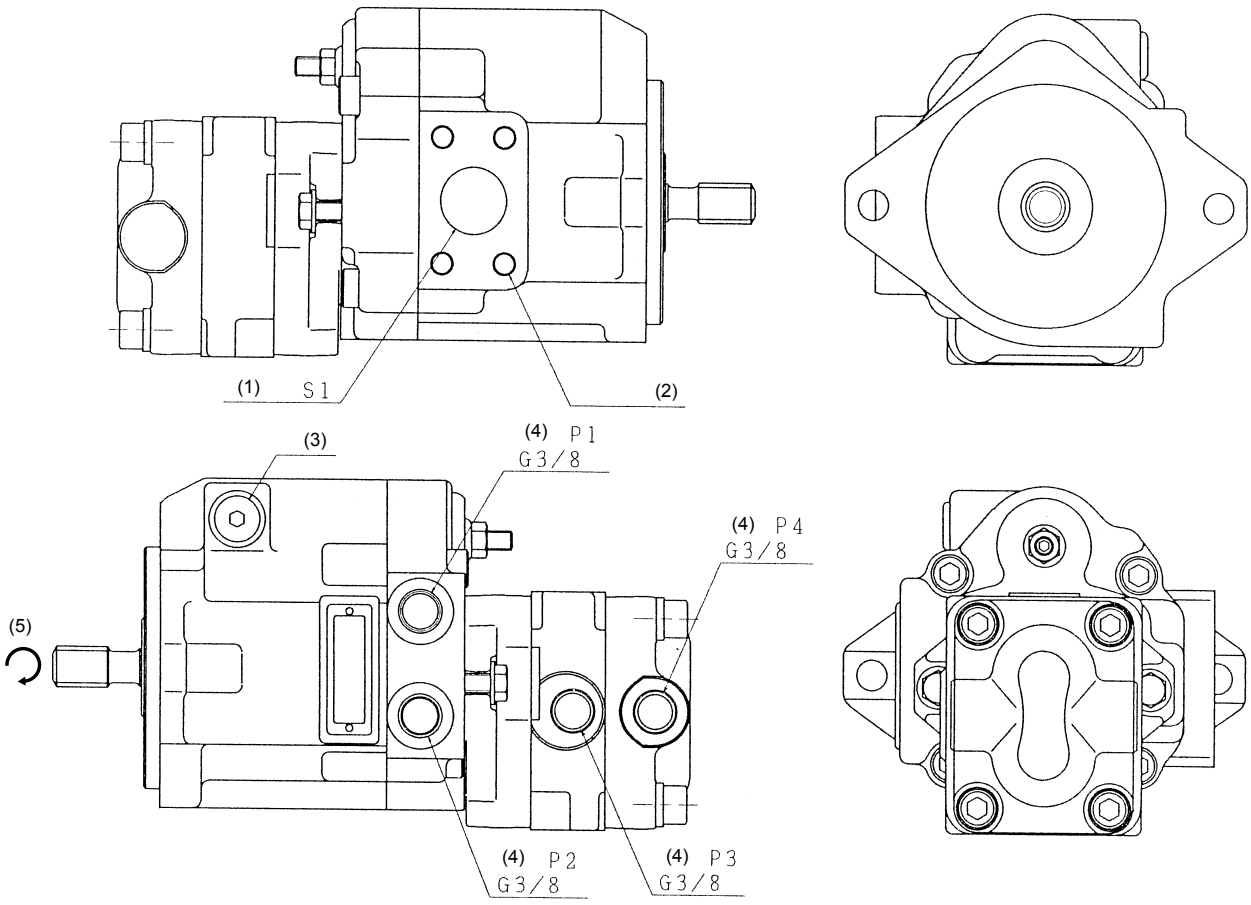


	Item	Unit	Standard		Conditions
Specifications	Air flow resistance	kPa (mmAg)	Below 2.747 (below 280)		Rated air flow rate: 2.0 m^3/min. Test dust: JIS Z8901, Class 8 powder Dust concentration: 1 g/m^3 Air flow resistance: 2.94 kPa (300 mmAg) Full life for an increase
	Cleaning efficiency	%	Initial	Full life	
			Above 99	Above 99.9	
	Dust containment	g	Above 50		
	Filtering area	m^2	0.45 (effective)		
Other conditions		As per JIS D1612			
Heat-resistant temperature		-30 °C ~ 90°C			

D.Hydraulic system

a. Main pump

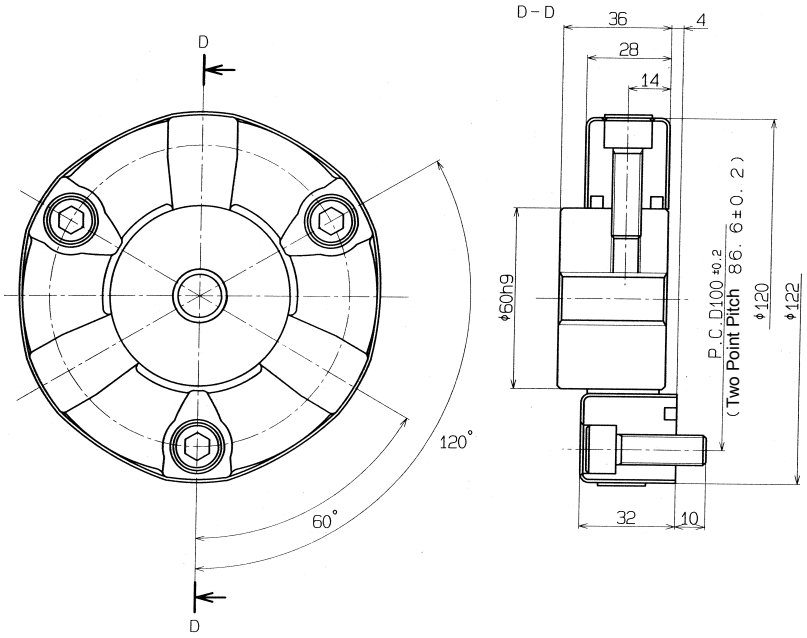
1. Outer view



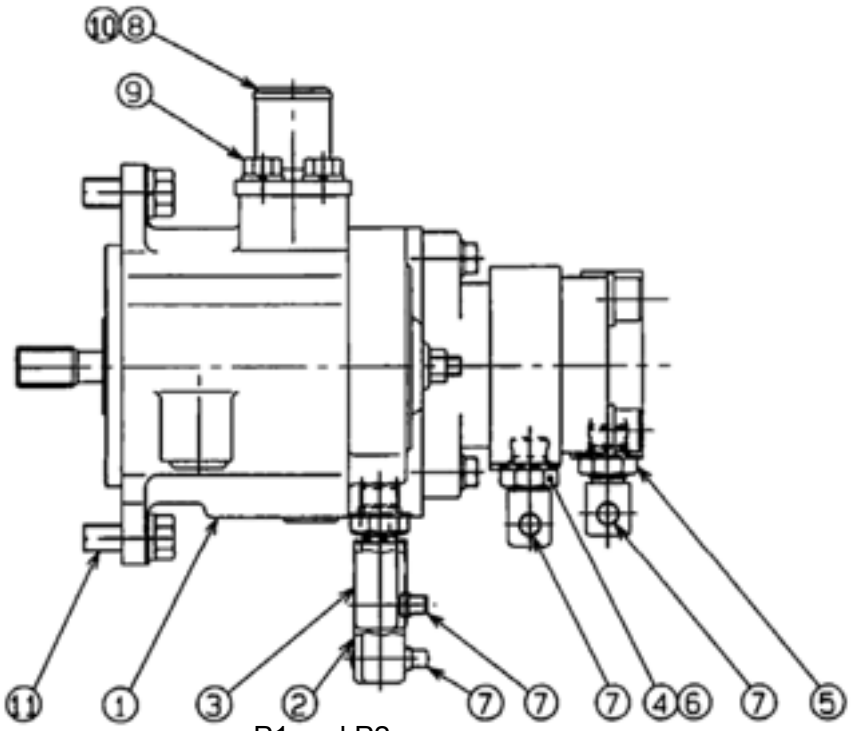
(1) Suction port (2) 4 - M10 (3) Oil inlet (4) Discharge port

(5) Rotation direction, Clockwise

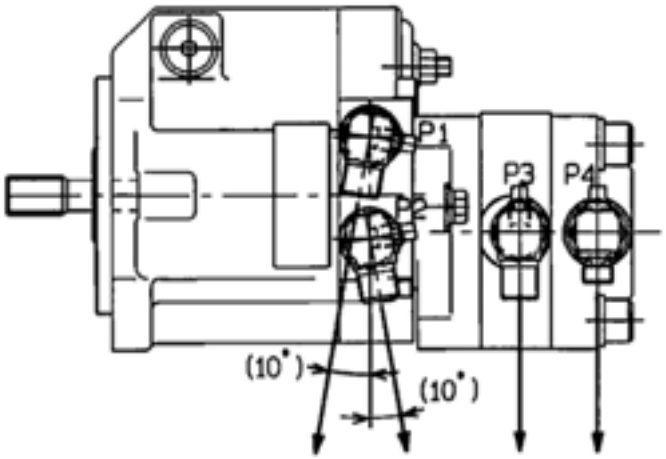
2. Pump coupling



3. Pump hose adapter

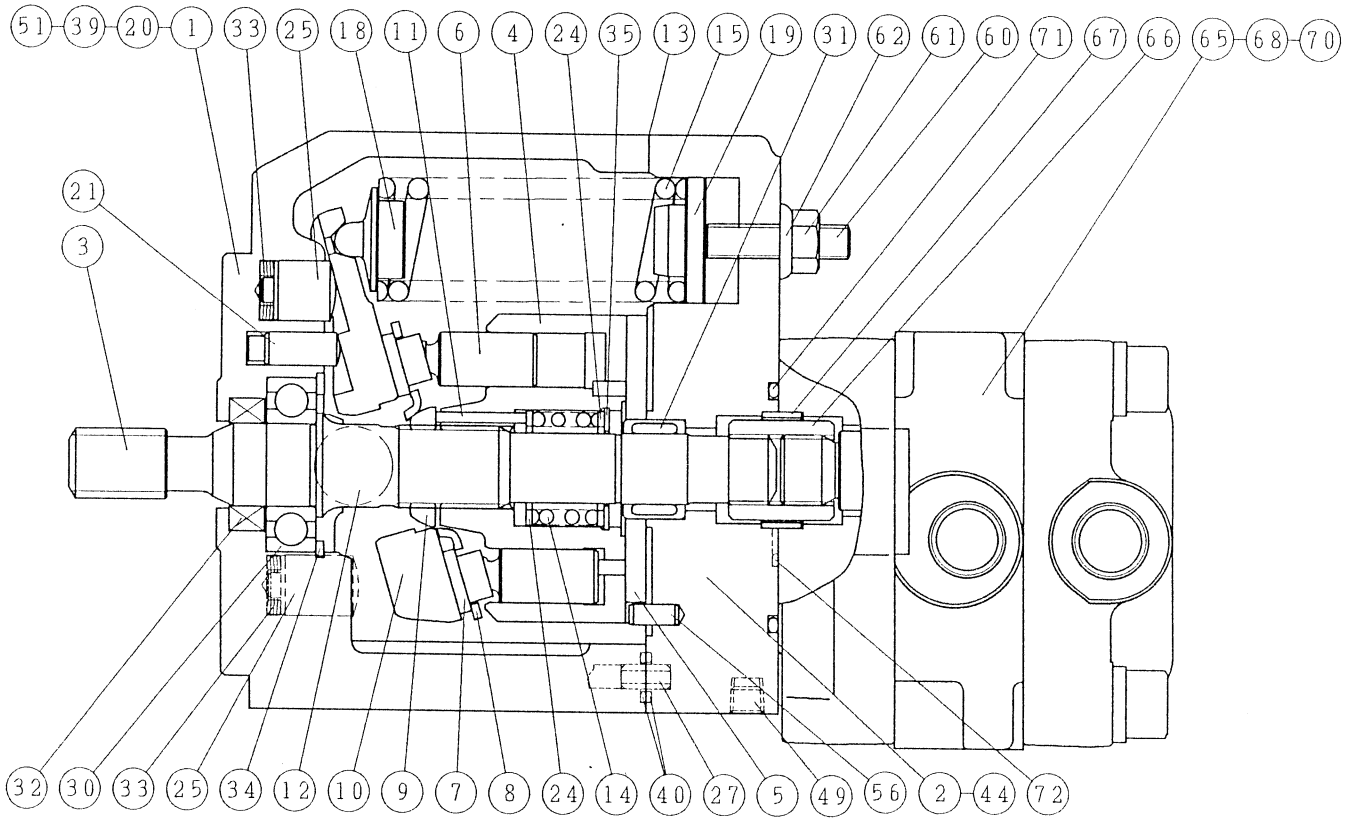


P1 and P2 are common.



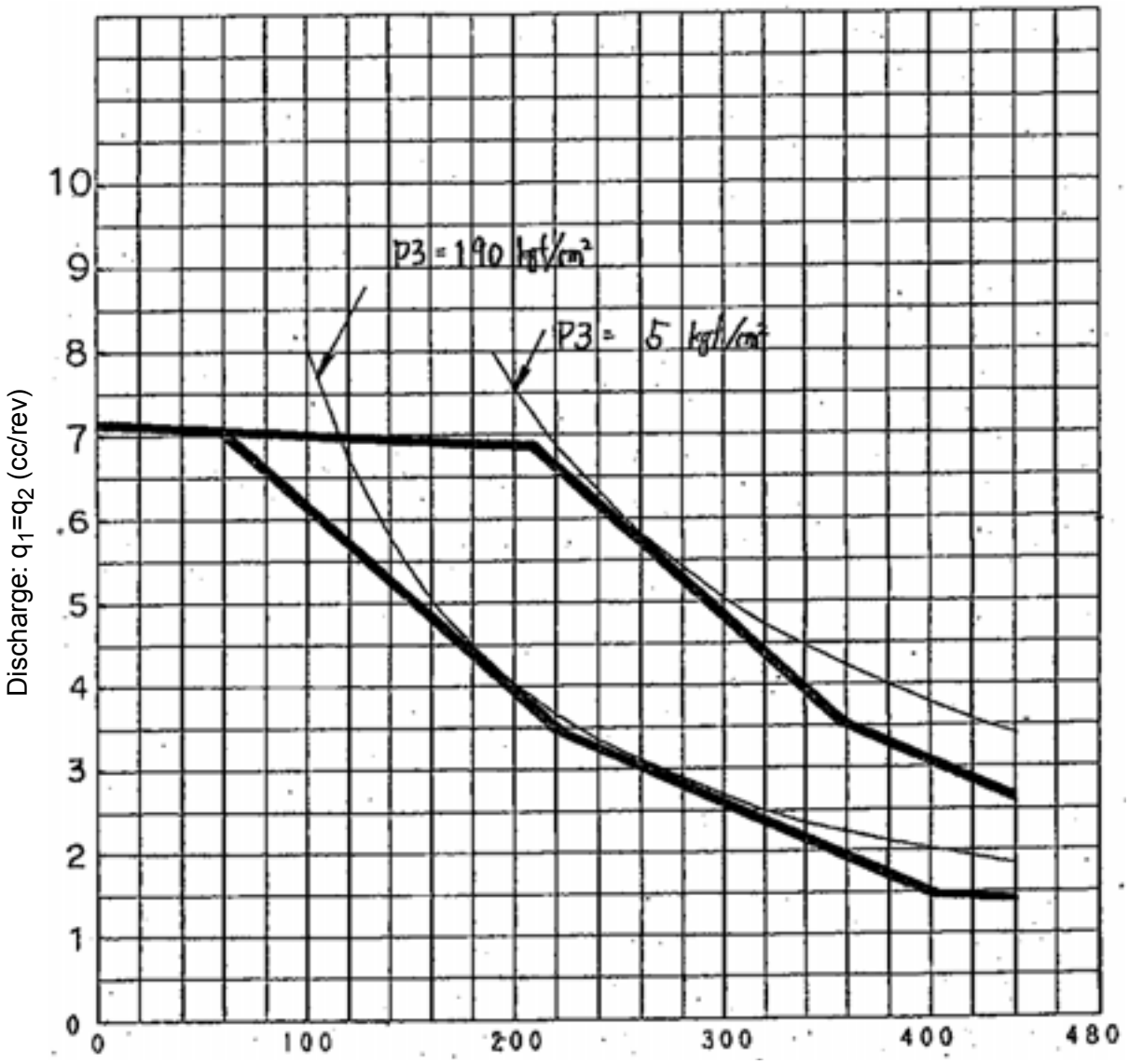
No.	Part Name	Q'ty	Remarks
(1)	Pump assembly (Piston)	1	
(2)	Pipe joint (L, G3/8 - G3/8)	1	
(3)	Pipe joint (L, G3/8 - G3/8)	1	R1/8 P1, P2, P3, P4
(4)	Pipe joint (L, G3/8 - G3/8)	1	
(5)	Pipe joint (L, G3/8 - G1/4)	1	
(6)	O-ring	1	
(7)	Plug	4	For 3/8
(8)	Flange (Suction)	1	
(9)	Bolt	4	M10 x 1.5 7T
(10)	O-ring	1	S35
(11)	Bolt	2	M12 x 1.25 7T

4. structure

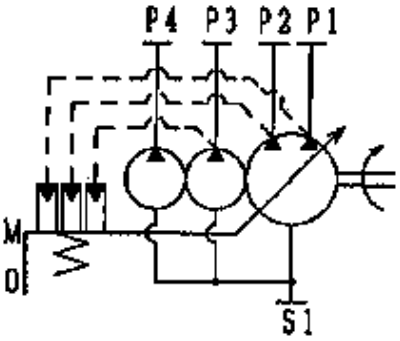


(1) Body S	(10) Swash plate	(21) Rod G	(35) Snap ring	(62) Seal washer
(2) Body H	(11) Needle	(24) Retainer	(39) O - ring	(65) Gear pump
(3) Shaft	(12) Swing pin	(25) Stopper pin	(40) O - ring	(66) Coupling
(4) Cylinder barrel	(13) Packin	(27) Pin	(44) Hex bolt	(67) Collar
(5) Valve plate	(14) Spring C	(30) Ball bearing	(49) Hex plug	(68) Bolt
(6) Piston	(15) Spring T	(31) Needle bearing	(51) Plug	(69) O - ring
(7) Shoe	(18) Spring holder	(32) Oil seal	(56) Spring pin	(70) Washer
(8) Shoe holder	(19) Spring guide	(33) Belleville spring	(60) Hex screw	(71) O - ring
(9) Barrel holder	(20) Pin	(34) Snap ring	(61) Nut	(72) O - ring

5. P-Q performance curve



Test condition		Remark	
Oil	ISOVG46	Pump intake torque	3.44 kgf·m
Oil temp	50 ± 5 °C		(at P_3=5 kgf/cm²)
RPM	2300 rpm		3.44 kgf·m
Direction	Clockwise		(at P_3=190 kgf/cm²)
q_3	4.5 cc/rev		
q_4	2.7 cc/rev		
P_4	40 kgf/cm²		



6. Pump Specifications, Type : PVD-00B-14P-5G3-4552A, code NO. : RA221-6111

1.Capacity	P_1, P_2: 7.2 x 2 cm^3/rev	P_3: 4.5 cm^3/rev	P_4: 2.7 cm^3/rev
2.Pressure at bench	P_1, P_2: 21.6 MPa (220 kgf/cm^2)	P_3: 18.6 MPa (190 kgf/cm^2)	P_4: 3.9 MPa (40 kgf/cm^2)
3.Speed	Rated Speed: 2300 min^{-1} Max. Speed: 2600 min^{-1}	Rotation Direction: Clockwise	
4.Suction pressure	-0.02 ~ +0.04 MPa (-0.2 ~ +0.4 kgf/cm^2)		
5.Oil	ISO VG 32, 46, 68 Anti - Wear hydraulic fluid		
6.Oil temp	Temp range : -20 ~ +100 °C		
7.Control	Constant torque control		
8.Torque	at P_3= 0.49 MPa T=37.0 N·m at P_3= 20.6 MPa T=39.0 N·m		
9.Pump discharge	P_1, P_2: 16.56 l/min x 2 (4.37 us gal/min)	P_3: 10.35 l/min (2.73 us gal/min)	P_4: 6.21 l/min (1.64 us gal/min)

7. Discharge rate

		Unit	U15-3	Remarks
P1/P2 maker-specified type			PVD-00B-14P-5G3-4552A(F)	
Pp maker-specified type				
Service port flow rate		L/min	27/-	without load / with load
Rated load pressure	P1/P2	Mpa(kgf/cm^2)	21.6 (220)	
Rated load pressure	P3/Pp	Mpa(kgf/cm^2)	18.6(190)	
Theoretical discharge rate	P1/P2/P3/Pp	cc/rev	7.2/7.2/4.5/2.7	
Theoretical discharge rate at rated output	P1/P2	L/min	16.6/16.6	
	P3/Pp	L/min	10.4/6.2	
85% of theoretical discharge rate	P1/P2	L/min	14.1/14.1	
	P3/Pp	L/min	8.8/5.3	
80% of theoretical discharge rate	P1/P2	L/min	13.3/13.3	
	P3/Pp	L/min	8.3/5.0	

8. Function

1) Outline

This compact, lightweight hydraulic pump has a mechanism that provides for the performance of two variable pumps. Yet it needs as small a space as for just one conventional pump. This pump is also equipped with a pilot gear pump.

The pump features a constant horsepower control function for making most of the engine power. The greater the pump load becomes, the lesser the discharge rate becomes. As a result, when the pump discharge pressures P_1 and P_2 have risen and the resultant force of the piston higher, the swash plate exceeds the spring force and tilts from the oscillating center of the oscillating pin. In this way, the discharge rate can be kept low.

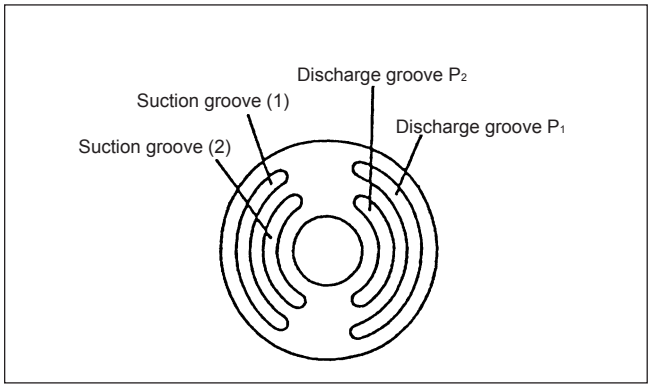
2) Function

An even number of pistons are used in this swash plate variable piston pump. This is to produce the performance of two same-capacity pumps in one pump casing.

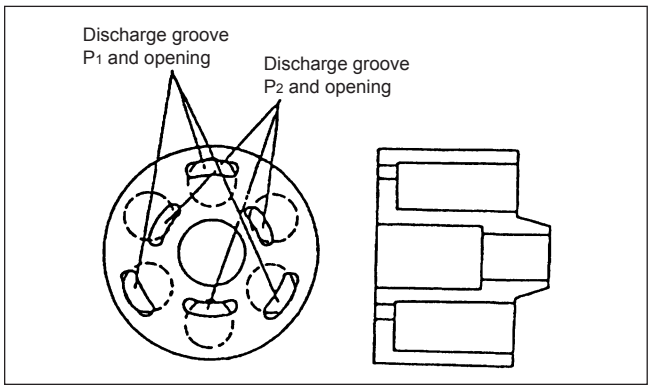
Conventional valve plates have one suction groove and one discharge groove, as shown in Fig. 4. The new system, on the other hand, is provided with two suction grooves and two discharge grooves, as shown in Fig. 3. The discharge grooves P_1 and P_2 are located in the outer and inner sides, respectively. Every other piston chamber of cylinder barrel gets open to either of these discharge grooves in the valve plate. In other words, both the inner and outer suction grooves behave just the same way, whereas the inner and outer discharge grooves work independently from each other.

In this design with an even number of pistons, the same number of pistons gets open outward and inward of the valve plate. Because all the pistons are of the same diameter, located in a same-pitch circle and slide over the same swash plate, the discharge rates of the discharge grooves P_1 and P_2 are the same.

There is another advantage in employing just a single swash plate. Even though the swash plates tilting angle varies according to the variable control, the discharge rates of P_1 and P_2 ports change accordingly and equally.

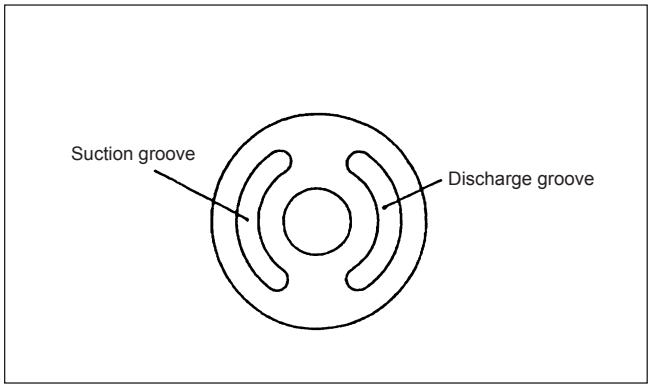


(a) Valve plate

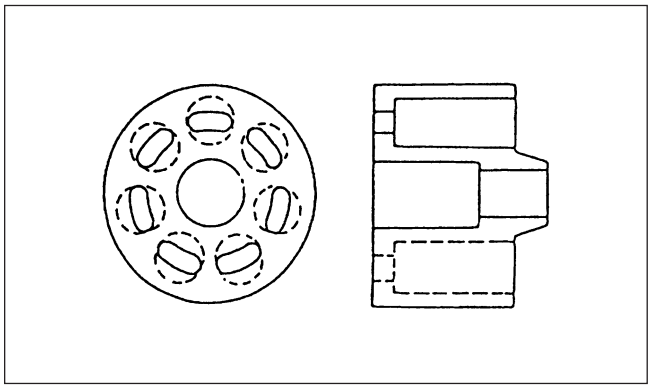


(b) Cylinder barrel

Fig. 3 Operating principle



(a) Valve plate



(b) Cylinder barrel

Fig. 4 Conventional swash plate piston pump

b. Control valve

1. Relife valve specifications

Type of valve: CP CV NSC10-KP11-2
Manufacturer: Nabco

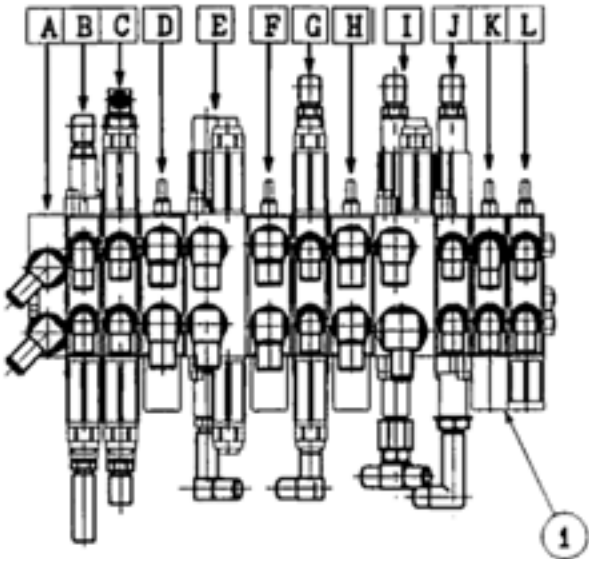
1) Bench set pressure specifications

No.	Product name	Mpa (kgf/cm^2)	Remarks
(1)	Main relief valve	P1 · P2 : 21.6 $^{+1.0}_{-0.5}$ (220 $^{+10}_{-5}$) P3 : 18.6 $^{+1.0}_{-0.5}$ (190 $^{+10}_{-5}$)	MRV-P1 · MRV-P2 · MRV-P3
(2)	Unti-void valve		At swing cylinder rod ACV-B1
(3)	Port relief valve	17.7 (180)	At boom cylinder bottom CRV-B8 b1
(4)	Port relief valve	27.5 (280)	At boom cylinder rod CRV-b2
(5)	Port relief valve	23.5 (240)	Arm & bucket CRV-5A, CRV-B5, CRV-B9
(6)			

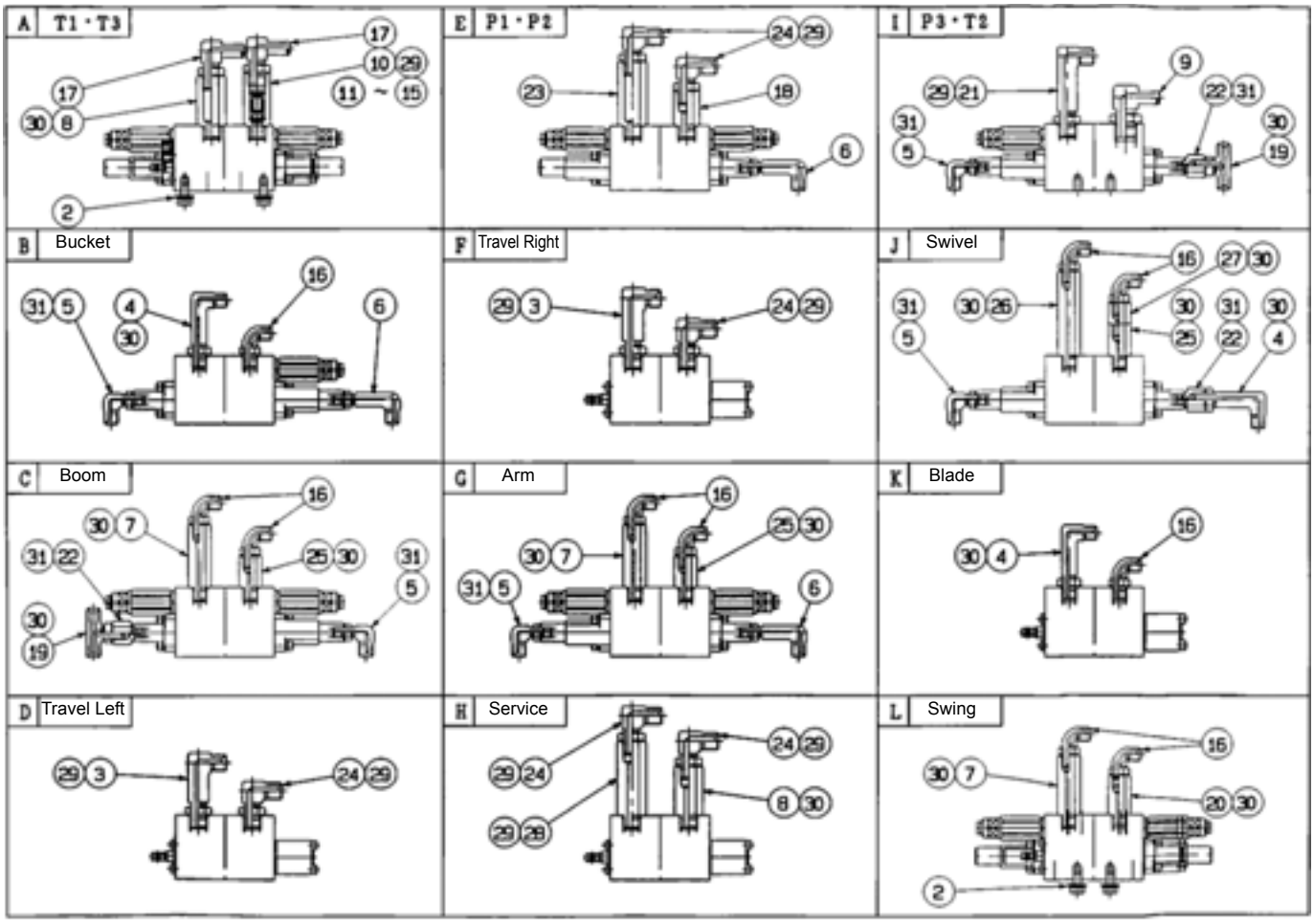
2) List of pressures

		Unit	U15-3	Remarks
Main relief valve				
P	Machine set pressure	Mpa(kgf/cm^2)	(230 ± 10)	
	Working part		Bucket	
	Bench set pressure	Mpa(kgf/cm^2)	21.6 (220 $^{+10}_{-5}$)	
P2	Machine set pressure	Mpa(kgf/cm^2)	(225 ± 10)	
	Working part		Arm	
	Bench set pressure	Mpa(kgf/cm^2)	21.6 (220 $^{+10}_{-5}$)	
P3	Machine set pressure	Mpa(kgf/cm^2)	(200 ± 10)	
	Working part		Dozer	
	Bench set pressure	Mpa (kgf/cm^2)	18.6 (190 $^{+10}_{-5}$)	
Pp	Machine set pressure	Mpa (kgf/cm^2)	(45 ± 5)	
	Working part		-	
	Bench set pressure	Mpa (kgf/cm^2)	3.9 (40 $^{+2}_{-0}$)	
	Pilot secondary pressure	Mpa (kgf/cm^2)	21.5 (22)	Bucket dump
Overload relief valve				
At bench test	Boom rod/bottom (b1, b2)	Mpa (kgf/cm^2)	27.5 (280)/17.7 (180)	
	Arm rod, bottom, bucket bottom (b3, b4, b5)	Mpa (kgf/cm^2)	23.5 (240)	
	Swivel (C1)	Mpa (kgf/cm^2)	13.2 (135)	
On the machine	Boom bottom (b1)	Mpa (kgf/cm^2)		
	Boom rod (b2)	Mpa (kgf/cm^2)		
	Arm rod, bottom, bucket bottom	Mpa (kgf/cm^2)		
	Swivel (C1)	Mpa (kgf/cm^2)		

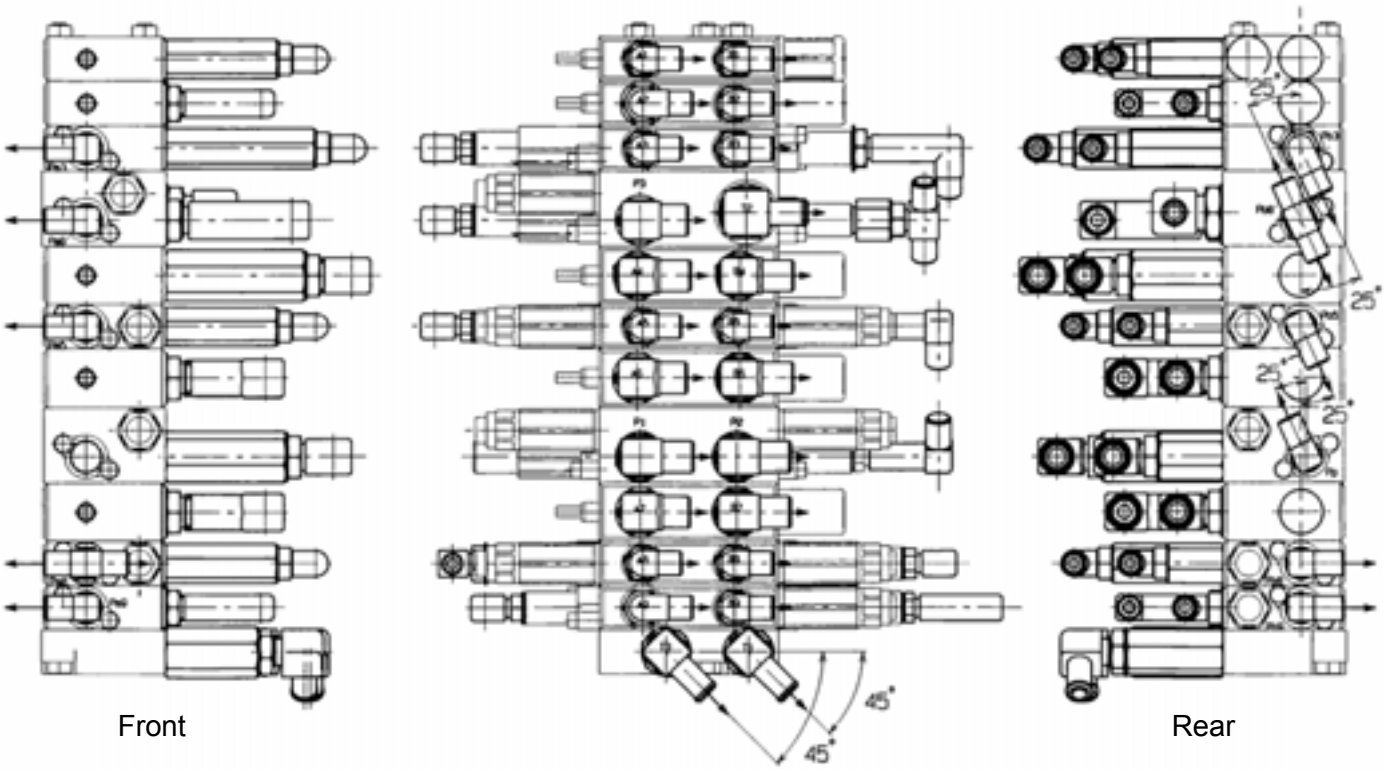
2. Control Valve (1)



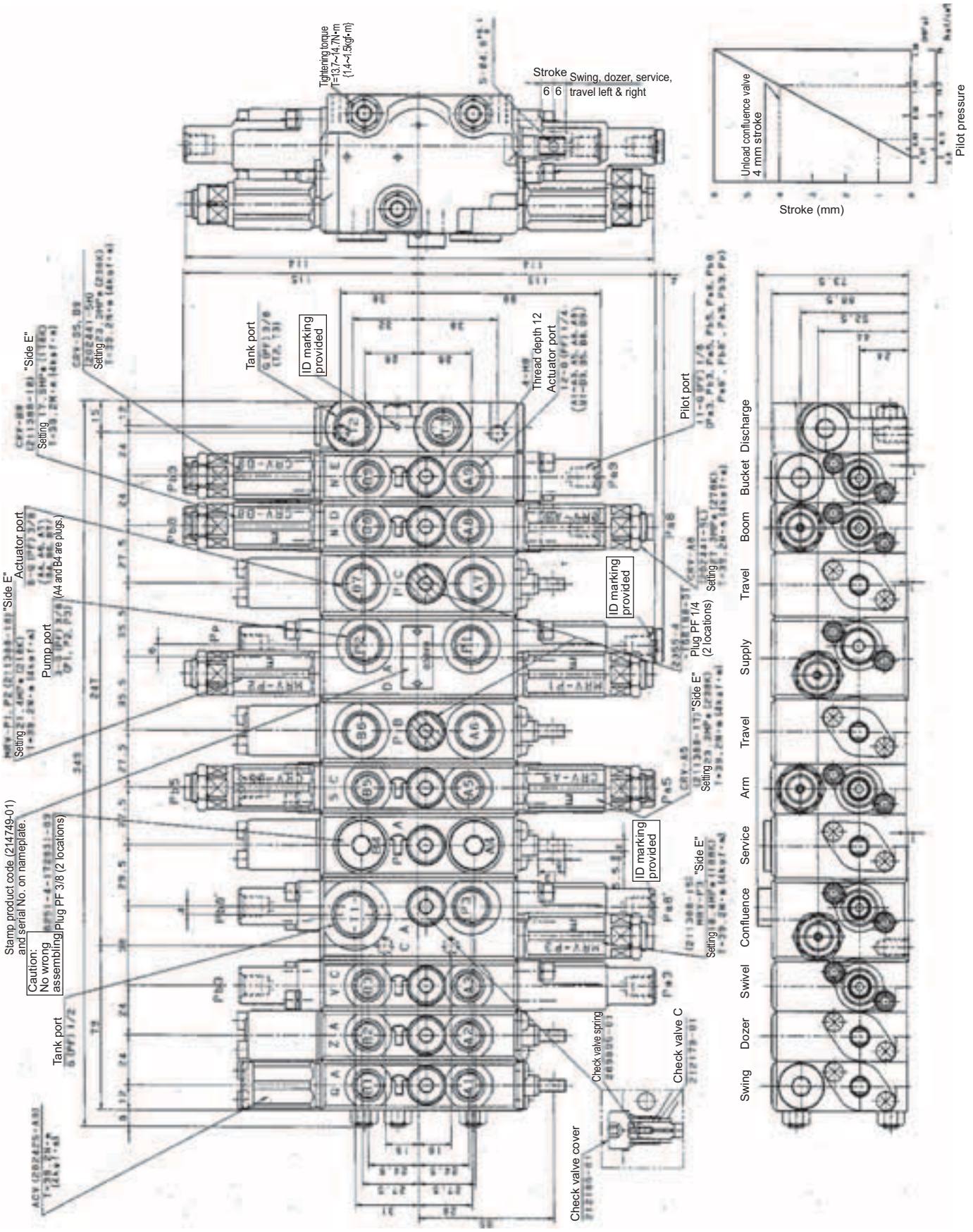
No.	Part Name	Q'ty	No.	Part Name	Q'ty
(1)	Control valve, assembly	1	(17)	Elbow pipe joint (G3/8-13)	2
(2)	Bolt	4	(18)	Straight pipe joint (3-3-35)	1
(3)	Shouldered elbow	2	(19)	T-pipe joint (F2)	2
(4)	Pipe joint (L. G1/4-G1/4)	3	(20)	Pipe joint (Bushing G1/4)	1
(5)	Pipe joint (L. G1/8-G1/4)	5	(21)	Pipe joint (S, G3/8-G3/8)	1
(6)	Pipe joint (L. G1/8-G1/4)	3	(22)	Pipe joint (S, G1/8-G1/4)	3
(7)	Pipe joint (S. G1/4-G1/4)	3	(23)	Pipe joint (S, G3/8-G3/8)	1
(8)	Pipe joint (S. G3/8-G3/4)	2	(24)	Pipe joint (L, G3/8-G3/8)	6
(9)	Pipe joint (L. G1/2-14)	1	(25)	Pipe joint (S, G1/4-G1/4)	3
(10)	Valve, assembly (Check)	1	(26)	Pipe joint (S, G2-G2)	1
(11)	Stay	1	(27)	Pipe joint (S, G1/4-G1/4)	1
(12)	Poppet	1	(28)	Pipe joint (S, G3/8-G3/8)	1
(13)	Spring	1	(29)	O-ring	13
(14)	Washer	1	(30)	O-ring	14
(15)	Hole circlip	1	(31)	O-ring	8
(16)	Pipe joint (L, G1/4-G1/4)	10			



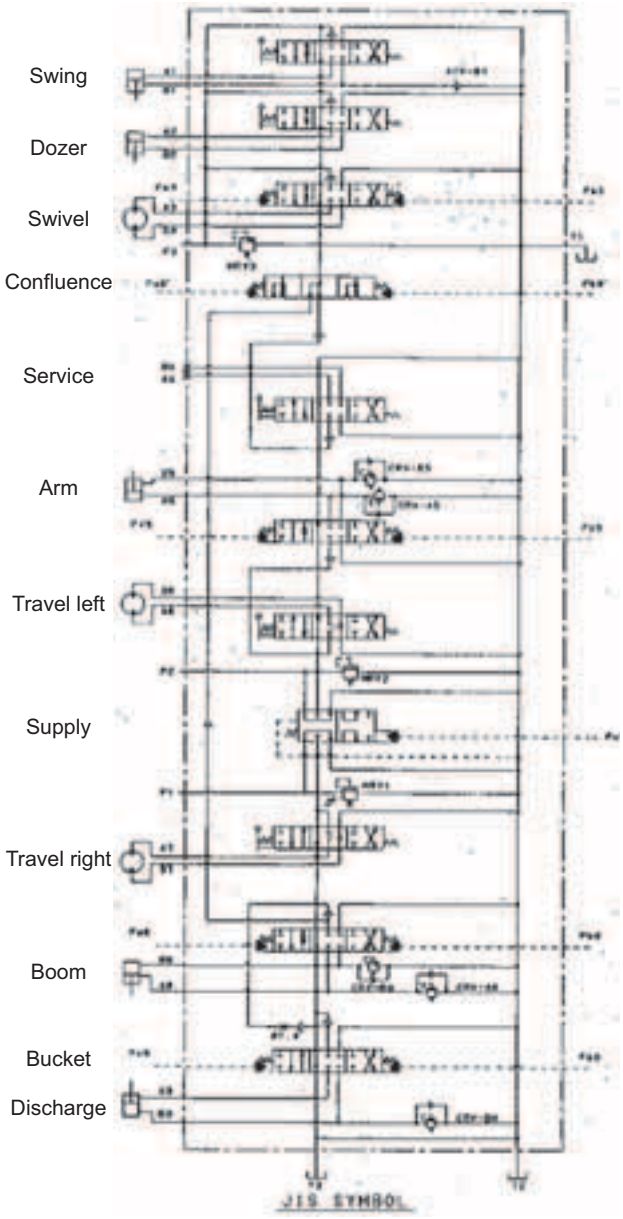
3. Control Valve (2)



4.Control Valve (3)



5. Control Valve (4)



Valve specifications

- Rated pressure: 22.6 MPa {230 kgf/cm^2}
  (Under condition of 4 million boost-up actions)
- Rated flow rate: 15 L/min
- Relief valve set pressure level
  : 4.30 ~ 24.5 MPa {50 ~ 250 kgf/cm^2}
- Overload valve set pressure level
  : 4.30 ~ 24.5 MPa {50 ~ 250 kgf/cm^2}
- Spool length spring force (manual control)
  [Travel] At neutral: 98.1 N {10 kgf}
  At stroke end: 131 N {13.4 kgf}
  [Others] At neutral: 83.4 N {8.5 kgf}
  At stroke end: 103 N {10.5 kgf}
- Maximum pilot operating pressure
  : 4.90 MPa {50 kgf/cm^2}
- Allowable tank pressure
  : Below 0.98 MPa {10 kgf/cm^2}
- Oil in use: General mineral hydraulic oil
- Operating oil temperature range
  : -20 ~ +90 °C (100 °C)
- Oil contamination level: Within Class NAS9

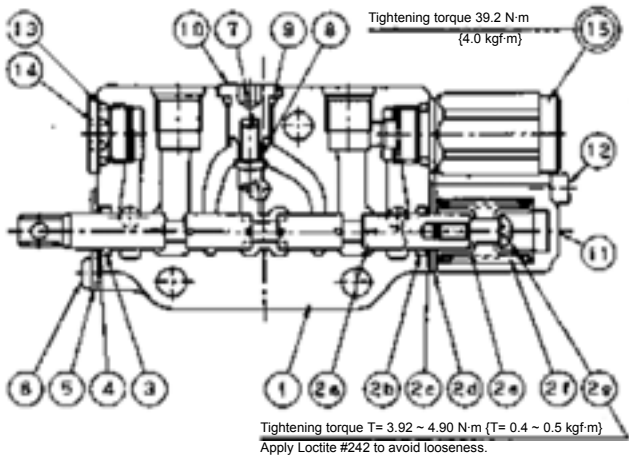
Operating conditions

- Relief valve set pressure
  P1·P2: 21.4 $^{+0.49}_{0}$ MPa {218 $^{+5}_{0}$ kgf/cm^2 at 16.6 L/min}
  P3: 18.4 $^{+0.49}_{0}$ MPa {188 $^{+5}_{0}$ kgf/cm^2 at 10.4 L/min}
- Operating flow rate
  P1·P2: 16.6 L/min
  P3: 10.4 L/min
- Service port flow rate (P2+P3): 27.0 L/min
- Overload valve set pressure
  A5·B5·B9: 23.3 $^{+0.49}_{0}$ MPa {238 $^{+5}_{0}$ kgf/cm^2 at 5 L/min}
  A8: 27.3 $^{+0.49}_{0}$ MPa {278 $^{+5}_{0}$ kgf/cm^2 at 5 L/min}
  B8: 17.5 $^{+0.49}_{0}$ MPa {178 $^{+5}_{0}$ kgf/cm^2 at 5 L/min}
- Spool leak amount
  Leak amount from A1, A8, B1 to i: Below 3 cm^3/min
  Leak amount from others to i: Below 7 cm^3/min
  (* 9.8 MPa {100 kgf/cm^2}) (Oil viscosity 37 cSt)
- Spool operating pressure with pilot on (See Characteristics Chart.)
  : 0.37 ~ 1.96 MPa {3.6 ~ 20 kgf/cm^2}
  Po port pilot pressure: 3.50 MPa {35.7 kgf/cm^2}
- Operating oil temperature range
  : -20 ~ +90 °C (100 °C)

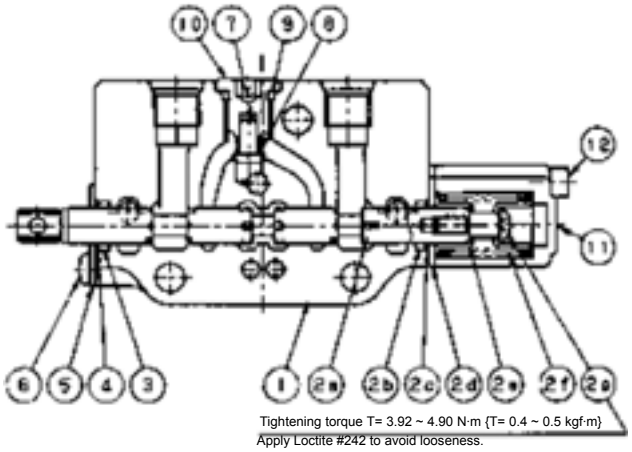
Figures in { } are just for your reference.

6. Control valve sectional view

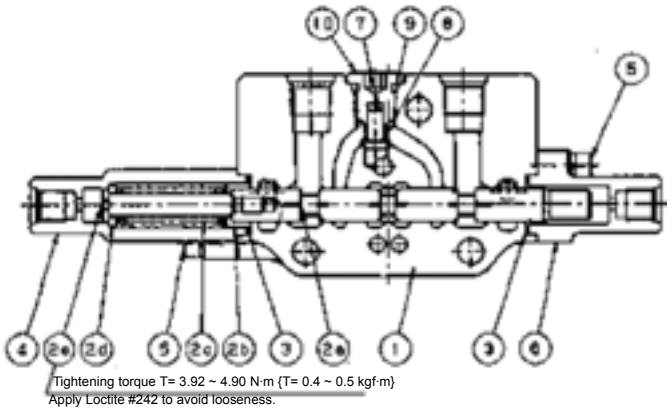
1) Swing section : A-A, RB238-70011



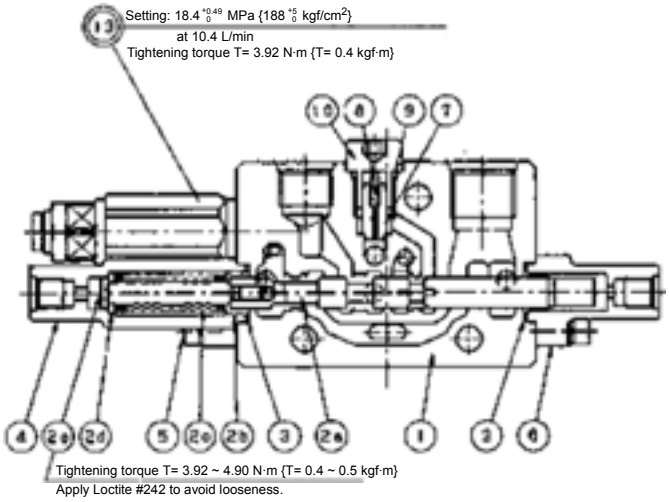
2) Dozer section : B-B, RA221-70021



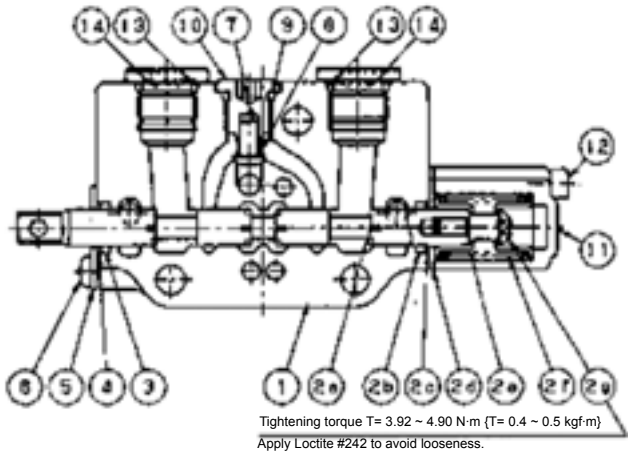
3) Dozer section : C-C, RA221-70031



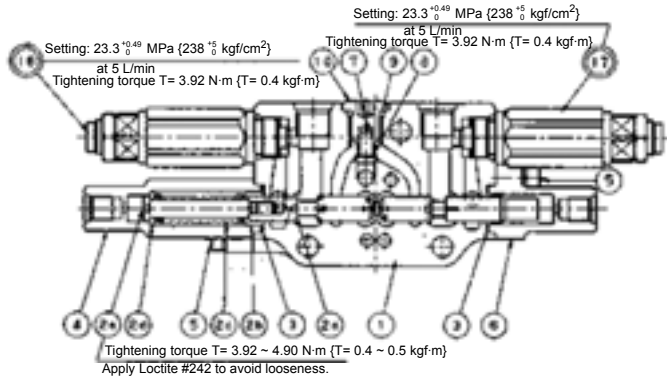
4) Confluence section : D-D, RA221-70911



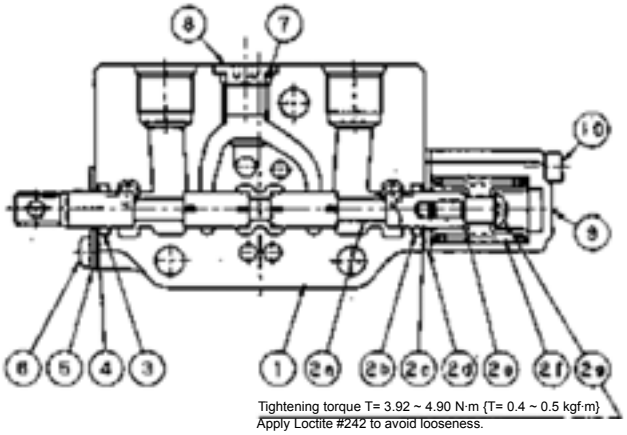
5) Service port section : E-E, RA221-70041



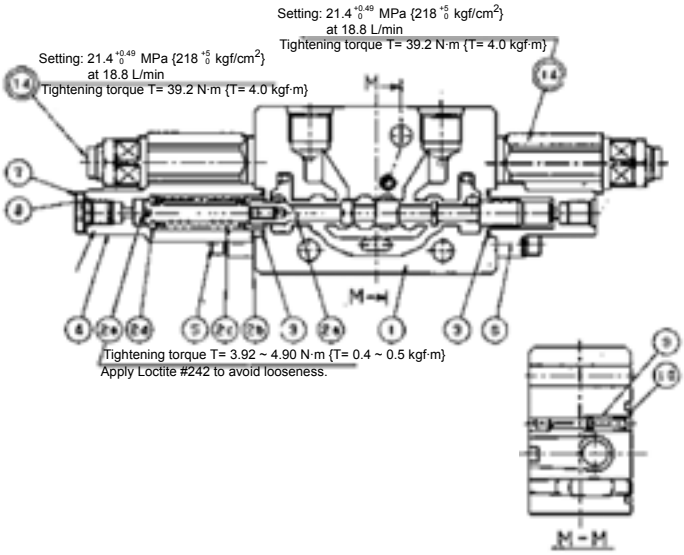
6)Arm section : F-F, RA221-70051



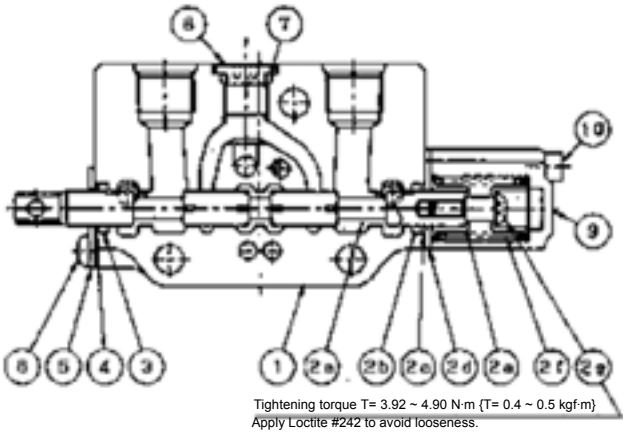
7) Travel R section : G-G, RA221-70061



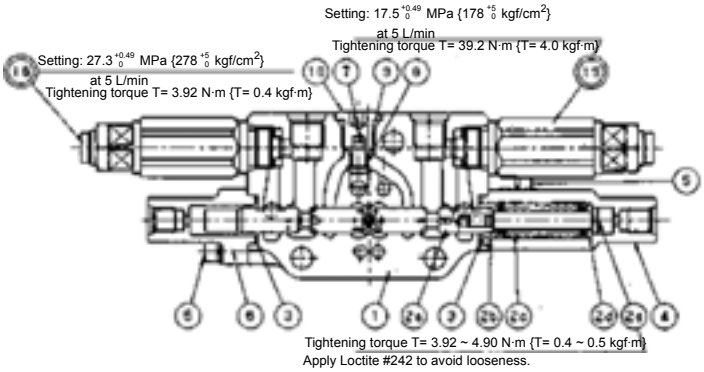
8) Inlet section : H-H, RB238-70941



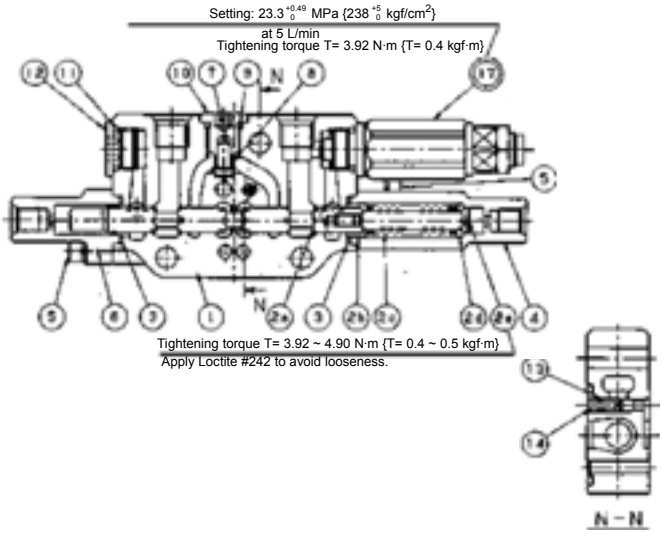
9) Travel L section : I-I, RA221-70091



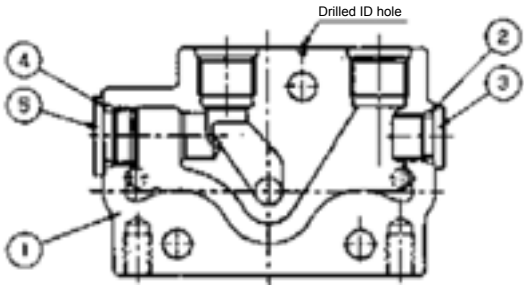
10) Boom section : J-J, RA221-70071



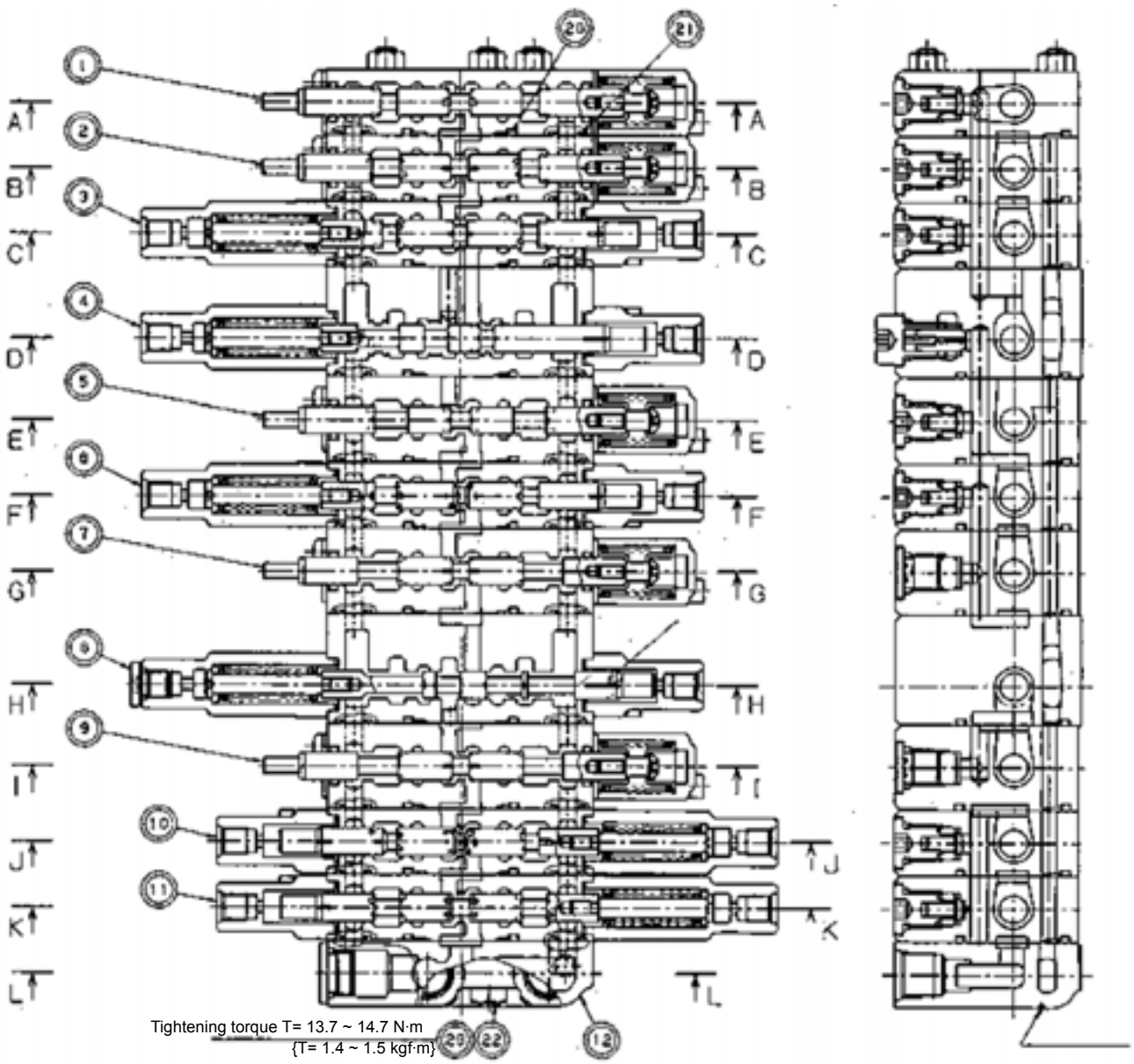
11) Bucket section : K-K, RB238-70081



12) Outlet : L-L, RB238-70971



7. Inner sectional view



c. Swivel motor

1. Swivel system specifications

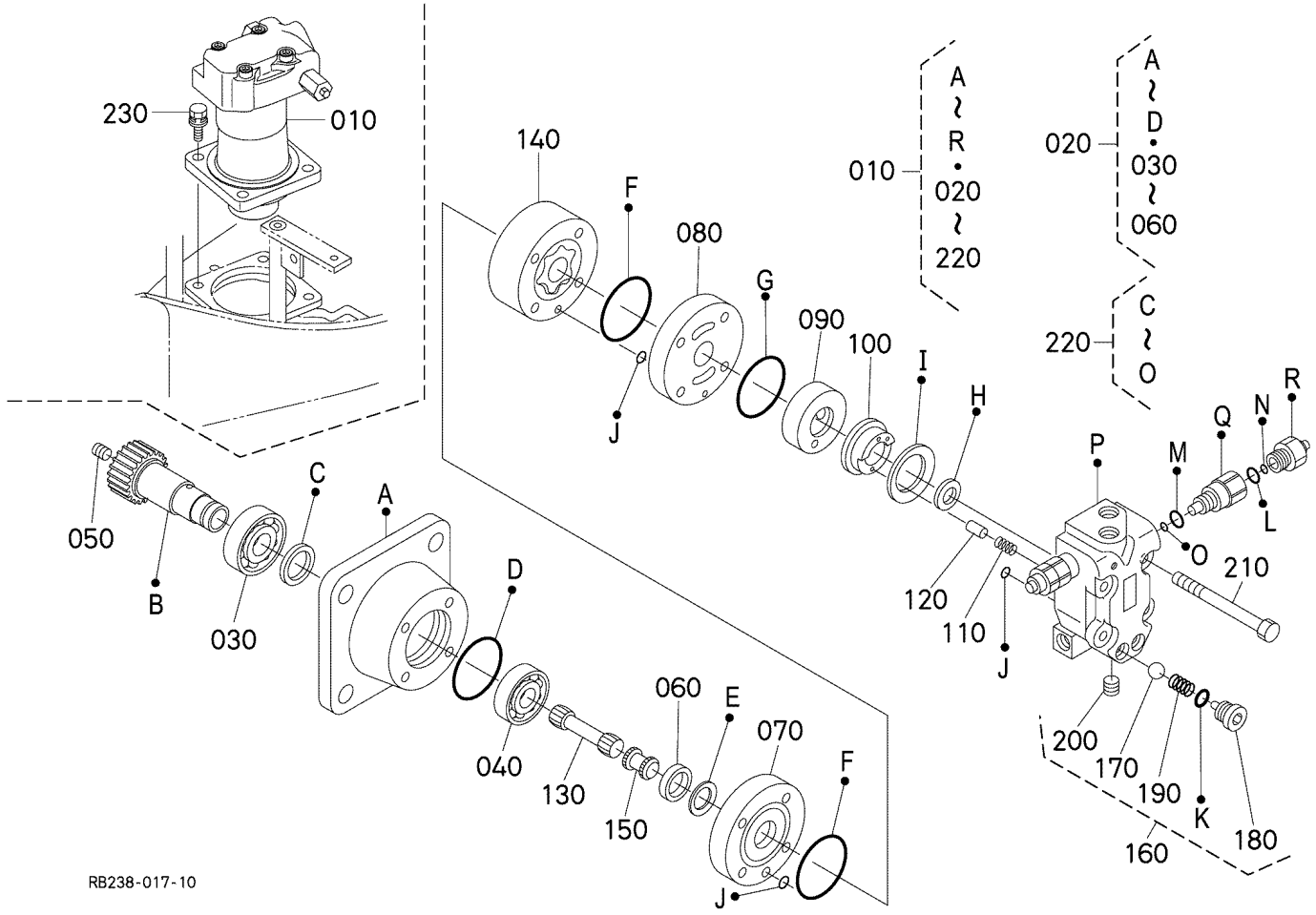
(A) Reference on new vehicle

		Unit	U15-3	Remarks
Maker			Eaton Fluid Power Ltd.	
Type			2-200DOS-E3888	
Capacity		cc/rev	195	
Brake V Pressure		Mpa (kgf/cm^2)	13.2 (135)	
Drain spec.	Locked	L/min	1.0	
	Rotating	L/min	0.5	
Swivel speed		rpm	8.7 ± 0.9	
Swivel speed (Three times rotation)		sec.	20.8	
Swivel startup		sec.	2.1 ± 0.2	Front horizontal, heaped, engine at max. rpm, 0 to 90° swivel
Swivel block performance		mm/min	120	Front horizontal, heaped, 15°, engine at stop
Allowable slope angle for swivel		deg. (kg)	18 ≦	Front horizontal, heaped, engine at max. rpm
Play at bucket tip		mm	73+20	

(How to measure the play at bucket tip)
1. Dump the arm and crowd the bucket. Position the bucket 1 m above the ground.
2. Push the bucket tip with a force of 5 kgf or so. Take this position as "0", and push the bucket tip in the opposite direction with a force of 30 kgf.
3. Measure the displacement of the bucket tip.
4. Take the above steps more than 5 times, but without swing.

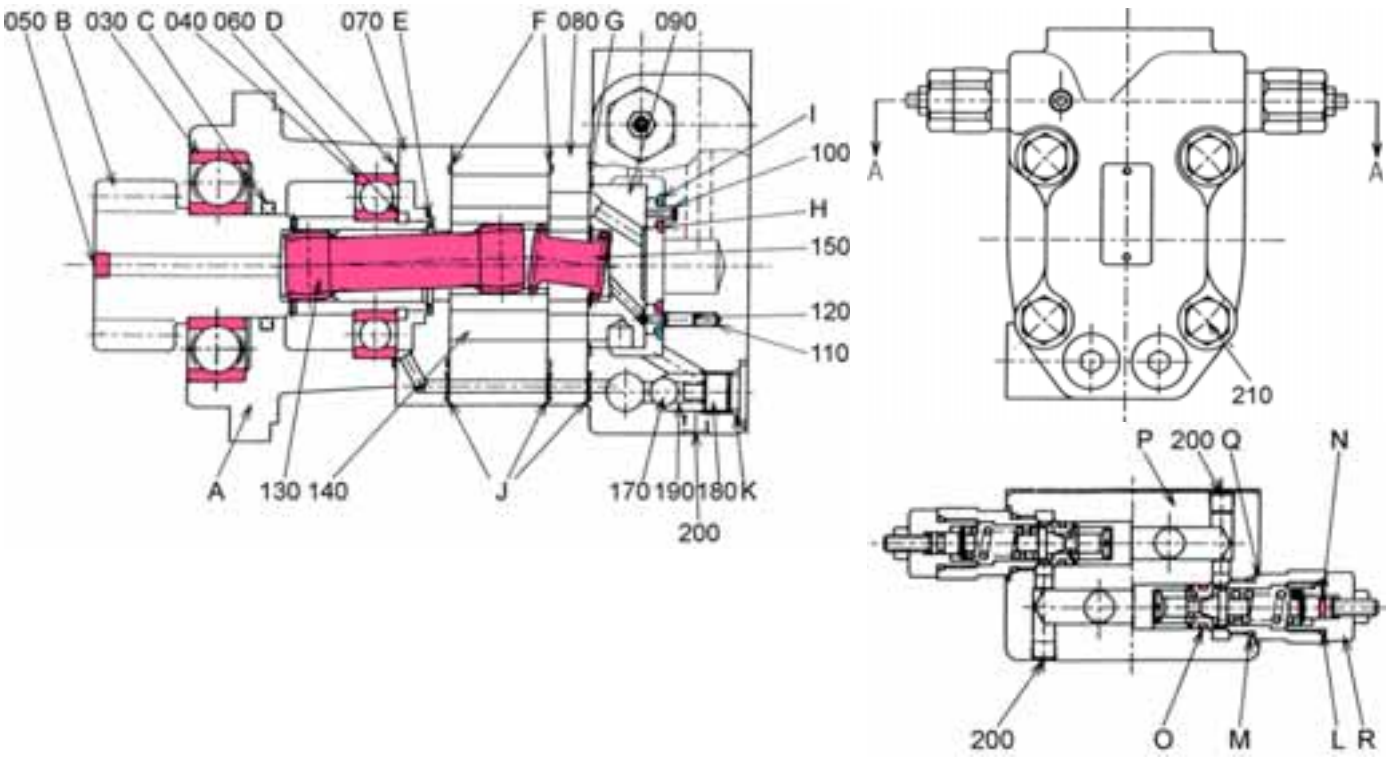
(How to measure the swivel block performance)
1. The swivel block performance must be checked with a hydraulic oil temperature of 45 ± 5°C on a 15-degree slope.

2. Component of swivel motor



No.	Part Name	Q'ty	Remarks
010	Assy motor,swivel	1	Include A ~ R and 020 ~ 220
020	Assy gear	1	Include A ~ D and 030 ~ 060
030	Bearing,ball	1	
040	Bearing,ball	1	
050	Plug	1	
060	Retainer	1	
070	Plate	1	
080	Plate,valve	1	
090	Valve	1	
100	Plate	1	
110	Spring	2	
120	Pin	2	
130	Drive	1	
140	Gear,roller	1	
150	Valve,drive	1	
160	Assy valve	1	Include k, 170, 180, 190, 200
170	Ball	2	
180	Plug	2	
190	Spring	2	
200	Plug	3	
210	Bolt	4	
220	Kit seal	1	Include C ~ Q
230	Bolt	4	

3. Cross-sectional View of Swivel Motor

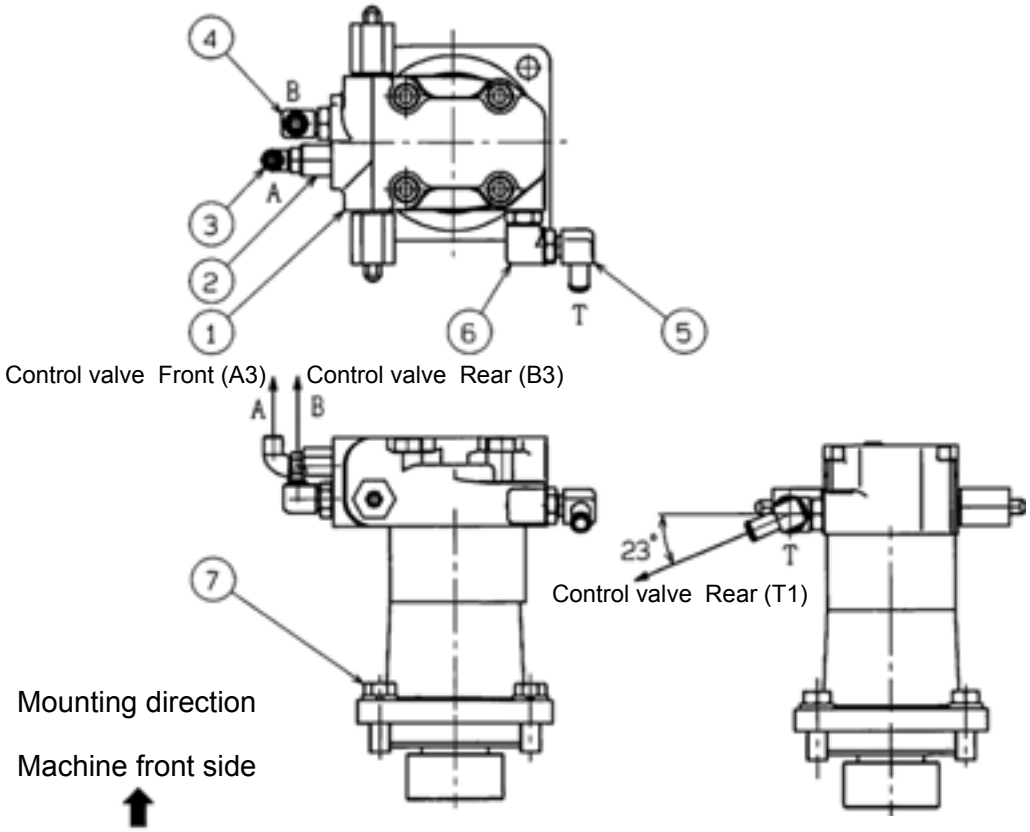


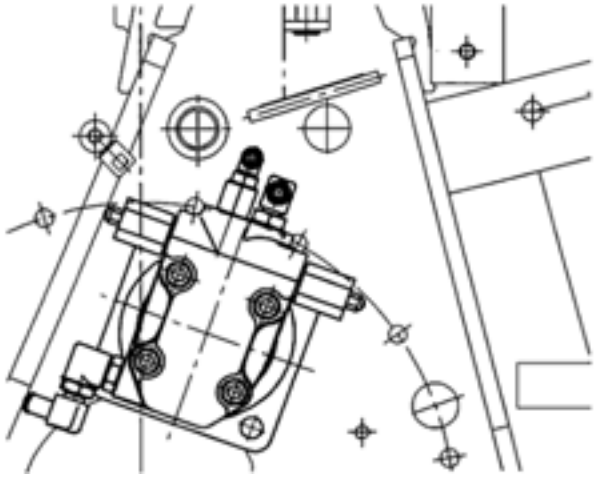
No.	Part Name	Q'ty	Remarks
1	Bearing housing	1	
2	Pinion gear	1	
3	Ball bearing	1	6308 LLU
4	Ball bearing	1	6207
5	Piug	1	R1/8
O 6	X-ring	1	
7	Retaining ring	1	
O 8	O-ring	1	AS568-041
O 9	Shaft face seal	1	
10	Wear plate	1	
O 11	O-ring	2	AS568-041
12	Valve plate	1	
O 13	O-ring	1	AS568-038
14	Valve	1	
15	Balancing plate	1	
16	Spring	2	
O 17	Inner face seal	1	
18	Pin	2	
19	Outer face seal	1	
20	2K drive	1	
21	Gear roller	1	
22	Valve drive	3	
23	O-ring	1	AS568-011
24	Valve housing assembly	1	Include 25 ~ 44
25	Valve housing	(1)	

No.	Part Name	Q'ty	Remarks
26	Relief cartridge	(2)	Include 32 ~ 44
27	Steel ball	(2)	
28	Plug	(2)	
O 29	O-ring	(2)	1BP14
30	Spring	(2)	
31	Prug	(3)	R1/8
32	Cartridge	(2)	
33	Screw guide	(2)	
34	O-ring	(2)	1BP16
35	Needle valve	(2)	
36	Spring washer	(2)	
37	Spring presser	(2)	
38	Orifice plate	(2)	
39	Spring	(2)	
O 40	O-ring	(2)	1BP18
O 41	O-ring	(2)	1BP5
42	Hexagon socket setscrew	(2)	
43	Hexagon nut	(2)	
O 44	O-ring	(2)	1BP12
45	Nameplate	1	
46	Rivet	2	
47	Hexagon bolt	4	
	Pinion gear assembly		Include 1 ~ 8
O	Seal kit		Include O items

4. Swivel Motor fittings

The outer diameter is same as that of current model. Relief pressure differs.

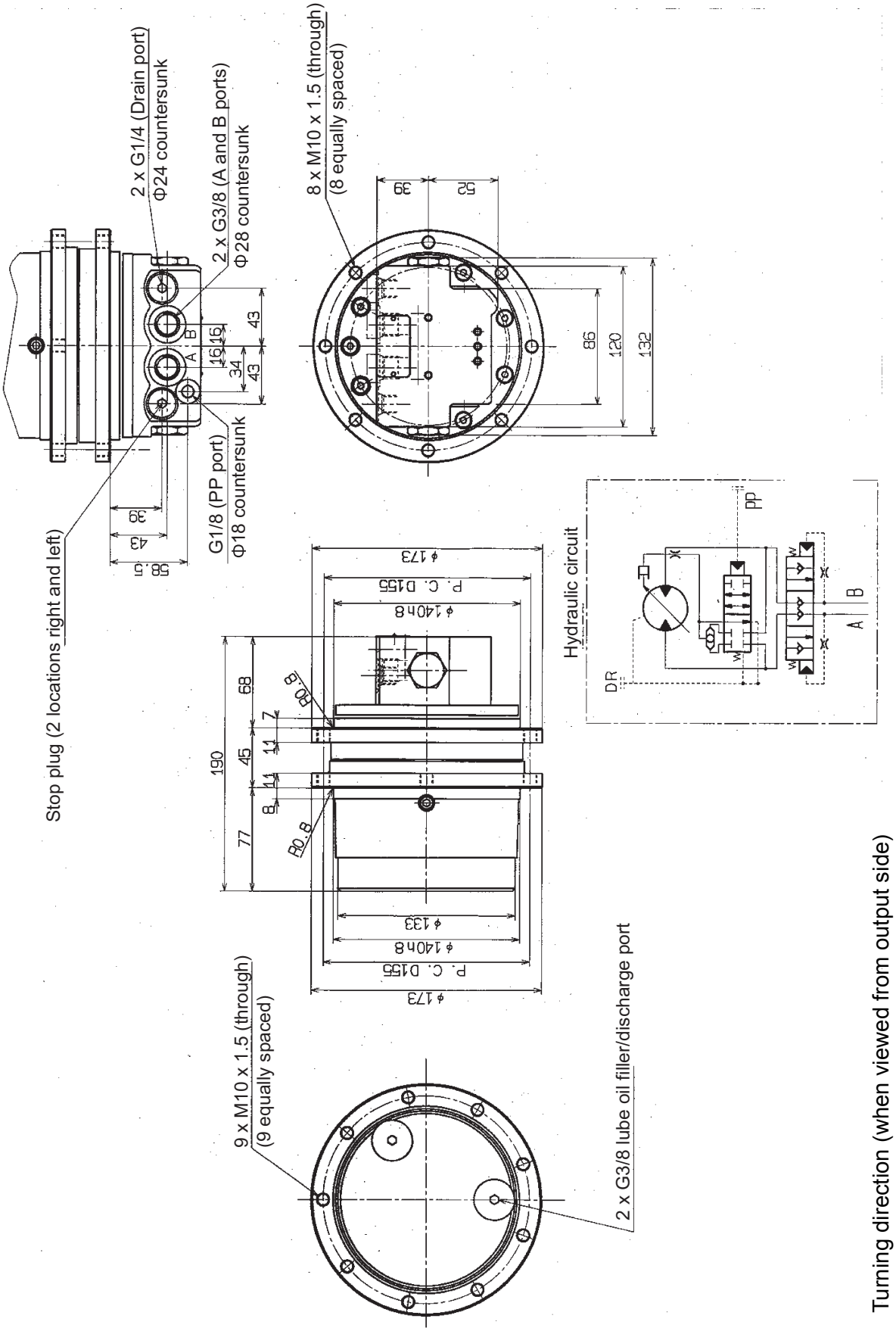




No.	Part Name	Q'ty	Remarks
(1)	Motor assembly (Swivel)	1	
(2)	Pipe joint (S, G3/8-G1/4)	1	A
(3)	Pipe joint (L, G1/4-G1/4)	1	For 3/8 A
(4)	Pipe joint (L, G3/8-G1/4)	1	B
(5)	Pipe joint (S, G3/8-13)	1	T
	O-ring	1	T
(6)	Pipe joint (L, G3/8-G3/8)	1	For 3/8 A, B
(7)	Bolt	4	M14 x 1.5 T

d. Travel motor (Wheel motor)

1. Overview (RA221-61291)

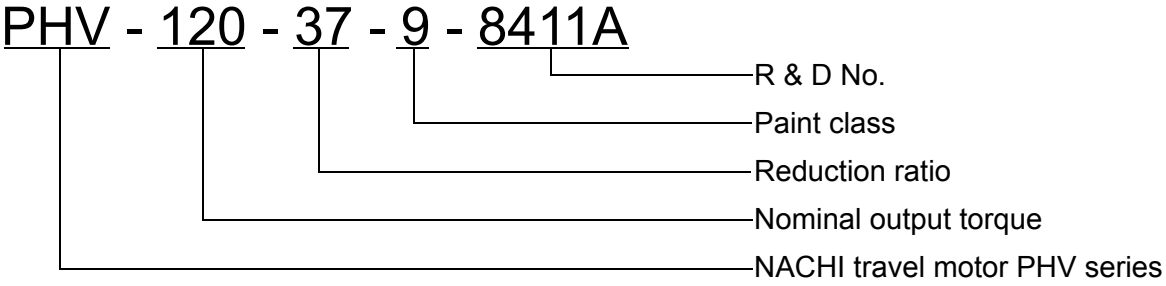


Turning direction (when viewed from output side)

Inlet	Outlet	Turning direction
B	A	Clockwise
A	B	Counterclockwise

2. Specifications

(1) Motor type ID mark



(2) Motor specifications

Gear box	Max. theoretical output torque 1st/2nd	1443 N·m (147 kgf·m) / 730N·m (75 kgf·m)
	Max. output speed	39.4 / 77.4 min^{-1} at 16.6 l/min
	Reduction ratio	1 / 36.96
Motor	Displacement	11.36 / 5.79 cm^3/rev
	Max. pressure	21.6 MPa (220 kgf/cm^2)
	Max. speed	1461 / 2867 min^{-1}
	Max oil flow	16.6 l/min
	Hi - Low change pressure	0.5 MPa (5 kgf/cm^2)
Others	Equivalent capacity for one turn of motor assy.	419.9 / 214.0 cm^3/rev
	Operating oil	ISO - VG46 or equivalent
	Temperature	-20 ~ 100 °C
	Filtering	10 μm
	Gear box oil	SAE -90 (API, Class : GL5), Gear oil
	Gear box oil amount	250 cm^3
	Weight	17 kg

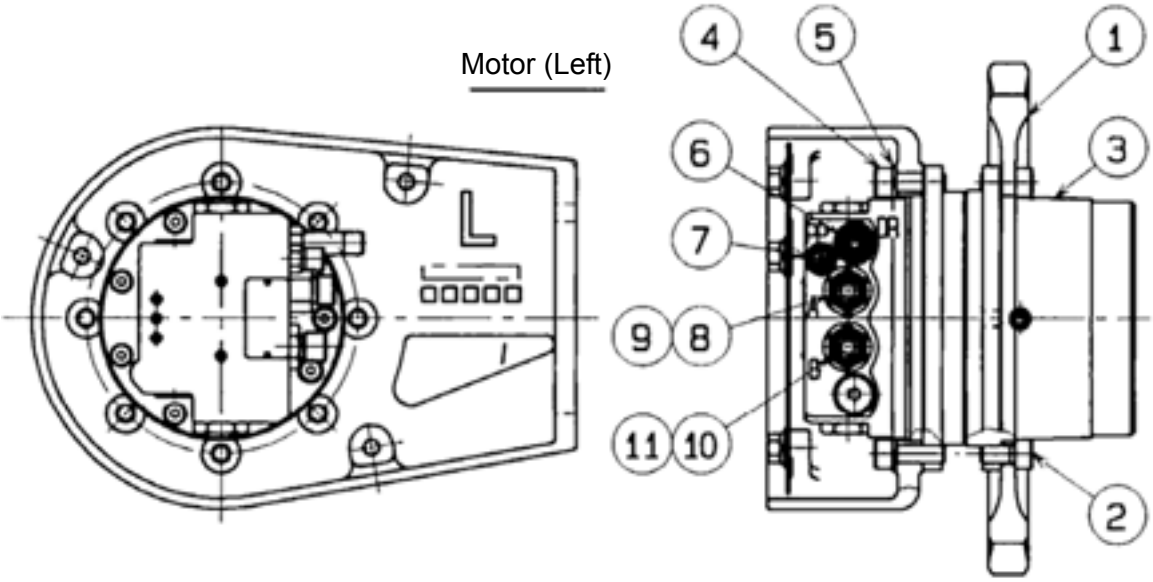
(3) Travel performance specifications

		Unit	U15-3	Remark
Type			PHV-120-37-9-8411A	
Climbing performance		% / deg.	58 / 30 ≦	
Maximum traction force		KN(kgf)	12.8 ± 1.3 (1255 ± 126)	1F
Travel block performance		mm / 10m	300 ≧	Travel posture, 20°, 10 minutes, engine at stop, bucket : empty
Travel speed		km/h	2.2 ± 0.2 / 4.0 ± 0.4	1F / 2F Rubber crawler
First speed		sec / 10m	16.1	Rubber crawler
Second speed		sec / 10m	8.8	Rubber crawler
Crawler speed		sec / turn	5.7 / 3.0	1F / 2F
Travel straightness		mm / 10m	600 ≧	Travel position, 10 minutes, engine at max. rpm
Drain amount	Locked	l / min	4.0 >	0:1 temp. 50 °C ± 5, For one minutes New machine's drain specifications
	Rotating	l / min	0.5 >	
Drain (machine body raised)	Locked	cc / min	90 ~ 180 / 180 ~ 420	1F / 2F actual measurement sample data
	Rotating	cc / min	5 ~ 20 / 20 ~ 45	1F / 2F actual measurement sample data

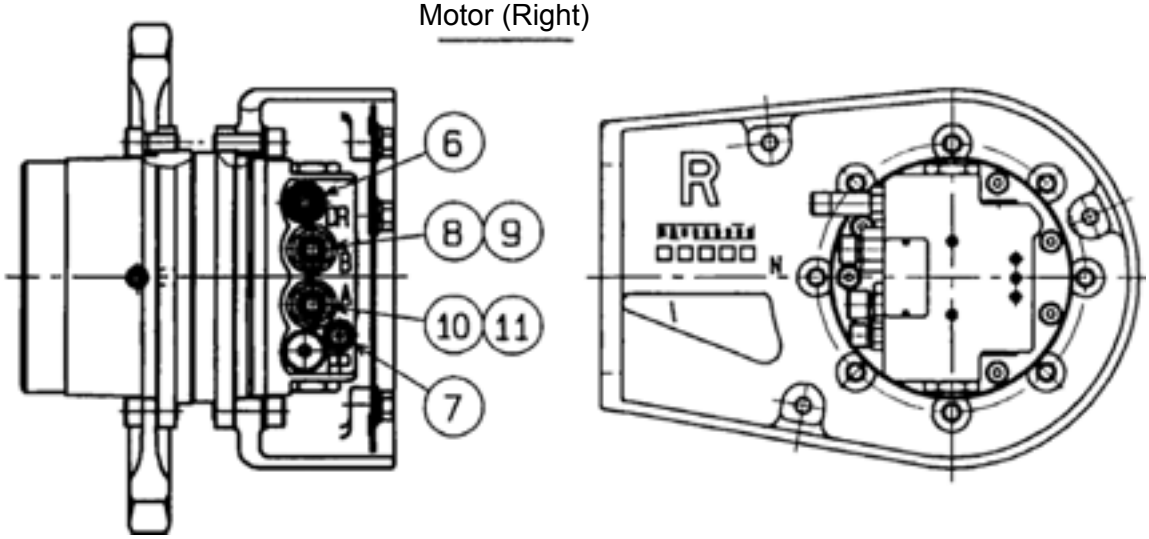
1. Measurement conditions
   (1) Hydraulic oil temperature: 50 ± 5°C, Machine front at travel position
2. How to measure the travel block performance
   (1) Travel the machine over a distance of 1 m or more on a 20° slope. Test it more than 3 times.
   (2) Mark the lower travel structure and the crawler to measure the displacement in the 10-minute time span.
   (3) Test it more than two times and record the greater displacement.
3. Crawler speed
   (1) Raise the machine body and mark the crawler. Run the crawler half a turn in advance. Measure the running speed twice or more.

3. Piston motor installation

Motor (Left)

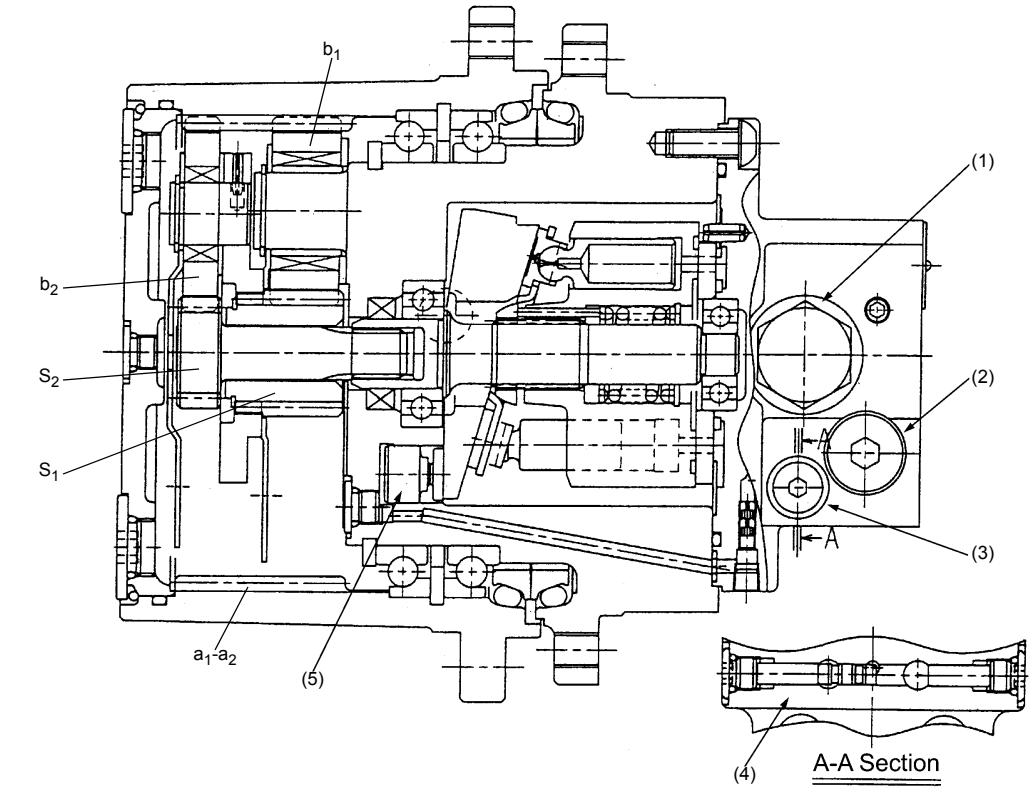


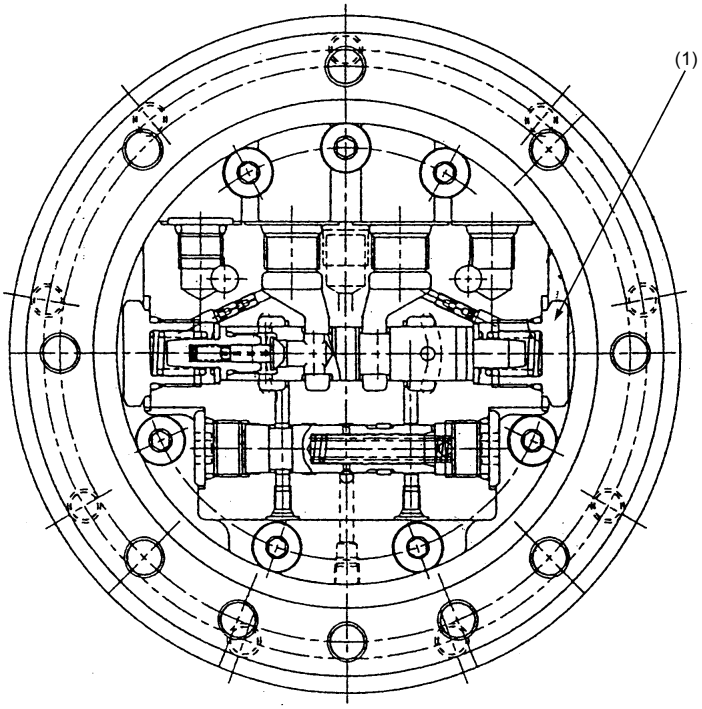
Motor (Right)

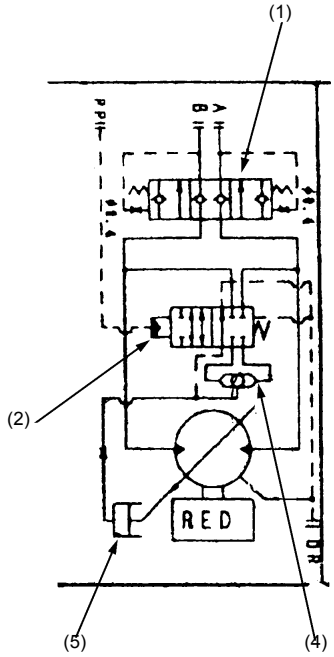


No.	Part Name	Q'ty
(1)	Drive Sprocket	2
(2)	Hex socket bolt	18
(3)	Motor, assembly (Wheel)	2
(4)	Hex socket bolt	16
(5)	Spring washer	16
(6)	Pipe joint (S, G1/4-G1/4)	2
(7)	Pipe joint (S, G1/8-G1/4)	2
(8)	Adaptor	2
(9)	O-ring	2
(10)	Straight pipe joint	2
(11)	O-ring	2

4. Structure



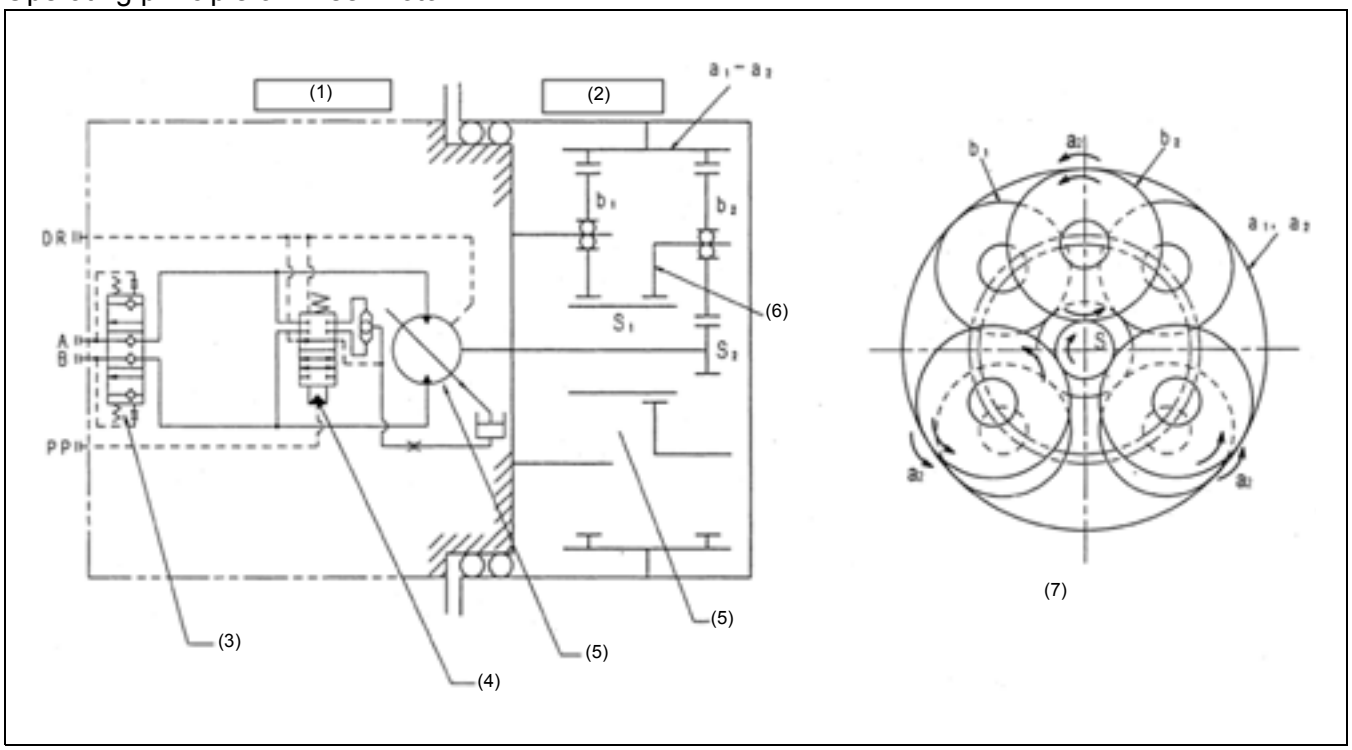




(1) Counter balance valve
(2) HI - Lo change valve
(3) Selector valve
(4) Selector valve
(5) Hi - Lo piston

4. Principle of operation

(1) Operating principle of wheel motor



(1)	Stationary part	(5)	Hydraulic motor
(2)	Rotating part	(6)	Symple planetary gear reducer (two - step)
(3)	Counter balance valve	(7)	Carrier 2
(4)	Two - speed spool	(8)	b_1 : four planet gears, b_2 : three planet gears

Description of operation

The PHV series travelling motor has a stationary main body composed of a hydraulic motor and hydraulic valve and a rotating main body composed of a simple planetary gear reducer.

(2) Reducer

1) Function

The PHV series travelling motor reducer, which is a simple two-step planetary gear reducer, converts the high-speed revolution of the hydraulic motor to low-speed high torque to obtain case rotation.

2) Description of operation

In the figure shown to the right, the gear S2 is spline-coupled with the hydraulic motor output shaft (or they are combined). The revolution of the gear S2 is single-reduced through the gears (S2, b2, a2). This single-reduced revolution is double-reduced through the gears (S1, b1, a1) spline-coupled with the carrier 2. The reduced revolution is transmitted to the rotating main body through the annular gears a1 and a2, providing travelling driving force.

The reduction ratio of a simple two-step planetary gear reducer is generally expressed as shown below.

$$R = \frac{Zs1}{Zs1 + Za1} \times \frac{Zs2}{Zs2 + Za2}$$

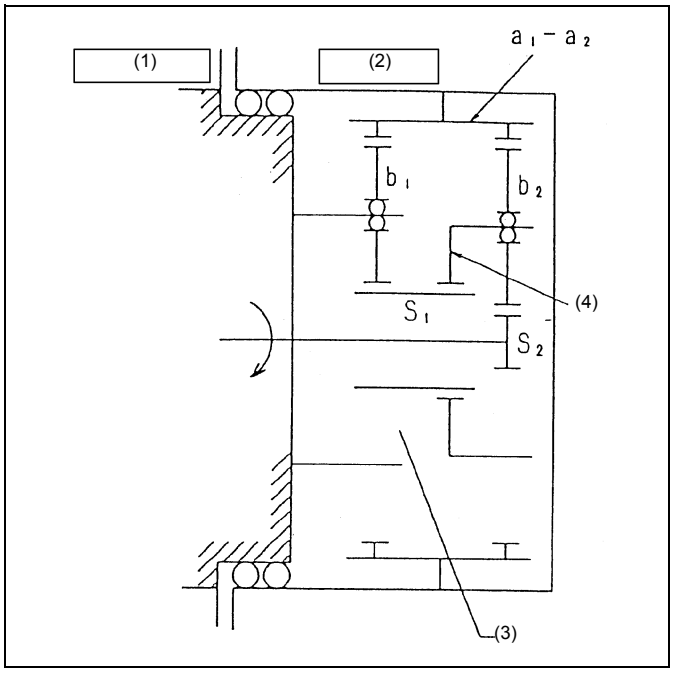
Where

Zs1, Zs2: Number of teeth of gears s1 and s2

Za1, Za2: Number of teeth of gears a1 and a2

Because the PHV series travelling motor is of the main body rotating type, the reduction ratio is expressed as shown below.

$$R' = \frac{1}{1\text{-}1/R}$$



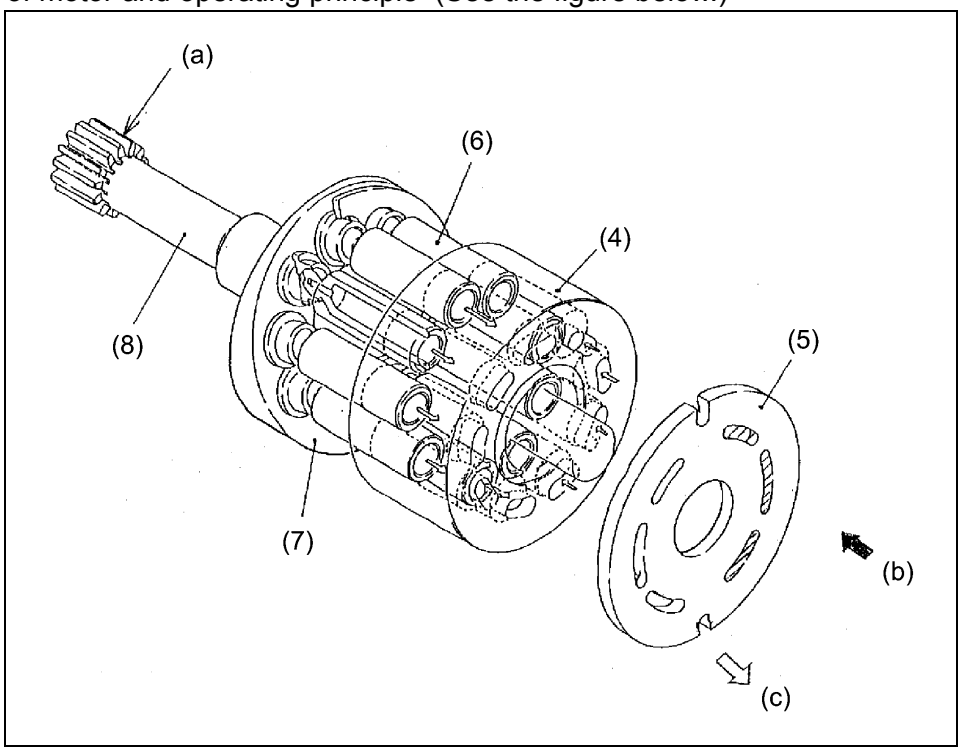
(1) Stationary part
(2) Rotating part
(3) Symple planetary gear reducer (two - step)
(4) Carrier 2

(3) Hydraulic motor

1) Function of motor

The hydraulic motor, which is an axial piston motor (rotating cylinder and swash plate type), converts the hydraulic energy supplied from the pump to revolving movement.

2) Structure of motor and operating principle (See the figure below.)



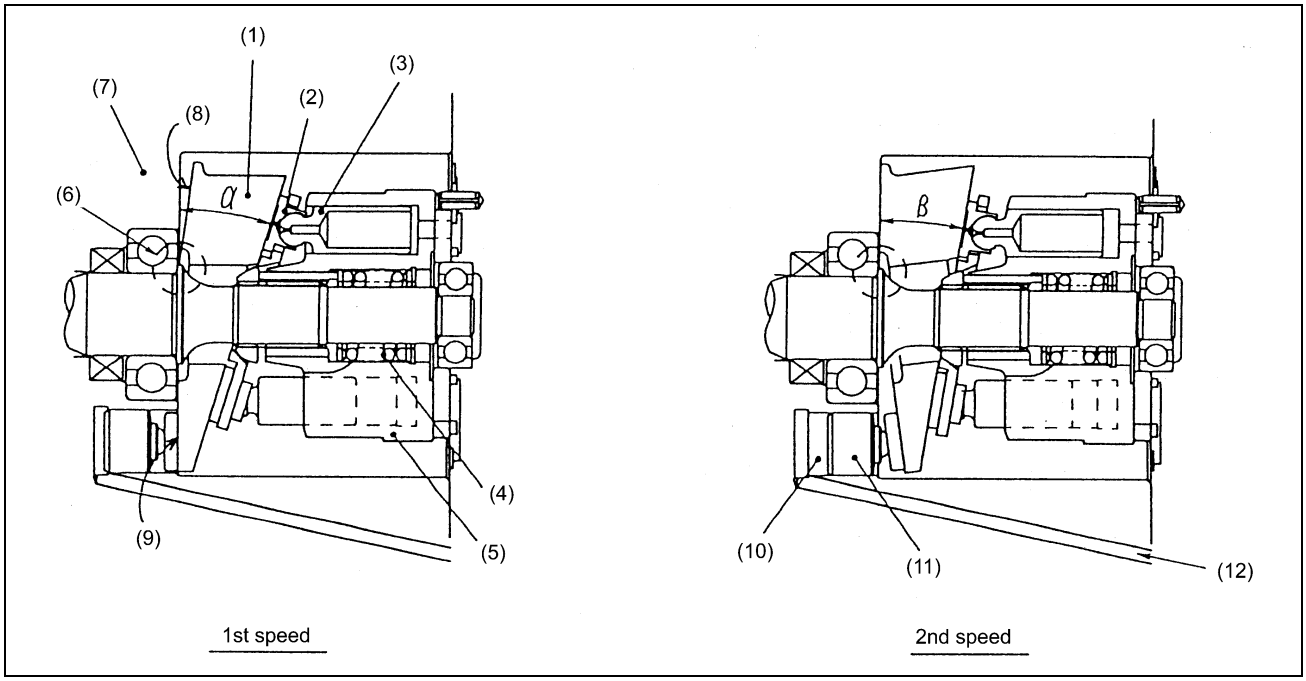
(4) Cylinder barrel
(5) Valve plate
(6) Piston
(7) Swash plate
(8) Shaft

(a) The motor shaft and gear S2 are combined or coupled through splines
(b) Port A
(c) Port B

The pressure oil flowing in through the hydraulic valve is supplied to the valve plate (5). When the pressure oil is supplied to the port A, the oil flows into the cylinder port, which corresponds to the port A, in the cylinder barrel (4) and presses the piston (6). This pressing force is converted to turning force through the swash plate (7) and the resulting turning force is transmitted to the shaft (3) spline-coupled with the cylinder barrel (4). The return oil in the cylinder port flows out through the port B of the valve plate (5).

In the case of reverse rotation, the pressure oil flows in through the port B and flows out through the port A.

3) Operating principle of two-speed motor
The swash plate has two faces I and II on the surface opposite to the shoe-sliding surface and supported by the two balls fixed in the body 2 .
The ball is positioned eccentrically above the central axis. In the 1st speed state, therefore, the face II is pressed against the body 2 by hydraulic oil force applied to the piston and the spring force in the cylinder barrel and the swash plate angle becomes α. At this time, the motor is of large capacity.
When the speed selector lever is switched to the g2nd speed position, the operating pressure is conducted through the two-speed spool to the control room and the control piston moves until the face II of the swash plate touches the body 2, fixing the swash plate angle at β. At this time, the motor is of small capacity.
When the engine is stopped, the control room is connected to the drain port through the two-speed spool and the swash plate is returned to the 1st speed position by the spring force. At the time of starting, therefore, the motor is always in the 1st speed state.

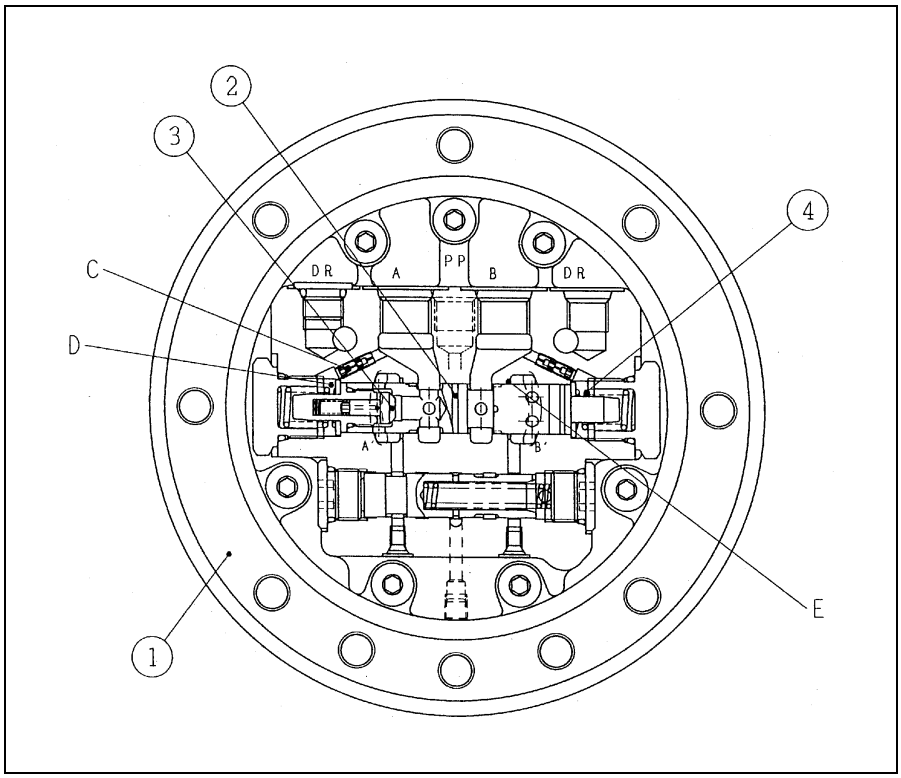


(1) Swash plate
(2) Shoe
(3) Piston
(4) Spring
(5) Cylinder barrel
(6) Ball
(7) Body 2
(8) Face II
(9) Face I
(10) Control room
(11) Control piston
(12) Operating pressure

(4) Hydraulic valve (counter balance valve)

When the pressure oil is supplied through the port A, the pressure oil pushes open the check valve (3) and flows into the inlet-side port A' of the hydraulic motor. At the same time, the pressure oil flows through the choke hole C into the room D and slides the spool valve (2) to the right, overcoming the force of spring (4). As a result, the hydraulic motor return oil flows in through the port B', passes through the opening E of the main body (1) and spool valve (2) and returns to the port B. These processes make the hydraulic motor rotate. When the pressure oil is supplied through the port B, the above-mentioned processes are reversed and the hydraulic motor rotates reversely.

When the pressure oil supplied through the port A is made unpressurized, the spring force works to return the spool valve to the left. At this time, the oil in the room D controls the speed at which the spool valve returns to the left, utilizing the choking effect of the choke hole C. Even if the pressure oil supplied through the port A is made unpressurized, the hydraulic motor continues rotating using an inertial force. At this time, the return oil is gradually controlled through the sliding speed of the spool valve and the helix shape, thus stopping the hydraulic motor smoothly.

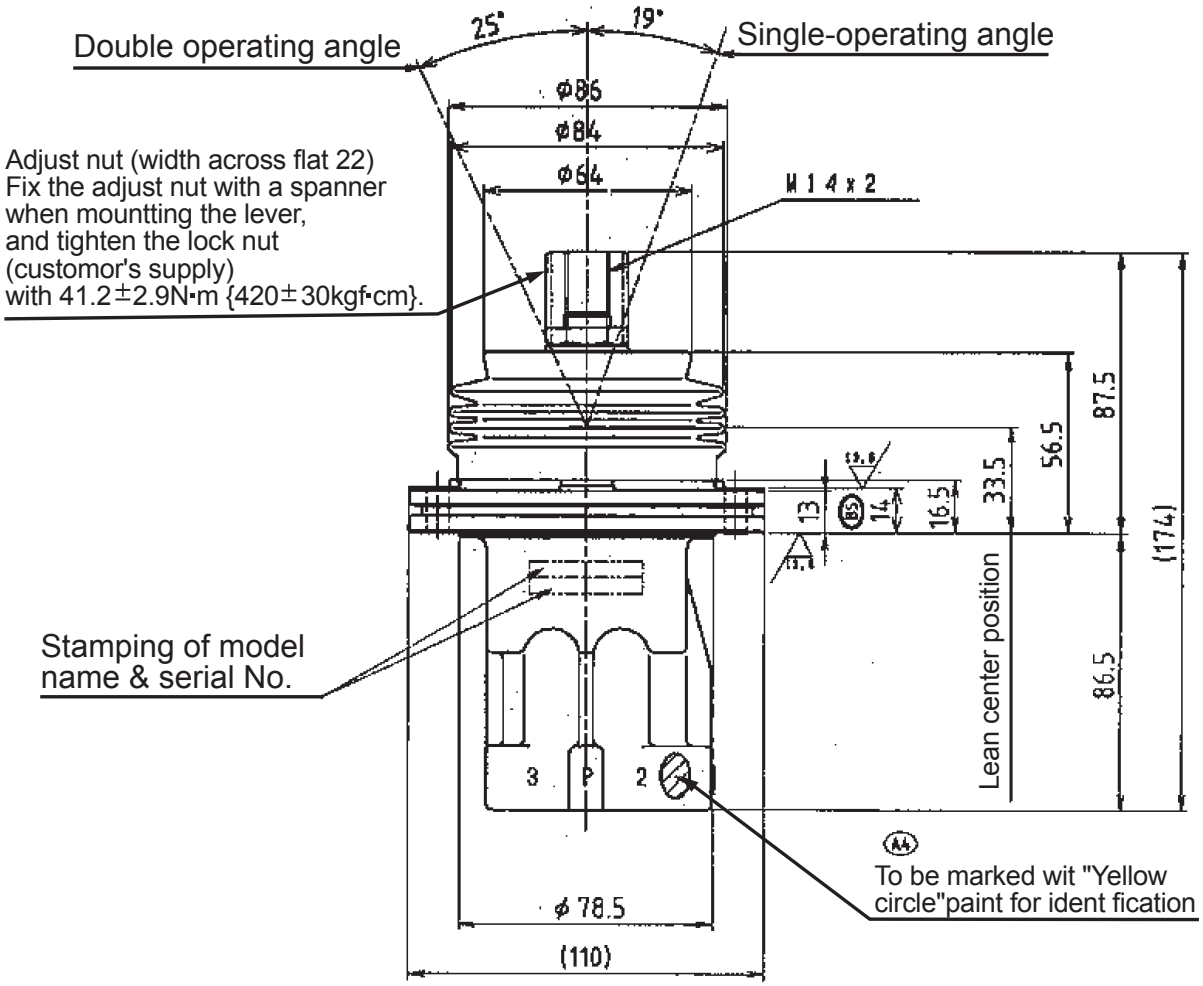


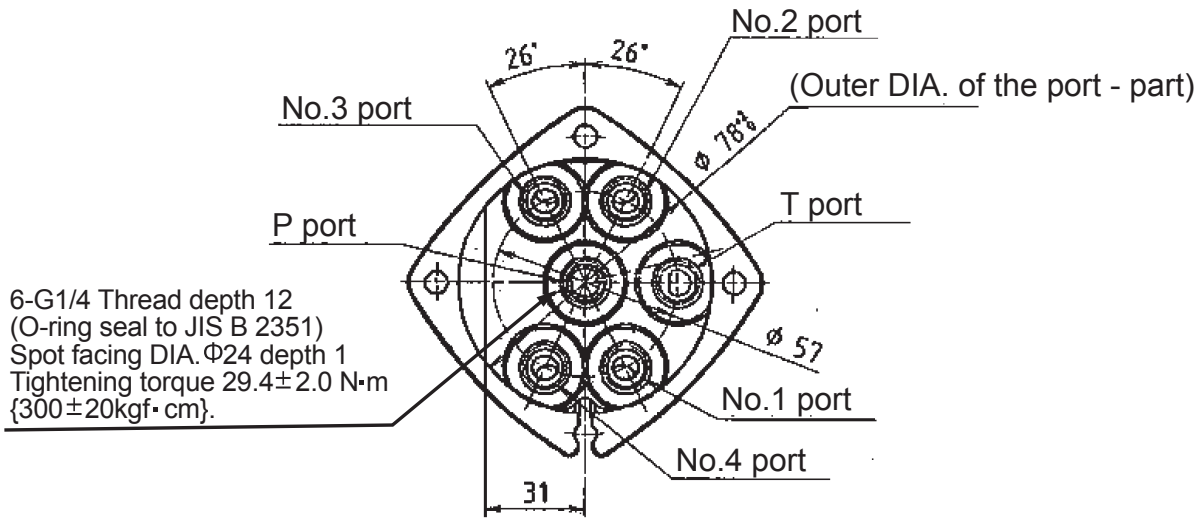
e. Pilot valve (Remote control valve)

1. Structure

Maker : Kawasaki Precision Machinery Ltd.
Type : PV 48 M 2043 A
Code No. : RA221-61721

1) Control diagram





2) Specifications

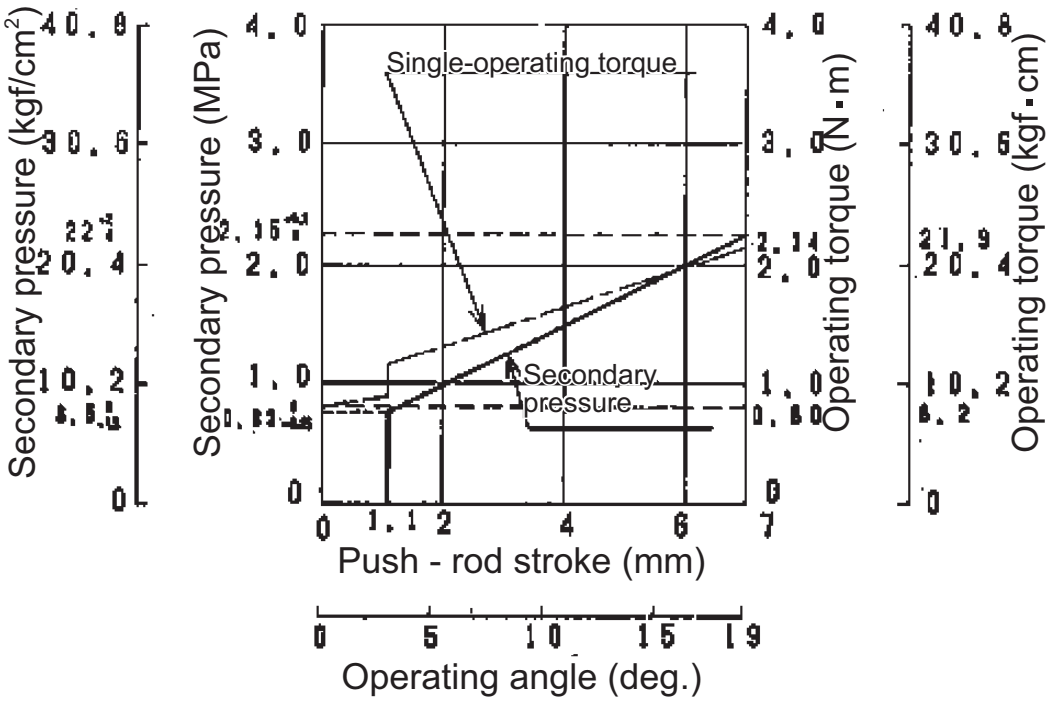
1. Max primary pressure: 6.9 MPa {70 kgf/cm^2}
2. Max. back pressure: 0.3 MPa {3 kgf/cm^2}
3. Rated flow: 15 L/min
4. Secondary pressure characteristics: Refer to the 'Control diagram' shown right
5. Operating torque: Refer to the 'Control diagram' shown right
6. Max allowable external torque: Refer to the 'Max. allowable external torque' shown right
7. Hydraulic oil: mineral hydraulic oil
8. Oil temp. range: -20 °C ~ +90 °C
9. Filter: A filter of 40 mesh and over should be applied at the entrance of port P for proventing the spool sticking.

3) Operating specifications

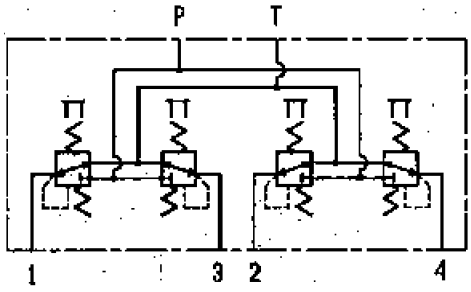
1. Primary pressure: 3.9MPa {40 kgf/cm^2}

4) Max. allowable external torque

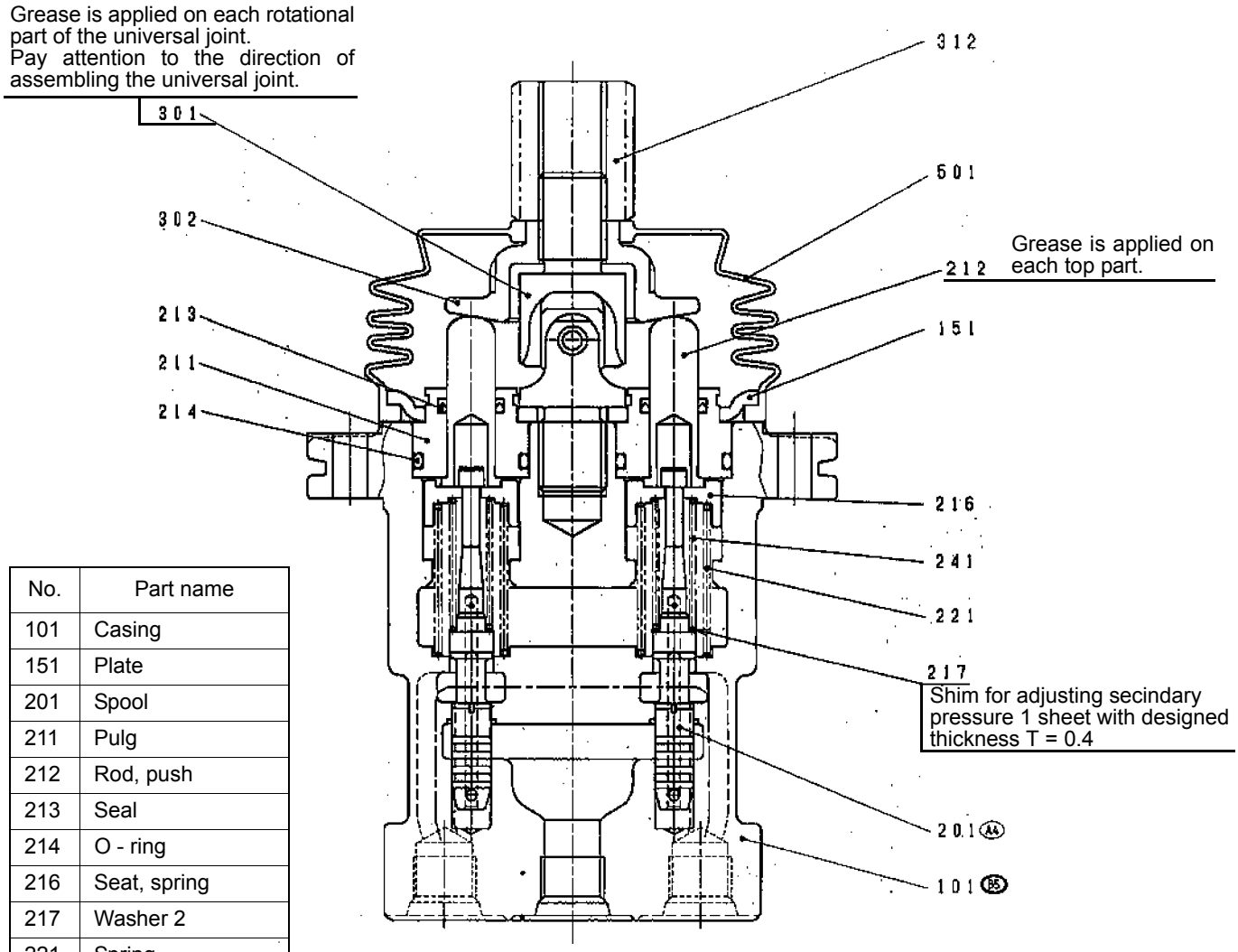
	Rated	Intermittent
Bending torque	32.4 N·m {330 kgf·cm}	88.3 N·m {900 kgf·cm}
Torsional torque	20.6 N·m {210 kgf·cm}	30.9 N·m {315 kgf·cm}



2. Sectional view



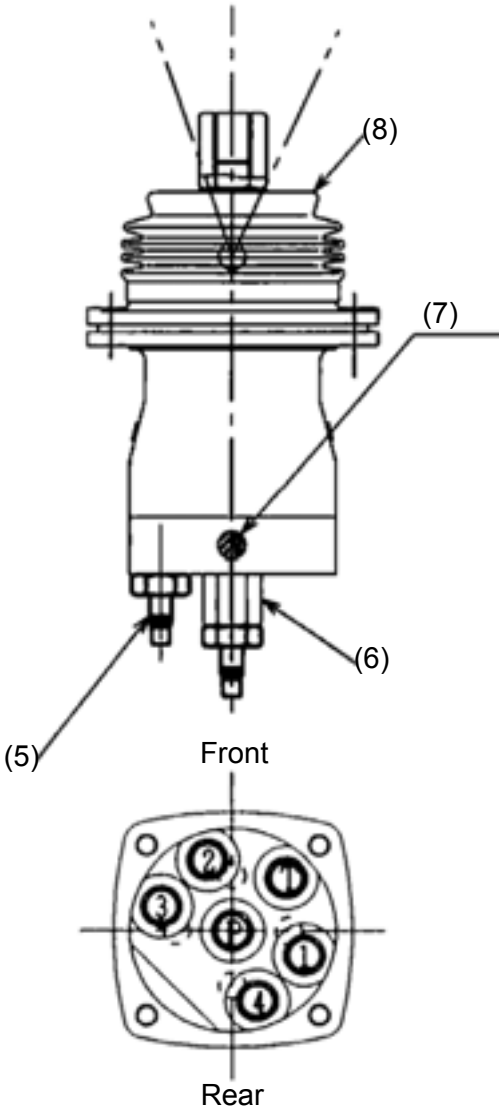
Htdraylic symbol



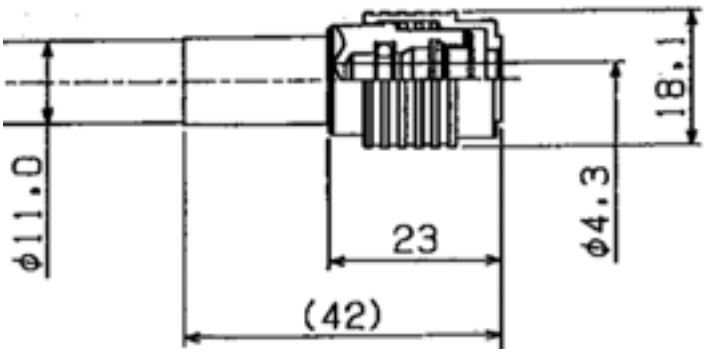
No.	Part name
101	Casing
151	Plate
201	Spool
211	Pulg
212	Rod, push
213	Seal
214	O - ring
216	Seat, spring
217	Washer 2
221	Spring
241	Spring
301	Joint
302	Plate, circular
312	Nut, adjusting
501	Bellows

3. Adaptors

P/V (both right and left)



(Quick coupler)



Left pilot valve

No.	Position for use	Color of hose tape
(1)	Swivel Left	Red
(2)	Arm dumping	Blue
(3)	Swivel Right	Yellow
(4)	Arm raking	Green
P	P-port	White
T	T-port	None

Right pilot valve

No.	Position for use	Color of hose tape
(1)	Bucket raking	Pink
(2)	Boom lowering	Light blue
(3)	Bucket dumping	Brown
(4)	Boom raising	Gray
P	P-port	White
T	T-port	None

No.	Part Name	Q'ty	Remarks
(5)	Pipe joint (S, G1/4-8.6)	5	Other than P-port
(6)	Filter	1	P-port only
	Pipe joint (S, G1/4-8.4)	1	
(7)	Valve, assembly (Pilot)	1	
(8)	Yellow paint	1	

f. Cylinders

1. Cylinder speed

(A) Reference on new vehicle
(B) Allowable limit

		Unit	U15-3	Remarks
Boom cylinder	Down (A)/(B)	sec	2.2 ± 0.3	MAX to GL
	Up (A)/(B)	sec	2.5 ± 0.3	GL to MAX
	Cushion	sec	*0.5 ~1.5	Empty bucket/crowded
Arm cylinder	Crowd (A)/(B)	sec	3.5 ± 0.3	
	Dump (A)/(B)	sec	2.4 ± 0.3	
Bucket cylinder	Crowd (A)/(B)	sec	2.8 ± 0.3	
	Dump (A)/(B)	sec	1.9 ± 0.3	
Boom swing cylinder	LH (A)/(B)	sec	4.6 ± 0.3	
	RH (A)/(B)	sec	3.7 ± 0.3	
Dozer cylinder (Full stroke)	Down (A)/(B)	sec	1.9 ± 0.3	
	Up (A)/(B)	sec	1.4 ± 0.3	

* Hydraulic oil temperature 50° C

2. Gravity fall

(A) Reference on new vehicle
(B) Allowable limit

		Unit	U15-3	Remarks
(Bucket under load)		kg	72	Bucket pile-up x earth specific gravity 1.8
Boom cylinder	(A)/(B)	mm	25≧/125≧	
Arm cylinder	(A)/(B)	mm	15≧/75≧	
Bucket cylinder	(A)/(B)	mm	10≧/50≧	
Swing block	90° swivel, 100 times	mm	6.0≧	90° swivel, 100 times
Dozer cylinder	(A)/(B)	mm	25≧/125≧	Machine body raised
(Bucket under no load)			Actual reference on new vehicle	
Boom cylinder	(A)	mm	5	
Arm cylinder	(A)	mm	3	
Bucket cylinder	(A)	mm	0	
Swing block	(A)	mm	0	90° swivel, 100 times
Dozer cylinder	(A)	mm	2	

(Measuring procedure)
1. Equip the machine with standard bucket.
2. Air-vent all the cylinders.
3. Measure the gravity fall for 10 minutes.
4. Arm dump and bucket bottom 1 m above ground
5. Load : Heaped in bucket
   Soil gravity : 1.8

3. Specifications and part codes of boom, arm, bucket and swing cylinder

		Unit	U15-3	Remarks
Boom	Tube outside diameter - Inside diameter - Rod outside diameter	mm	70-60-30	
	Stroke	mm	469	
	Fully retracted	mm	765	
	Sealing kit part code		YW181-9521Δ	
	Piston tightening torque	N•m (kgf•m)	410 ~ 450 (42 ~ 46)	
	Piston thread size		M24 x 1.5	
	Piston wrench size	mm	41	
Arm	Tube outside diameter - Inside diameter - Rod outside diameter	mm	70-60-35	
	Stroke	mm	335.5	
	Fully retracted	mm	924.5	
	Sealing kit part code		YW182-9531Δ	
	Piston tightening torque	N•m (kgf•m)	510 ~ 550 (52 ~ 56)	
	Piston thread size		M24 x 1.5	
	Piston wrench size	mm	36	

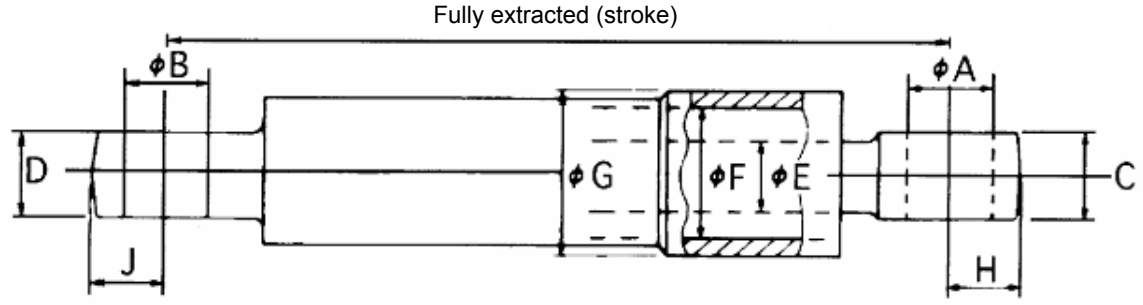
		Unit	U15-3	Remarks
Bucket	Tube outside diameter - Inside diameter - Rod outside diameter	mm	70-60-35	
	Stroke	mm	269	
	Fully retracted	mm	529	
	Sealing kit part code		YW182-9531Δ	
	Piston tightening torque	N•m (kgf•m)	510-550 (52~56)	
	Piston thread size	mm	M24 x 1.5 8T	
	Piston wrench size	mm	36	
Swing	Tube outside diameter - Inside diameter - Rod outside diameter	mm	65-55-30	
	Stroke	mm	326	
	Fully retracted	mm	610	
	Sealing kit part code		YW179-9511Δ	
	Piston tightening torque	N•m (kgf•m)	343.0 ~ 392 (35 ~ 40)	
	Piston thread size	mm	M22 x 1.5	
	Piston wrench size	mm	32	

Blade cylinder

		Unit	U15-3	Remarks
Blade	Tube outside diameter - Inside diameter - Rod outside diameter	mm	70-60-30	
	Stroke	mm	112	
	Fully retracted	mm	348	
	Sealing kit part code		YW181-9521Δ	
	Piston tightening torque	N•m (kgf•m)	343.0 ~ 392.0 (35 ~ 40)	
	Piston thread size	mm	M22 x 1.5	
	Piston wrench size	mm	32	
Leg stretcher	Tube outside diameter - Inside diameter - Rod outside diameter	mm	65-55-30	
	Stroke	mm	250	
	Fully retracted	mm	478	
	Sealing kit part code		YW178-9511Δ	
	Piston tightening torque	N•m (kgf•m)	343 ~ 395 (35 ~ 40)	
	Piston thread size	mm	M22 x 1.5	
	Piston wrench size	mm	32	

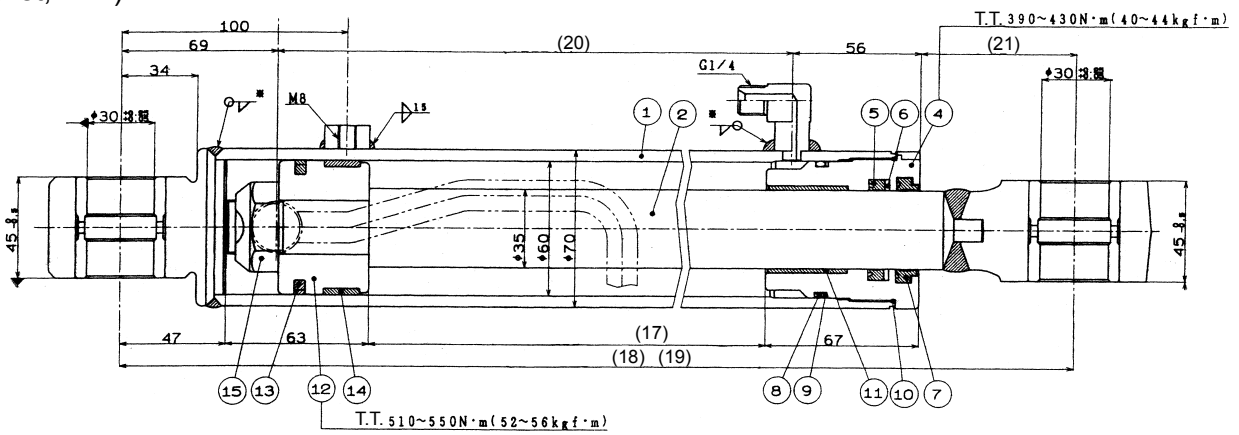
4. List of cylinder dimensions

Model		A	B	C	D	E	F	G	H	J	Port thread dia.	Remarks
U15-3	Boom	40-30	40-30	45	45	30	60	70	35	35	G1/4	
	Arm	40-30	40-30	45	45	35	60	70	32	32.5	G1/4	
	Bucket	40-30	40-30	45	45	35	60	70	32	32	G1/4	
	Swing	40-30	40-30	35	35	30	55	65	32	32	G1/4	
	Blade	40-30	40-30	45	45	30	60	70	32	32	G1/4	
	Track	34-30	34-30	35	35	30	55	65	27.5	28	G1/4	



5. Cylinders' section view

(Bucket, Arm)

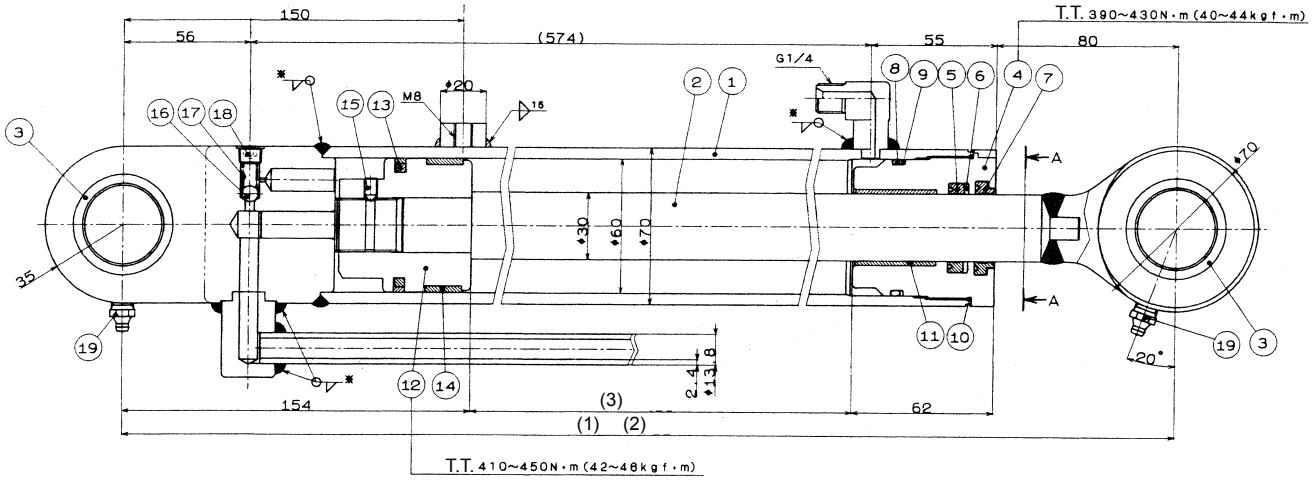


(1) Cylinder tube
(2) Cylinder rod
(3) Bushing
(4) Cylinder head
(5) Packing
(6) Backup-ring
(7) Scraper
(8) O-ring
(9) Backup-ring
(10) O-ring
(11) DU-bushing
(12) Piston
(13) Piston seal
(14) Wear-ring
(15) Lock nut, M24
(16) grease nipple

[mm]

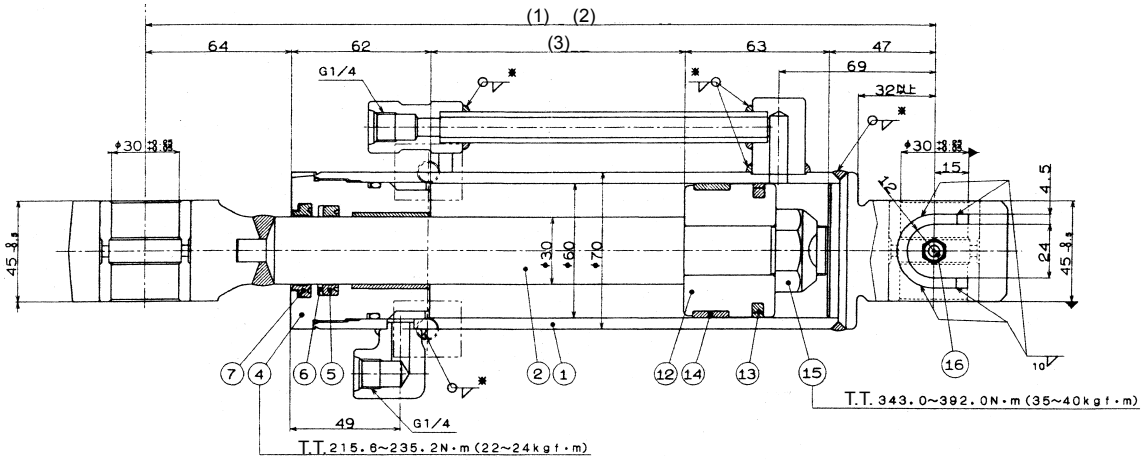
	Bucket	Arm
(17) Stroke	269	335.5
(18) Retracted L	529^{+3}_{0}	589 ± 1.5
(19) Extended L	802^{0}_{-5}	924.5 ± 2.5
(20)	325	387.5
(21)	79	76.5

(Boom)



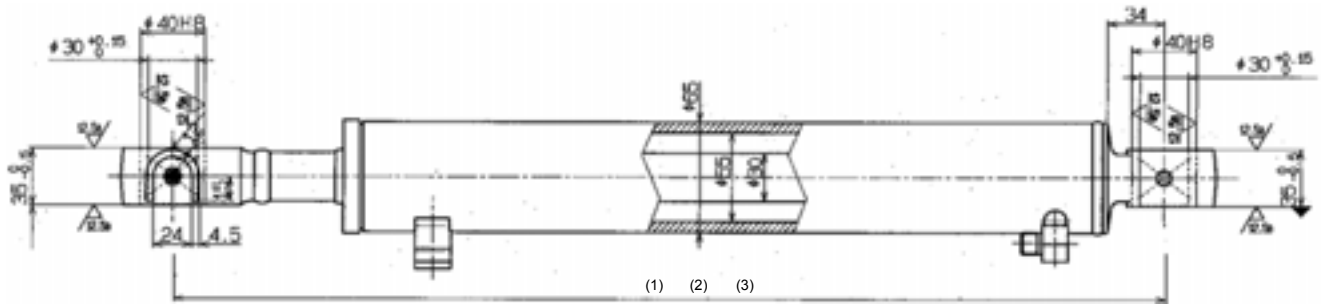
(1)Retracted L = 765 ± 1.5 (2)Extended L = 1234 ± 2.5 (3)Stroke = 469

(Blade)



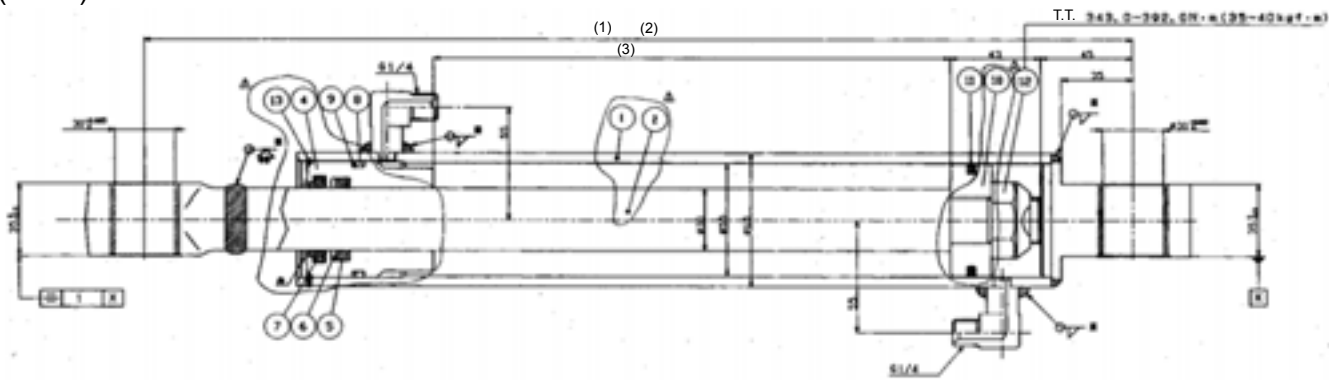
(1)Retracted L = 348 ± 1.5 (2)Extended L = 460 ± 2.5 (3)Stroke = 112

(Swing)



(1)Retracted L = 610^{+3}_{0} (2)Extended L = 940^{0}_{-5} (3)Stroke = 330

(Truck)



(1)Retracted L = 478 ± 1.5 (2)Extended L = 728 ± 2.5 (3)Stroke = 250
T.T. : Tightening torque

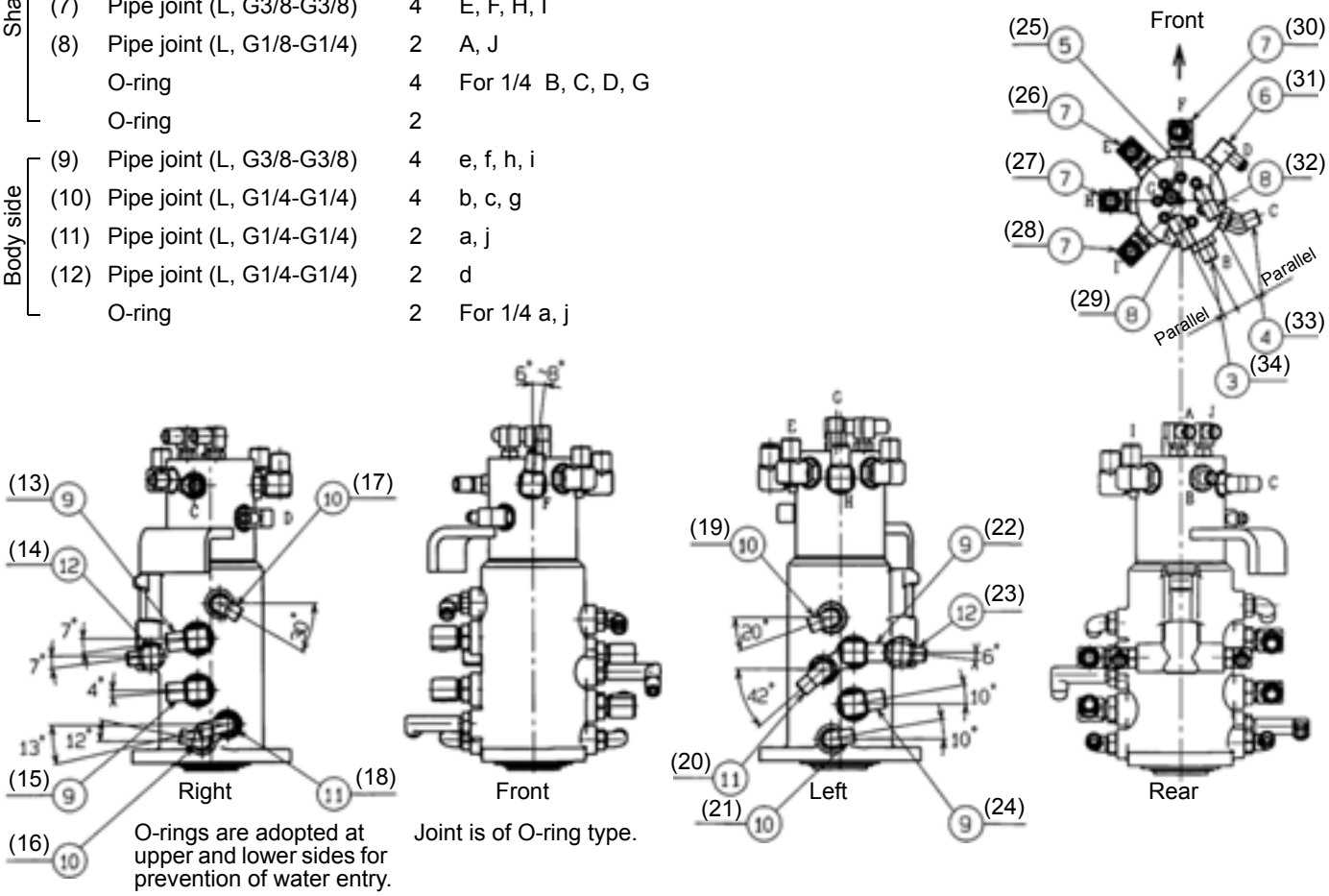
[Cylinder essential quality]

1. Seal durability:
   Must conform to class “A” (0.05 ml / 100m) of “JIS B 8354” under following conditions.
   Oil pressure : 21.6 MPa (220 kgf / cm^2),
   Oil temperature : 100 deg, Speed : 16.6 m / min,
   Sliding distance : 300km
2. Dust Seal properties :
   Dust enter must be 11 mg or less under following conditions.
   Speed : 16.6 m / min, Stroke : 150 mm,
   Number of repetitions : cycles,
   Vibration applied to facility : 7.4 Hz
3. Internal oil leakage :
   Must be within 1 cm^3 for 3 min under the condition of the main relife pressure 21.6 MPa (220 kgf / cm^2) applied to the stroke end (Oil temperature 50 ± 5 deg).
4. Minimum operating pressure :
   Must be within 4 % of the main relief pressure 0.86 MPa (8.8 kgf / cm^2) applied to the bottom port after 3 or more cycles with full stroke sliding under none load (Oil temperature 50 ± 5 deg).
5. Withstanding pressure :
   Permanent deformation and oil leakage must not occur after pressure 2 times as high as the main relief pressure 43.1 MPa (440 kgf / cm^2) is applied by 40000 time or more.
6. Withstanding external force :
   Any damages, distortions, oil leakage, permanent deformations must not occur in any parts when external force 2 times as high as the main relief pressure 43.1 MPa (440 kgf / cm^2) the cylinder thrust force (12240 kgf) is applied by 30000 times or more.
7. Rust prevention of plating :
   Must be rating number 9 or higher after 4 cycles (64 hour) of CASS testing. Thickness of platinf must be kept more than Ep-ICr30 (0.03 mm)
8. Cushion performance : (Cushion type cylinder only)
   Cushion facility must be set in bottom side for contraction with following performance.
   Oil temperature : 30 deg / cushion time : 2 seconds or less
   Oil temperature : 50 deg / cushion time : 1 ± 0.3 seconds
   Oil temperature : 80 deg / cushion time : 0.3 seconds or more
9. Piston rod surface treatment :
   Piston rod rubbing part : Ni-Hcr or Hcr plating
   Thickness 9.03 mm or more
   Hardness HV (25g) 700 or more
   Induction hardening : HRC 50 to 56, Depth 2 to 3 mm

g. Swivel Joint (Rotary joint)

1. Swivel Joint (1)

	No.	Part Name	Q'ty	Remarks
	(1)	Swivel joint, assembly	1	
	(2)	Bolt	4	M12 x 1.25 7T
Shaft side	(3)	Adapter	1	B
	(4)	Pipe joint (L, G1/4-G1/4)	1	C
	(5)	Pipe joint (L, G1/4-G1/8)	1	C
	(6)	Pipe joint (L, G1/4-10)	1	D
	(7)	Pipe joint (L, G3/8-G3/8)	4	E, F, H, I
	(8)	Pipe joint (L, G1/8-G1/4)	2	A, J
		O-ring	4	For 1/4 B, C, D, G
		O-ring	2	
Body side	(9)	Pipe joint (L, G3/8-G3/8)	4	e, f, h, i
	(10)	Pipe joint (L, G1/4-G1/4)	4	b, c, g
	(11)	Pipe joint (L, G1/4-G1/4)	2	a, j
	(12)	Pipe joint (L, G1/4-G1/4)	2	d
		O-ring	2	For 1/4 a, j

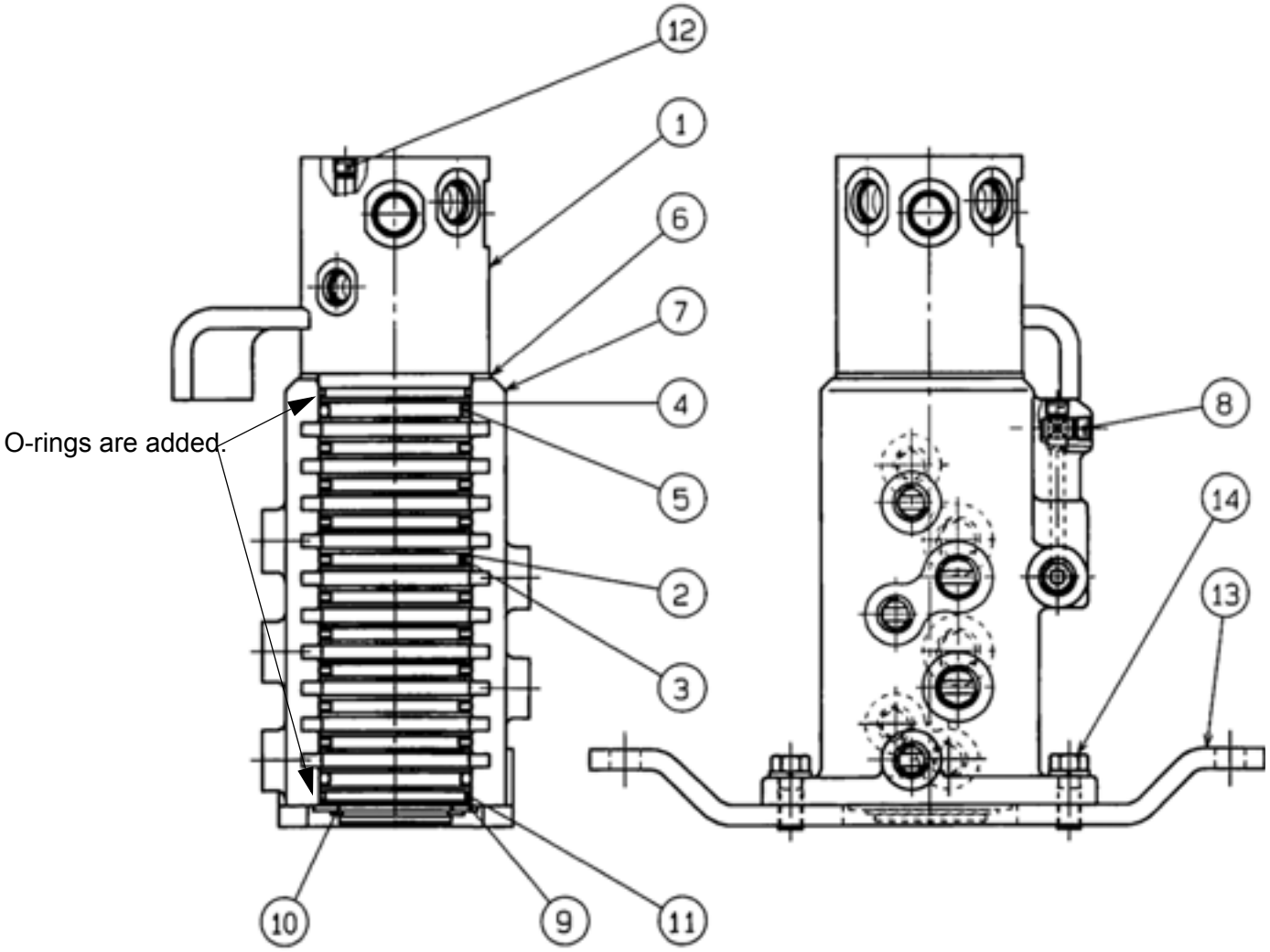


O-rings are adopted at upper and lower sides for prevention of water entry.

Joint is of O-ring type.

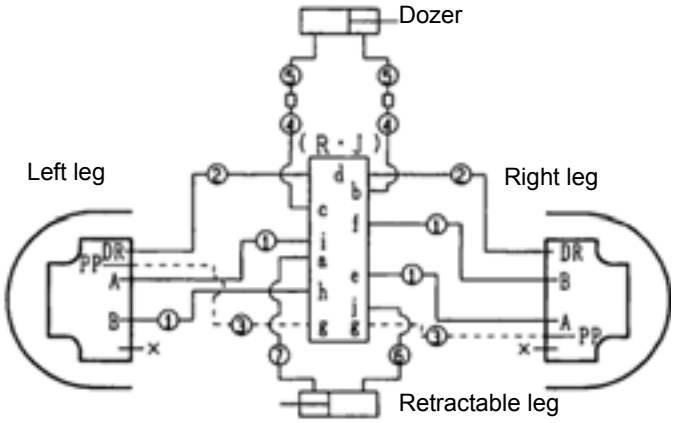
(13) Travel (Right) upper port (e)
(14) Travel drain (d)
(15) Travel (Right) lower port (e)
(16) Travel 2-speed signal (g)
(17) Blade cyl. (Rod) (b)
(18) Truck cyl. (Bottom) (i)
(19) Blade cyl. (Bottom) (c)
(20) Truck cyl. (Rod) (a)
(21) Travel 2-speed signal (g)
(22) Travel (Left) upper port (i)
(23) Travel drain (d)
(24) Travel (Left) lower port (h)
(25) Travel 2-speed signal
(26) Travel (Right) lower port
(27) Travel (Left) lower port
(28) Travel (Left) upper port
(29) Truck cyl. (Rod)
(30) Travel (Right) upper port
(31) Travel drain
(32) Truck cyl. (Bottom)
(33) Blade cyl. (Bottom)
(34) Blade cyl. (Rod)

2. Swivel Joint (2)



No.	Part Name	Q'ty	Remarks
(1)	Shaft (Swivel joint)	1	
(2)	Ring (Backup)	18	
(3)	Ring (D)	9	
(4)	Ring (Backup)	2	
(5)	O-ring	2	
(6)	Collar	1	
(7)	Body (Swivel joint)	1	
(8)	Plug (R1/8)	2	
(9)	Collar	1	
(10)	Shaft circlip	1	
(11)	Plug (R1/8)	2	
(12)	Base (Swivel joint)	7	
(13)	Bolt	1	
(14)	Shaft (Swivel joint)	4	M10 x1.25 7T

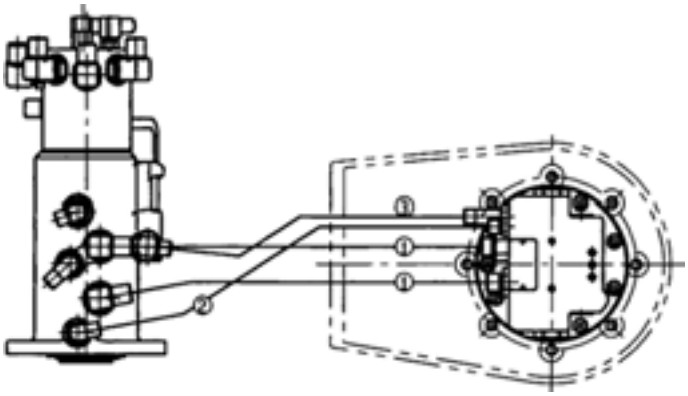
3. Route of Hose (Travel, dozer)



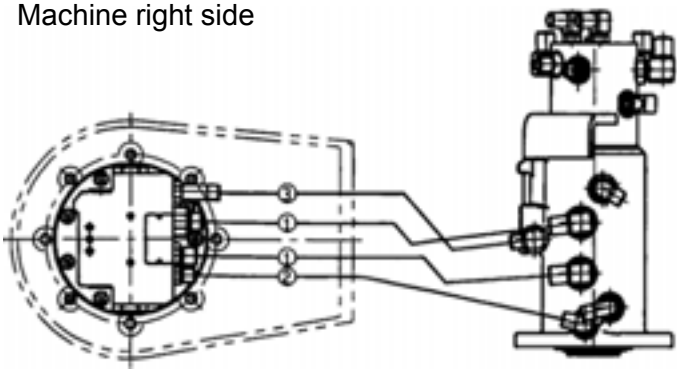
	Swivel joint side	Travel motor, cyl. Side
a.	Retractable leg (Retraction)	Cyl. rod side
b.	Dozer UP	Cyl. rod side
c.	Dozer DOWN	Cyl. bottom side
d.	Drain	Right and left drain ports
e.	Right backward	Right A (Lower)
f.	Right forward	Right B (Upper)
g.	Dual pilot	Left/Right travel 2-speed
h.	Left backward	Left A (Lower)
i.	Left forward	Left B (Upper)
j.	Retractable leg (Elongation)	Cyl. bottom side

Route of hose (Swivel joint ~ Travel motor)

Machine left side



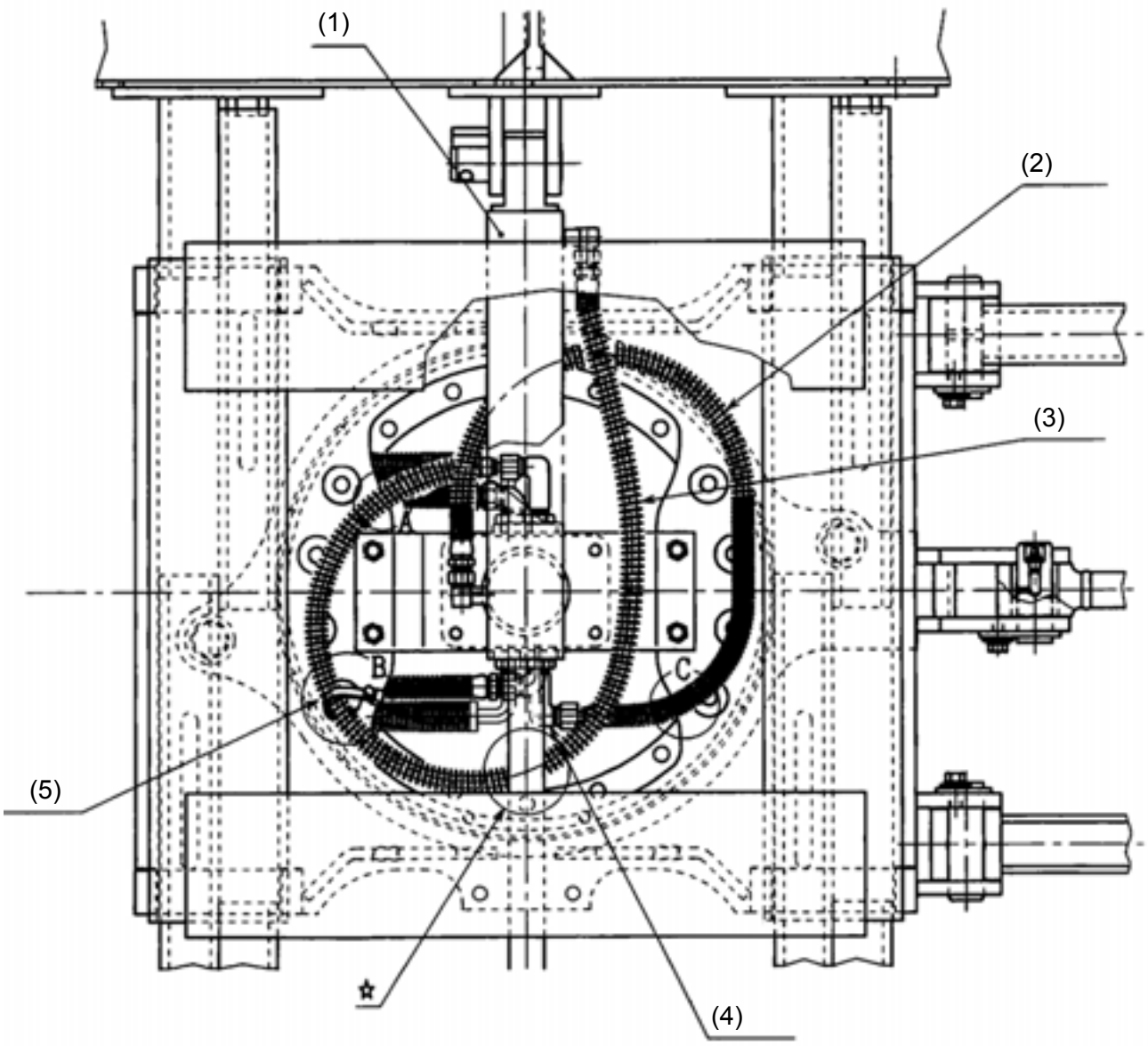
Machine right side



No.	Mounting Position	Q'ty	Dimension (mm)	
(1)	Rotary joint (i) ~ Travel motor left A	1	750	
	Rotary joint (b) ~ Travel motor left B	1	750	
	Rotary joint (f) ~ Travel motor right B	1	750	
	Rotary joint (e) ~ Travel motor right A	1	750	
(2)	Rotary joint (g) ~ Travel motor left PP	1	780	white x 1
	Rotary joint (g) ~ Travel motor right PP	1	780	white x 1
(3)	Rotary joint (d) ~ Travel motor left DR	1	740	
	Rotary joint (d) ~ Travel motor right DR	1	740	
(4)	Rotary joint (b) ~ Relay	1	310	
	Rotary joint (c) ~ Relay	1	310	
(5)	Rotary joint (b) ~ Relay	1	310	
	Rotary joint (c) ~ Relay	1	310	
(6)	Relay ~ Dozer cyl. rod	1	930	
(7)	Relay ~ Dozer cyl. rod	1	660	

4. Route of Hose (Truck Cylinder Hose)

As viewed from below the truck frame

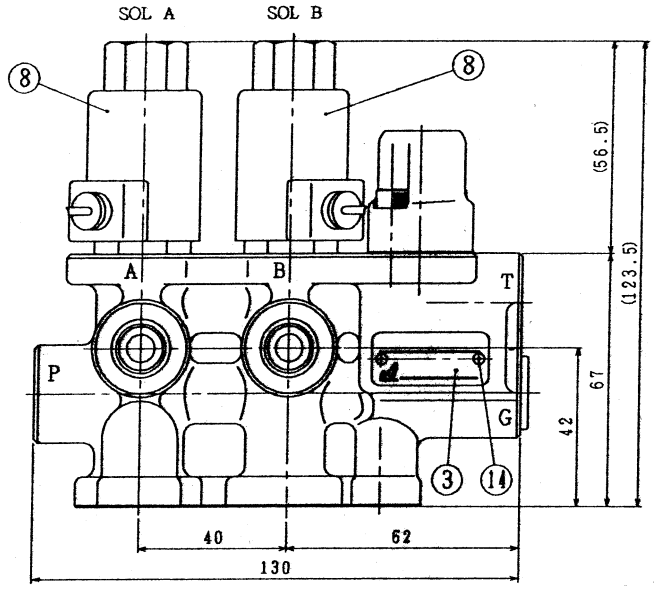


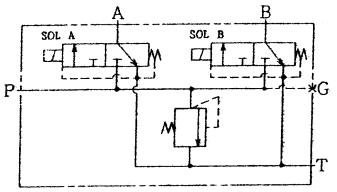
(1) Truck cylinder
(2) To cyl. rod side
(3) To cyl. bottom side
(4) Adjust the angle of the adaptor and secure the clearance between the plate of C and the hose to be more than 1 mm and less than 10 mm.
(5) Clamp the hose at this position by vinyl tape.
(Secure more than 1 mm clearance between the retractable cylinder and the rod. (☆))

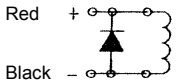
h. Unload valve

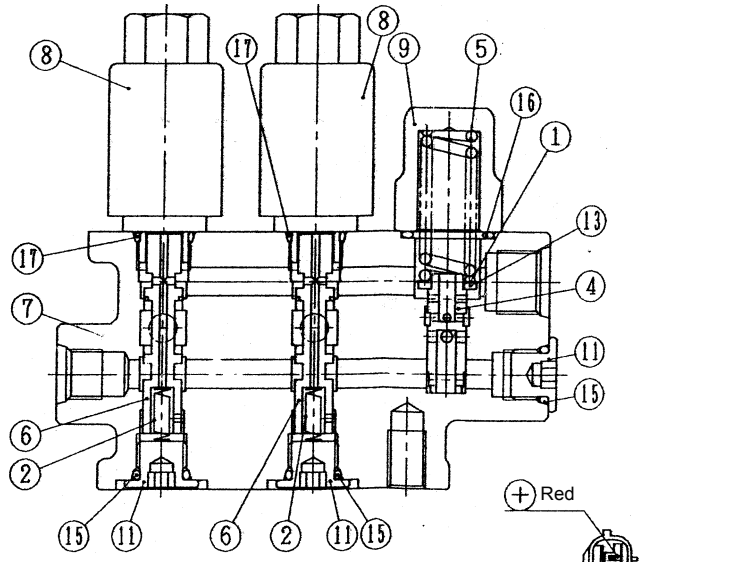
1. Structure

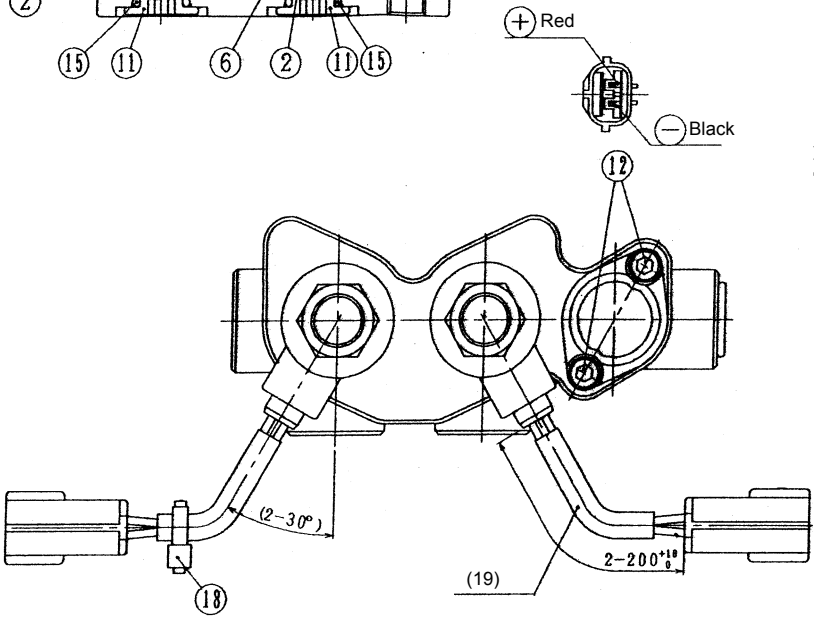
Maker : Nishina









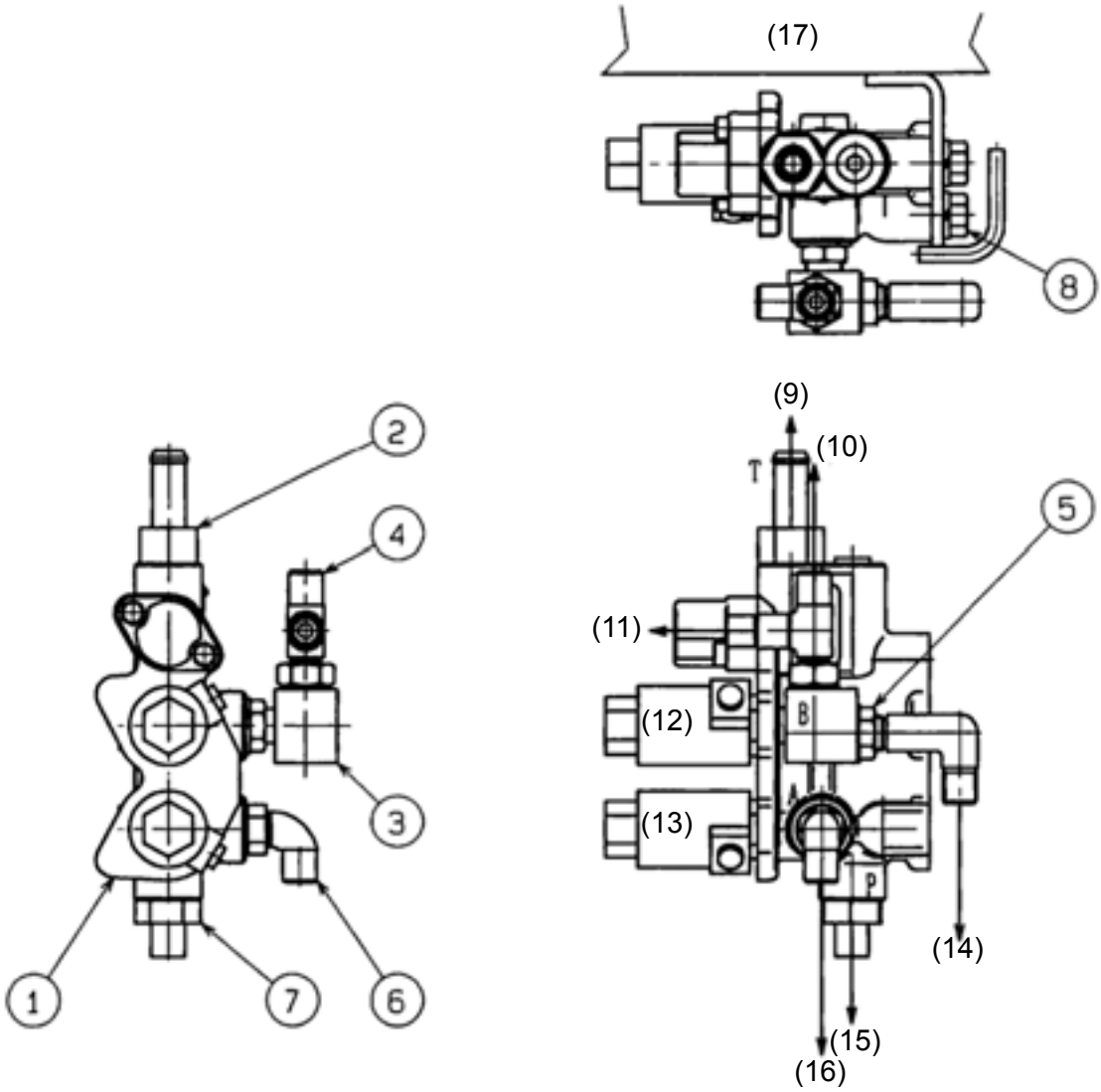


(1)	Shim	(11)	Plug
(2)	spring	(12)	Hollow bolt
(3)	Name plate	(13)	Washer
(4)	Plunger	(14)	Screw
(5)	Spring	(15)	
(6)	Spool	(16)	O-ring
(7)	Body	(17)	
(8)	Solenoid	(18)	Cable clamp
(9)	Cover	(19)	Protection tube

2. Specifications

(1)	Allowable voltage:	DC 10.8 ~ 14.4V
(2)	Current:	1.2 A at 20 °C
(3)	Power consumption:	14.4W
(4)	Coil resistance:	Approx. 10 Ω at 20 °C
(5)	Insulation:	JIS C 4003 H
(6)	Surge killer:	Diode
(7)	Relief valve set pressure:	$3.9^{+0.2}_{0}$ MPa ($40^{+0.2}_{0}$ kgf/cm^2) at 6l/min
(8)	Cracking pressure:	3.4 MPa (35kgf/cm^2) at 2l/min
(9)	Valve pressure loss:	p → A, B 0.5 MPa (5.1 kgf/cm^2) or less at 6l/min
(10)	Port size:	A, B, G = G 1/4 P, T = G 3/8 (JIS B2351 O - type)

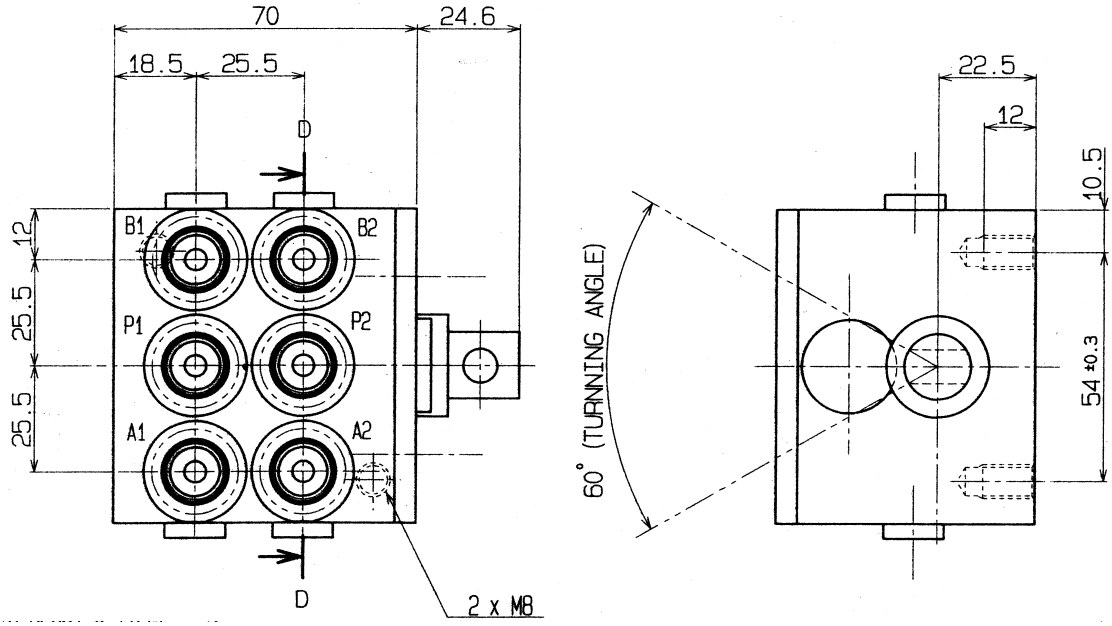
3. Adaptor installation

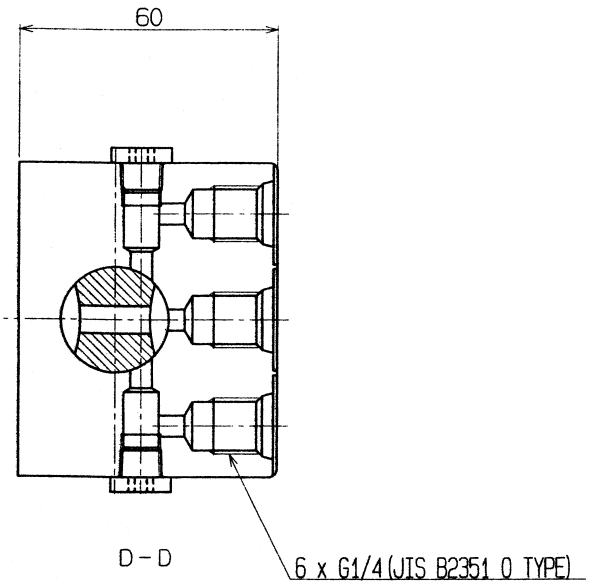


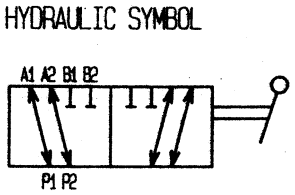
No.	Part Name	Q'ty	Remarks	No.	Part Name
(1)	Valve, assembly (Unloading)	1		(9)	Tank cover
(2)	Straight pipe joint (Drain)	1	T	(10)	PV · Right side P
	O-ring	1	For G3/8 P	(11)	PV · Left side P
(3)	Pipe joint (L. G1/4-G1/4)	1	B	(12)	Unloading
(4)	T-pipe joint (F2)	1	B	(13)	2-speed
(5)	Shouldered elbow	1	B	(14)	CV · Pp
	O-ring	1	For G1/4 A	(15)	Pump · P4
(6)	Pipe joint (L. G1/4-G1/4)	1	A	(16)	Swivel joint · 2-speed signal (G)
(7)	Straight pipe joint	1	P	(17)	Hydraulic oil tank
	O-ring	1			
(8)	Bolt	2	M10 x 1.5 7T		

i. Selector valve

1. Structure







2. Function

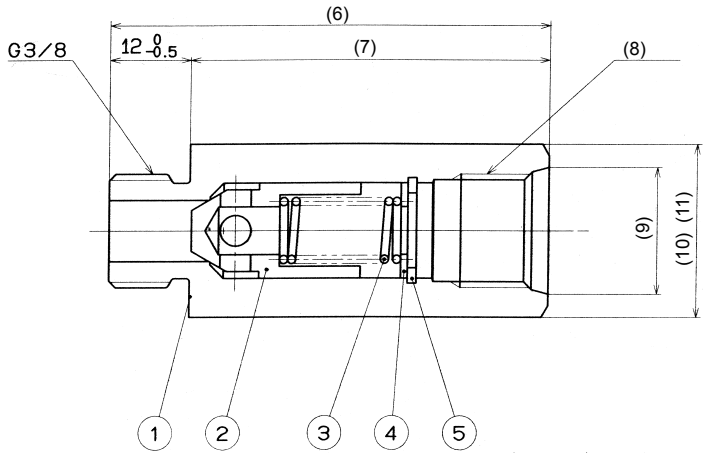
This valve is to select the oil flow direction for blade cylinder or track cylinder.

3. Specifications

1) Operating pressure and flow : Main relief pressure (20.6 MPa) at 10.4 l/min.
2) Inside leakage : 8 cc/min at 20.6 Mpa, 50 °C

j. Accessaries of hydraulic compornents

1. Check valve assy



(1) Shim
(2) spring
(3) Name plate
(4) Plunger
(5) Spring

[mm]

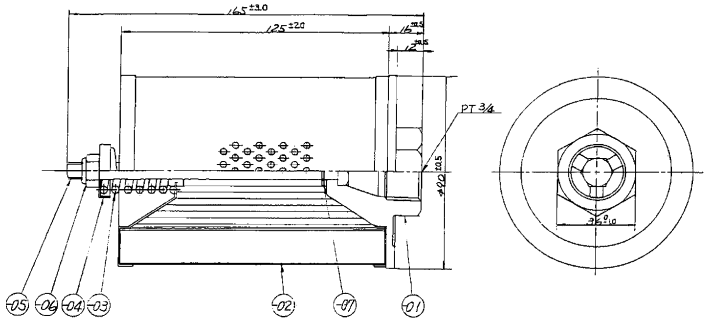
Model	(6)	(7)	(8)	(9)	(10)	(11) HEX
KX36-3 KX41-3 EU KX41-3V	67	55	G 1/2	ϕ26	30.02	27
U15-3	65	53	G 3/8	ϕ18.6	25.4	22

Cracking pressure : 196 ± 29 KPa (2 ± 0.3 kgf/cm^2)
U15-3 : Check valve = RB238-63802

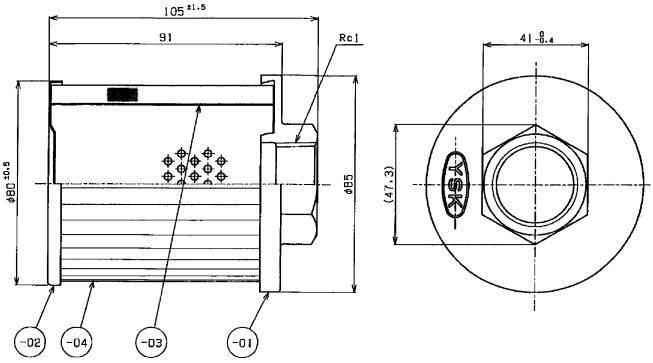
2. Hydraulic filter

Specifications items	Suction filter	Return filter
1.Filtration area	1650 cm^2	3600 cm^2
2.Filtration level	105 μm (150 mesh)	10 μm nominal
3.Oil flow	80 l/min	70 l/min
4.Hex.spanner	41 mm	36 mm
5.Filter dia.	ϕ 85	ϕ 90
6.Filter length	105	125
7.Relief opening pressure		0.1MPa (1.0 ± 0.15 kgf/cm^2)
8.Code number	RB238-62151	RA011-62191

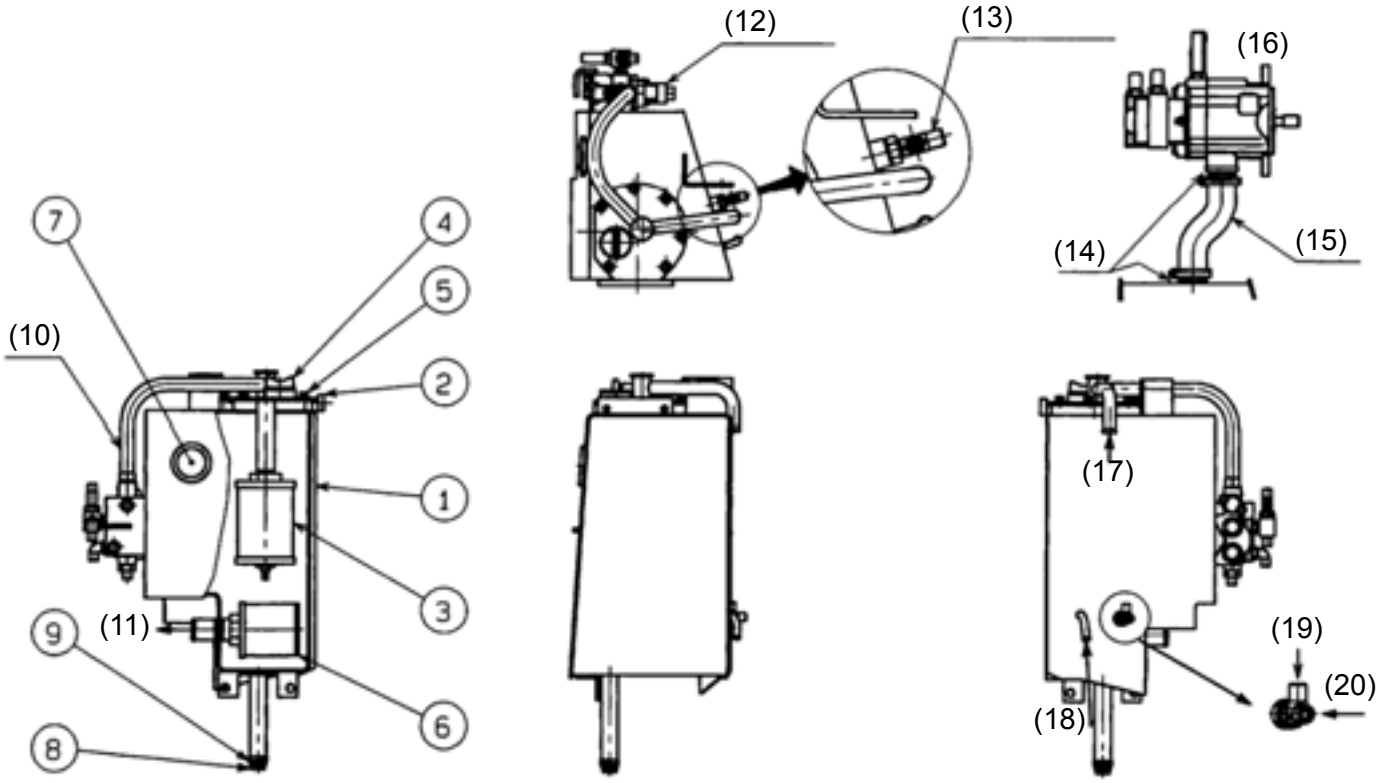
(Return filter)



(Suction filter)

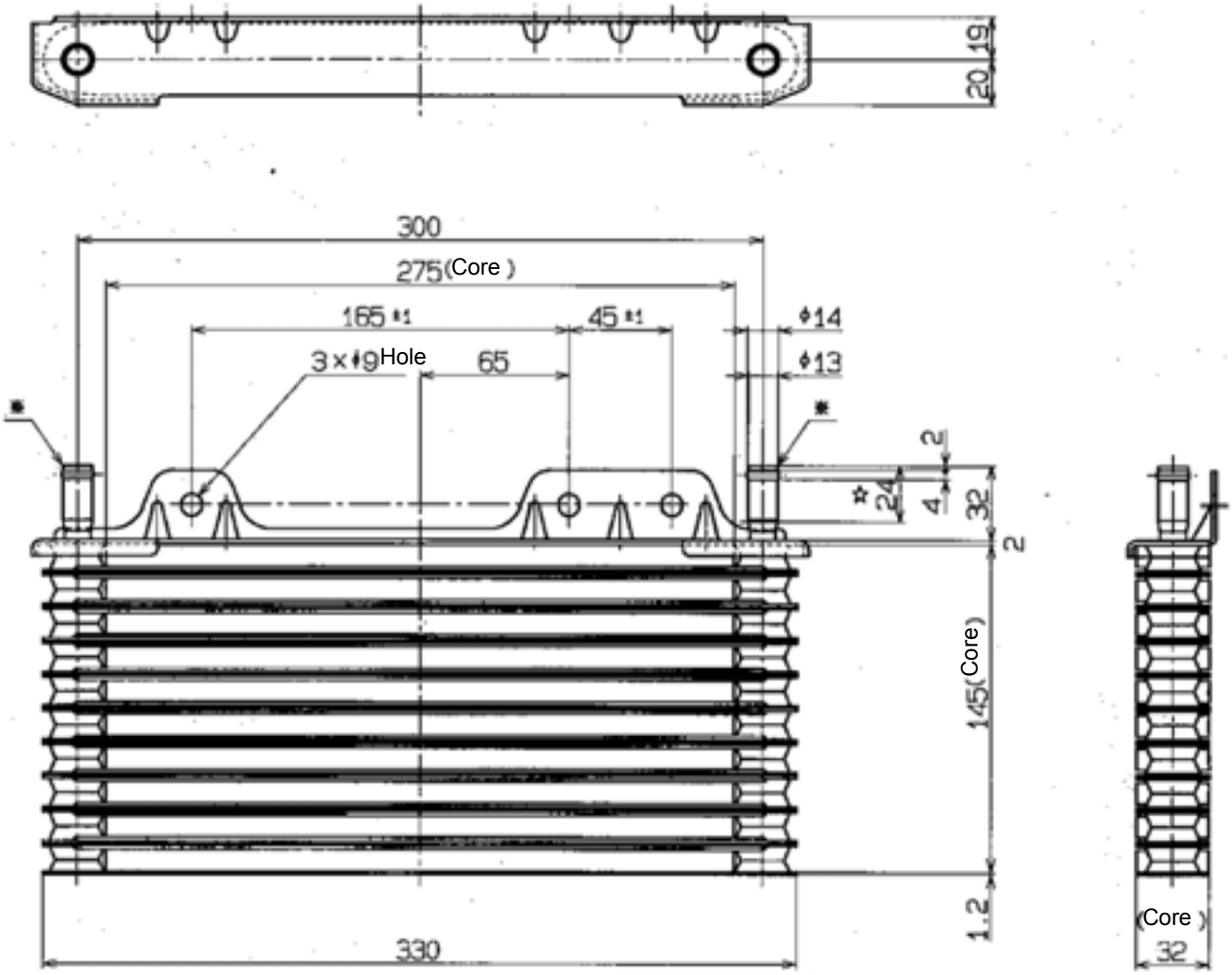


3. Oil Tank



No.	Part Name	Q'ty	No.	Part Name
(1)	Oil tank	1	(10)	Hose (1/2)
(2)	Cover (Tank, return)	1	(11)	Pump
(3)	Filter (Return)	1	(12)	Unloading valve
	O-ring	1	(13)	Direct the pipe joint (F2) as shown in the figure.
(4)	Plug (Oil filler)	1	(14)	Press it securely up to the hilt.
	O-ring	1	(15)	Hose (Suction)
(5)	Bolt	6	(16)	Pump
(6)	Filter (Suction)	1	(17)	Pipe (Return)
(7)	Gauge (Oil level)	1	(18)	Swivel joint · Travel drain
	O-ring	1	(19)	Right PV · T
(8)	Plug	1	(20)	Left PV · T
(9)	Washer with rubber	1		

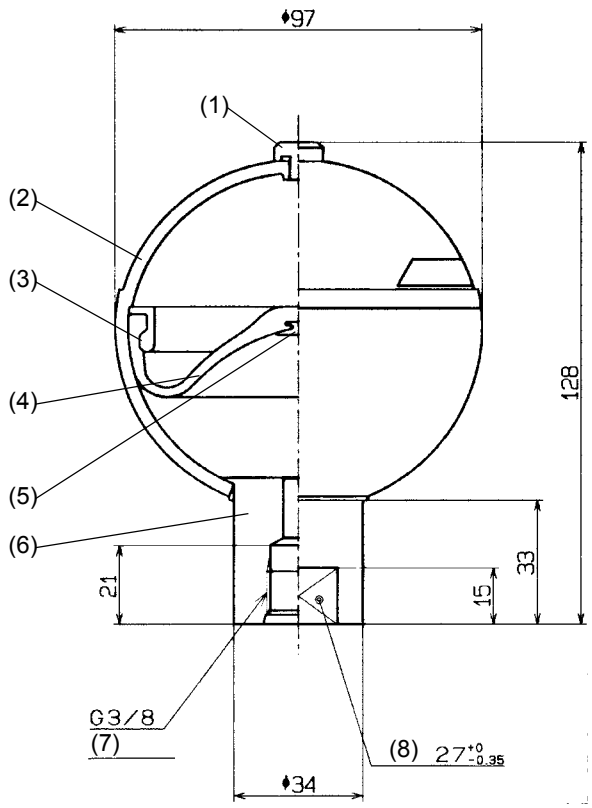
4. Oil cooler



Oil cooler specifications

Div.	Item	Unit	Standard
Performance specifications	Heat radiation	kW (kcal/h)	4.81 (4140)
	Ve=15L/min. Δt=75 °C.to1=110°C		
	Va=8m/s. Vw=-L/mim		
	Oil-side pressure loss	kPa (Kgf/cm^2)	95
	Air-side pressure loss	Pa (mmAq)	118
	Test pressure	kPa (Kgf/cm^2)	981 (10)
	Repeated pressure resistance	kPa (Kgf/cm^2)	981 (10) x 10^5 times
	Static pressure breakdown	kPa (Kgf/cm^2)	2.45 (25)
Structural specifications	Type of core	Drawn-cup type, louver-less, corrugated	
	Core dimensions	275 (W) x 145 (H) x 32 (D) f.p=4.0/2	
	Oil-side radiating area	m^2	0.2228
	Air-side radiating area	m^2	1.1584
	Oil capacity	L	0.22
	Dry weight	kg	0.88
Remarks	Black coating (powder)		

5. Accumlator



(1) Gas plug
(2) Shell
(3) Holder
(4) Bladder
(5) Poppet
(6) Oil port
(7) O - ring type
(8) Across

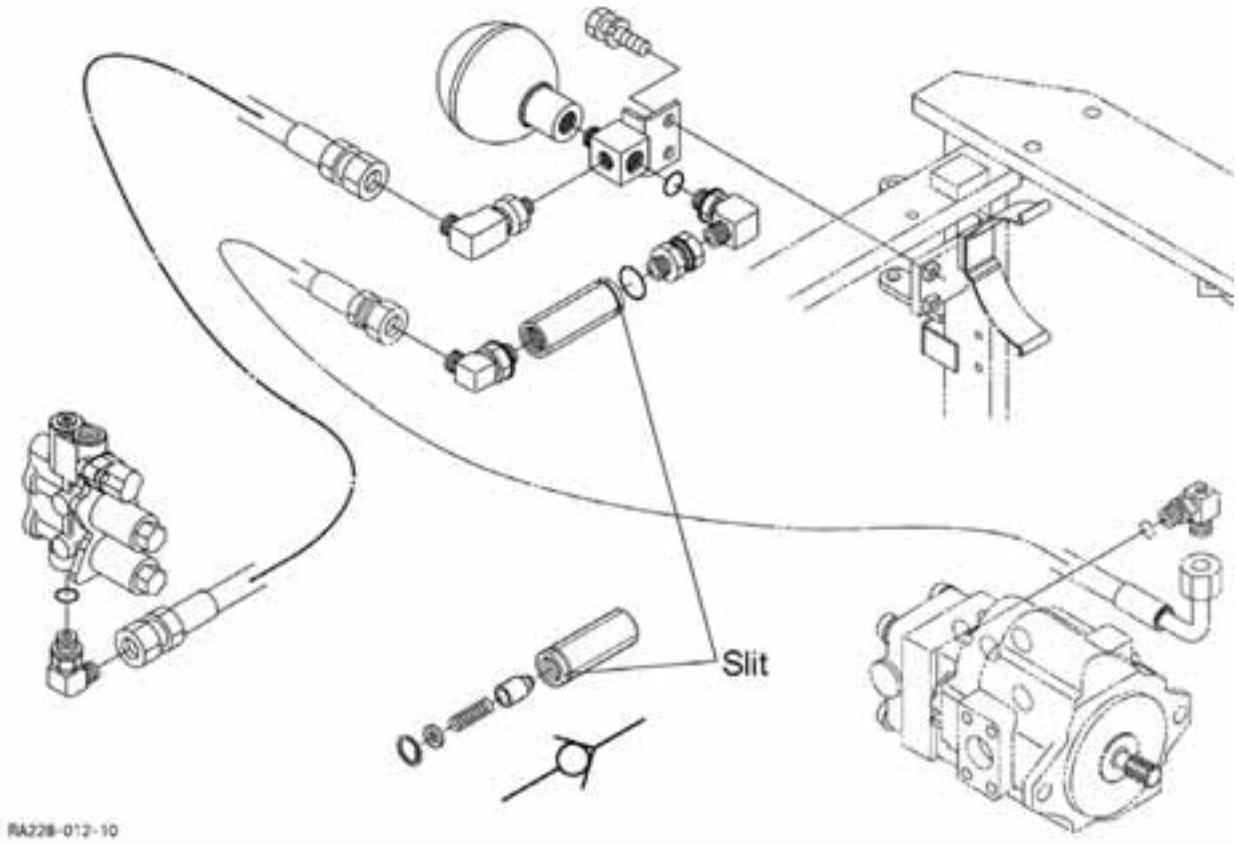
Specs

1. Gas : Nitrogen
2. Gas volume : 300cc
3. Max.operating pressure : 6.9 MPa (70 kgf/m^2)
4. Initial gas pressure : 1.2 MPa (12kgf/m^2) at 20 °C
5. Operating oil temp. : -30 100°C
6. Weight : 1.1 kgf

Machine models used : U15-3, U20-3, U25-3

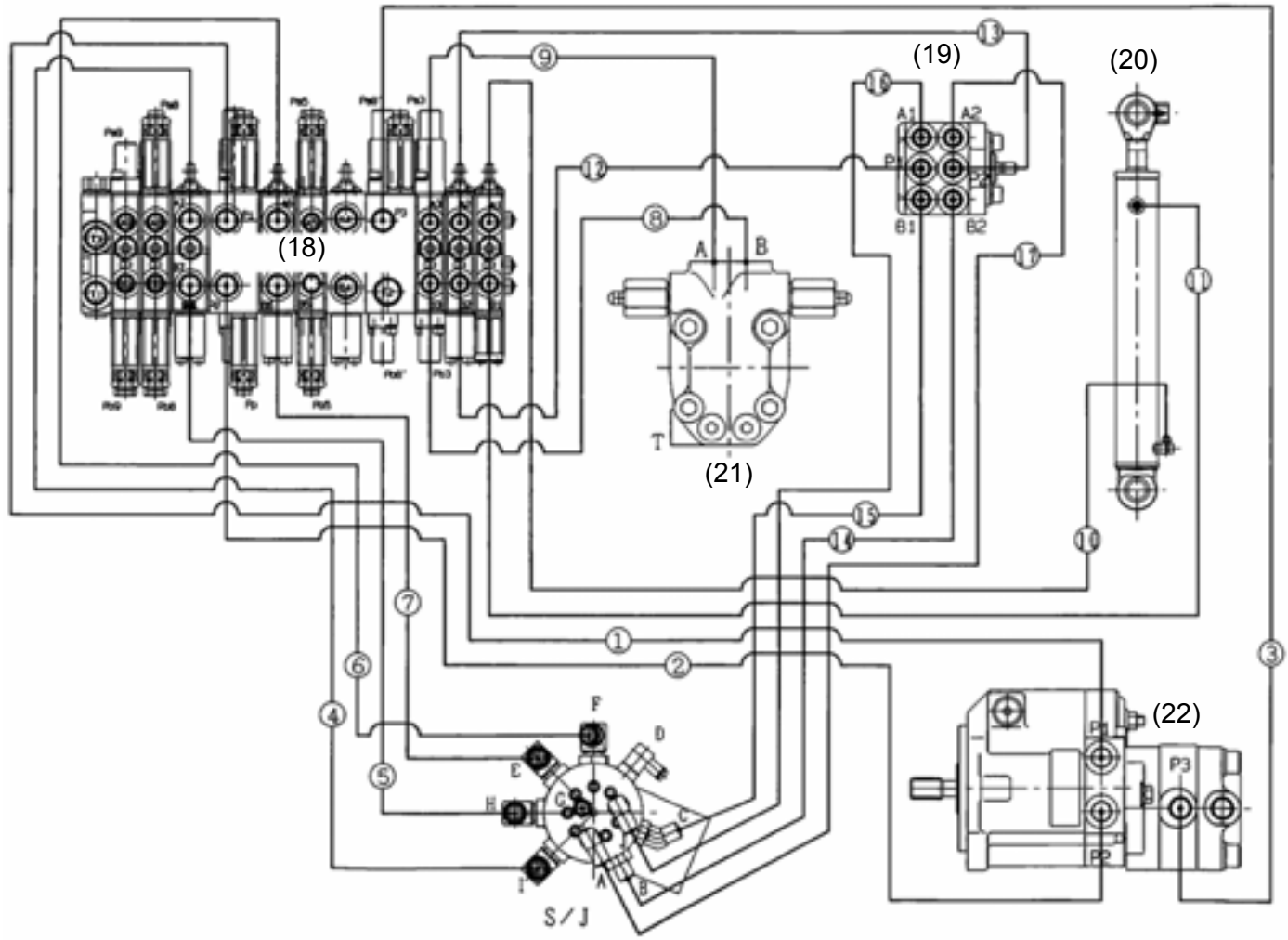
warning

It contains nitrogen under high pressure.
Don't allow fire or heat near it. Don't try to disassemble it.Wear eye protection and carefully drill a holl at the point marked ⊗ to release gas pressure before disposal.



h. Hydraulic system flow

1. Hydraulic Pressure Hose Circuit (High-pressure)

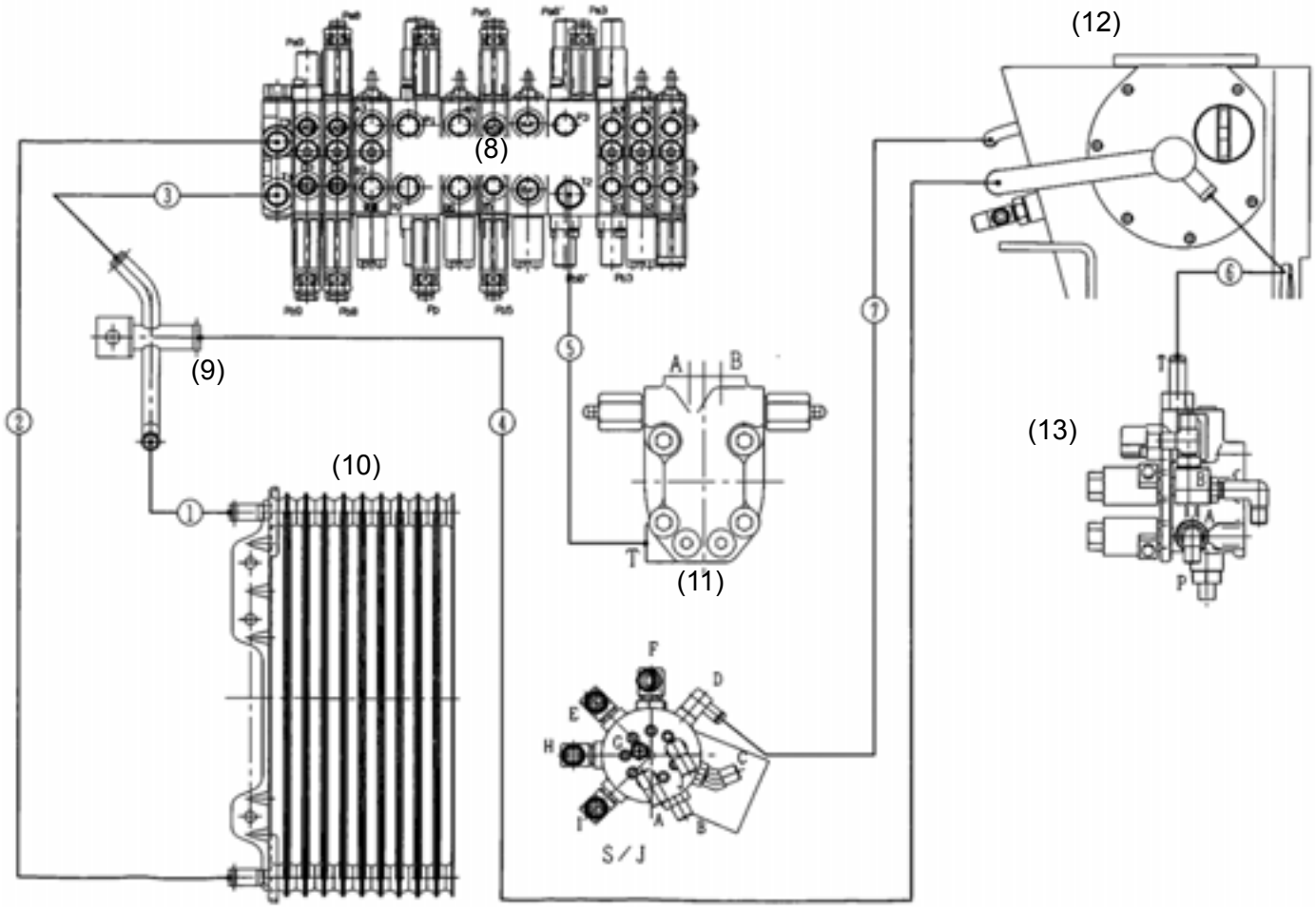


Hoses at upper side

No.	Position for use		Q'ty
(1)	Pump (P1)~CV (P1) White	P1	1
(2)	Pump (P2)~CV (P2) White	P2	1
(3)	Pump (P3)~CV (P3) White	P3	1
(4)	CV (A7)~SJ (I) Yellow	Travel Left Backward	1
(5)	CV (B7)~SJ (H) Green	Travel Left Forward	1
(6)	CV (A6)~SJ (F) Blue	Travel Right Backward	1
(7)	CV (B6)~SJ (E) Red	Travel Right Forward	6
(8)	CV (B3)~Swivel Motor (B) Gray	Swivel Left	1
(9)	CV (A3)~Swivel Motor (A) Light blue	Swivel Right	1
(10)	CV (A1)~Swing cyl. (Bottom) ?	Swing Left	1
(11)	CV (B1)~Swing cyl. (Rod) Orange	Swing Right	1
(12)	CV (B2)~Selector V (P1) Pink	CV dozer raising	1
(13)	CV (A2)~Selector V (P2) Brown	CV dozer lowering	1
(14)	SJ (B)~Selector V (B2)	Dozer raising (Rod)	1
(15)	SJ (C)~Selector V (B1)	Dozer raising (Bottom)	1
(16)	SJ (J)~Selector V (A1)	Truck elongation (Bottom)	1
(17)	SJ (A)~Selector V (A2)	Truck retraction (Rod)	1

No.	Part Name
(18)	Control valve
(19)	Selector valve
(20)	Swing cyl.
(21)	Swivel motor
(22)	Pump

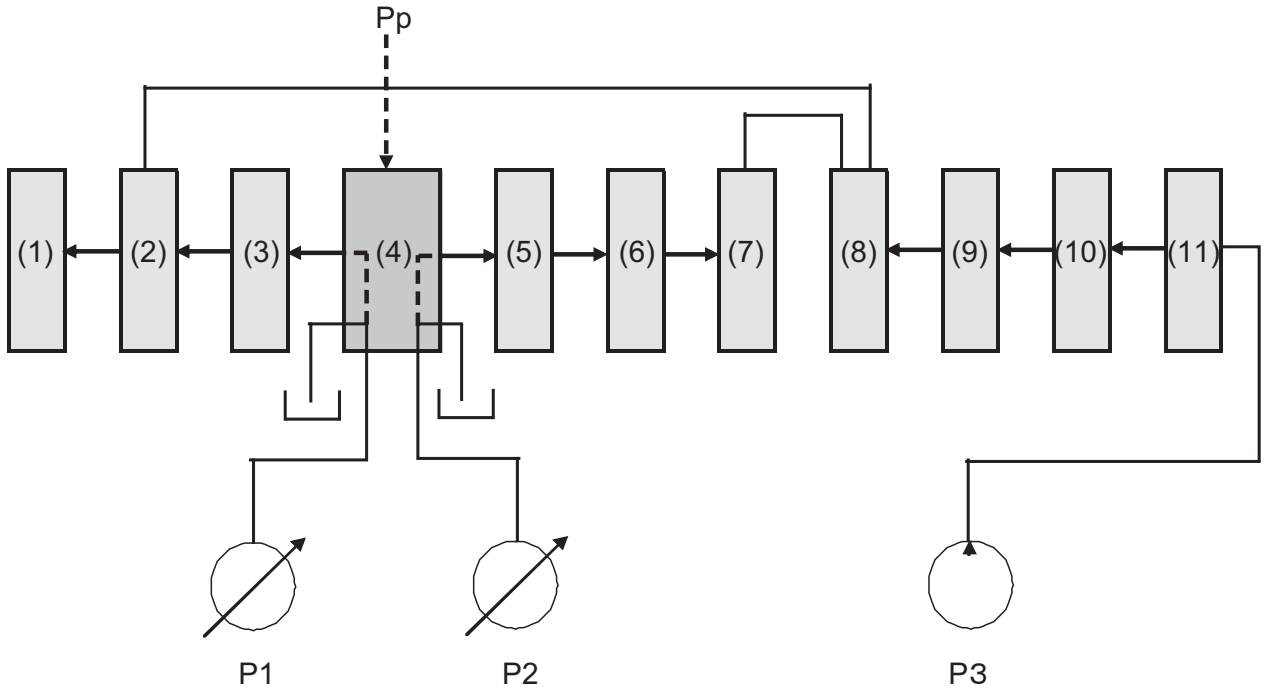
2. Hydraulic Pressure Hose Circuit (Low-pressure)



Low-pressure hoses

No.	Position for use		Q'ty	No.	Part Name
(1)	Pipe return~Oil cooler Front	Oil cooler OUT	1	(8)	Control valve
(2)	CV (T3)~Oil cooler Rear	Oil cooler IN	1	(9)	Return pipe
(3)	CV (T2)~Pipe return	Oil cooler bypass	1	(10)	Oil cooler
(4)	Pipe return~Oil tank	Return	1	(11)	Swivel motor
(5)	Swivel motor (T)~ CV (T1)	Swivel motor drain	1	(12)	Oil tank
(6)	Unloading V (T)~Oil tank	Unloading V return	1	(13)	Unloading valve
(7)	SJ (D)~Oil tank	Travel drain	1		

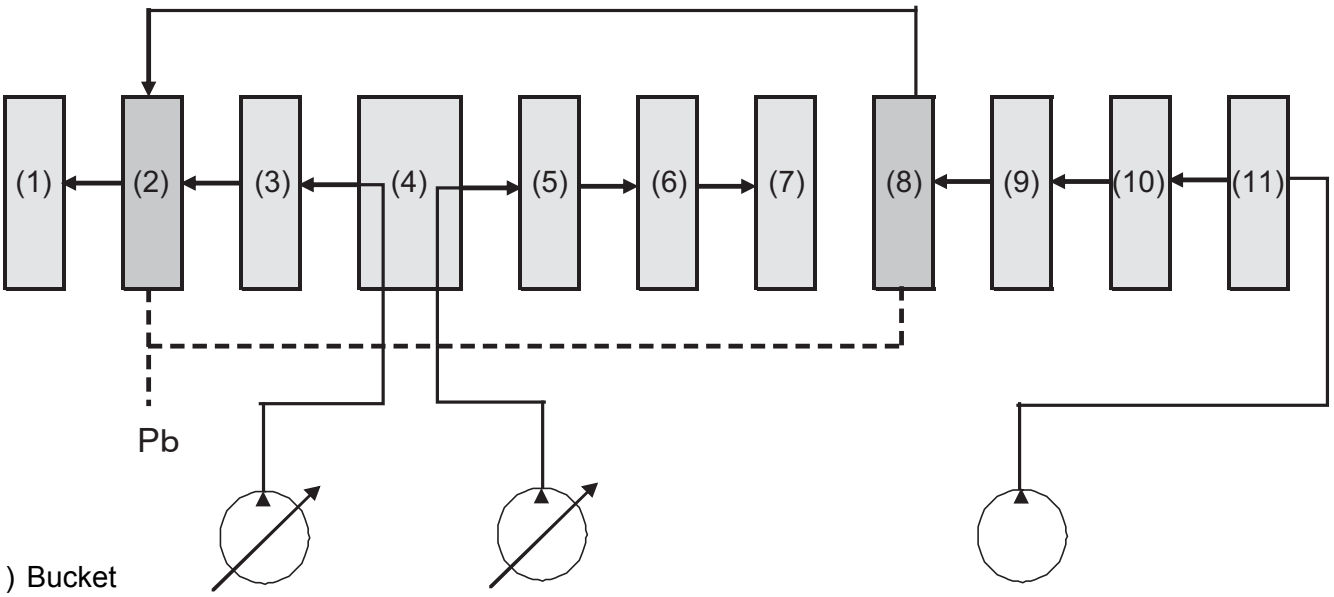
3. Travel Unloading function



(1) Bucket
(2) Boom
(3) Travel Left
(4) Supply
(5) Travel Right
(6) Arm
(7) Service
(8) Confluence
(9) Swivel
(10)Dozer
(11)Swing

With the unload lever being raised, oil of P1 and P2 flows from the supply section directly to the return circuit and results in no functions of P1 and P2 pump, from bucket (1) to service port (7) except pump 3 circuit. When the unload lever is lowered, the supply section opens to supply oil of P1 and P2.

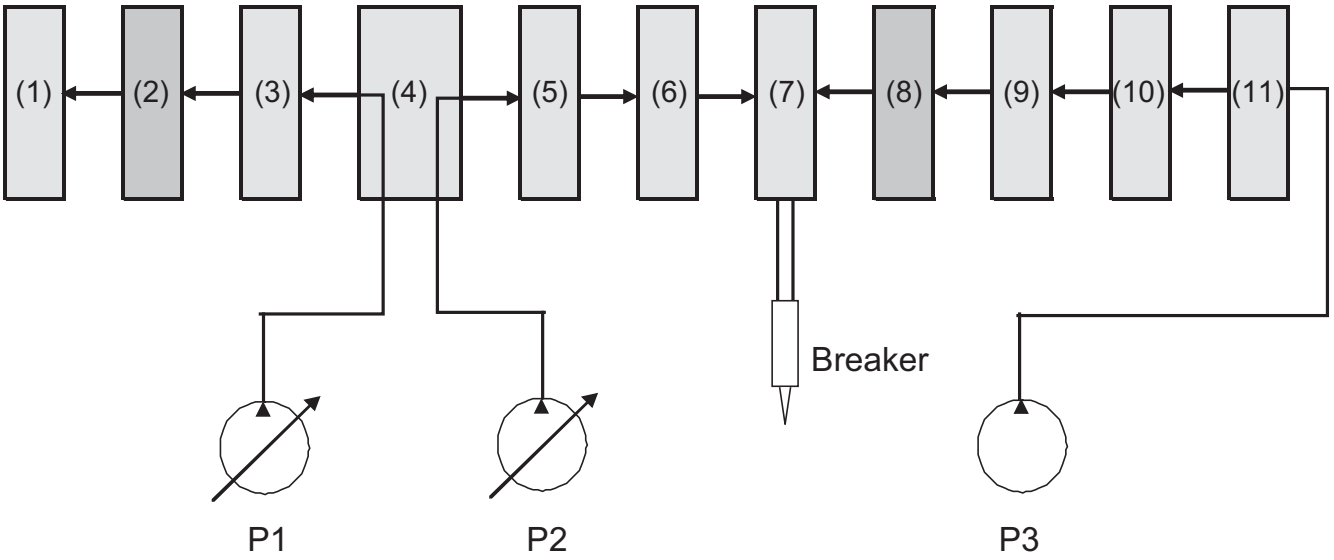
4. Boom Confluence



(1) Bucket
(2) Boom
(3) Travel Left
(4) Supply
(5) Travel Right
(6) Arm
(7) Service
(8) Confluence
(9) Swivel
(10) Dozer
(11) Swing

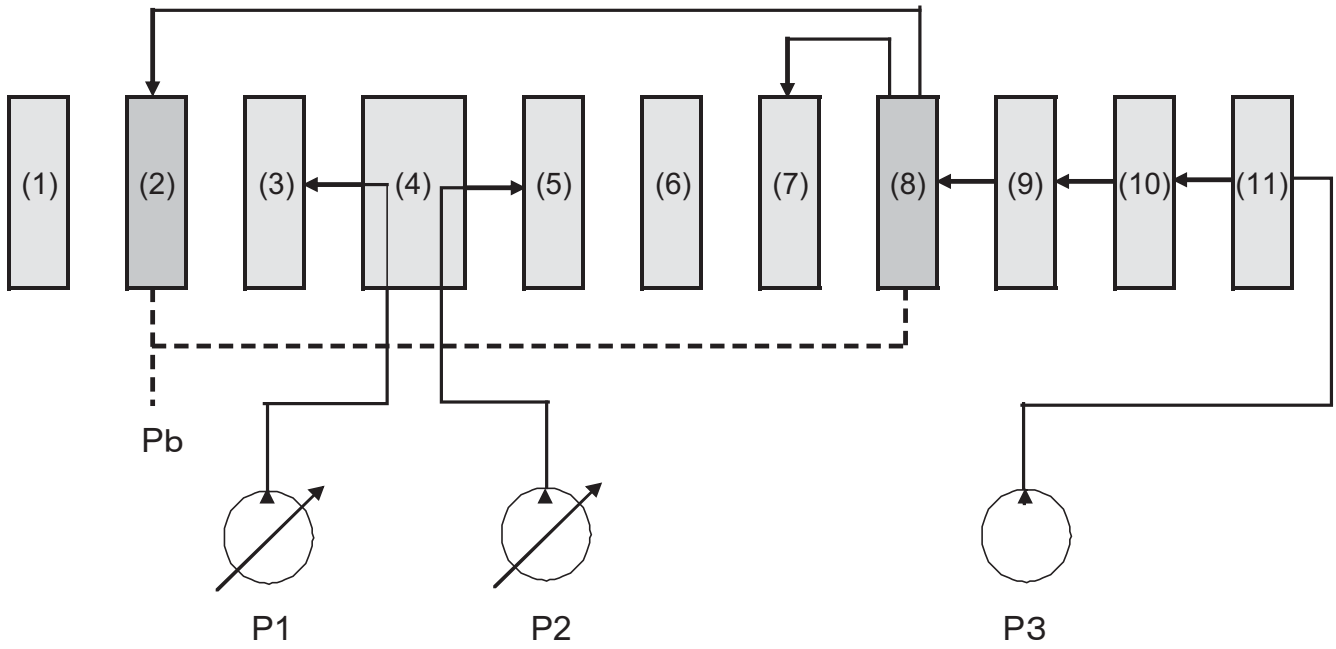
When boom operation is performed, the boom is operated so that the joint valve is switched over to joint P1 and P3.

5. Service port Confluence



When service port pedal is depressed, P2 and P3 pump's oil will be supplied to service port section.

6. Straight Travel Circuit



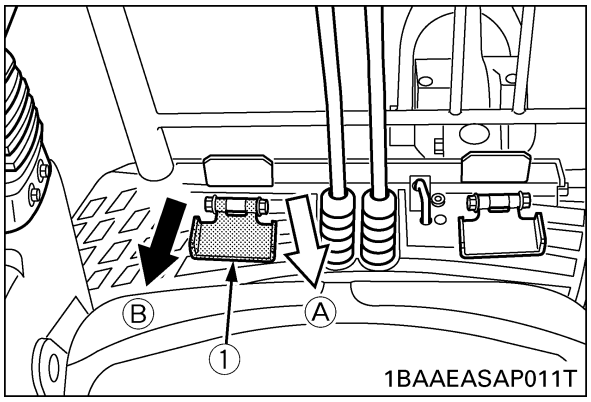
(1) Bucket
(2) Boom
(3) Travel Left
(4) Supply
(5) Travel Right
(6) Arm
(7) Service
(8) Confluence
(9) Swivel
(10) Dozer
(11) Swing

Since only the Boom and Service are jointed with P3, straight travel is possible.
When left and right travel levers are shifted, F or R, P1 supplies oil to the travel motor and P2, to the right motor.
P3 supplies oil to the boom section.
Therefore, only boom and service port operations are possible together with travel function.

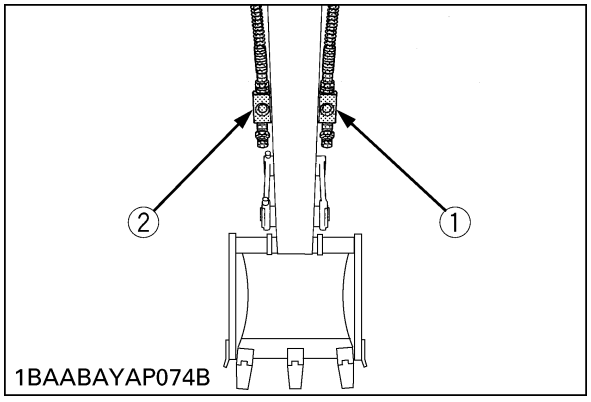
I. Service port system

1. Component layout

This pedal is used to operate attachments such as breakers.



(1) Service port pedal
(A) Sends oil to the port (A)
(B) Sends oil to the port (B)



(1) Port (A)
(2) Port (B)

- Push the right part of the pedal (⇩) to send oil to the port (A).
- Push the left part of the pedal (⬇) to send oil to the port (B).

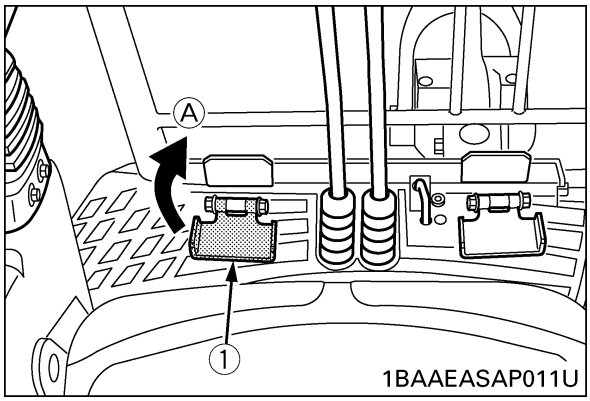
Max. Flow Volume Theoretical L min.	27.0
Max. Pressure MPa (kgf/cm2)	18.6 (190)

IMPORTANT:

- When the service port is not used for a long period, dirt particles can settle in the lower part of the service port lines.
  When the plugs on the service port lines are removed to connect attachments, drain approx. 100 cc of oil per side.
  Concerning the choice of a breaker, contact your dealer.

NOTE:

- When the service port is not in use, fold the service port pedal forward. The pedal gets fixed and can be used as footrest.



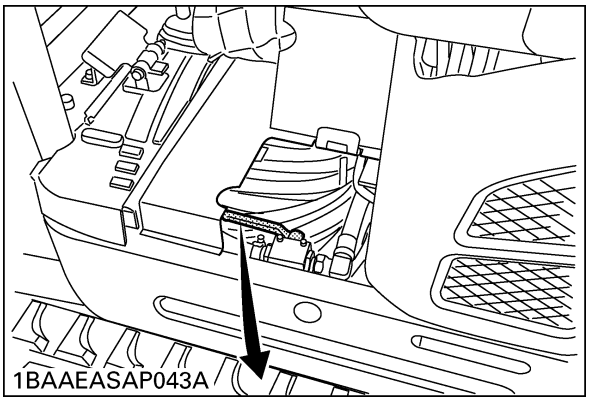
(1) Service port pedal (A) “Fix”

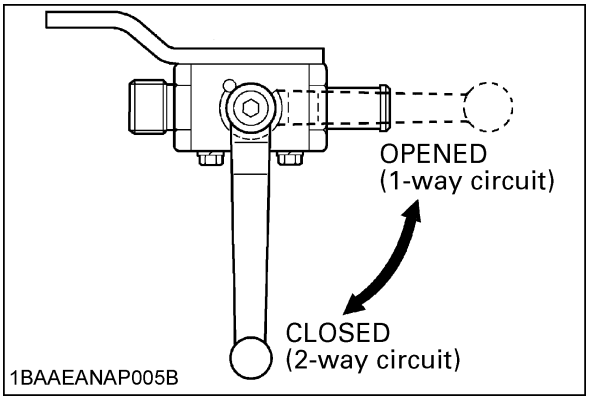
2. 1-way or 2-way valve

The selection valve which select 1-way or 2-way circuit of service port has been installed on the control valve.
When the breaker will be used, position the lever of selection valve to the "OPENED" position (1-way circuit) to reduce the back pressure.

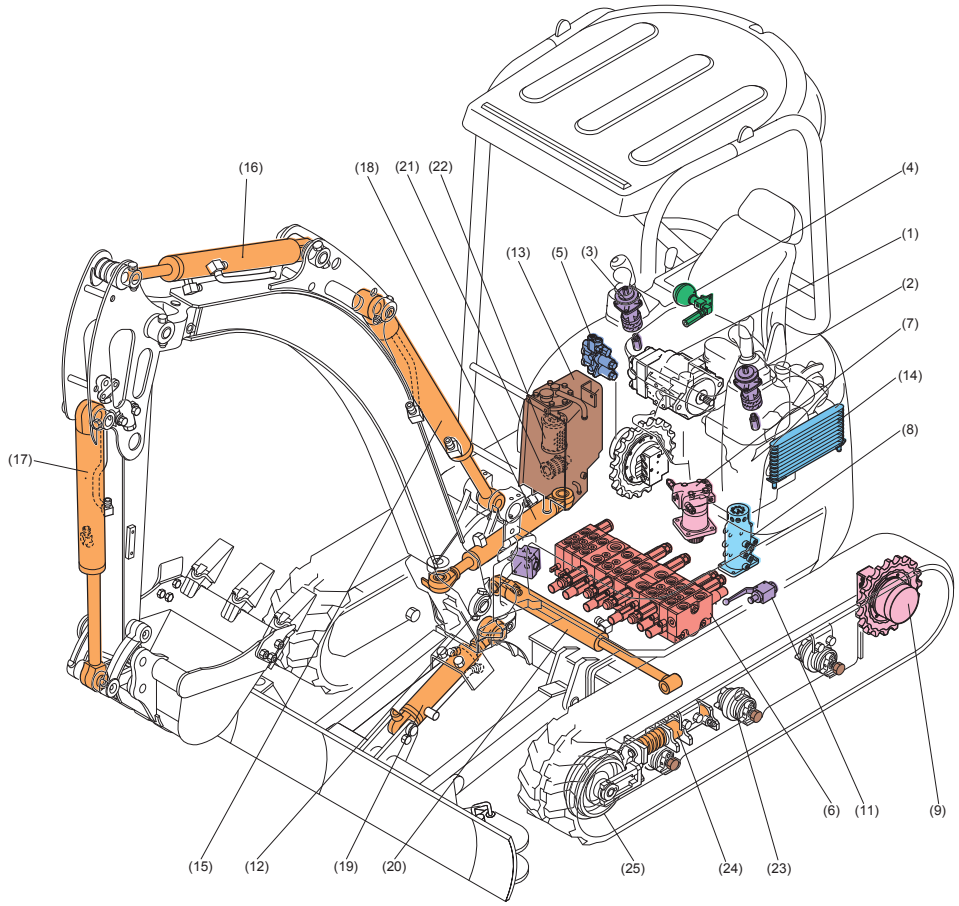
IMPORTANT:

- When the equipment (auger, crusher, telescopic arm, ...), which need 2-way circuit will be used, position the lever to the "CLOSED" position.



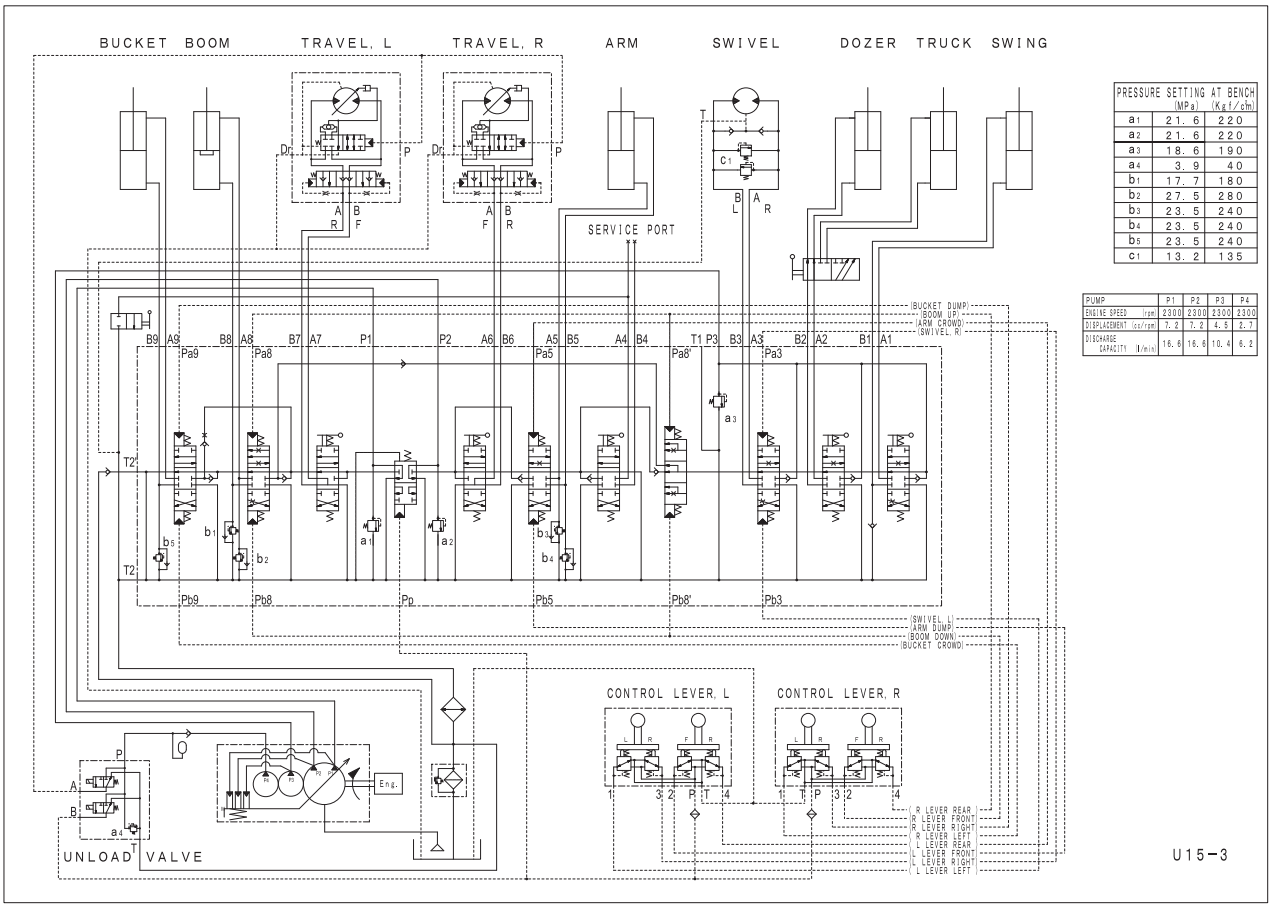


m.Hydraulic components layout : U15-3



No.	PART NAME
1	Main pump
2	Pilot valve, L
3	Pilot valve, R
4	Accumulater
5	Unload valve
6	Control valve
7	Swivel motor
8	Rotary joint
9	Travel motor, L
10	Travel motor, R
11	Change valve for SP (1 way, 2 way)
12	Change valve : Dozer-track
13	Hydraulic oil tank
14	Oil cooler
15	Boom cylinder
16	Arm cylinder
17	Bucket cylinder
18	Swing cylinder
19	Dozer cylinder
20	Track cylinder
21	Suction filter
22	Return filter
23	Track rollers
24	Grease tension cylinder
25	Idler

n. Hydraulic circuit diagram



PRESSURE SETTING AT BENCH

	(MPa)	(Kgf/cm²)
a1	21.6	220
a2	21.6	220
a3	18.6	190
a4	3.9	40
b1	17.7	180
b2	27.5	280
b3	23.5	240
b4	23.5	240
b5	23.5	240
c1	13.2	135

PUMP	P1	P2	P3	P4
ENGINE SPEED rpm	2300	2300	2300	2300
DISPLACEMENT cc/rpm	7.2	7.2	4.5	2.7
DISCHARGE CAPACITY l/min	16.6	16.6	10.4	6.2

E.Electrical system

a. New Functions of Electric System

1. Starter automatic release function

When the key is turned ON, the automatic release relay is excited to rotate the starter.
When the engine is started (the signal from the engine speed sensor exceeds the set value), the automatic release relay is demagnetized to shut down the power to the starter.

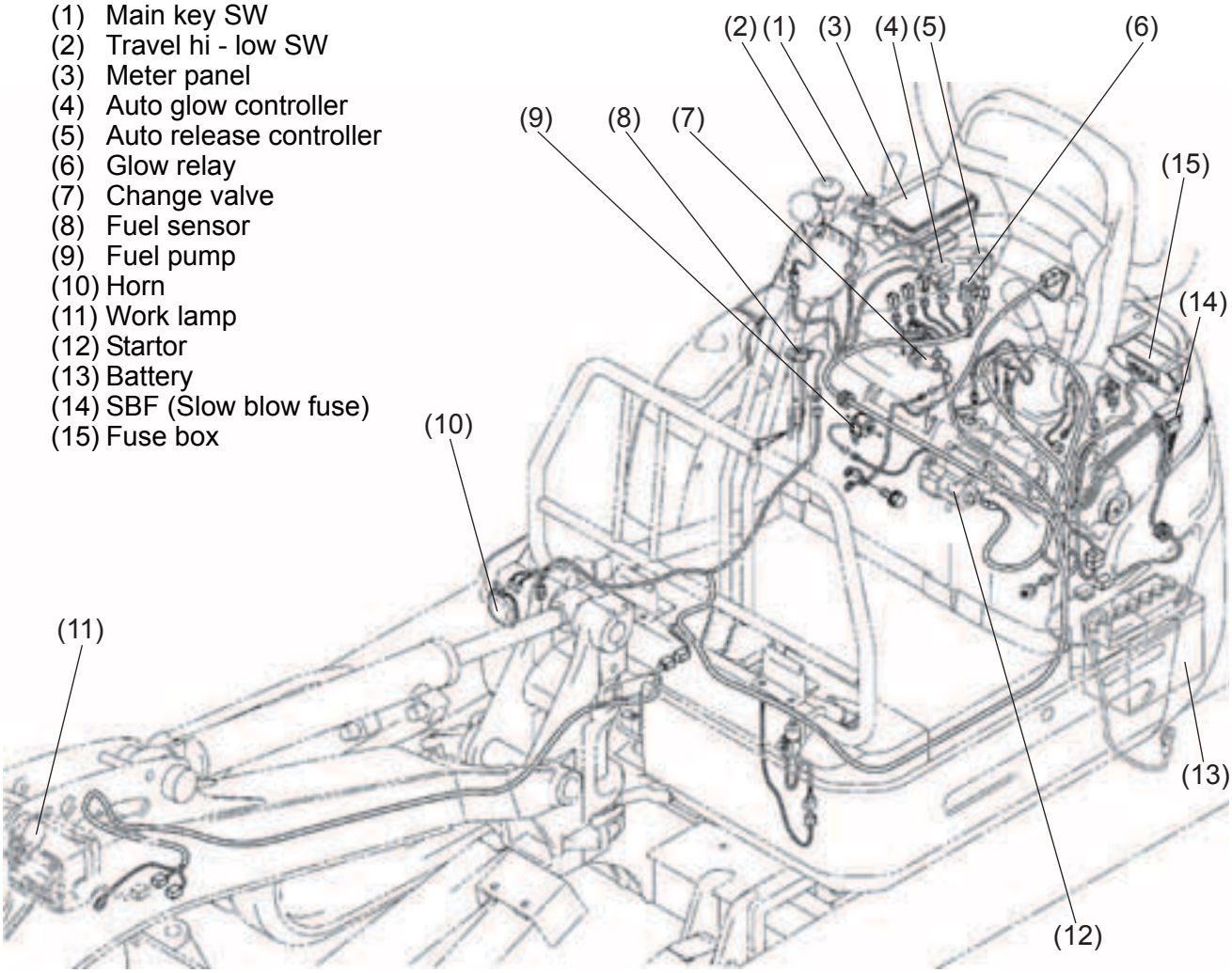
2. Auto-glow

Engine water temperature is detected and the glow plug is pre-heated for the time required for starting the engine.
At the starting position, the glow plug is pre-heated irrespective of water temperature.

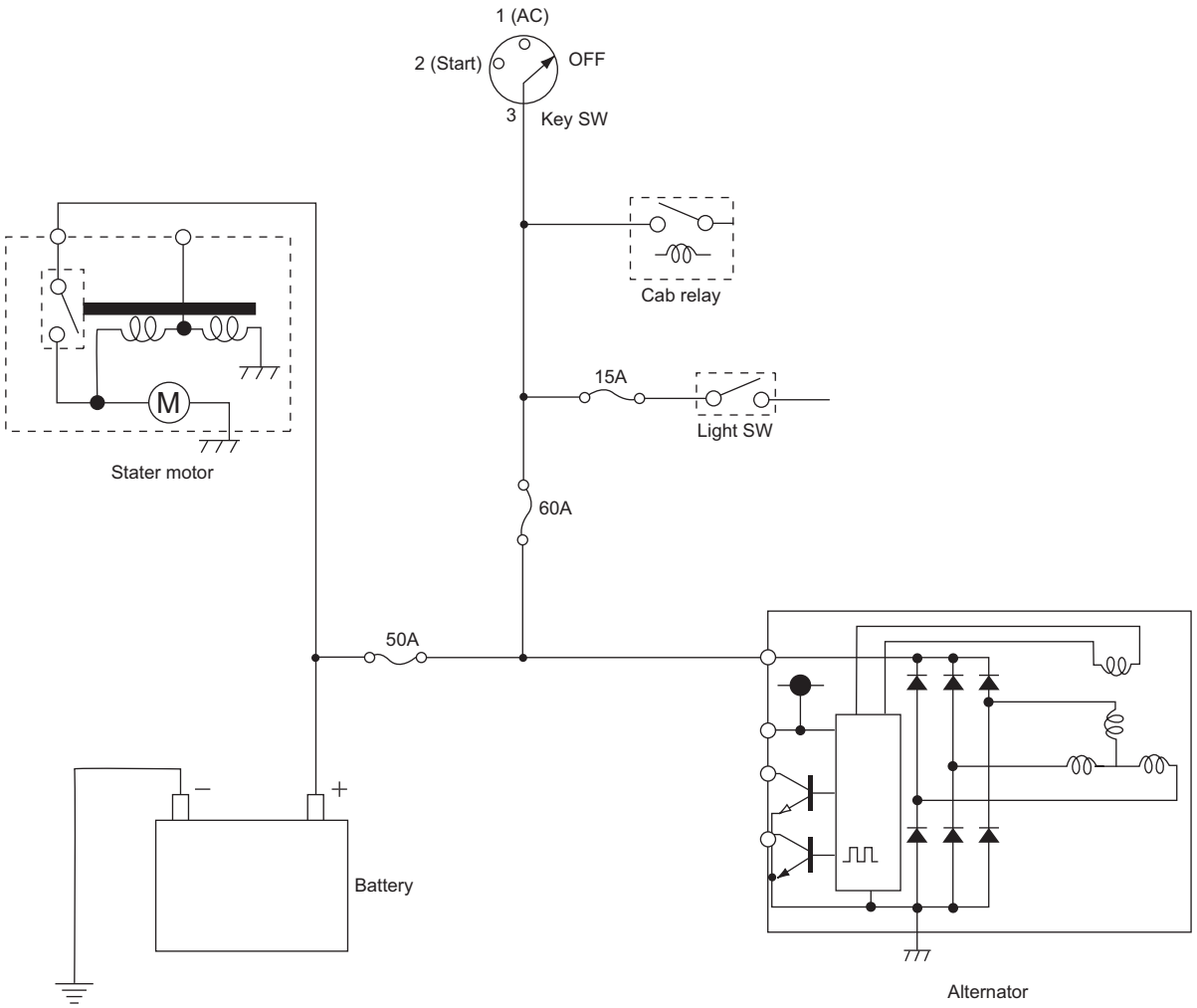
3. Theft-proof Specification

This is different from 3 ton, 4 ton class machines in the following points.
(1) It is not a standard part but specification to be adopted.
(2) Since it has no digital panel, preparation of a key setting panel is needed.
(3) Horn does not sound in emergency.

(1) Main key SW
(2) Travel hi - low SW
(3) Meter panel
(4) Auto glow controller
(5) Auto release controller
(6) Glow relay
(7) Change valve
(8) Fuel sensor
(9) Fuel pump
(10) Horn
(11) Work lamp
(12) Startor
(13) Battery
(14) SBF (Slow blow fuse)
(15) Fuse box

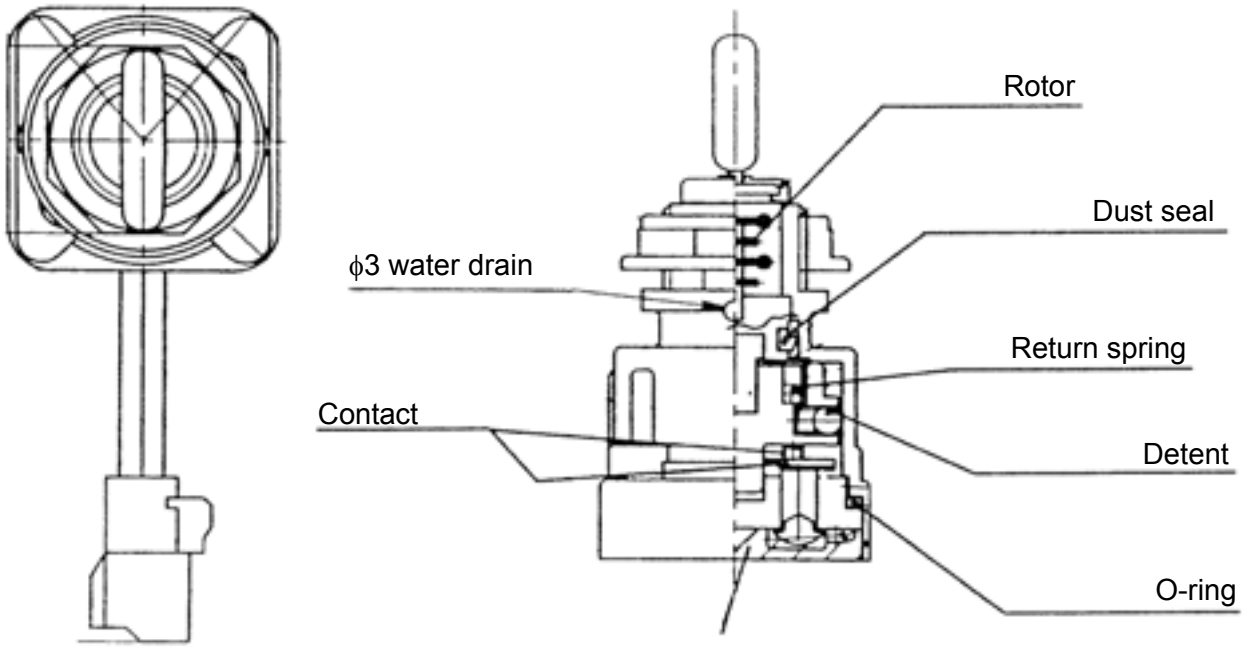


b. Battery circuit



1. Keep in mind that the battery voltage is applied through the above circuit all the time.
2. A 60A fuse is added close to the alternator, otherwise part of the harness may get short-circuited due to the alternator's current generated while the engine is running. In this way, the devices and harness can be protected against burn-out.

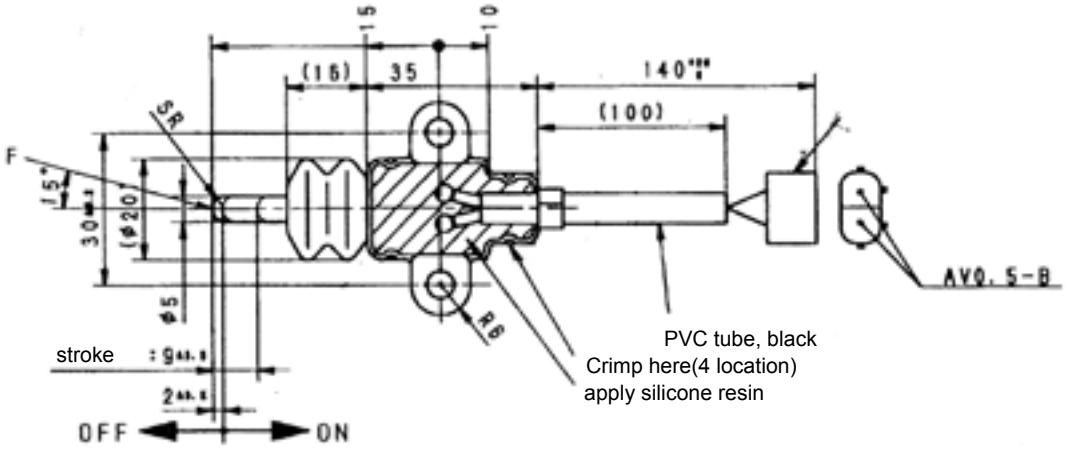
c. Key switch (Engine starter switch)

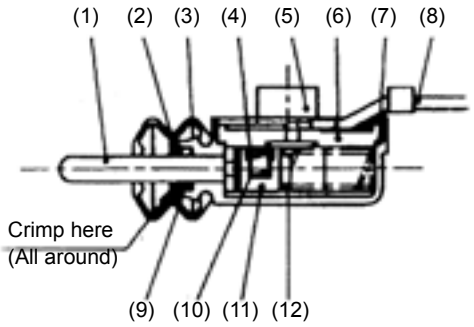


Key position	30	AC	Start
Off	●		
1st : AC position	●	●	
2nd : Start position	●	●	●

d. Safty lever lock switch

Part No.:RC411-53473

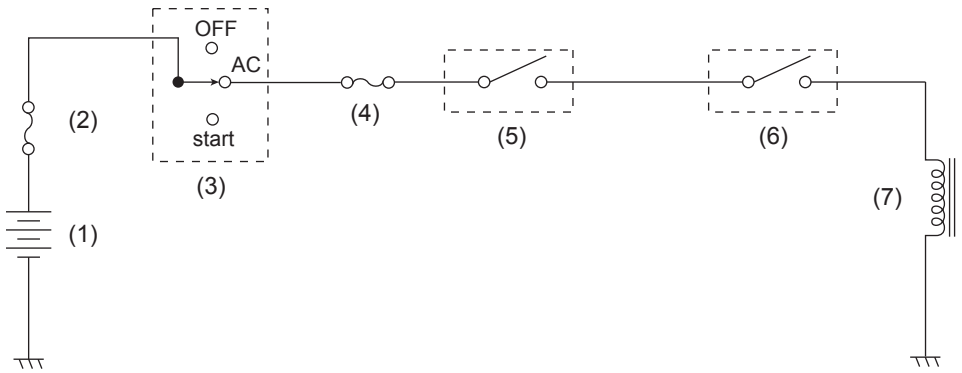




(1) Plunger
(2) Washer
(3) Boot
(4) Contact plate
(5) Body
(6) Base comp.
(7) Packing
(8) Cord
(9) O-ring
(10)Action spring
(11)Roller
(12)Spring

Specifications

1. Rated :DC14V, 1.5A
2. Insulasion :2MΩ or more
3. Operationg force of plunger:
   at Free position =17 ± 3 N
   at Max. stroke =32 ± 4 N
4. Full stroke :9 ± 5 mm



(1) Battery
(2) Fuse, 50A
(3) Key SW
(4) Fuse, 5A
(5) Lever lock SW, R
(6) Lever lock SW, L
(7) Lever lock solenoid

(1) Safety lock valve

(2) Safety lever lock circuit malfunction

1) Check battery voltage at (+) terminal of coupler.
   Check the fuse if no voltage were tested.
   Upper side solenoid valve is for the safety lock circuit.
   Lower one is for the travel hi-low function.

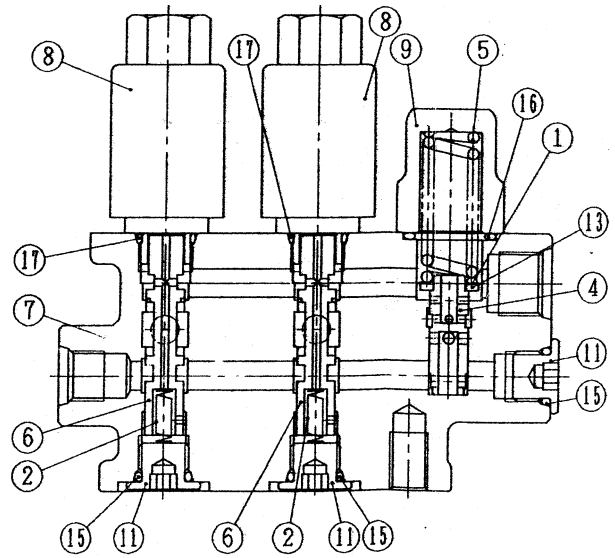
2) Pull the harness to see if the coupler is not out of the lever lock solenoid valve. (Pull by a 3 kg or less force.)
3) Continuity test of corresponding harness are required.
4) Solenoid valve check
   1. Coil resistance test
      Specification: Approx. 10 Ω at 20 °C
      • Shown here is a measurement with digital tester. (Note that the positive (+) and negative (-) connections are reversed with the analog type.)
   2. Coil insulation test
      Specification: Over 1 MΩ
5) Check lever lock switch for continuity by operating the lever and 12V test.

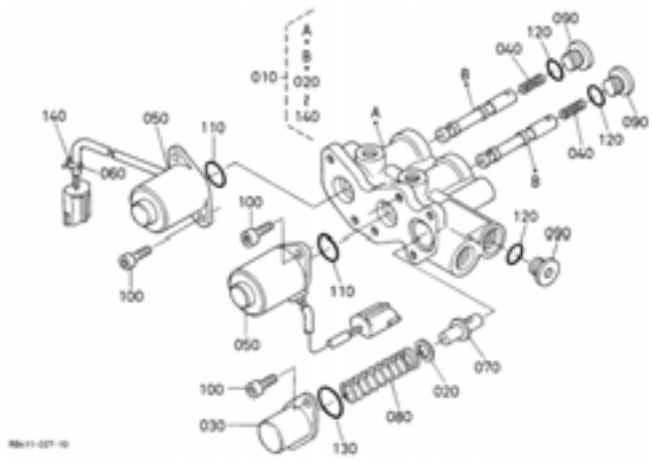

(Continuity test : Lever down)


(Battery 12V test : Key switch is on)

e. Solenoid valve

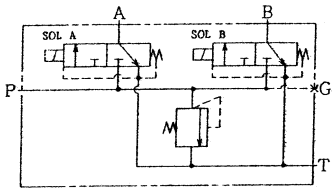
Maker : Nishina

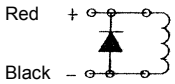




1. Structure

(1)	Shim	(11)	Plug
(2)	spring	(12)	Hollow bolt
(3)	Name plate	(13)	Washer
(4)	Plunger	(14)	Screw
(5)	Spring	(15)	
(6)	Spool	(16)	O-ring
(7)	Body	(17)	
(8)	Solenoid	(18)	Cable clamp
(9)	Cover	(19)	Protection tube



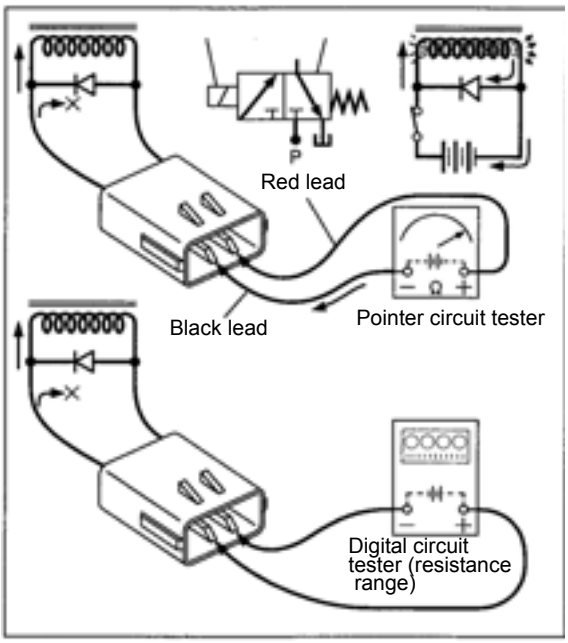


2. Specifications

(1)	Alow voltage:	DC 10.8 ~ 14.4V
(2)	Current:	1.2 A at 20 °C
(3)	Power consumption	14.4 W
(4)	Coil resistance:	Approx. 10 Ω at 20 °C
(5)	Insulation:	JIS C 4003 H
(6)	Surge killer:	Diode
(7)	Relief valve set pressure:	$3.9^{+0.2}_{0}$ MPa ($40^{+0.2}_{0}$ kgf/cm^2) at 6l/min
(8)	Cracking pressure:	3.4 MPa (35kgf/cm^2) at 2l/min
(9)	Valve pressure loss:	p → A, B 0.5 MPa (5.1 kgf/cm^2) or less at 6l/min
(10)	Port size:	A, B, G = G 1/4 P, T = G 3/8 (JIS B2351 O - type)

E : Electromotive force generated in coil (N)
N : No. of turns of coil
$\frac{d\phi}{dt}$:Rate of magnetic flex (ϕ) variation in short interval (dt second)

$$E = N \cdot \frac{d\phi}{dt}$$

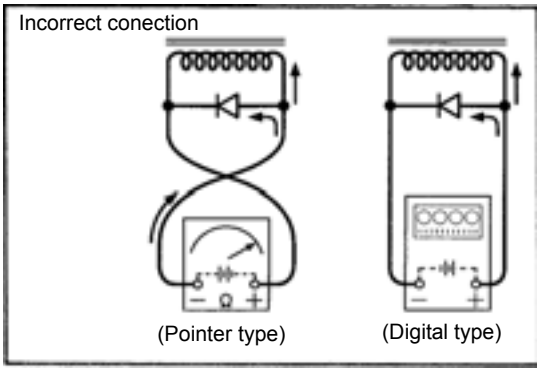


3. Solenoid test method

Solenoid continuity test procedure (In case of diode incorporafed.)

Connect the black and red leads to the positive (+) and negative (-) terminals, respectively, of a circuit tester (pointer type). Make sure the coupler is positioned as shown in the figure. In this state, the coil resistance can be measured properly.

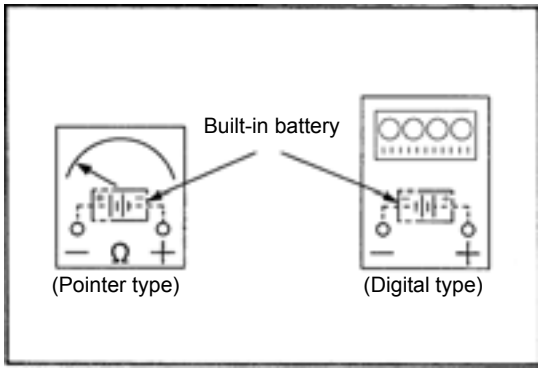
Be careful not to confuse the above connections. If reverse-connected, the measuring current of the circuit tester flows to the diode too and the coil resistance cannot be measured correctly.



[TIPS]

The circuit tester is battery-powered. The battery voltage is applied across the resistor, by which a current flows and the resistance is measured.

The built-in battery's polarities are different between the pointer type and digital type as illustrated below. In measuring the resistance of a diode-fitted coil, make connection between the positive (+) output terminal of the built-in battery and the cathode of the diode.



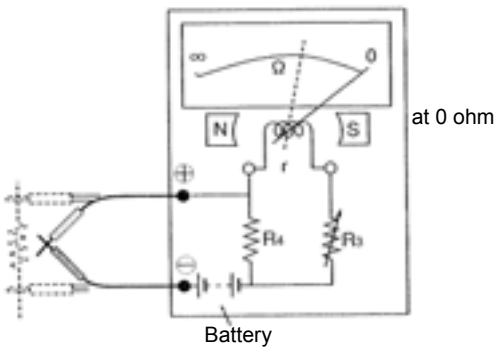


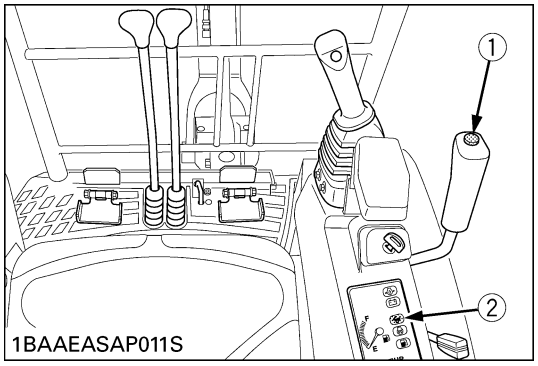
Fig. Ohmmeter principle

1. Construction and principle of circuit tester

Fig. in the left shows the inside of an ohmmeter. The built-in battery provides current through the circuit and makes the pointer swing accordingly. Before measuring a resistance, it is necessary to make 0-ohm adjustment. Bring the tester probes in contact with each other for short-circuiting. By so doing, the variable resistor R3 will be readjusted so that the pointer should swing full-scale, and also the built-in battery's power will be regulated. It should be noted that the measured resistance and the current flowing in the coil are not in proportion to each other. The scale is irregularly spaced. Changing the resistance of resistor R4 allows to adjust the ohmmeter's measuring range.

f. Travel hi-speed control circuit

1. Hi - Low switch and circuit diagram



(1) Travel speed switch
(2) mark

Travel speed will increase when pushing down this switch.

1. Press the travel speed switch. The travel speed changes from first speed to second. The mark lights up.
2. Press the travel speed switch again, and the travel speed changes from second to first. The mark lights out.

NOTE:
Each time the travel speed switch is pressed, the travel speed is switched between first and second.

2. Troubleshooting: Travel hi-speed malfunction

1) Turn the key switch to the ON position to see if 12 V is applied to terminal 2 of the travel hi-speed switch.

2) Press the travel hi-speed switch to see if the 12 V signal comes to terminal 1.

3) Turn on and off the travel hi-speed switch and check the continuity and discontinuity.

4) Check the continuity of the travel hi-speed solenoid coil and measure its resistance.

5) If there is no problem with the above steps, it means the electrical system functions. Now go to the hydraulic system.

6) Possible troubles with the hydraulic system include stuck solenoid spool, poorly performing pilot pump, malfunctioning primary relief valve, stuck Hi-Lo selector spool, etc.

3. Testing Hi - Low SW

1) Location of Hi-Low SW coupler and how to disconnect the coupler.
Small size driver (match-repair driver) is required.

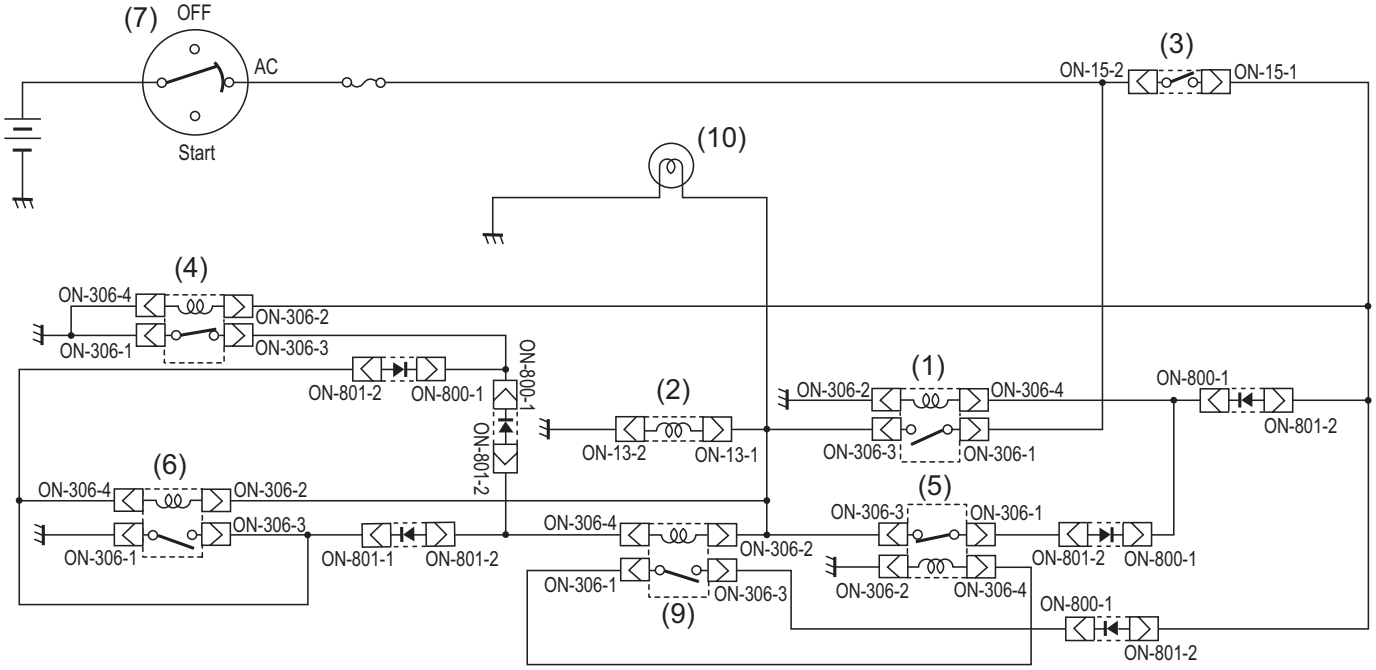
2) Check battery 12V.

3) Check continuity of the switch.

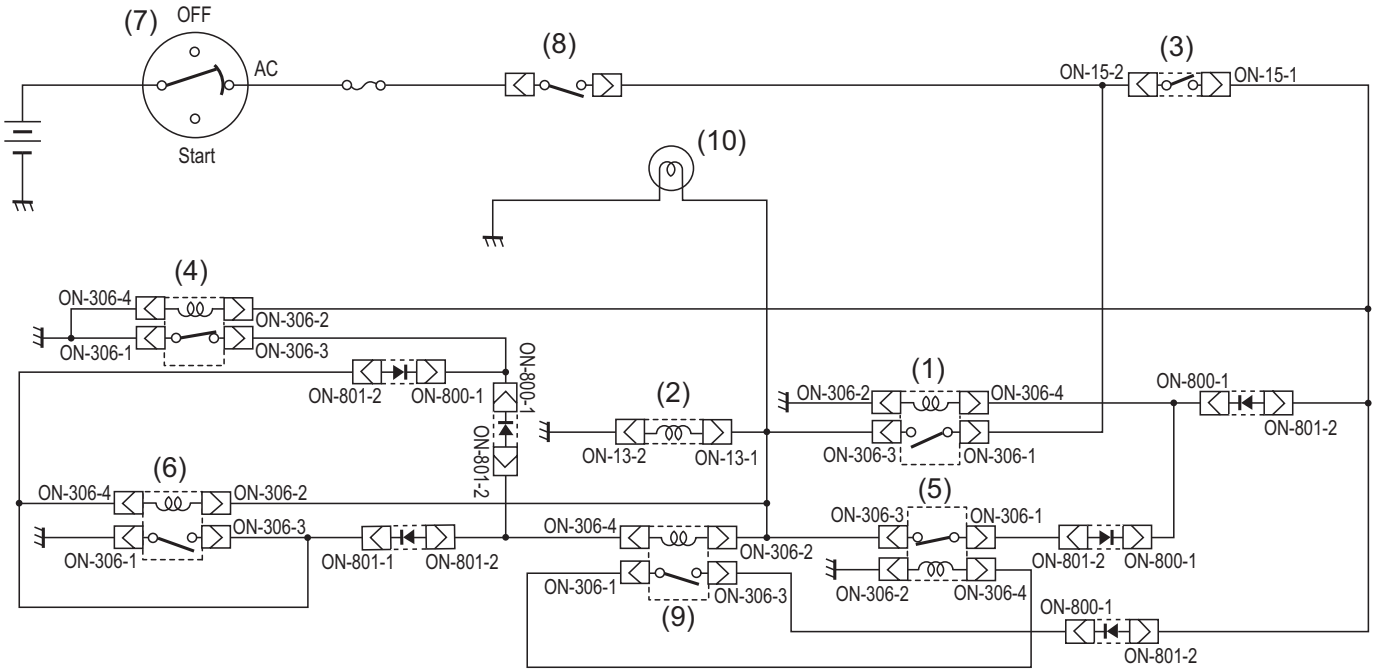
4) Testing Hi-Low solenoid coil resistance.

4. Hi - Low self hold circuit

1) Lever lock SW isn't linked.

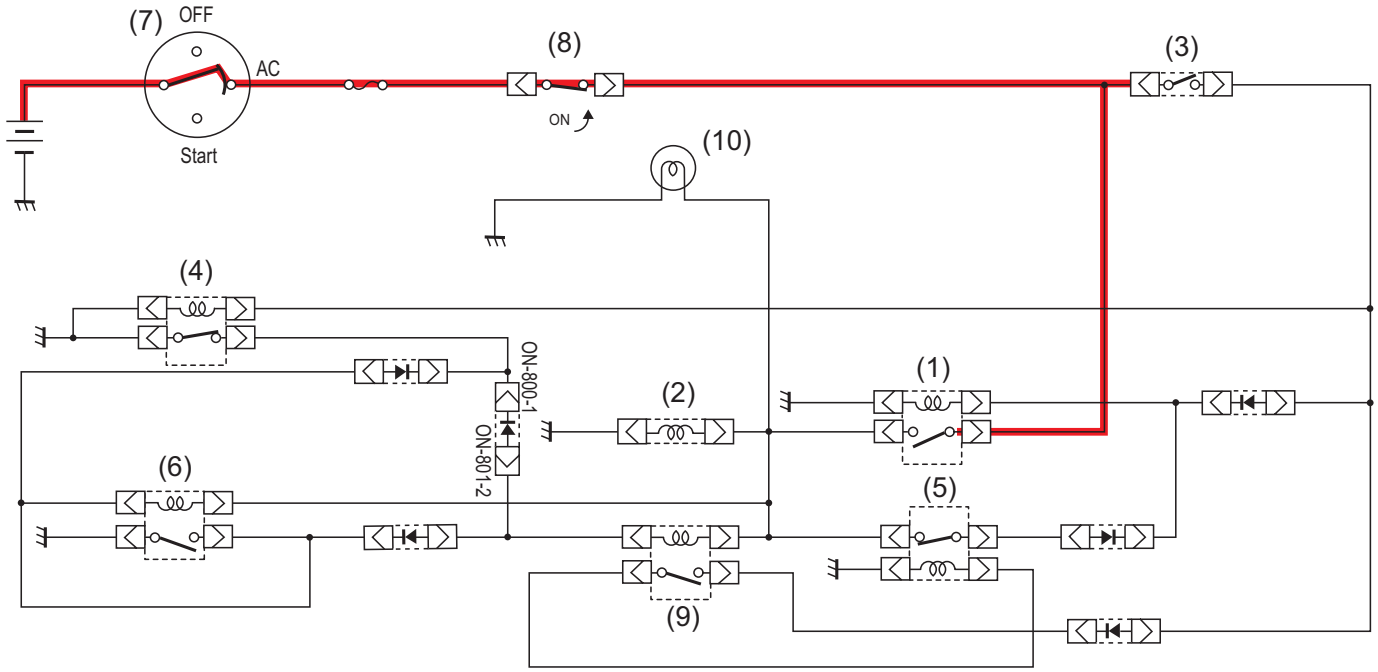


2) Lever lock SW is wired.



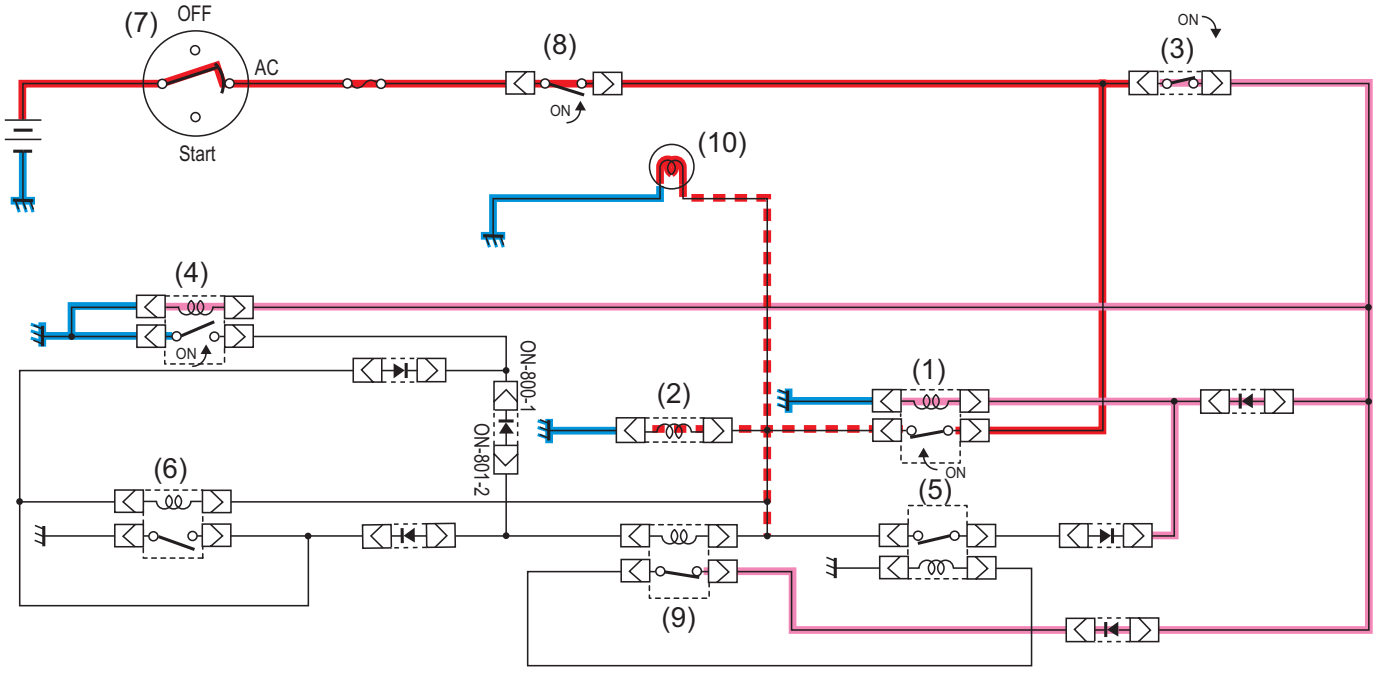
Note :
Lever lock SW (8) was not installed for the early production machines. It was connected with unload valve solenoid only.
Therefore, in these machines, travel speed won't be reset to low range with the lever lock SW OFF condition.

3) Key SW is ON and lever lock SW is ON.



(1) Travel hi-low drive relay
(2) Travel hi-low solenoid
(3) Travel hi-low SW
(4) Negative function relay
(5) First self-hold relay
(6) Second self-hold relay
(7) Main Key SW
(8) Lever lock SW
(9) Self-hold cancel relay
(10) High speed lamp

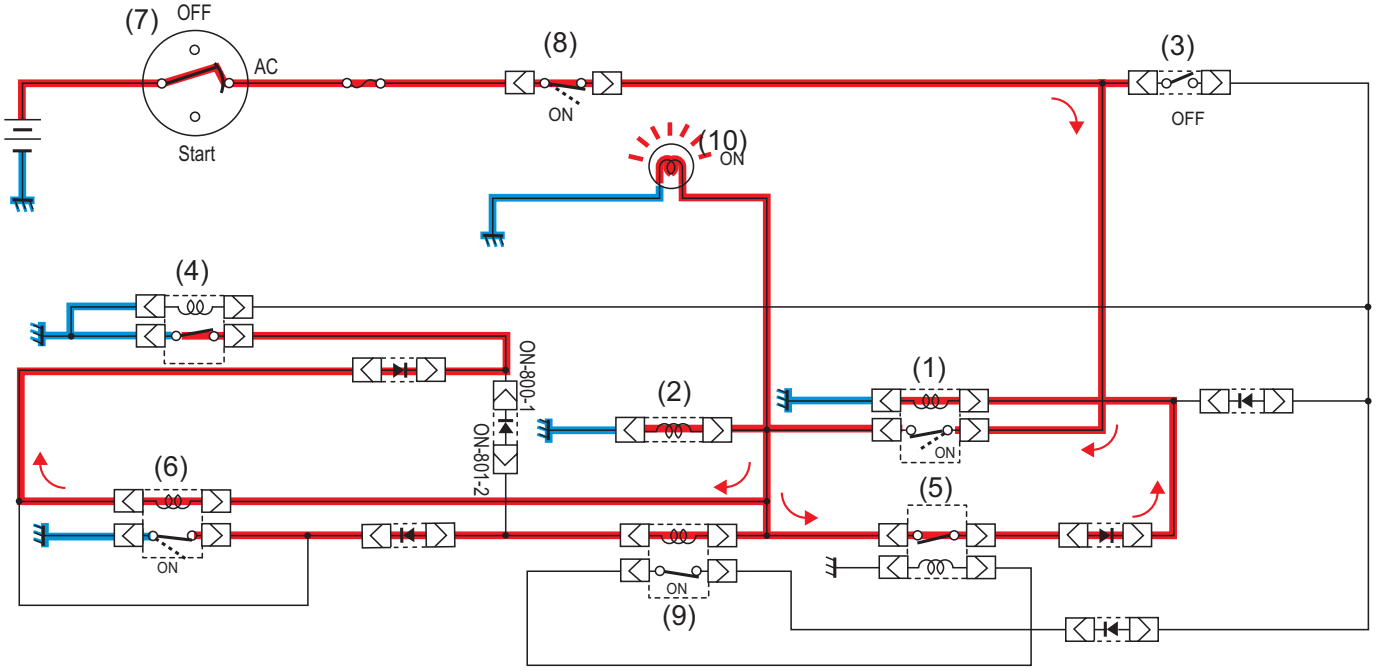
4) Push the travel hight-low SW ON. (Hold SW Button ON)
Then travel high-low drive relay turns on and travel high-low solenoid (2) becomes activated. And so travel motor runs at high speed.
ON condition relays : (1) Travel hi-low drive relay
(4)Negative function relay



5) Hand off from the high-low SW button

As first self-hold relay (5) is B-type relay, buttery current flows through this normal close contact terminal and activates travel high-low drive relay (1). In this was travel motor keeps running at high speed.

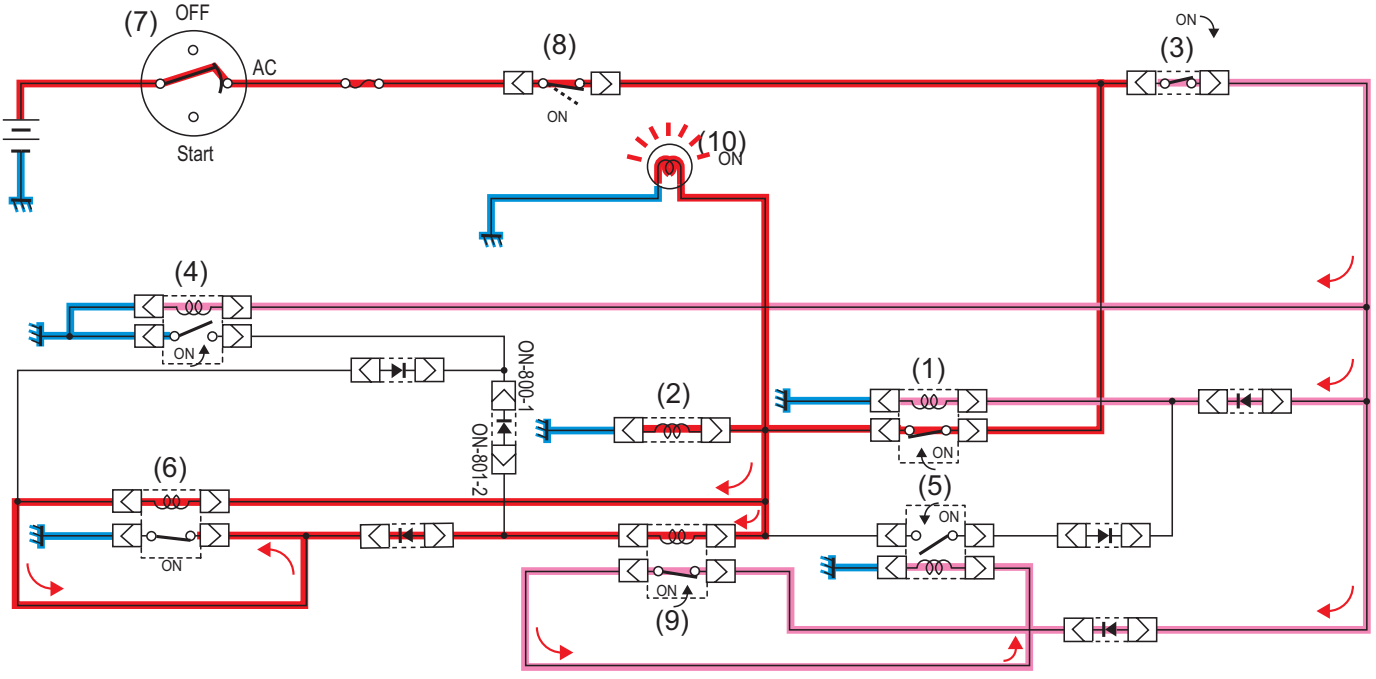
ON condition relay : (1) Travel hi-low drive relay
(6) Second self-hold relay
(9) Self-hold cancel relay



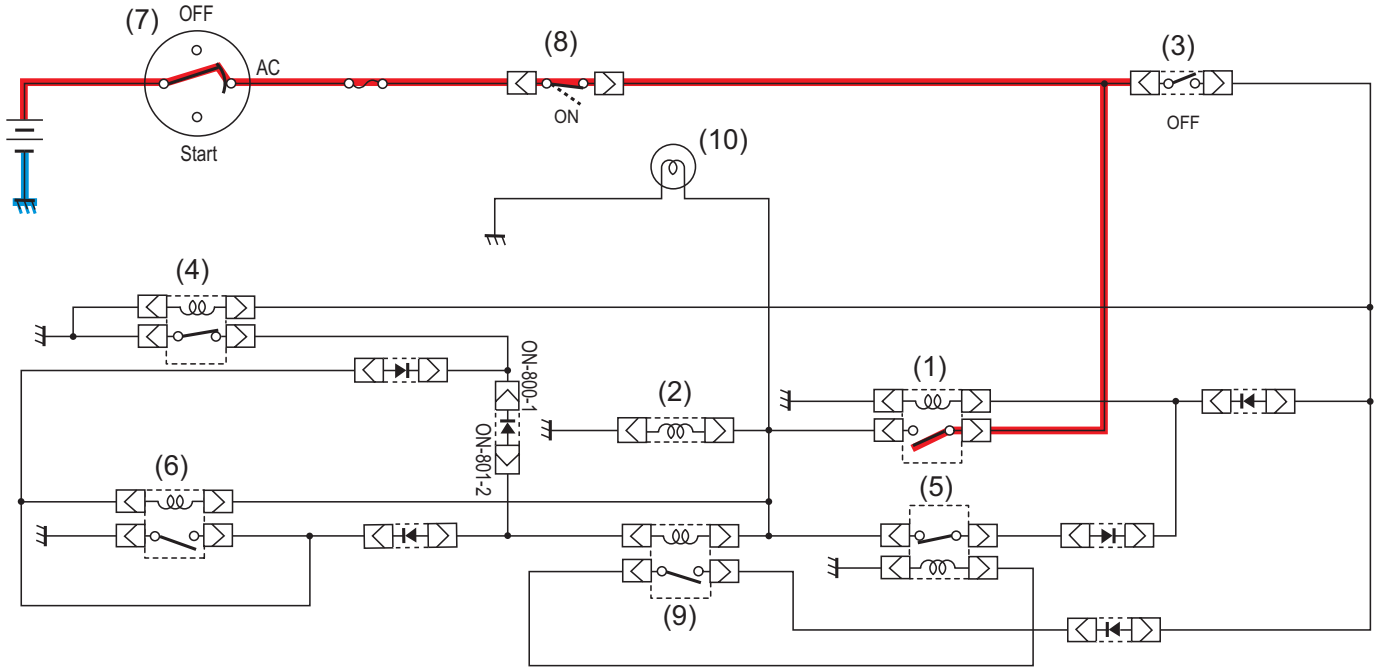
6) Push the travel high-low SW ON again (Hold the SW button ON)

When the travel high-low SW is pushed ON, battery current flows through the coil of travel high-low drive relay (1) and turn it ON.

Then the travel high-low solenoid is activated and runs the travel motor at high speed. On this stage, all 5 relay turn ON positions.

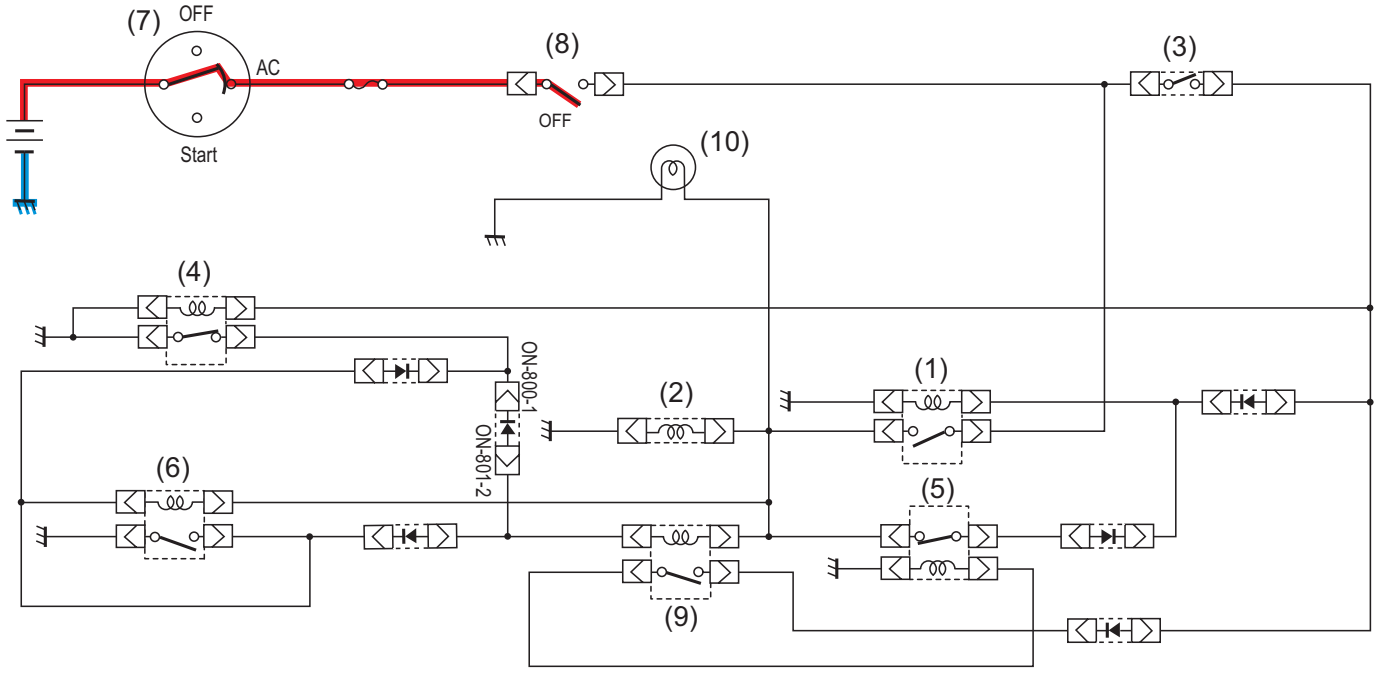


7) Hand off from the travel high-low SW button.



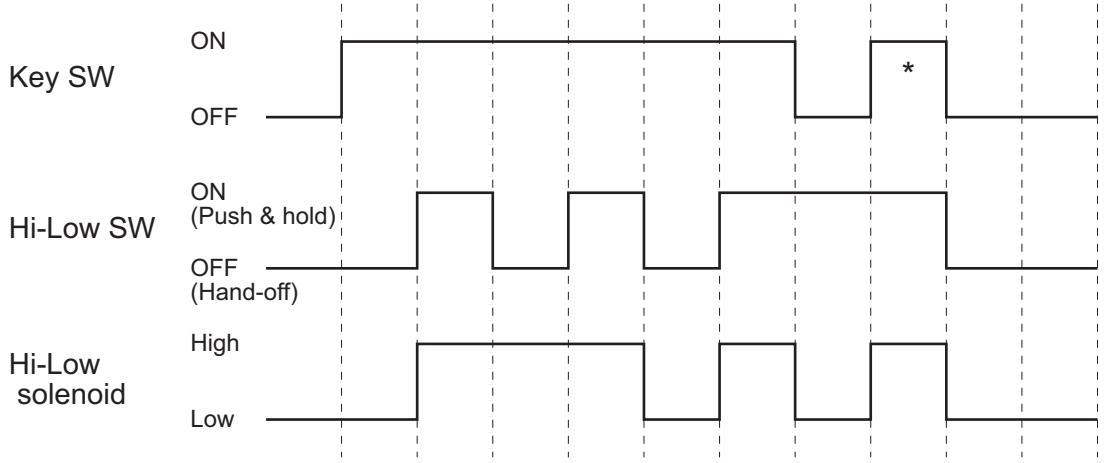
8) Pull up the lever lock SW (OFF position)

No battery current flows in this system and so the travel motor runs at low speed even after leaving the machine previously at high speed conditions.

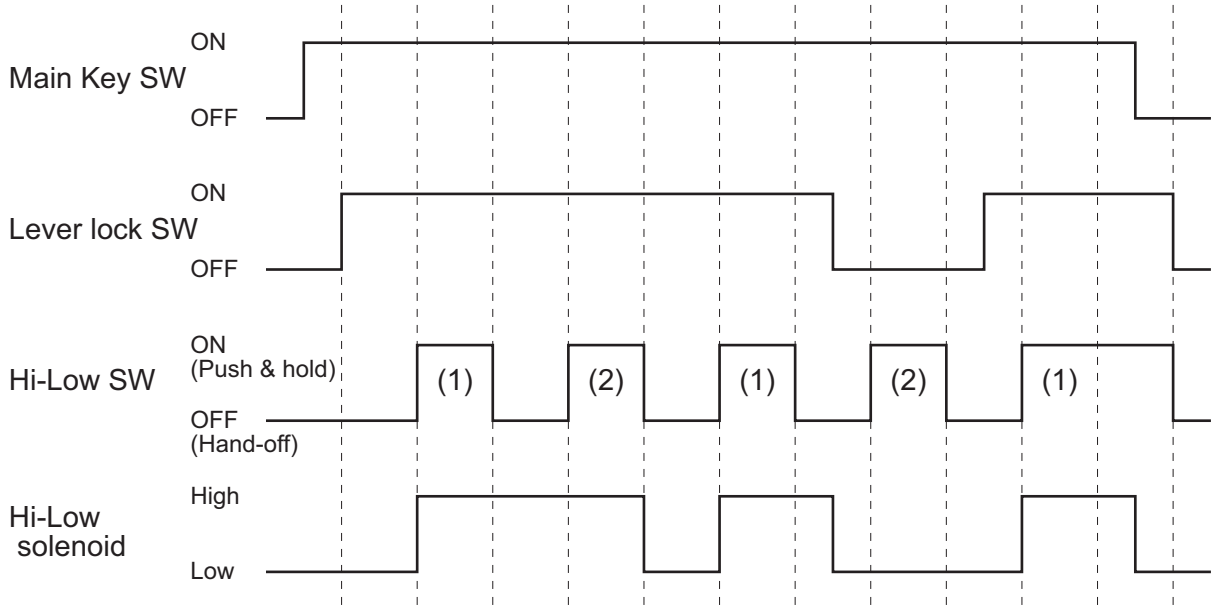


Note :
Lever lock SW (8) was not installed as shown above for the early production machines. It was connected with unload valve solenoid only.
Therefore, in these machines, travel speed won't be reset to low range with the lever lock SW OFF condition.

9) Function chart : Lever lock SW isn't wired

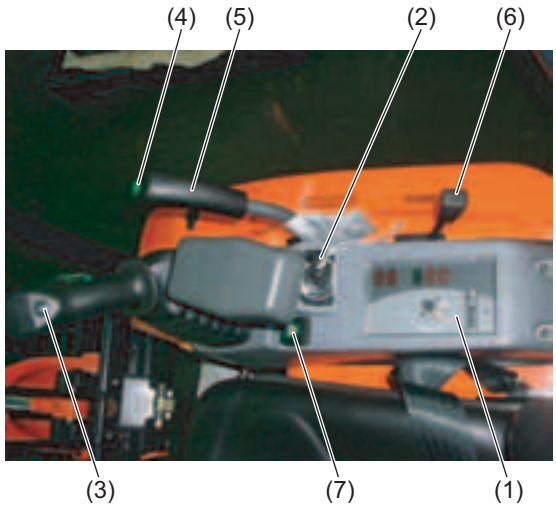


10) Function chart : Lever lock SW is wired



* Note :
Although it is technically possible to turn the main key SW ON and OFF or shift the lever lock SW Up and Down while holding the travel high-low SW. But normally operator won't do. This is just for your information.

g. Meter panel

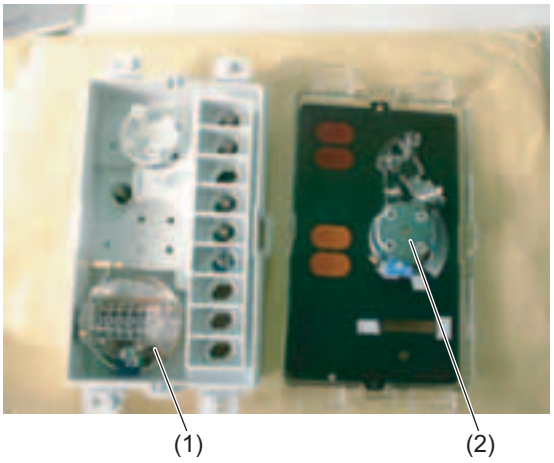


1. Installation view

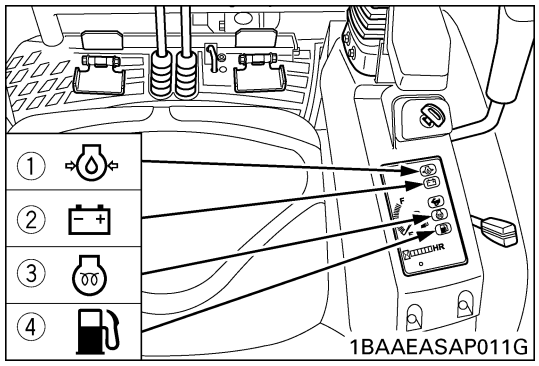
(1) Meter panel
(2) Main key SW
(3) Horn SW
(4) Hi - Low SW
(5) Dozer lever
(6) Accel lever
(7) Work lamp SW

2. Mater inside view

(1) Horn meter
(2) Fuel gauge



3. Warning lamps indication



① Warning Lamp "Engine Oil Pressure"

This lamp lights up when there is an abnormality in the engine oil circulation.
It lights up when the starter switch is in position “RUN” and goes out as soon as the engine starts running. Should the lamp light up while the engine is running, check the engine oil level.

② Warning Lamp "Battery Charge"

This lamp lights up when there is a malfunction in the charge system. The lamp lights up when the Starter Switch is in position “RUN” and goes out as soon as the engine starts.

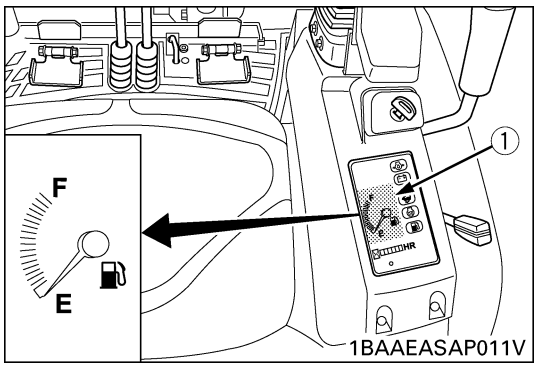
③ Indicator Lamp "Glow"

This lamp lights up when the starter switch is in position “ON” and goes out after the engine has been sufficiently preheated.

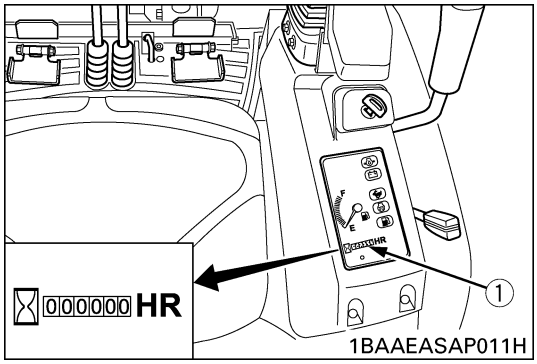
④ Warning Lamp "Fuel Level too Low"

This lamp lights up when the fuel level in the fuel tank is lower than in the following table.

2L



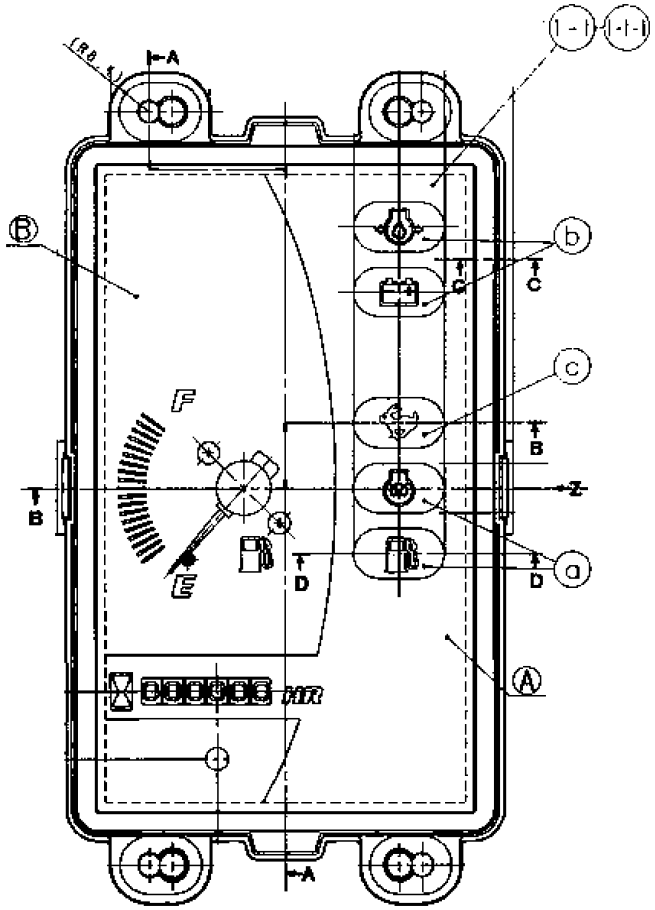
(1) Fuel level indicator

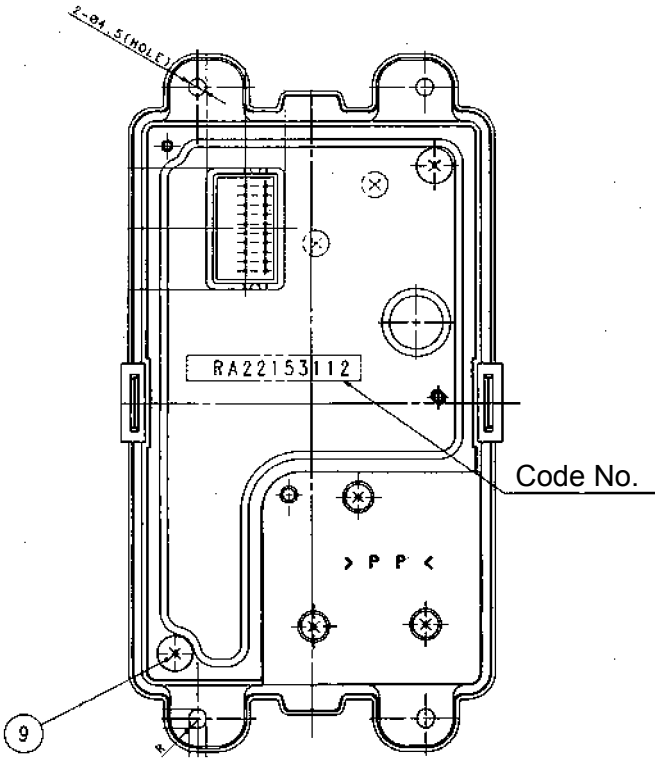


(1) Hourmeter

The meter counts up about 1 for one operating hour. The electric meter keeps counting even when the engine is stopped but the key is in position “ON”.

4. Meter structure





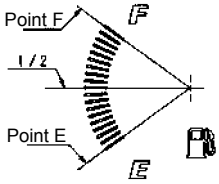
Fuel meter

(1) Indicator is of movable magnet type (MG-23) and vibration-proof.
(2) Performance is as per JIS D5606.
(3) The scale graduations other than E, F and 1/2 are dummy.

Graduation specifications

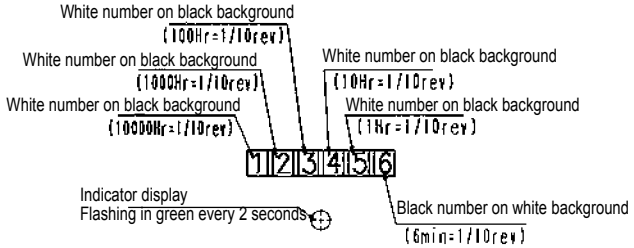
Graduation	F	(1/2)	E
Allowable error ( )	+7.5 0	-	0 -7.5
Resistance value (Ω)	10	(38)	90

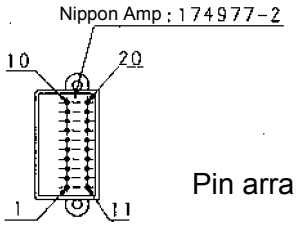
Test voltage: DC14.5 ± 0.5 V
Test temperature: 20 ± 5 °C
Test order : Order of OFF → F → E
(Wait for longer than 3 minutes before inspection.)



Points E and F on the scale

Details of counter

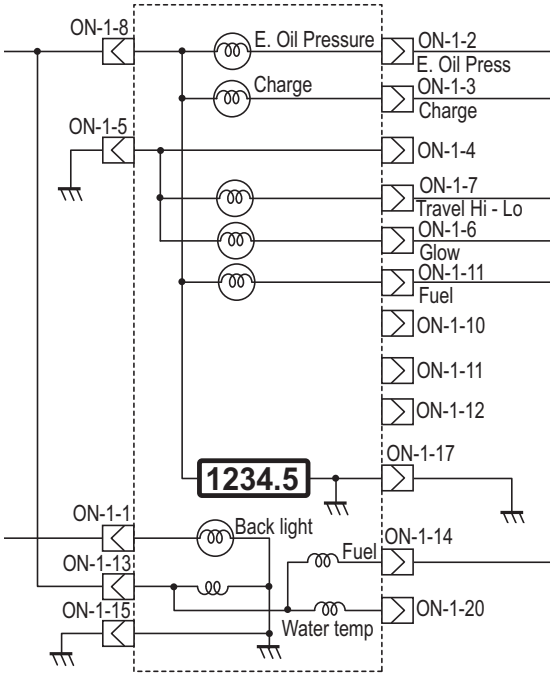


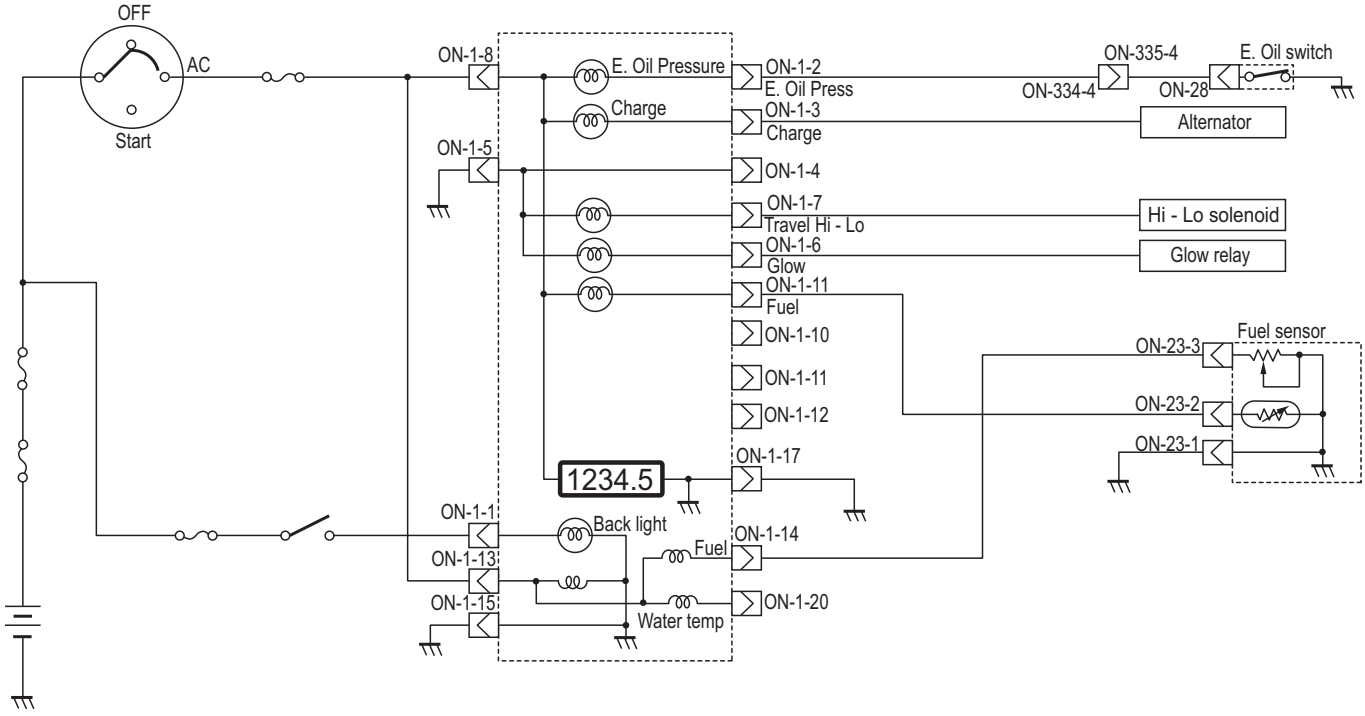


Pin arrangement

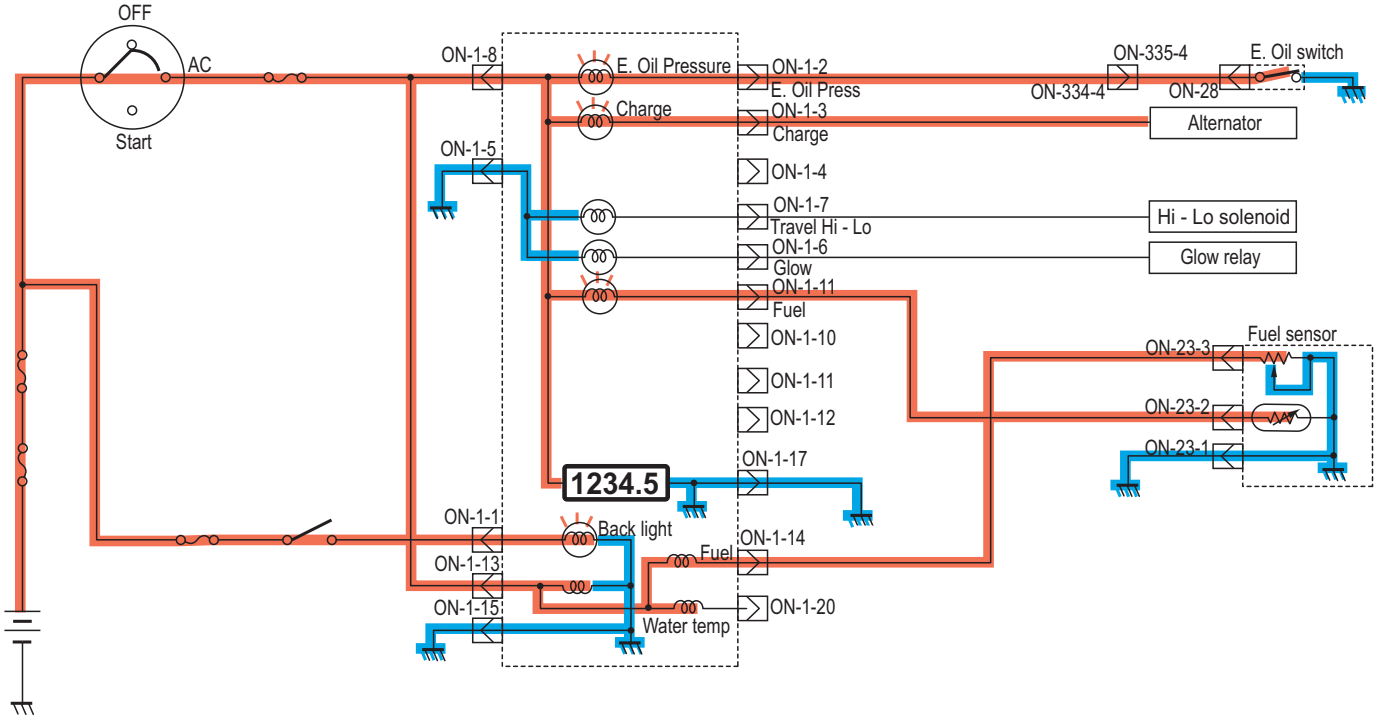
(1)	Illumi (+)	(11)	Empty
(2)	Engine hydraulic	(12)	Empty
(3)	Charge	(13)	Meter power
(4)	Empty	(14)	Fuel meter
(5)	Ground (lamp)	(15)	Illumi, meter GND
(6)	Bi-speed travel	(16)	Empty
(7)	Glow	(17)	HM GND
(8)	Power (+)	(18)	Empty
(9)	Fuel short alarm	(19)	Empty
(10)	Empty	(20)	Empty

5. Meter panel circuit diagram





Key SW at ON (AC) position
(Engine stop condition)



6. Fuel gauge coil resistance test

Sample data : 86.8 Ω
between 3 : 65.8 Ω
terminal : 152.6 Ω

7. Hour meter function test LED and stepping motor function check.

Connect the battery 12V to the white harness and the ground to the black wire.
Check to see LED lights up every two seconds and the internal gears are turning.
Then hour meter function is OK.

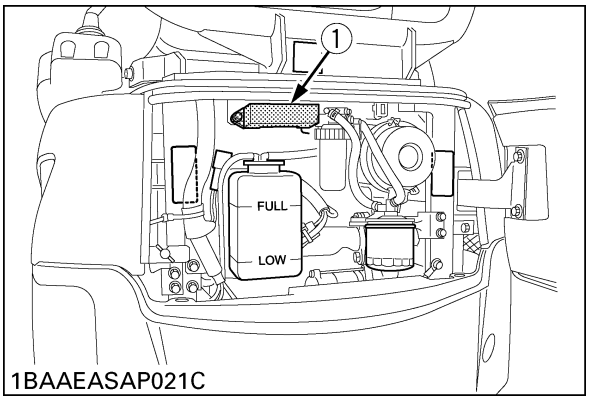
Notice :
Above two test procedures are only for your information.

h. Fuses

1. Replacing Fuses

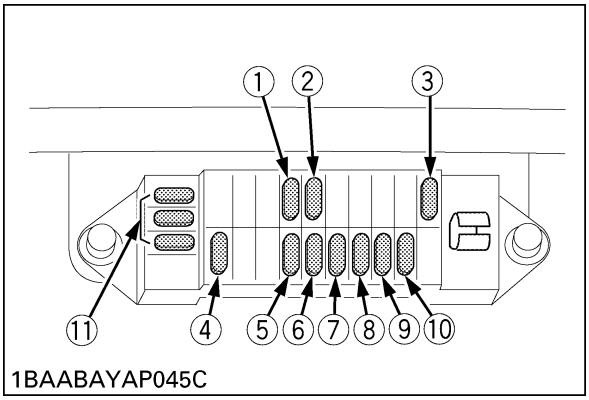
1) Remove the cover of the fuse box.
2) Replace the burnt out fuse with a fuse having the same capacity.

2. Fuse Capacities and Circuits



1BAAEASAP021C

(1) Fuse box

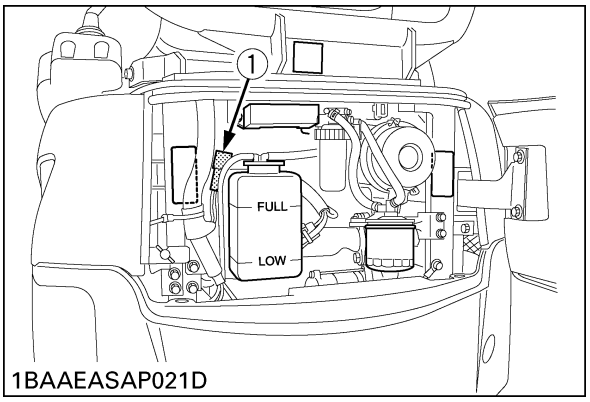


1BAABAYAP045C

No.	Capacity	Circuit
(1)	5A	Auto glow
(2)	5A	Anti theft main
(3)	15A	Cigarette lighter
(4)	10A	Anti theft sub
(5)	5A	Auto release
(6)	10A	Beacon
(7)	15A	Work light
(8)	10A	Horn
(9)	5A	Lever lock, Travel Hi-Low
(10)	10A	Alternator, Fuel pump, Meter
(11)	5A, 10A, 15A	Spare fuses

3. Slow Blow Fuse

Slow blow fuse is provided to protect the electrical circuits. If the fusible link is blown, check the electrical circuits for trouble and then replace with a new compatible slow blow fuse.

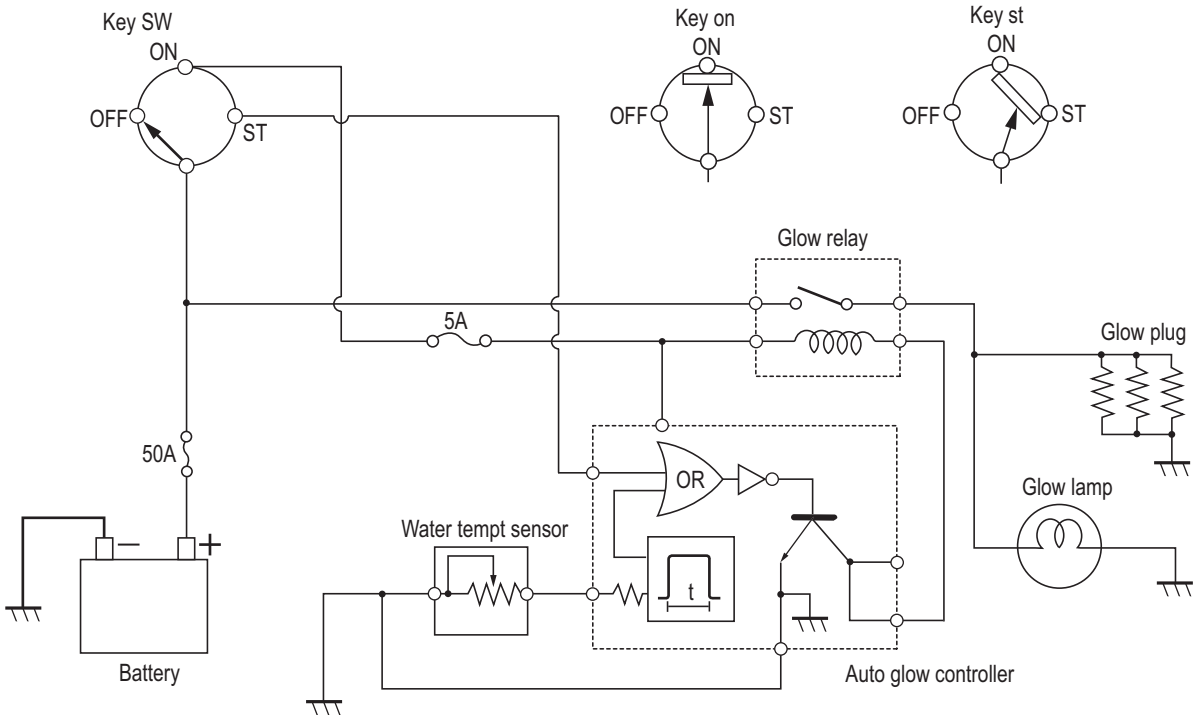


1BAAEASAP021D

(1) Slow blow fuse

Capacity of the slow blow fuse : 50 A
(2 pieces)

i. Auto glow circuit



1. Function

1. The glow controller receives a water temperature sensor signal or a key switch start position signal and makes the signal voltage (1) drop to the ground level. Now the current starts flowing to the relay coil. (NOR signal circuit)
2. Turn the key switch from the OFF to ON position, and the glow relay is kept on for the time "t" as shown in Fig. 2 (Function chart) to light up the glow lamp.
3. While the key switch is set at the ST position, the glow relay is turned on again to light up the glow lamp.
4. As indicated in Fig. 3 (Timer curve), the pre-glow time (glow lamp-on time) "t" is compensated depending on the water temperature.
5. Once the current flows to the relay coil, the battery voltage starts flowing to the glow plug.

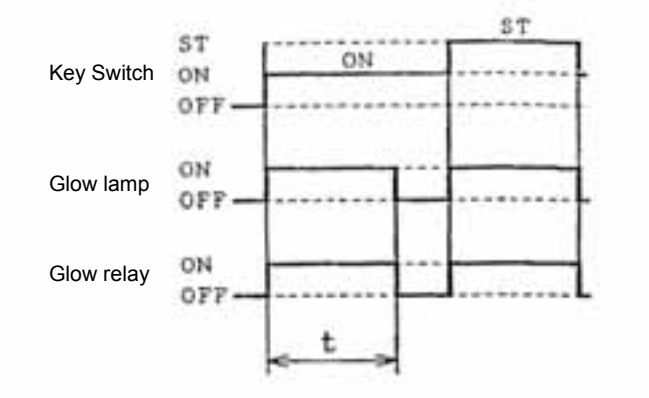
Reference: NOR logic circuit

Water temp sensor signal	Key SW ST signal	OR	
H	H	H	L
H	L	H	L
L	H	H	L
L	L	L	H

H: High level, 12V
Indicates that a signal voltage is applied.
L: Low level, 0V
Indicates that no signal voltage is applied or that the terminal is grounded.

The NOR logic circuit is a composite circuit of OR gate and NOT gate.

Fig 2. Function chart



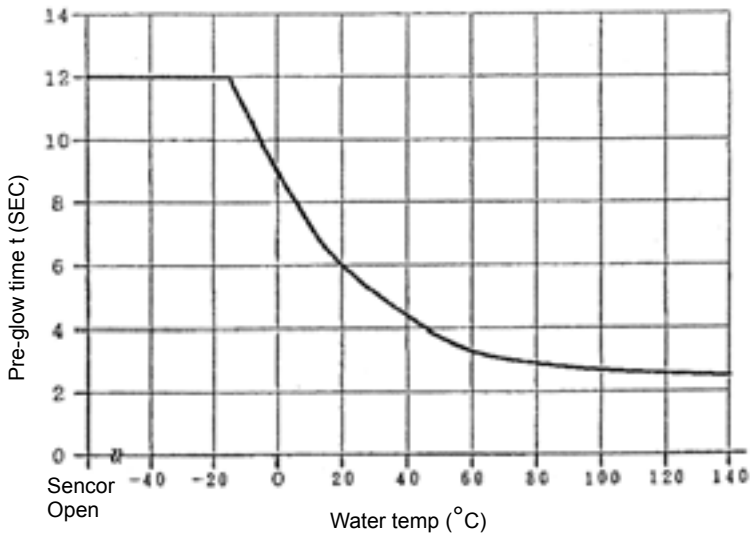
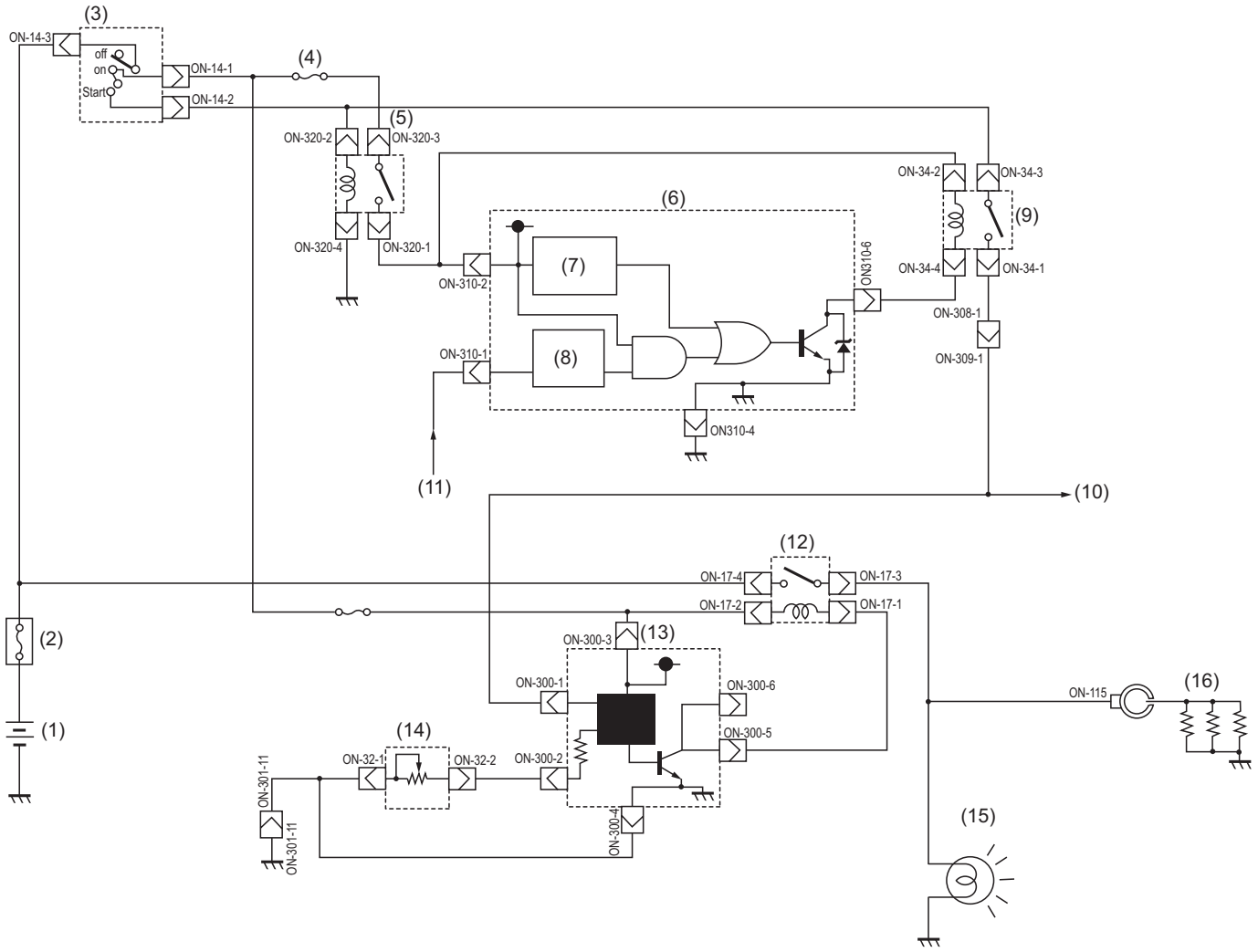


Fig 3. Timer curve

Table 1. Timer function values

Water temp (°C)	Thermistor resistance (Ω)	Pre-glow time (sec)
140	58	2.55
100	155	2.73
80	277	2.95
60	530	3.37
40	1100	4.22
20	2525	5.85
10	3997	7.12
0	6544	8.77
-10	11123	10.81
-20	19716	12.00
-30	36630	12.00
-40	71770	12.00

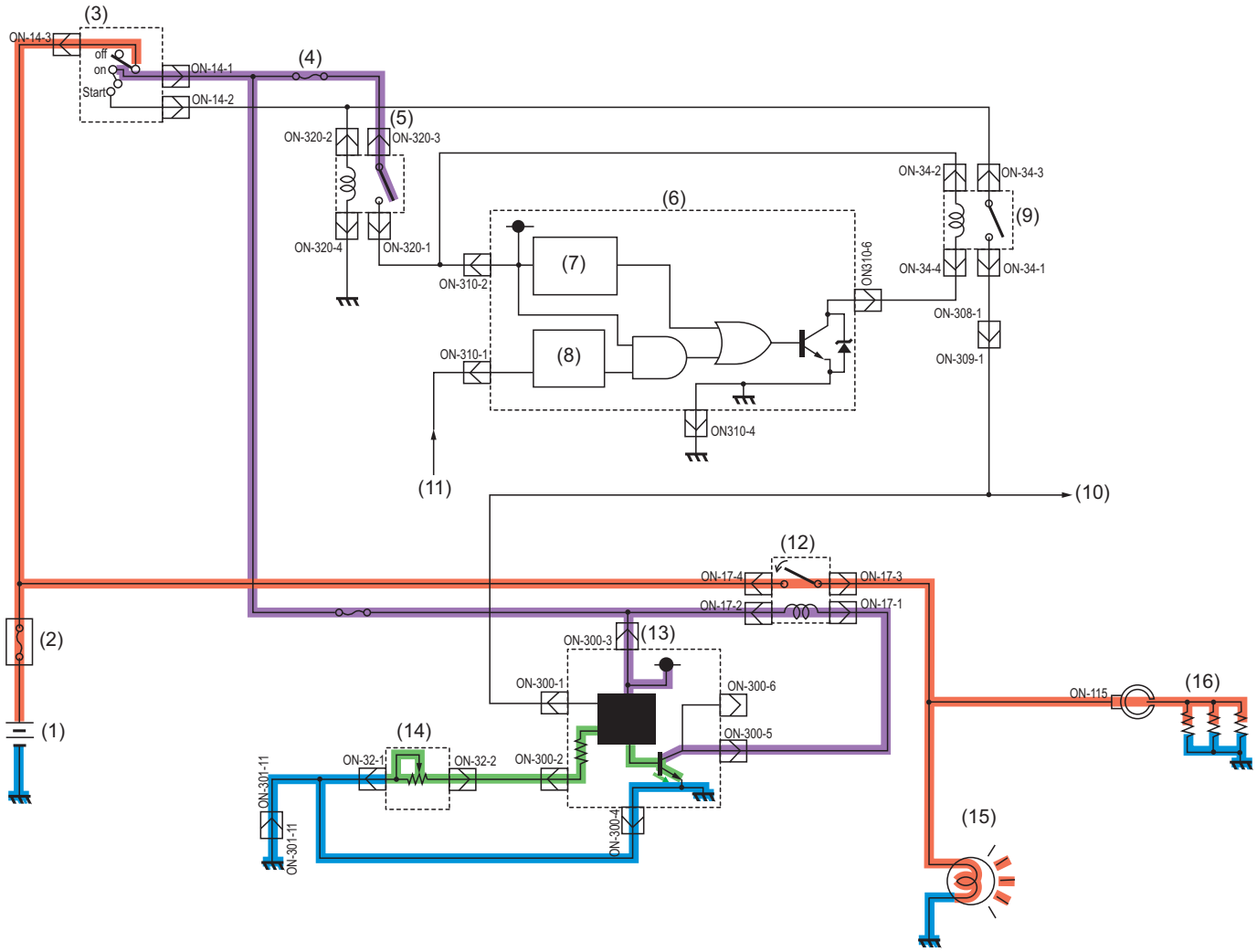
2. Auto glow control circuit diagram



(1)	Battery	(9)	Auto release relay
(2)	Fuse 50A	(10)	To starter motor
(3)	Key SW	(11)	From altemator
(4)	Fuse SA 5A	(12)	Glow relay
(5)	Auto release stabilizing relay	(13)	Auto glow controller
(6)	Auto release controller	(14)	Water temp sensor
(7)	Low-voltage detection	(15)	To glow lamp
(8)	Rotation detection	(16)	Glow plug

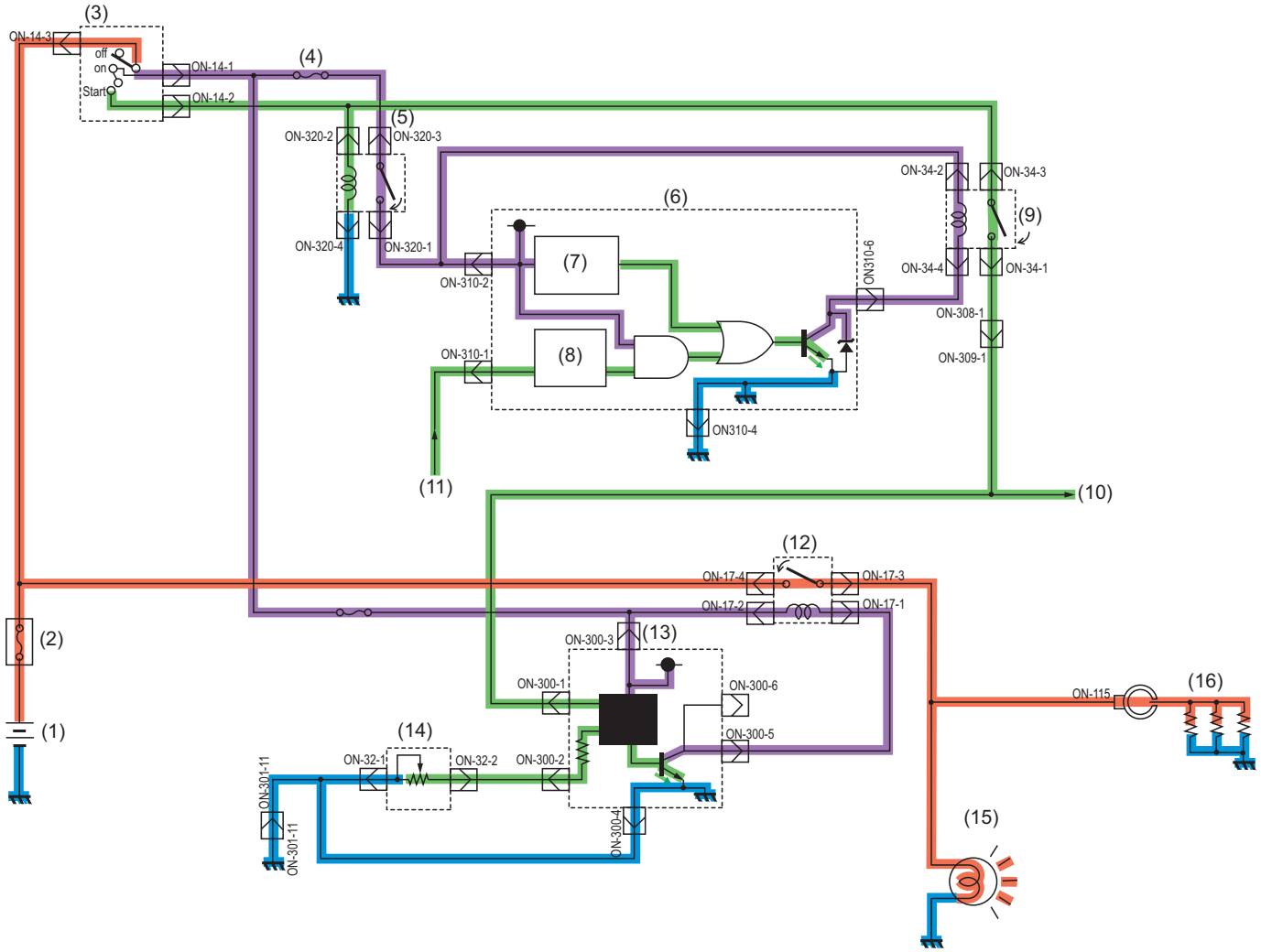
1) At key ON position :

According to the water temp. sensor signal, auto glow controller detects and calculates the required time to glow plugs and supply the current to the glow relay to turn on.
Then the battery current flows to the glow plugs and the glow lamp.



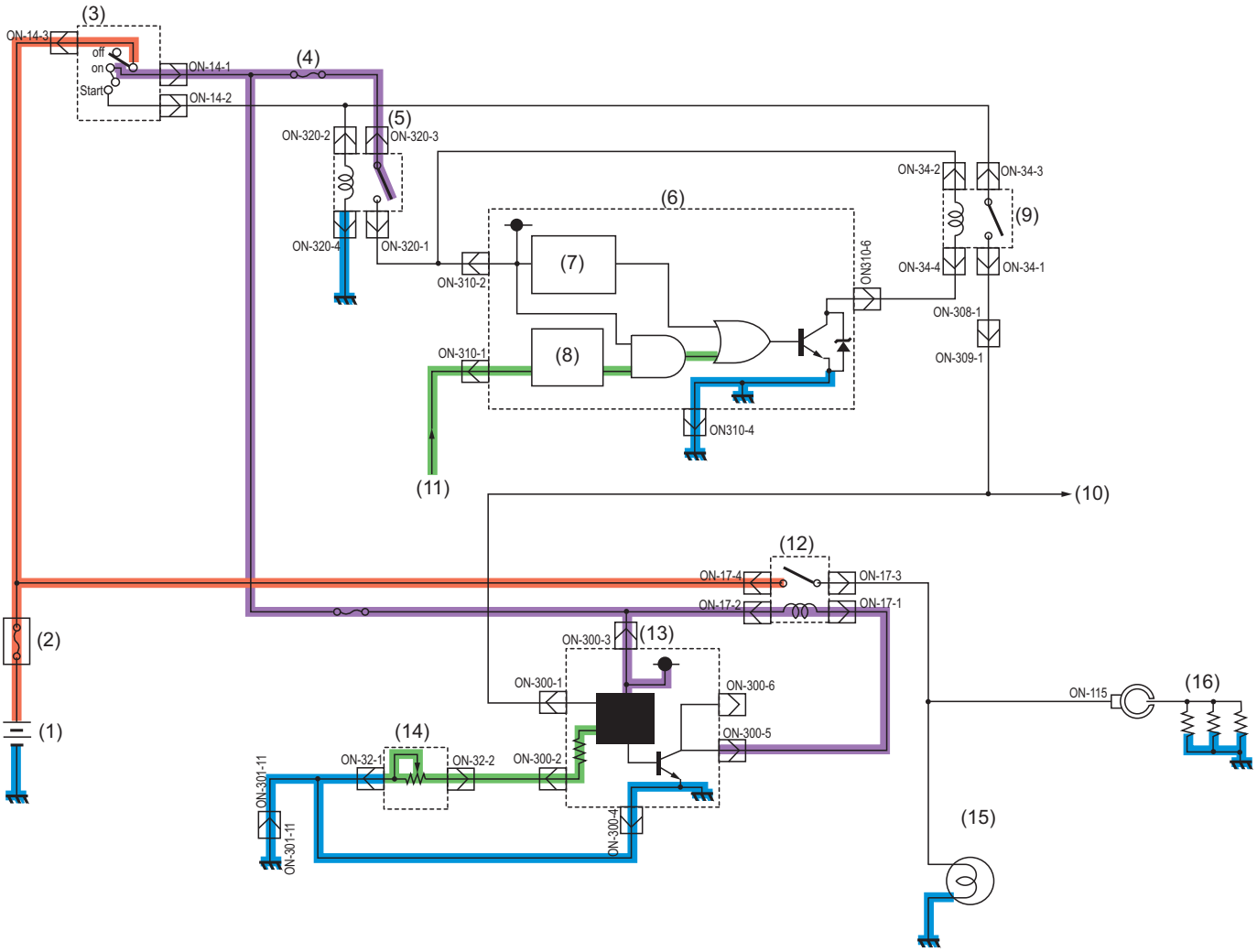
(1)	Battery	(9)	Auto release relay
(2)	Fuse 50A	(10)	To starter motor
(3)	Key SW	(11)	From altemator
(4)	Fuse SA 5A	(12)	Glow relay
(5)	Auto release stabilizing relay	(13)	Auto glow controller
(6)	Auto release controller	(14)	Water temp sensor
(7)	Low-voltage detection	(15)	To glow lamp
(8)	Rotation detection	(16)	Glow plug

2) Key SW at “start“ position :
(Engine stop condition)



(1)	Battery	(9)	Auto release relay
(2)	Fuse 50A	(10)	To starter motor
(3)	Key SW	(11)	From altemator
(4)	Fuse SA 5A	(12)	Glow relay
(5)	Auto release stabilizing relay	(13)	Auto glow controller
(6)	Auto release controller	(14)	Water temp sensor
(7)	Low-voltage detection	(15)	To glow lamp
(8)	Rotation detection	(16)	Glow plug

3) After engine start running :



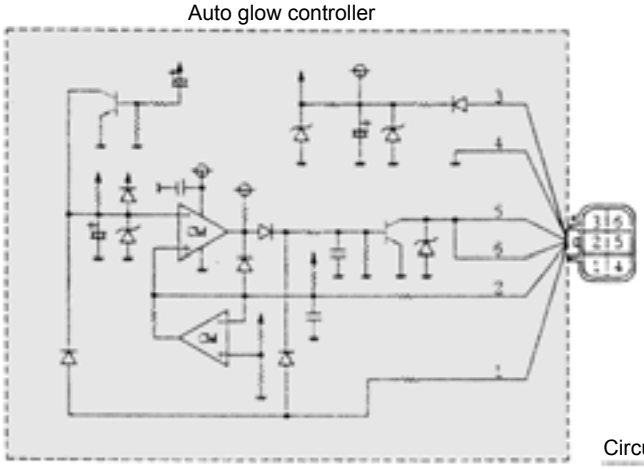
(1)	Battery	(9)	Auto release relay
(2)	Fuse 50A	(10)	To starter motor
(3)	Key SW	(11)	From altemator
(4)	Fuse SA 5A	(12)	Glow relay
(5)	Auto release stabilizing relay	(13)	Auto glow controller
(6)	Auto release controller	(14)	Water temp sensor
(7)	Low-voltage detection	(15)	To glow lamp
(8)	Rotation detection	(16)	Glow plug

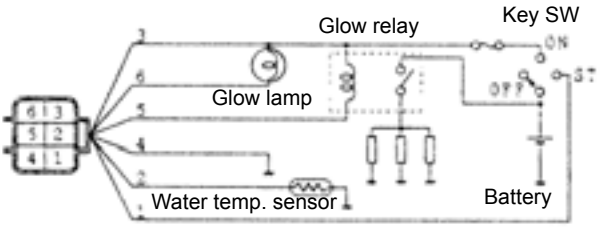
3. Auto glow controller

(C/N RC417-53791)

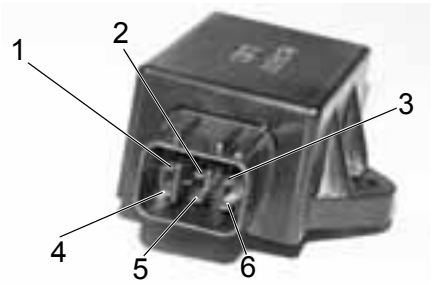
1) If the automatic glow controller seems to malfunction, take it out of the machine, as shown at left, and check the performance of the controller itself referring to the circuit diagram below.
2) The circuit diagram below shows the actual connections. In practice, apply the battery voltage between the coupler pin 3, and ground the coupler pin 4.
3) When the coupler pins 5 and 6 are connected as shown in the diagram, the glow lamp stays on for a certain period of time, and the relay gets activated, it means that the automatic glow controller functions well.
4) If the water temperature sensor signal is not fed to the coupler pin 2, the controller will be in action for about 12 seconds the same way as for the -20 °C condition.

Auto glow controller

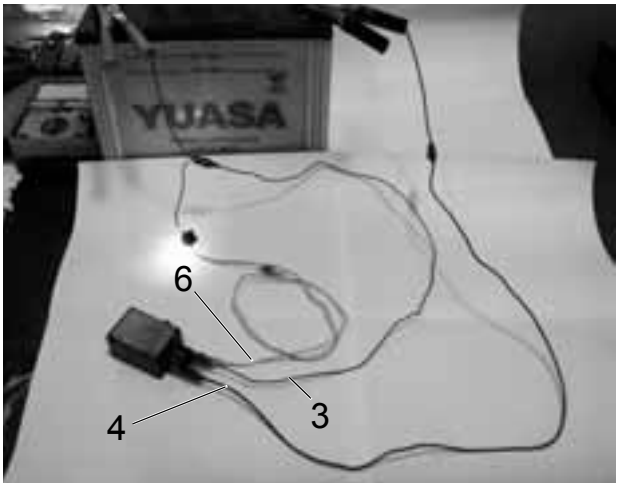




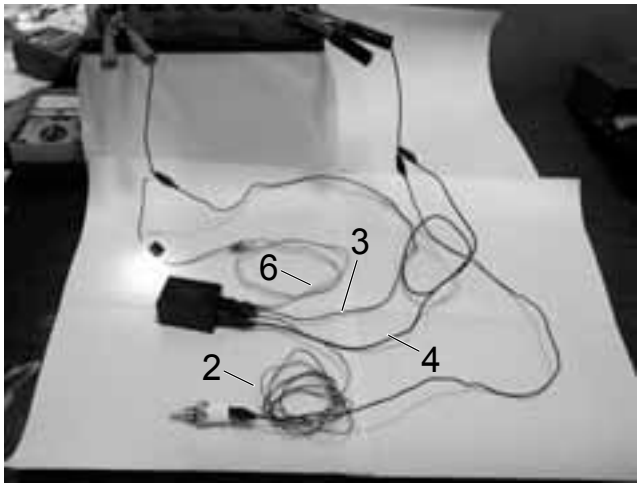
Circuit diagram to test



Note : If a test-purpose glow lamp is not available, set the circuit tester to the V range and watch the tester's pointer movement.



12 seconds: Without temp. sensor

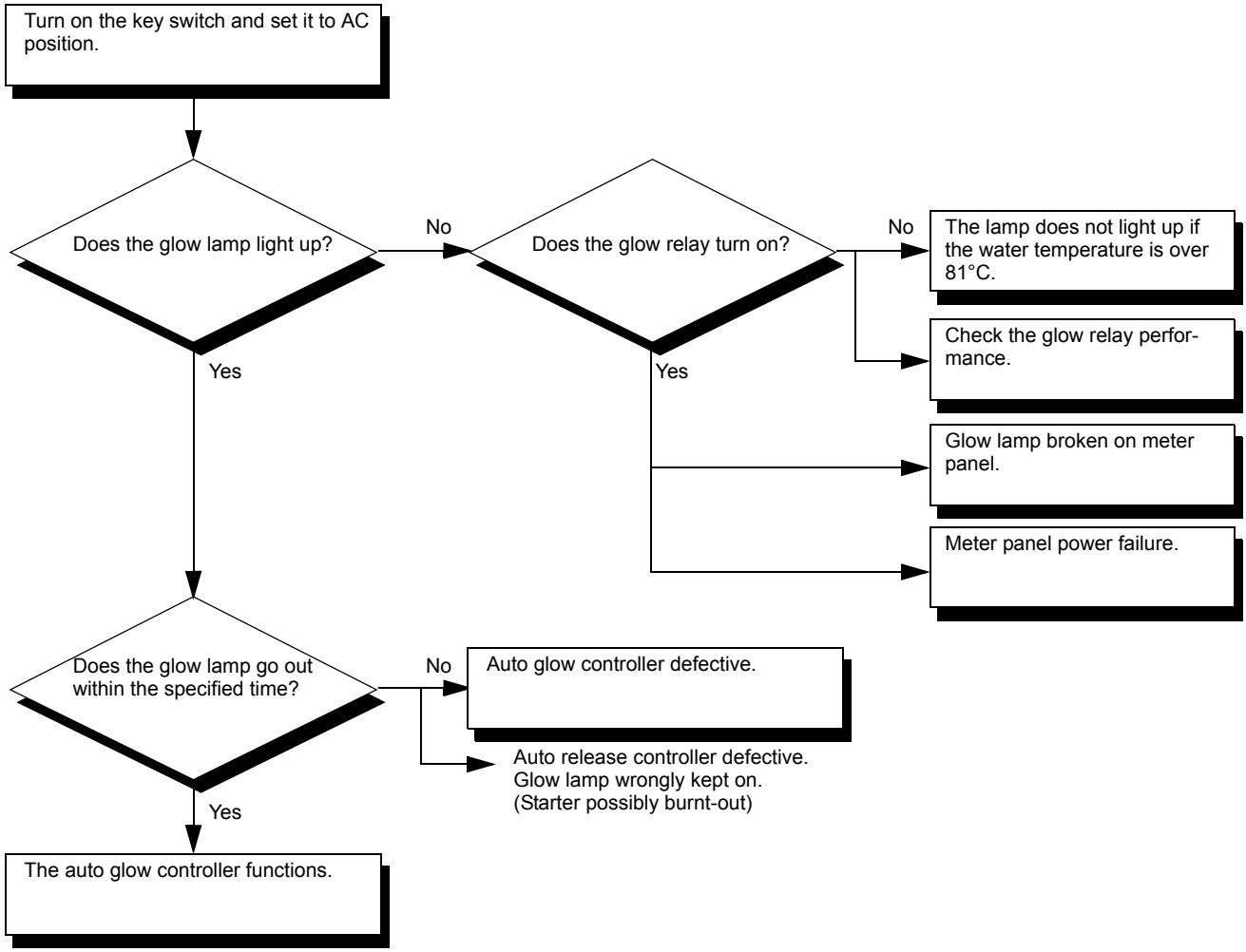


With temp. sensor

5) Practical inspection

Checking the auto glow controller on actual machines

1. Set the key switch to AC position.
2. Make sure the glow lamp lights up.



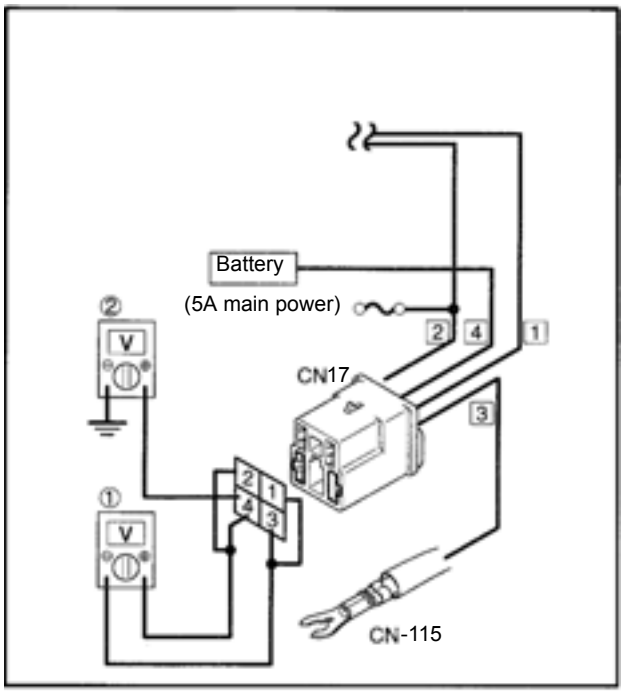
4. Auto glow circuit

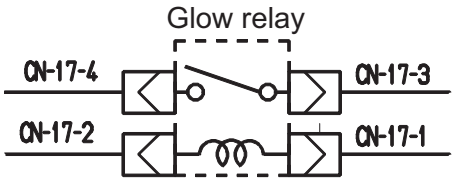
1) Water temperature sensor circuit check
When the water temperature sensor and its wiring function, the engine's water temperature is detected and the glow plug is preheated for a time required to get the engine started.

2) First make sure the water temperature sensor functions. Disconnect the water temperature sensor coupler and put your fingers in slight contact with the glow relay. Now turn the key switch to the ON position and feel the glow relay clicking.
   - When it clicks, check the glow plug coupler as well as the glow relay.
   - If it does not click, measure the voltage, check for continuity, and check the glow relay.

3) Voltage check
   - Keep the glow relay coupler in position.
   - Turn the key switch to the ON position.

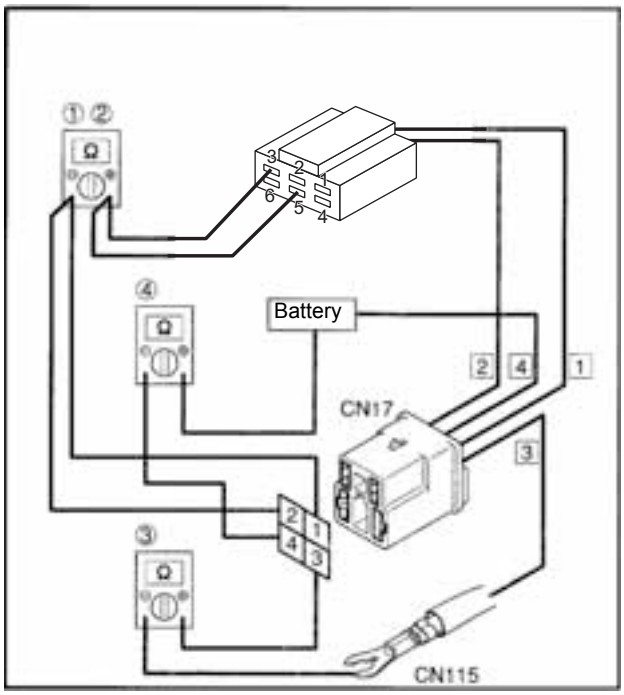
   1. Measure the voltage between the auto glow relay coupler terminals [3] and [4] as well as between [1] and [2] to see if it is 12 V.
      - 12 V reading for both: Check the glow relay.
      - Other reading: Measure the voltage in Step (2) below. Also check for continuity.
   2. Measure the voltage between the glow relay coupler terminal [4] and the body ground to see if it is 12 V.





4) Continuity check
   - Turn the key switch to the OFF position.
   - Disconnect the meter coupler .
   - Disconnect the glow relay coupler .

   1. Check for continuity between the auto glow relay coupler terminal [CN300-5] and the glow relay coupler CN terminal [CN17-1].
   2. Check for continuity between the auto glow relay coupler terminal [CN300-3] and the glow relay coupler terminal [CN17-2].
   3. Check for continuity between the glow relay coupler terminal [CN17-3] and the glow plug coupler.
   4. Check for continuity between the glow relay coupler terminal [CN17-4] and the battery's positive (+) terminal.



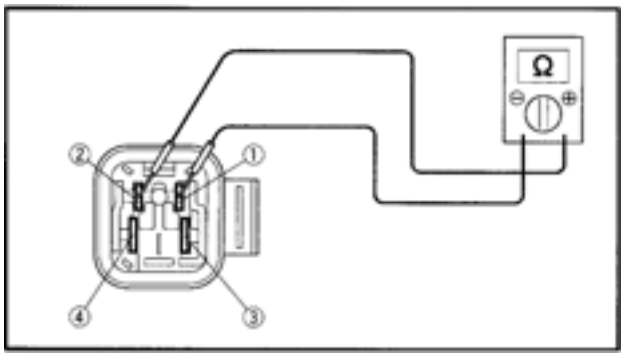
5) Glow relay check
   1. Glow relay
      Code No. : T1060-33711

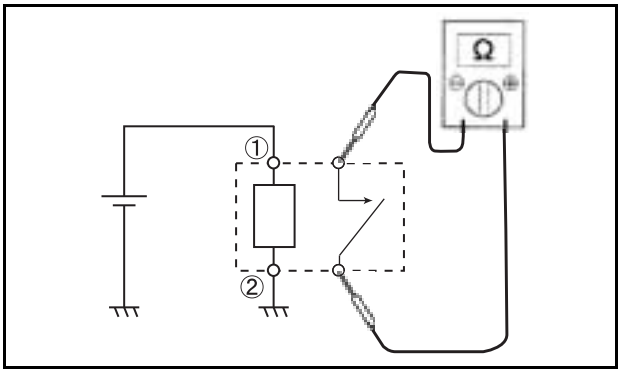
   2. Disconnect the glow relay coupler. Measure the resistance between points (1) and (2) on the glow relay alone.

   (Relay coil resistance)

Specification	52 - 80 Ω
Actual measurement(Sample)	About 58 Ω

   3. Apply 12 V between points (1) and (2) of the glow relay to check for continuity between points (3) and (4).

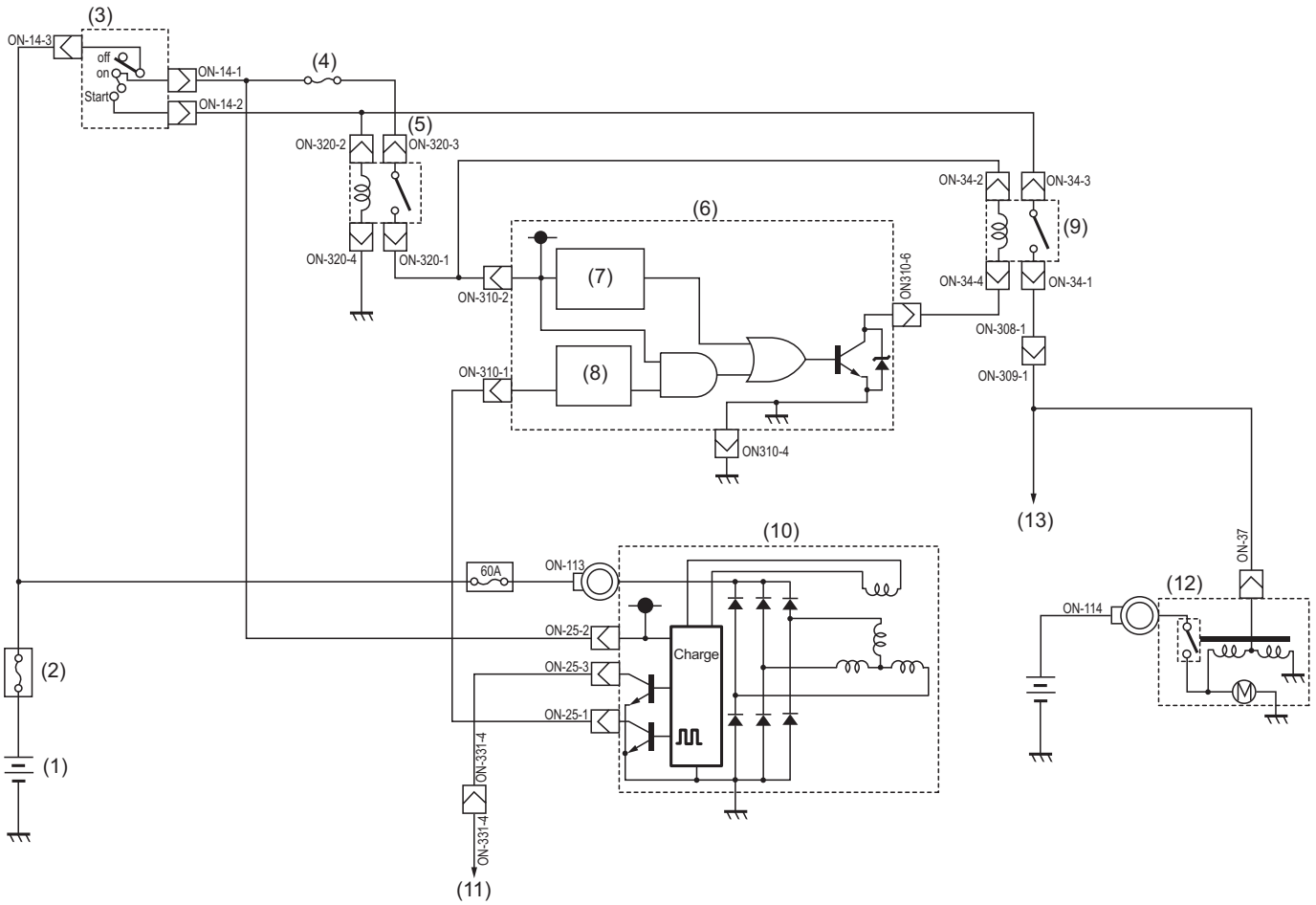




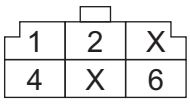
j. Auto release control system

1. Outline

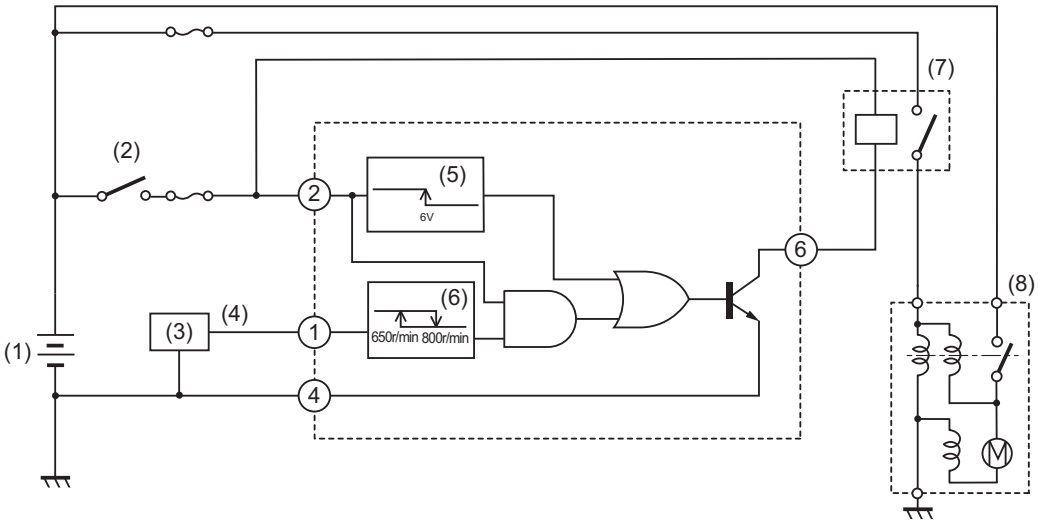
1) When the engine has started and the alternator has reached the specified rpm (N1 = 800 rpm in the figure below), the auto release controller is activated to turn off the auto release relay.
2) With the auto release relay off, the starter motor current is shut off to prevent the battery current from flowing to the starter motor.
3) In this way, the starter motor can be protected against key seizure even if the key switch fails to get back.



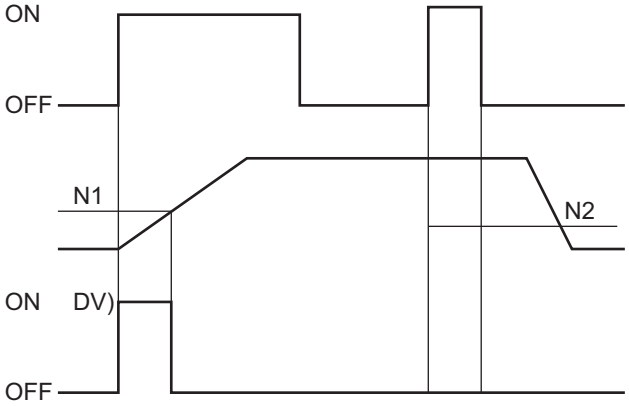
(1) Battery
(2) Fuse 50A
(3) Key SW
(4) Fuse SA 5A
(5) Auto release stabilizing relay
(6) Auto release controller
(7) Low-voltage detection
(8) Rotation detection
(9) Auto release relay
(10) Alternator
(11) Meter panel
(12) Starter
(13) To auto glow controller



2. Auto relase control, structure and function



(1) Battery 12V
(2) Main switch
(3) Alternator
(4) P - terminal
(5) Low voltage detection
(6) Rotation detection
(7) Starter relay
(Auto relase lever)
(8) Starter



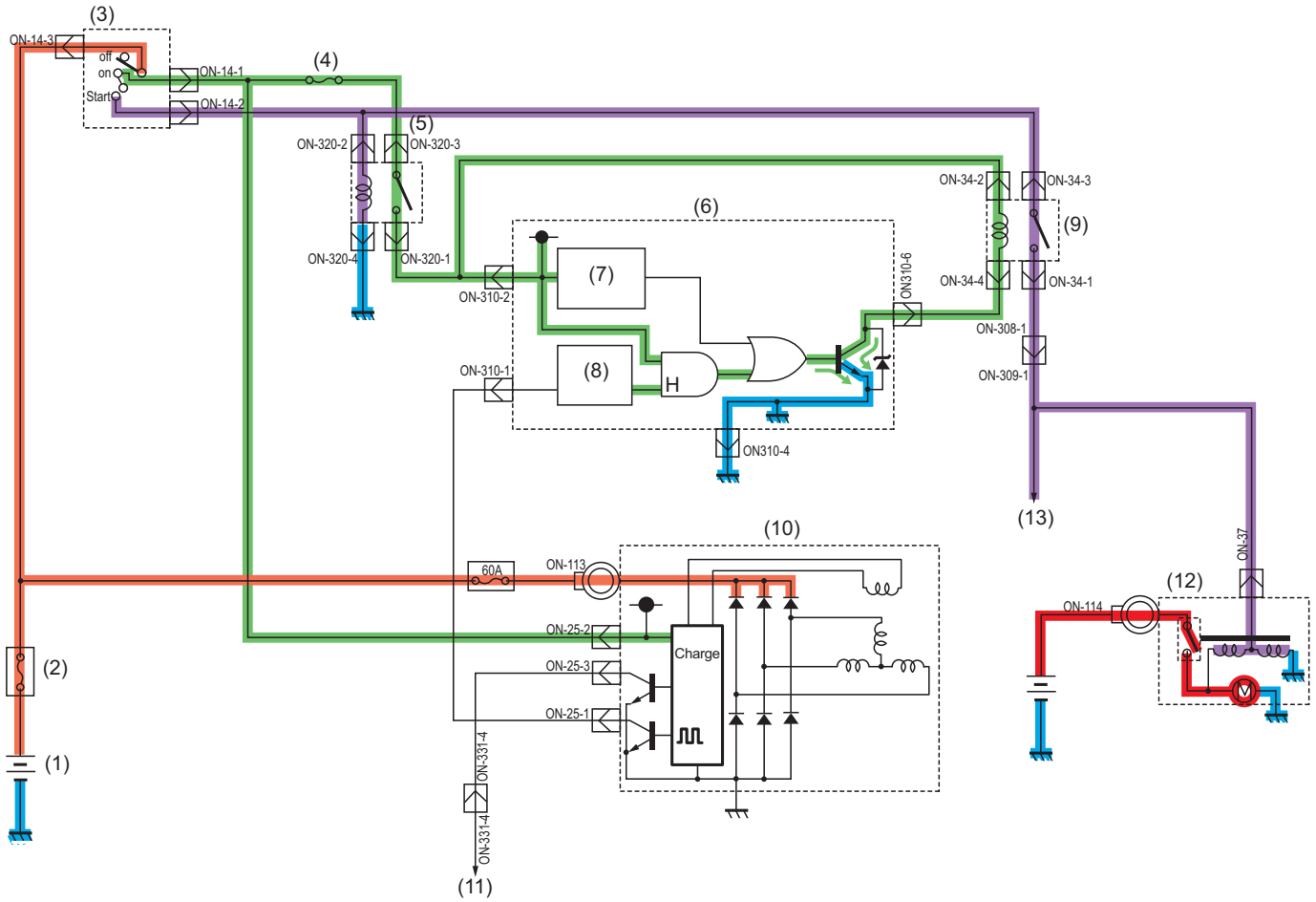
N1 :
N2 :

$(N = \frac{120f}{P})$

Function :

1. After engine starts and when alternator speed reaches to set value (P-terminal = N1), then transistor of the auto release controller turns OFF, terminal ⑥ stays H-level and auto release relay gose OFF - condition.
2. While engine is running (P-terminal = N2 or more), auto release controller terminal ⑥ stays H-level and auto release relay stays OFF - condition.
   Even if the main key is turned to the start - position.
3. Under the condition of low battery voltage (approx 6 V or lower) and main switch being at start position even at any engine speed, then the transistor of the auto release controller turns ON - condition, terminal ⑥ become L-level and auto release relay gose ON - condition. Then battary current flows to the starter.

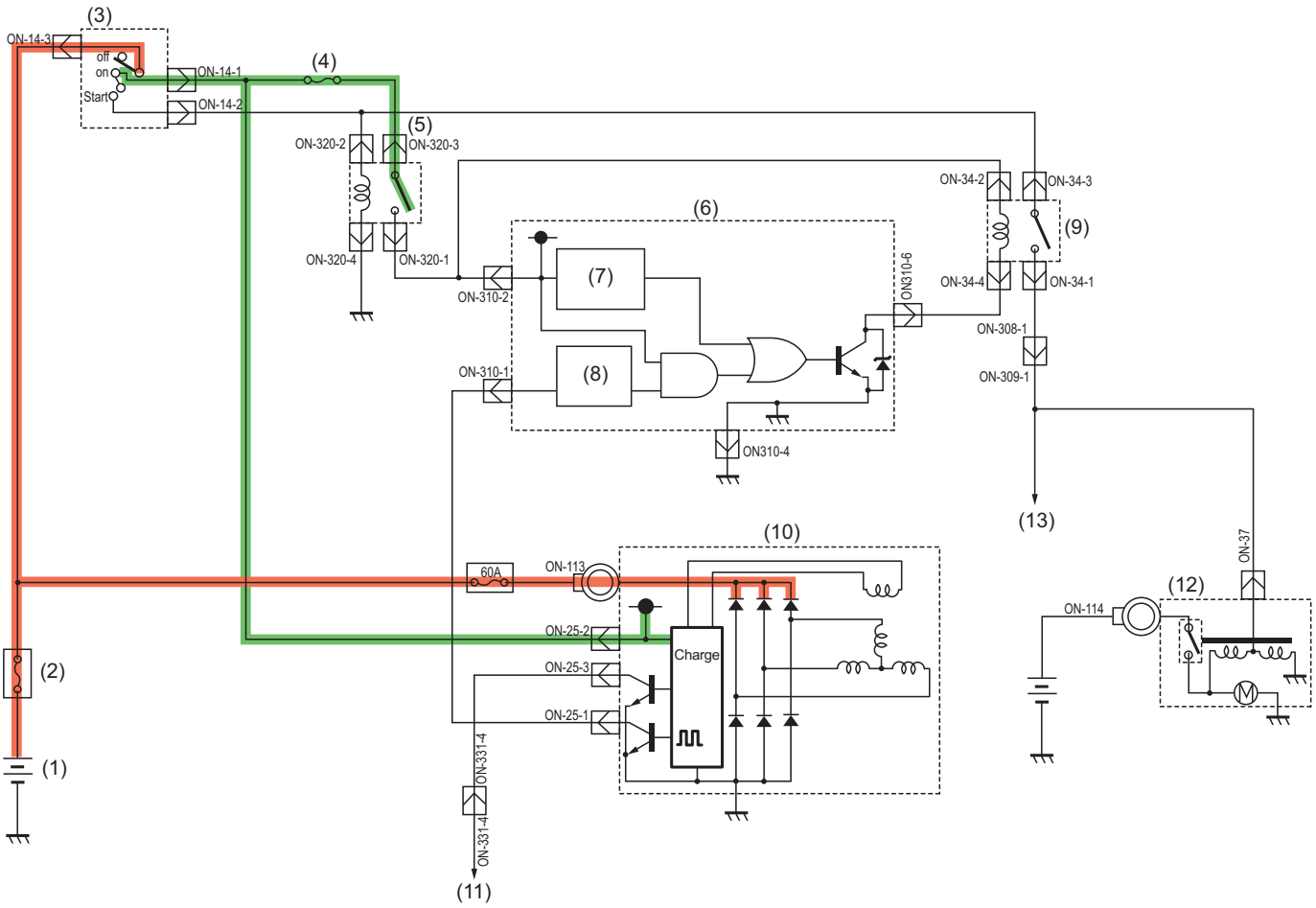
3. Key SW to engine start position



(1)	Battery	(9)	Auto release relay
(2)	Fuse 50A	(10)	Alternator
(3)	Key SW	(11)	Meter panel
(4)	Fuse SA 5A	(12)	Starter
(5)	Auto release stabilizing relay	(13)	To auto glow controller
(6)	Auto release controller		
(7)	Low-voltage detection		
(8)	Rotation detection		

1) Turn the key switch to the engine start position, and the battery voltage starts flowing as shown above and the auto release stabilize relay (5) turns on.
2) When the relay has turned on, current starts flowing in the auto release controller (6). This allows the base current into the transistor, which gets turned on.
3) Once the transistor has come on, the auto release relay (9) turns on too.
4) With the relay (9) now on, the battery current flows to turn on the starter solenoid switch. The start up current from the battery then switches on the starter, which gets the engine started.

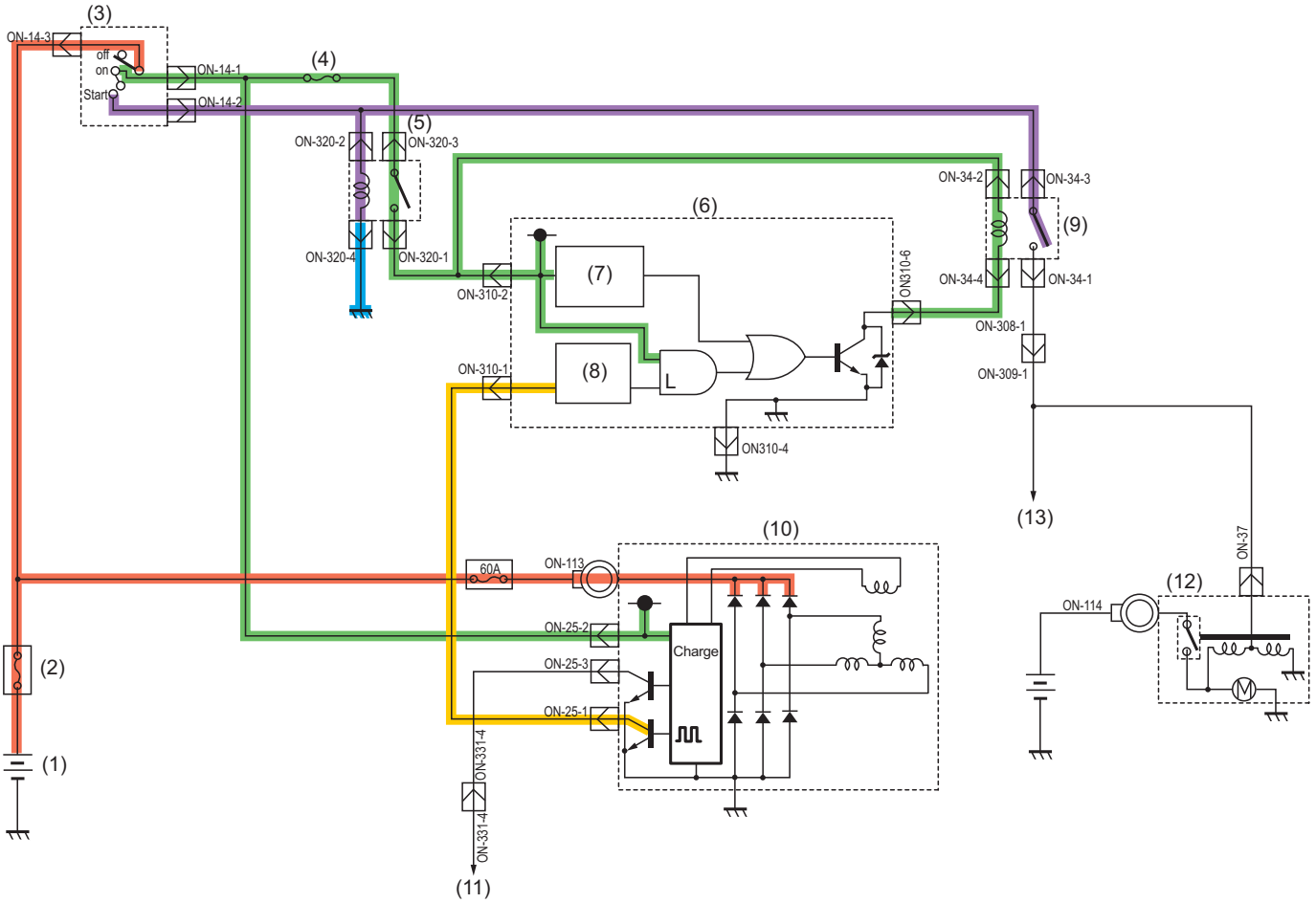
4. Key SW to AC position



(1)	Battery	(9)	Auto release relay
(2)	Fuse 50A	(10)	Alternator
(3)	Key SW	(11)	Meter panel
(4)	Fuse SA 5A	(12)	Starter
(5)	Auto release stabilizing relay	(13)	To auto glow controller
(6)	Auto release controller		
(7)	Low-voltage detection		
(8)	Rotation detection		

1) When the engine has got started, the operator is supposed to release the key at the engine start position. Now the key switch comes to the AC position.
2) The battery current stops flowing to the relay, which turns off the power to the starter.

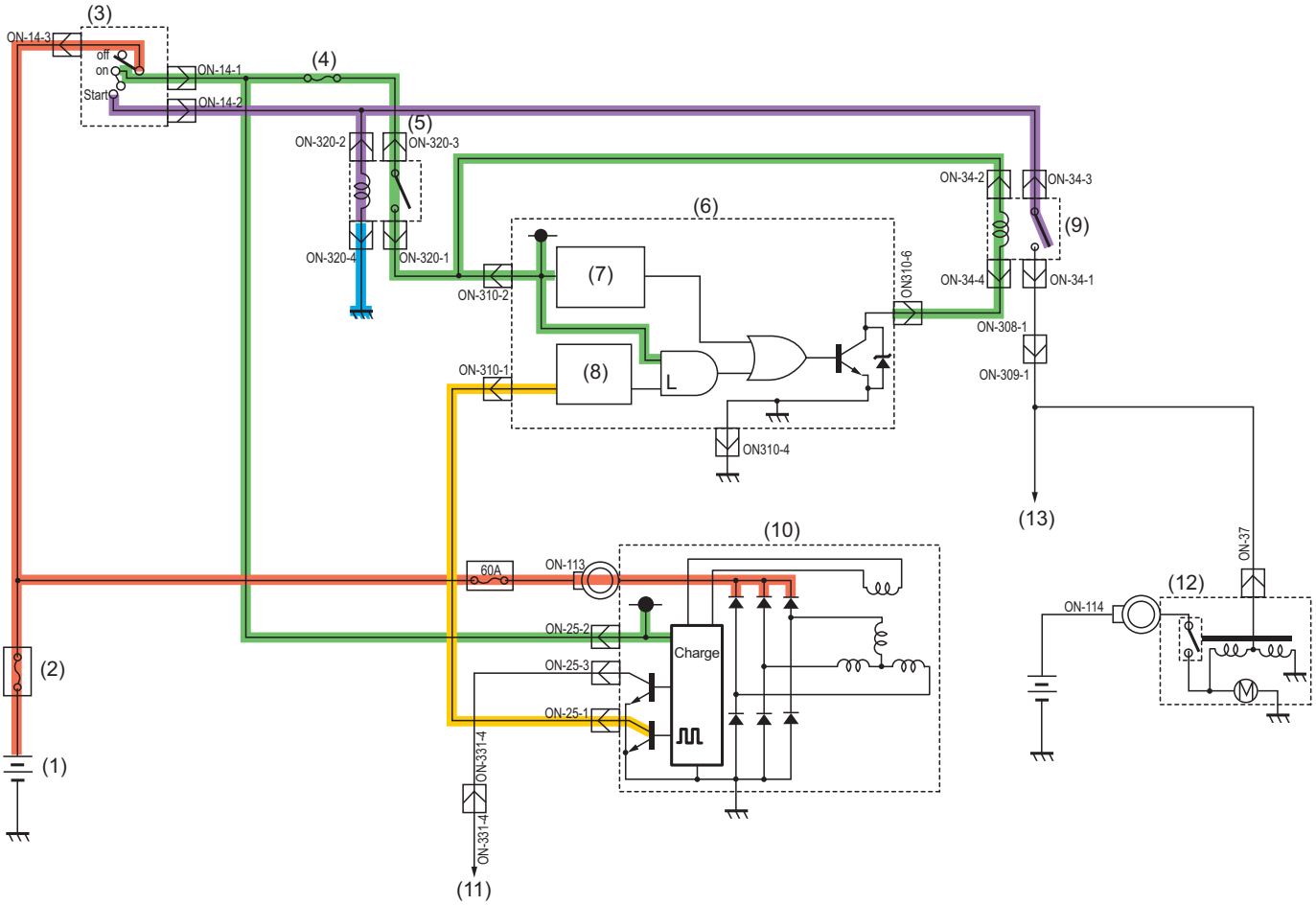
5. When the Key SW is stucked at the start position



(1)	Battery	(9)	Auto release relay
(2)	Fuse 50A	(10)	Alternator
(3)	Key SW	(11)	Meter panel
(4)	Fuse SA 5A	(12)	Starter
(5)	Auto release stabilizing relay	(13)	To auto glow controller
(6)	Auto release controller		
(7)	Low-voltage detection		
(8)	Rotation detection		

1) The key switch may get stuck for some reason. Even if the engine has got started and the operator has released the key, the key switch does not come back to the AC position.
2) With the key switch at the start position, the battery current starts flowing to turn on the auto release stabilize relay (5).
3) But the alternator (10) is sending the turning signal to the auto release controller (6). In so doing, the turning detection function gets activated and the auto release relay (9) turns off.
4) In this way, the battery current stops flowing to the starter (2). It helps protect the starter against burnout.

6. Key to the start position while engine is running



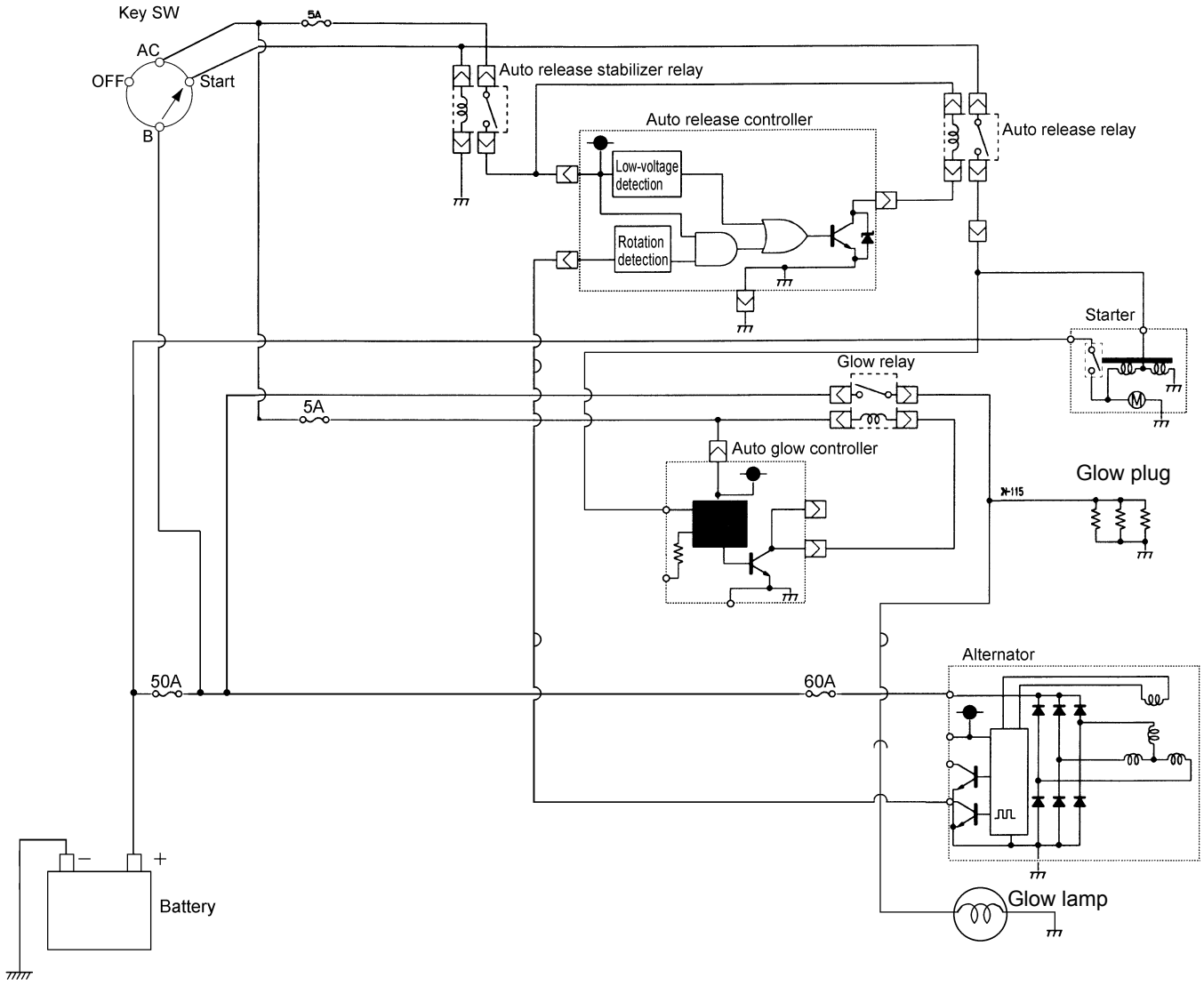
(1)	Battery	(9)	Auto release relay
(2)	Fuse 50A	(10)	Alternator
(3)	Key SW	(11)	Meter panel
(4)	Fuse SA 5A	(12)	Starter
(5)	Auto release stabilizing relay	(13)	To auto glow controller
(6)	Auto release controller		
(7)	Low-voltage detection		
(8)	Rotation detection		

1) Let's suppose that the operator turns the key to the start position while the engine is running.
2) In this case too, the turning signal comes from the alternator (10) as discussed before. In other words, the auto release relay (9) remains off.

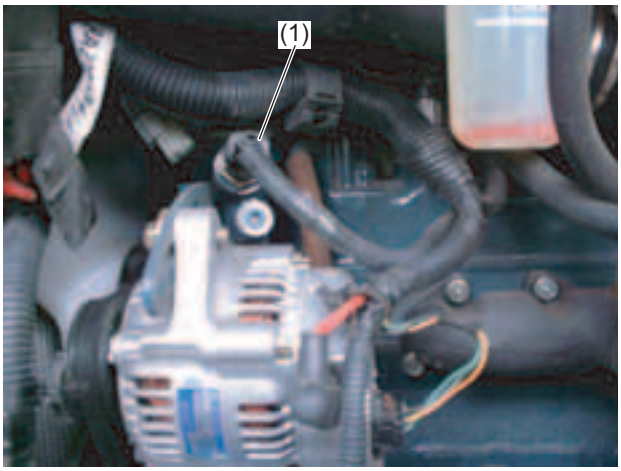
7. Function of low-voltage detection

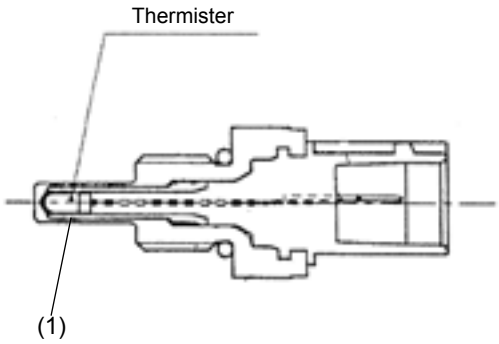
When battery voltage decreases down below 5 to 6 V at the cold start, this low-voltage detection functions to turn on the transistor and so turn on the auto release relay unconditionally.

8. Auto release and auto glow circuit combined



k. Water temp. sensor & gauge



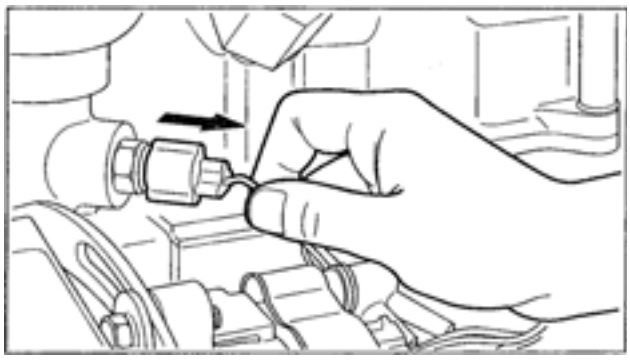


(1) sensor

1. Water temp. sensor circuit malfunction

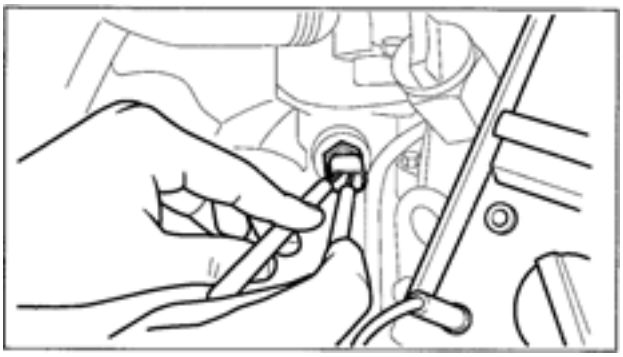
Water temp. sensor signal is sent to the auto glow controller.

1) Check couplers
Pull the harness to see if the water temperature sensor coupler is not out of position. Be sure that the coupler harness is tightly connected. (Pull by a 3 kg or less force.)
- If out of position, attach the coupler tightly and check the lamp and gauge again.



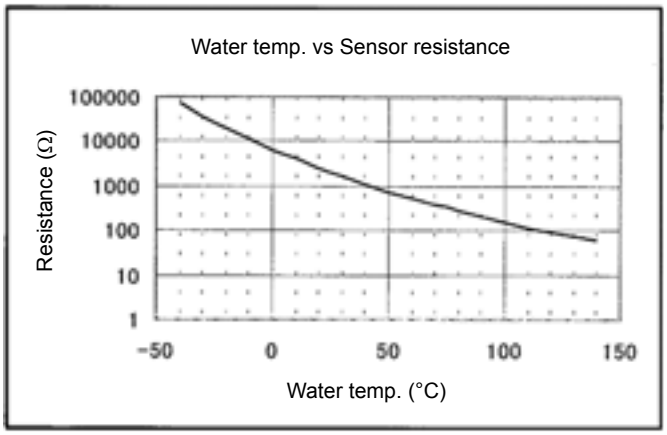
2) Check battery voltage at (+) terminal of harness coupler.
If no battery voltage, check the fuse and continuity of wireharness.
Sample data is 0.979V.

3) Water temperature sensor check
• Disconnect the coupler from the water temperature sensor and measure the resistance referring to the figure at right.



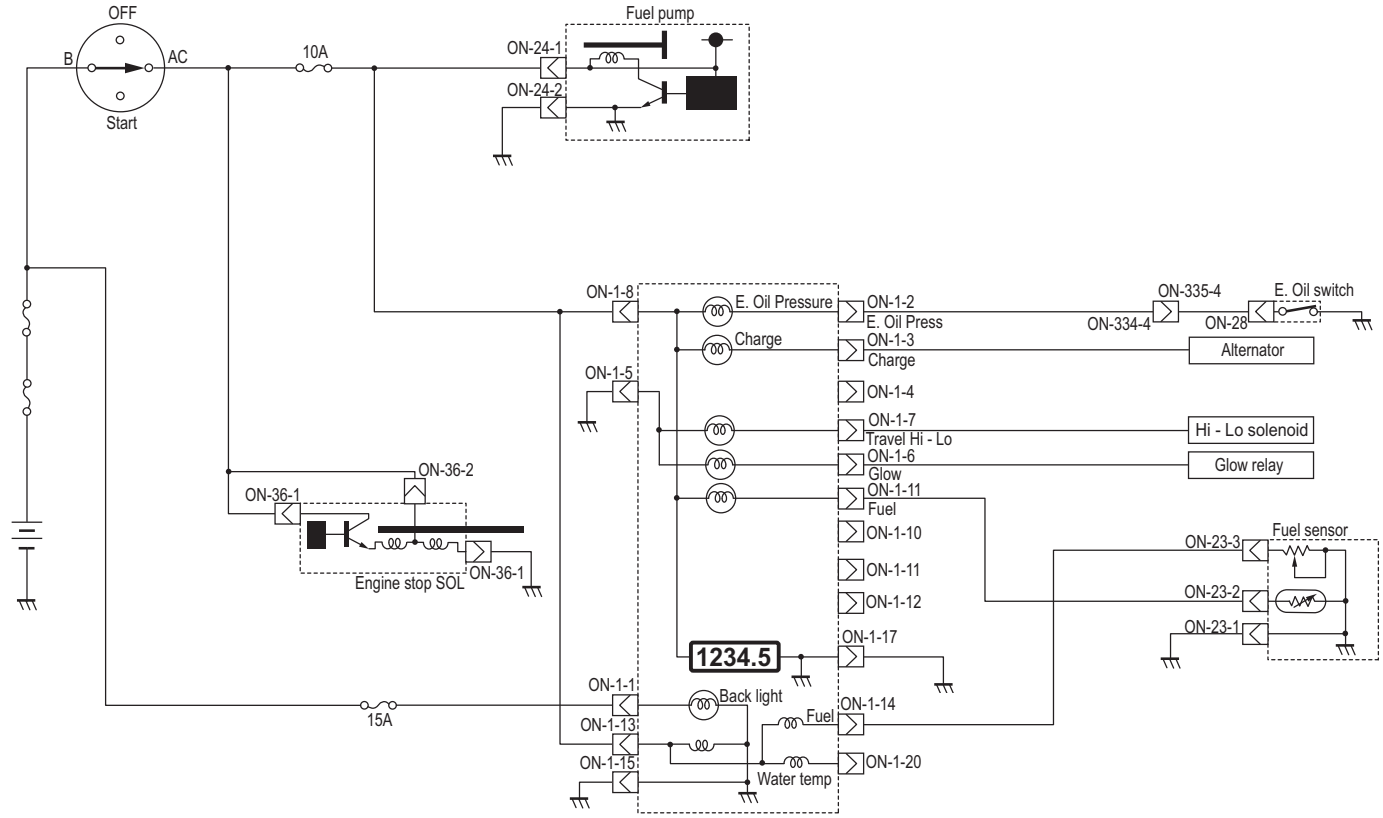
The temperature vs. resistance curve must meet the criteria listed below.

Temp (°C)	Resistance (kΩ)
-20	18.80 ± 12.6%
40	1.136 ± 8.4%
100	0.1553 ± 4.5%

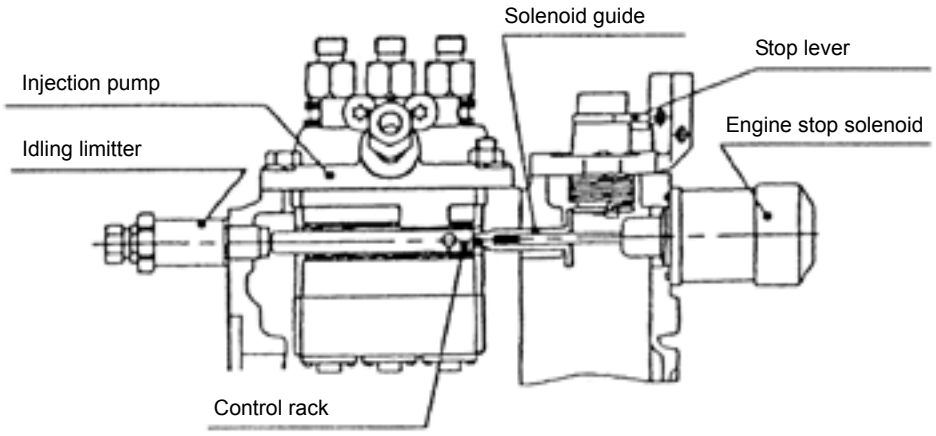


I. Fuel control circuit

(1) Function)



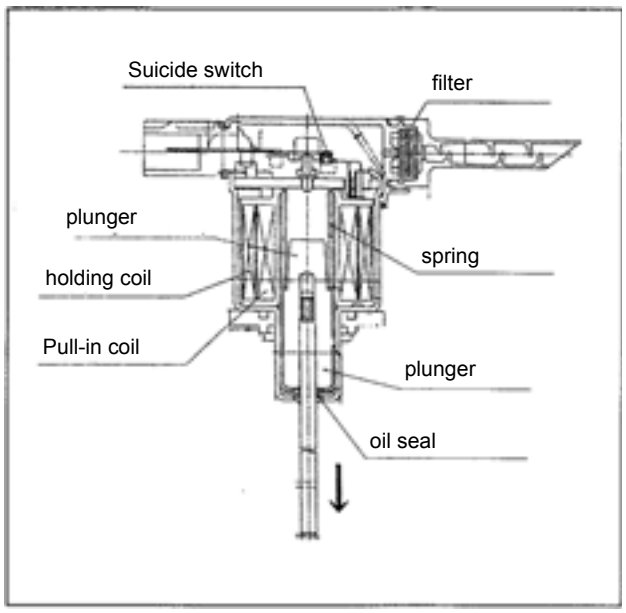
Engine stop solenoid



1. The fuel control circuit is mainly composed of the following devices.
   1)Fuel feed pump
   2)Engine stop solenoid
   3)Fuel gauge
   4)Fuel sensor
   5)Fuel residual sensor
2. The fuel sensor detects the position of the float and the remaining fuel amount is displayed in the fuel gauge.
3. The fuel residual sensor has a thermistor. When the sensor is well below the fuel level, the resistance value is high enough to allow no current to the warning lamp. If the fuel level has dropped below specified, however, the thermistor gets exposed to the air and becomes smaller in resistance. This allows the current to flow to the warning lamp that will light up.

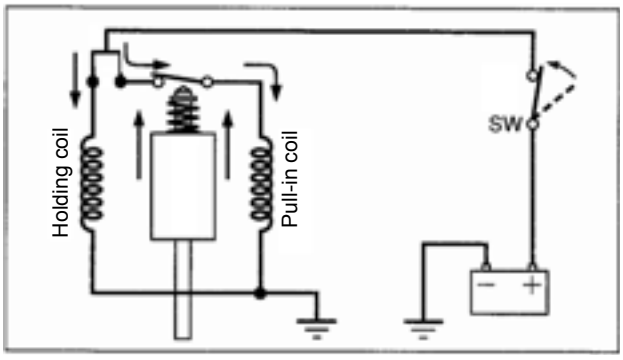
m.Engine stop solenoid

1. Structure



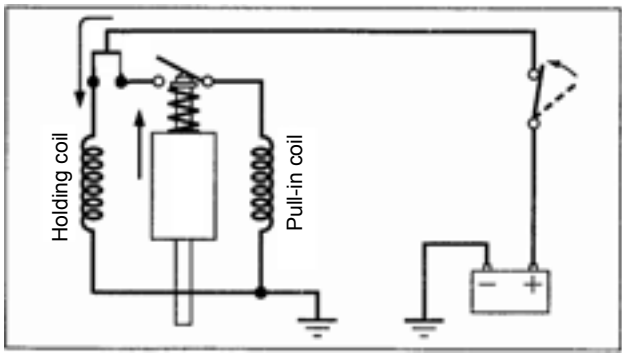
Specifications

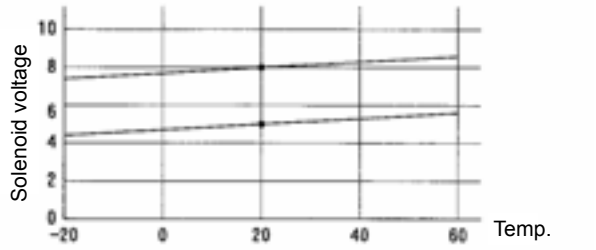
1. Rated voltage :DC12V
2. Rated ampare
   Pull-in coil :32A / DC12V
   Hold coil :77A / DC12V
   at 20°C
3. Resistance (Sample data)
   Pull-in coil : 0.3 ~ 0.8 Ω
   Hold coil : 15.0 ~ 16.0 Ω



2. Circuit and its function

The engine stop solenoid circuit is as shown at left.
Turn the key switch to the ON position, and the battery current flows both to the pull-in coil and the holding coil. These coils are excited to attract and lift the plunger.
Now the fuel injection pump is ready to get the engine started.
Being attracted upward, the plunger pushes and opens the contact, which discontinues the current flow to the pull-in coil.
With the current still flowing to the holding coil, the plunger stays in this position.
Turn the key switch to the OFF position, and the current flow to the holding coil is also interrupted. By the force of the return spring, the plunger comes back to the original position. By so doing, the fuel injection pump will be back to the engine-off status.





3. Engine stop solenoid

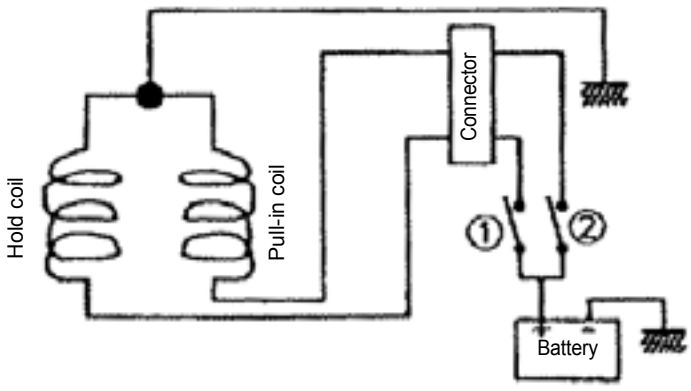
(C/N 1A021-6001-3)

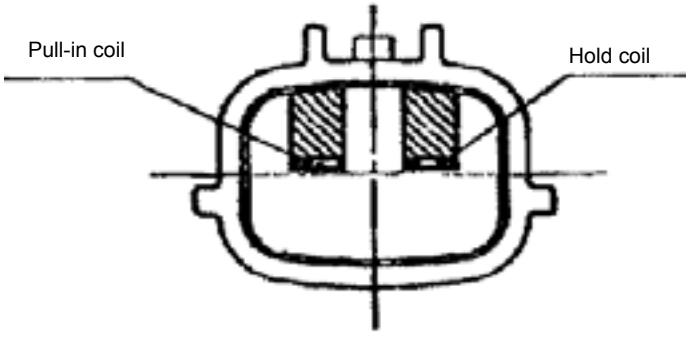
Operation of engine stop solenoid can be test as in the pictures.

1) Connect 12 V battery voltage to two terminal of engine stop solenoid.
2) Get body earth as shown in picture.
3) Then plunger pin comes out.
   This means pull-in coil is normal.

4) Take off pull-in coil terminal connection.
5) Plunger pin still keeps pushing out.
   This means hold-coil is normal.

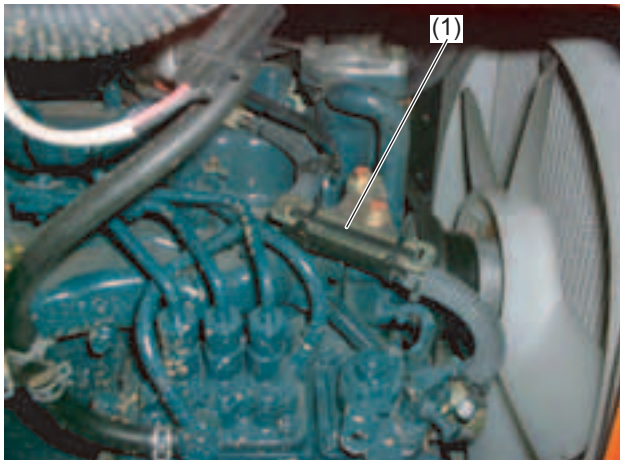
6) Take off second terminal connection.
7) This time plunger pin should be returned back by spring.
   This means engine stop solenoid functions normal.





n. coil commander

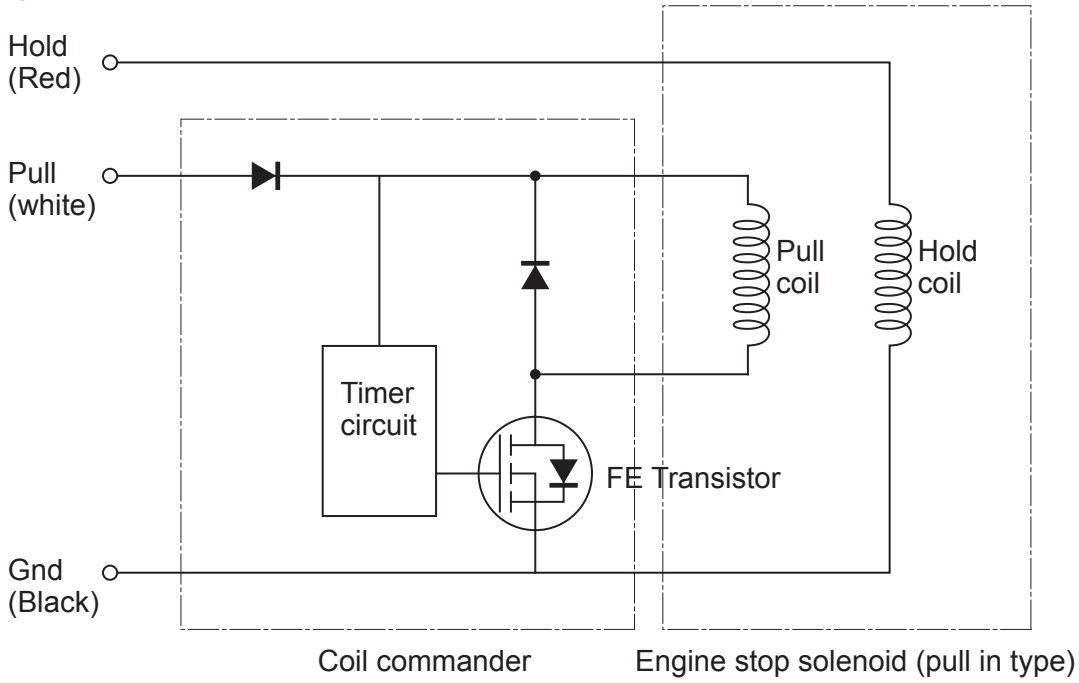
1. Location



The coil commander is connected with the engine stop solenoid as shown in the picture.

(1) Coil commander
Resistance (Sample data)
Red ↔ Black : 21.2 Ω
White → Black : 77.1 Ω

2. Circuit diagram

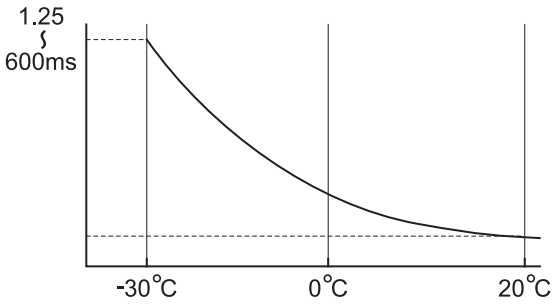


3. Function

Under some condition, such as low temp, large current flows to pull coil and may cause to cut the coil.

Coil commander is to regulate the current flow to pull coil by controlling the current time according to the temperature

Temperature vs Current Time

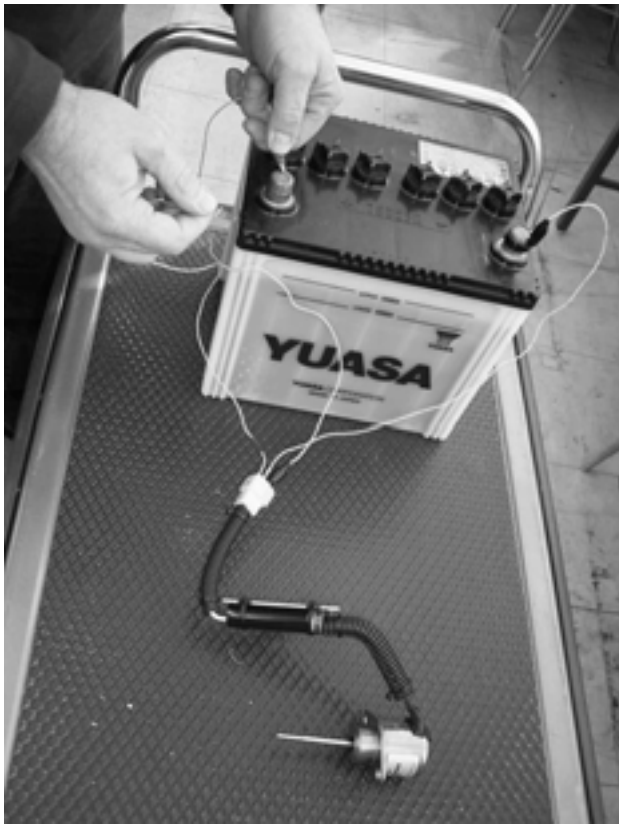


4. Inspeetion & troubleshooting

1) Check the continuity of hold coil.
2) Check pull in coil function after wiring 12V to red and while terminal and ground to black color terminal.
   Then engine solenoid functions and pull in the plunger head.

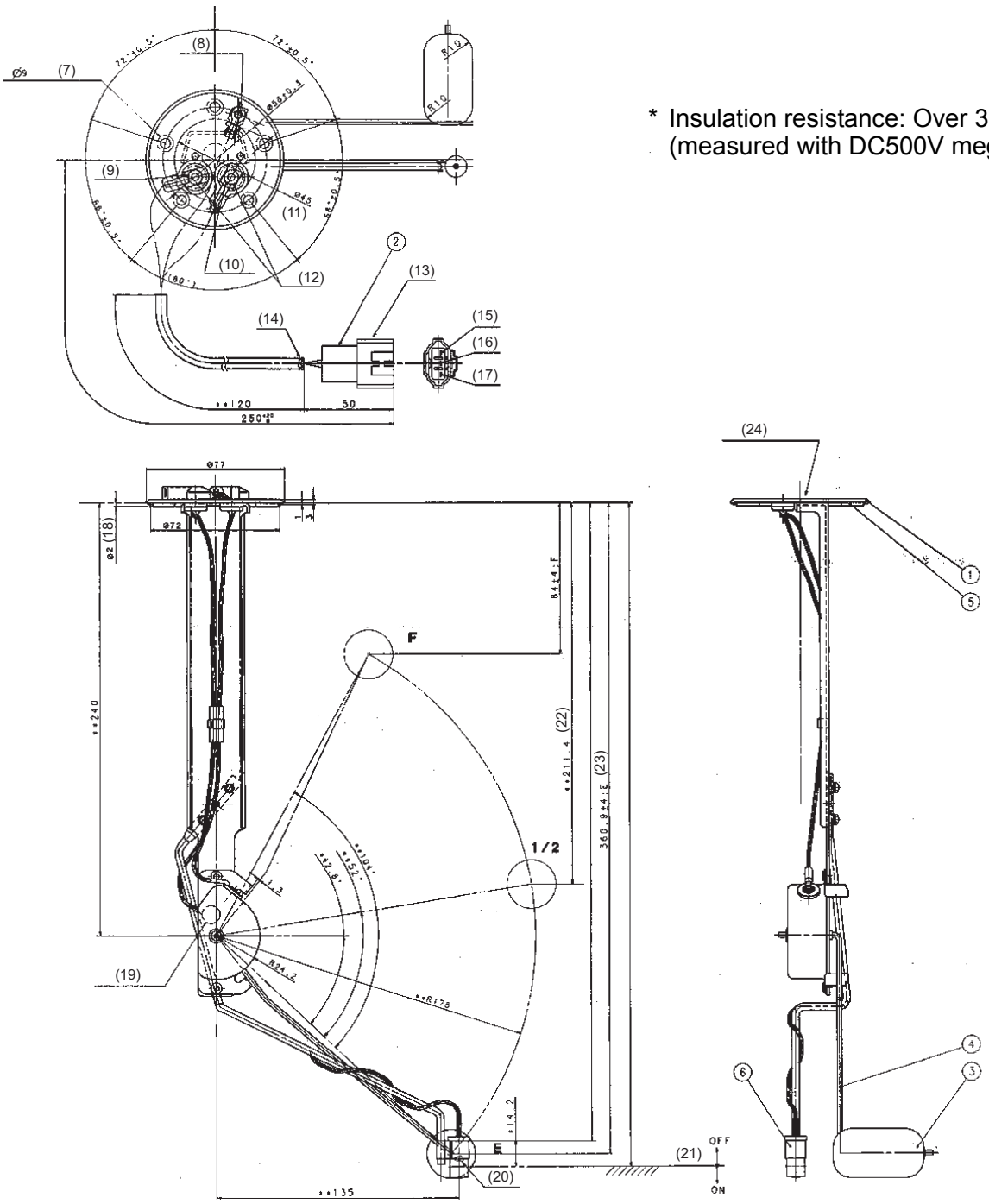
Photo : pull in condition

Photo : hold condition



o. Fuel sensor

1. Fuel sensor



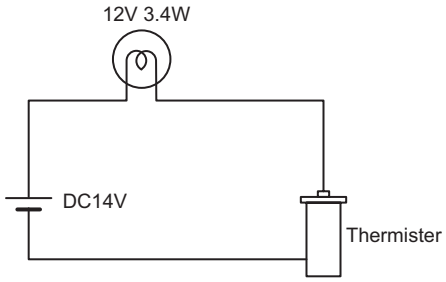
* Insulation resistance: Over 3 M Ω
(measured with DC500V megger)

(1) Lock collar assembly
(2) Cord assembly
(3) Float
(4) Float arm
(5) Mount spacer
(6) Thermistor assembly
(7) (Tank mounting pan-head screw dia.)
(8) Terminal to be retightened GND (black)
(9) F. unit (blue)
(10) Thermistor (red)
(11) (Tank hole)
(12) Sealing compound to be applied
(13) Connector housing: Sumitomo HM090, water-proof, SPM
Sumitomo Denso Part Code (6187-3801)
(14) Heat fusion
(15) GND AV0.5f (black)
(16) Unit AV0.5f (blue)
(17) Thermistor AV0.5f (black)
(18) When mounted
(19) Manufacturing date code stamped (Black indelible ink)
(20) Soldered
(21) Remaining-fuel sensor action level
(22) (Fuel shortage warning level: Production Control Dimension)
(23) Fuel shortage warning
(24) Terminal not atop lock collar

Fuel tank
Light oil or light oil gas
Water or mud deposits possible on flange surface
DC 12V
DC 10 ~ 16V

Float position	Full	1/2	Empty
Resistance (Ω)	3	32.5	110
Allowable error (Ω)	± 2	± 5	± 5

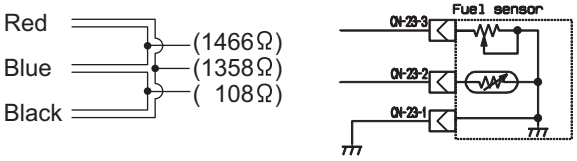
To be measured with constant current of 40 mA.



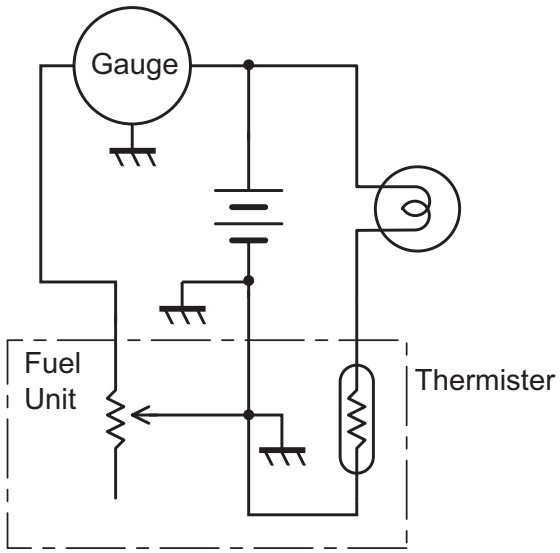
Circuit diagram

2. Fuel sensor testing

Sample data at certain amount of fuel.



1) Pull the harness to see if the fuel sensor couplers and the relay couplers are not out of position. Be sure that the coupler harness is tightly connected.
   • If out of position, attach the coupler tightly and check the meter reading again.



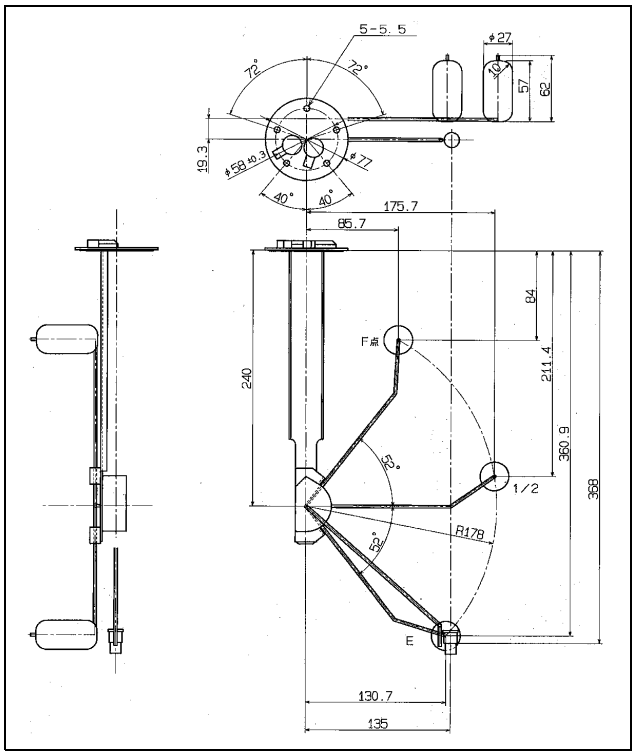
2) Check battery voltage at (+) terminal of wireharness-coupler.
If no battery voltage, check the fuse and continuity of wireharness.

3) Fuel sensor check
- Apply the positive (+) test lead to the coupler-fitted terminal.
- Apply the negative (-) test lead to the plated part to measure the resistance.

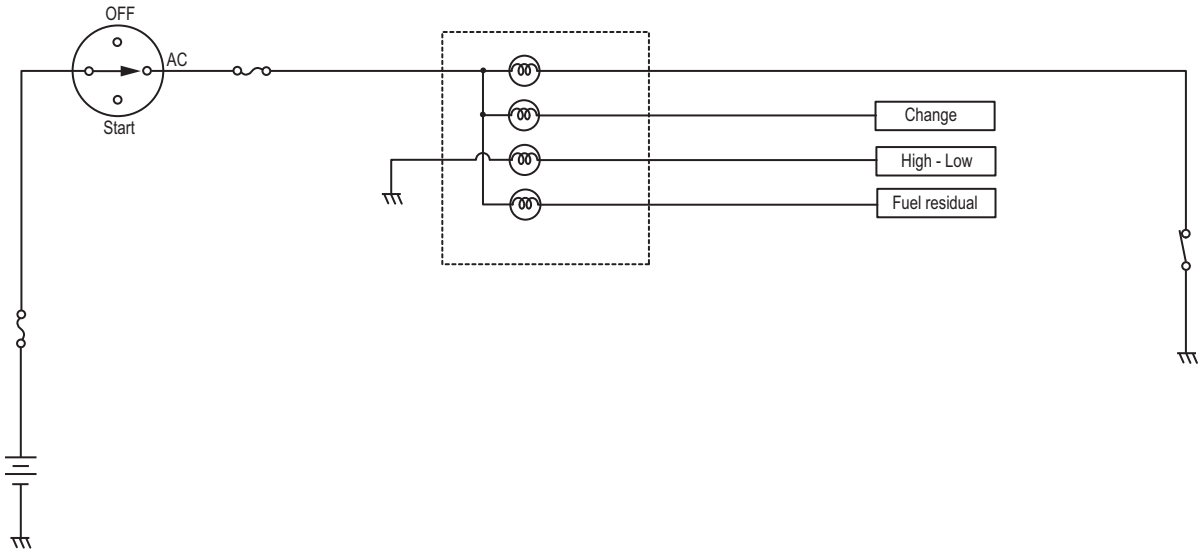
- Ref. value

Float position	F	1/2	E
Resistance (Ω)	3 ± 1.5	32.5 ± 1.5	110 ± 3.5

4) Directly connect the (+) terminal of wireharness coupler to the earth.
Then meter gauge indication raises gradually up to full range.
Because resistance is 0Ω.
In this case, meter gauge function is normal.



p. Engine oil pressure sensor circuit



1. Engine oil pressure sensor is N.C.(Normal close) type.
2. Check relay is N.O.(Normal open) type.
3. Meter panel (Big): (1)Engine oil pressure line.
   (2)Battery IG(+)
   (3)Charge line
   (4)Check relay line

Oil switch

1. Code No, :15531-39011
2. DC12V
3. Warning lamp :SW
4. Operating pressure :0.5 ± 0.1 kgf/cm^2
5. Insulation resistance :3MΩ or more

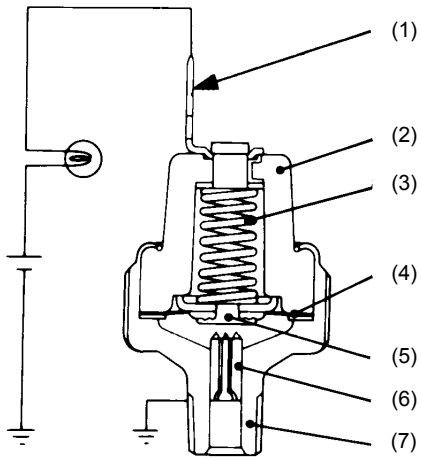
(1) In normal condition
When the engine lube oil pressure goes up, the contact of oil switch 6 opens to turn off the lamp.

(2) In trouble
When the above pressure comes down, the contact of oil switch 6 closes to turn on the lamp.

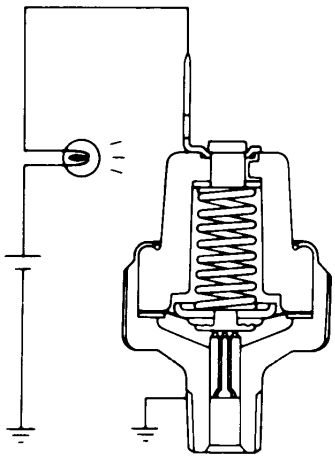
Operating pressure of oil switch
·····Ref. value : 0.5 kgf/cm^2 , 7.1 psi, 0.05 MPa

(1) Turminal
(2) Insulator
(3) Spring
(4) Rubber
(5) Contact revet
(6) Contact
(7) Body

(1) In normal



(2) In trouble



q. Engine electrical system

1. Engine oil pressure failure

1) Check engine oil pressure lamp.

Engine Condition	Lamp condition		
	Normal	Trouble case (1)	Trouble case (2)
Before engine starts	ON	ON	OFF
After engine starts	OFF	ON	OFF

Trouble case (1) :Engine oil pressure is low or oil switch fails.
Trouble case (2) :Wire harness is cut or oil switch fails.

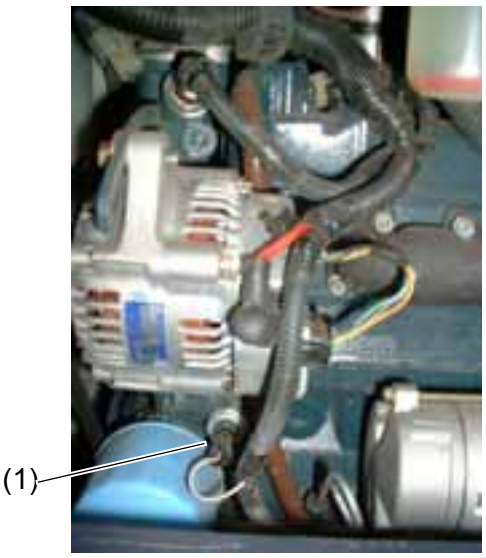
2) Check oil amount and replenish if nessesary.

3) Pull the harness to see if the oil switch coupler is not out of position. Be sure that the coupler harness is tightly connected. (Pull by a 3 kg or less force.)
   • If out of position, attach the coupler tightly and check the meter reading again.

4) Check battery valtage at (+).
Terminal of wireharness coupler. If no battery voltage, check the fuse and continuity of wireharness.

5) Check continuity of oil switch between switch terminal and body earth.

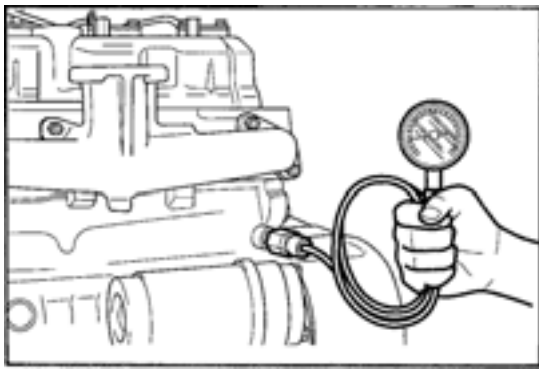
Engine condition	Continuity of oil switch
Engine stop	Yes
Engine starts	No
Engine oil switch is NC (Normal close) type.	



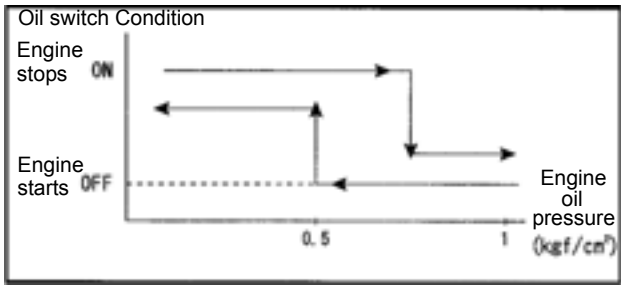
(1) Engine oil pressure sensor (NC)

6) Check engine oil pressure

Idling rpm	0.4 MPa(4 kgf/cm^2)
MAX. rpm	0.6 MPa(6 kgf/cm^2)



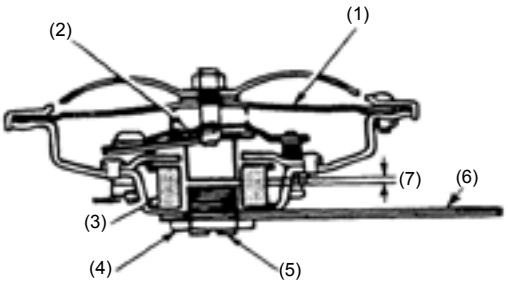
- Oil switch operating pressure
  Ref. value:0.05 ± 0.01MPa (0.5 ± 0.1kgf/cm^2)



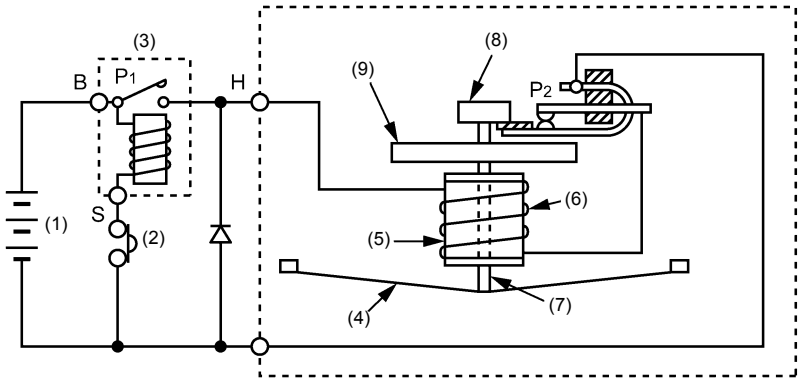
r. Horn circuit

1. Structure

(1) Diaphram
(2) Point
(3) Horn coil
(4) Nut
(5) Stop screw
(6) Stay
(7) Air gap



The horn consists of acoustic diaphragm, point, horn coil and other parts. It comes in spiral, flat and other types in construction.
Currently, the flat type is most widely used. A typical flat horn is shown at right.

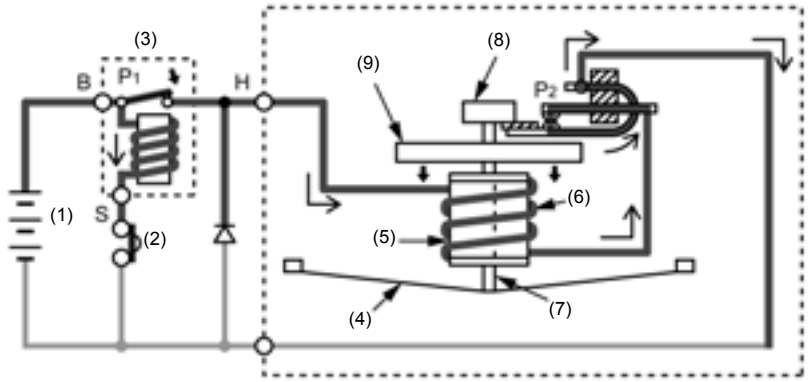


(1) Battery
(2) Horn switch
(3) Horn relay
(4) Diaphram
(5) Core
(6) Coil
(7) Moving bolt
(8) Adjust nut
(9) Moving plate

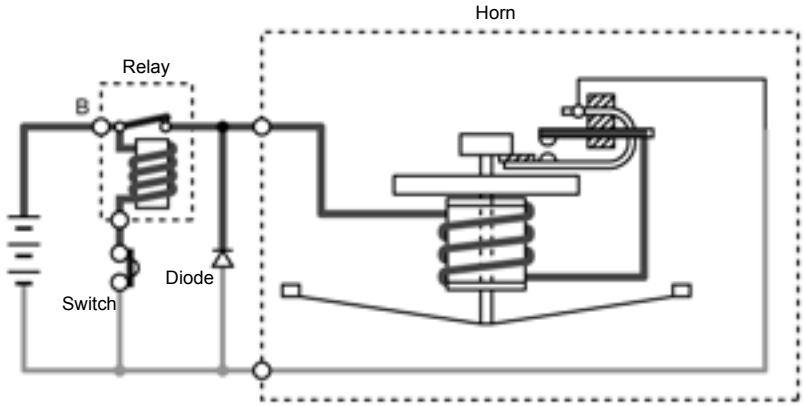
2. Function

Shown above is the horn drive circuit. When the horn switch is pressed, current flows to the horn relay to get its contact P1 closed. The current from the battery now flows directly through the horn coil and the contact P2, which magnetizes the core and attracts the moving plate. Then the contact P2 opens itself and the current is interrupted. The magnetic force then disappears and the spring-loaded diaphragm comes back to the original position. The contact P2 closes itself, and the current flows again through the coil to attract the moving plate. The above series of actions are repeated to keep the diaphragm vibrating, producing sound.

3. Current flow



(1) Battery
(2) Horn switch
(3) Horn relay
(4) Diaphram
(5) Core
(6) Coil
(7) Moving bolt
(8) Adjust nut
(9) Moving plate



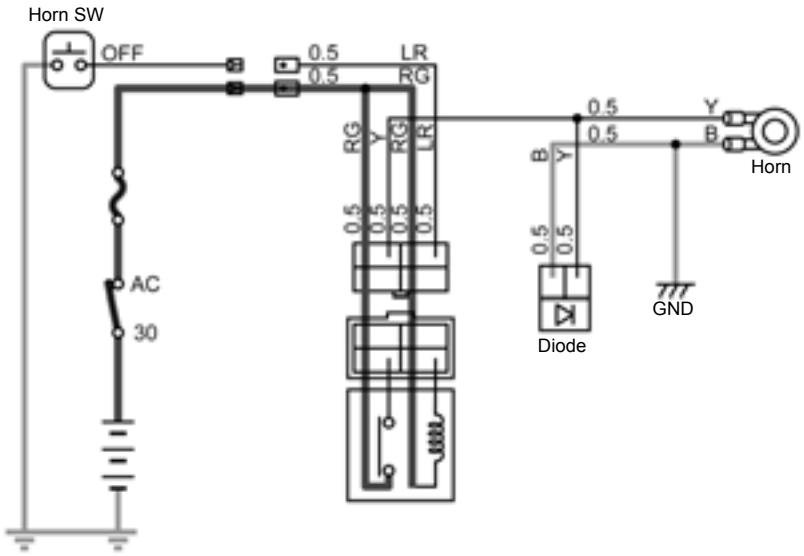
For your information

1. Function of diode: Prevention of horn switch by absorbing the surge current.
   Inductive type of load, such as solenoid valve generates arc spark at switch point.
   This diode installed parallel to solenoid valve let the surge current energy flow back to coil to consume as a joule heat.
   In this way, surge current won't flow to horn switch.

4. Horn circuit

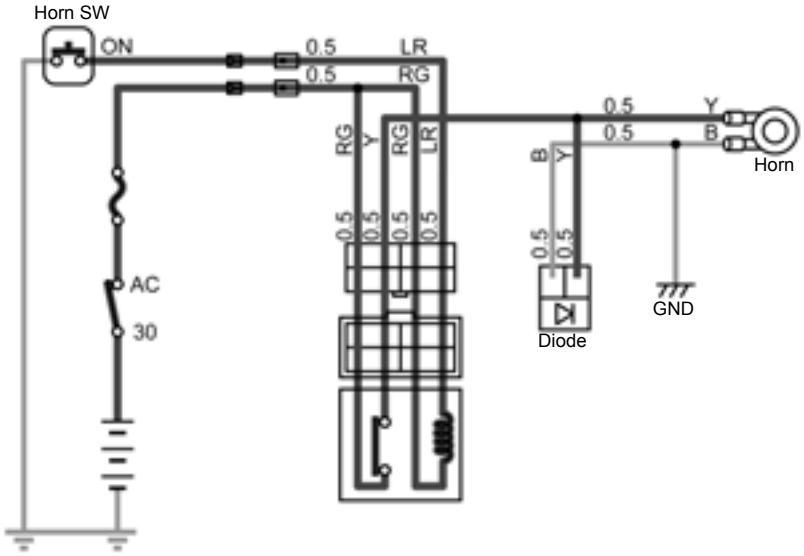
- When horn switch is off, current doesnít flow through relay.
  So relay remains off condition and horn doesnít sound.

(Horn SW is off position)



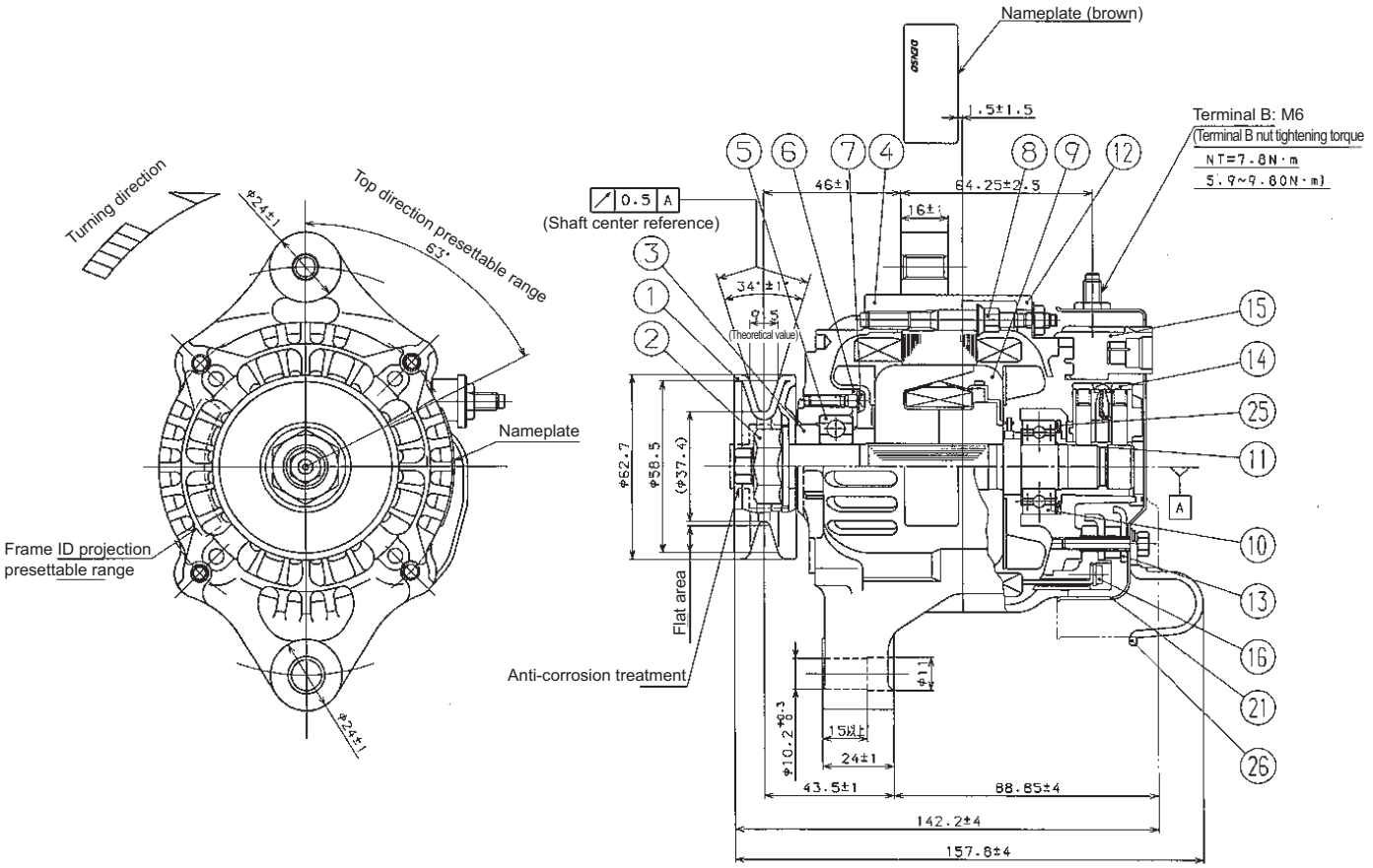
- When horn switch is on position, current flows through relay, magnetizes it and activates horn.

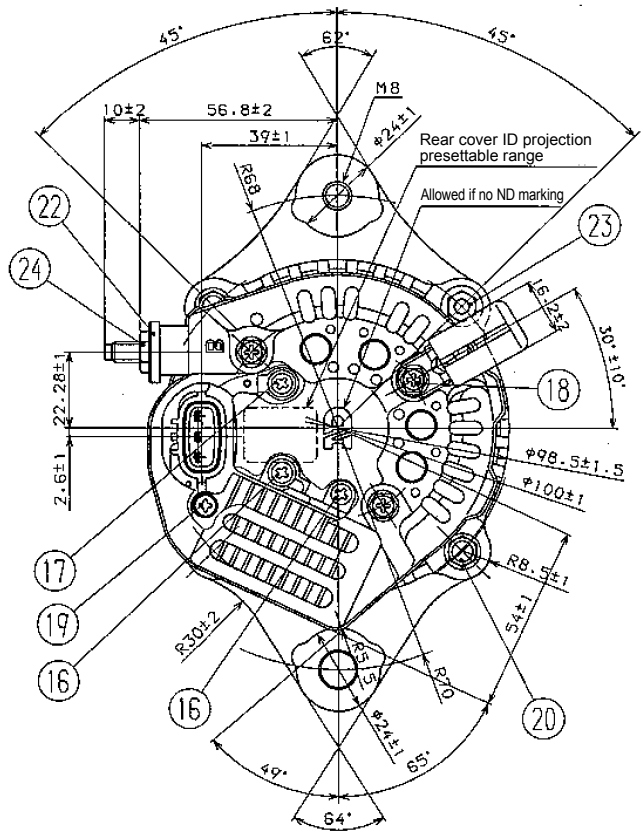
(Horn SW is on position)

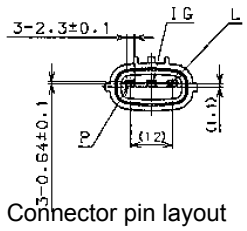


s. Charging system (Alternator)

1) Alternator structure (Code No. 16678-64012)



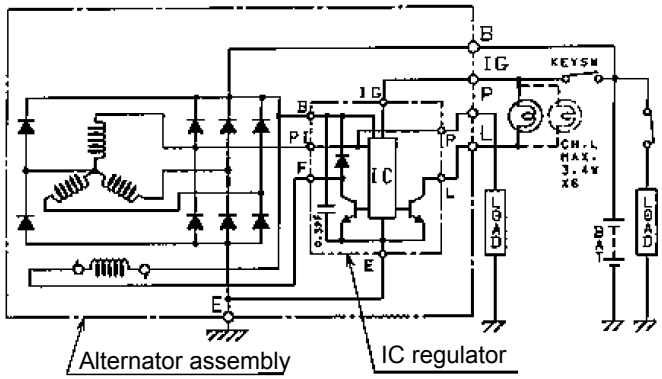




Connector pin layout

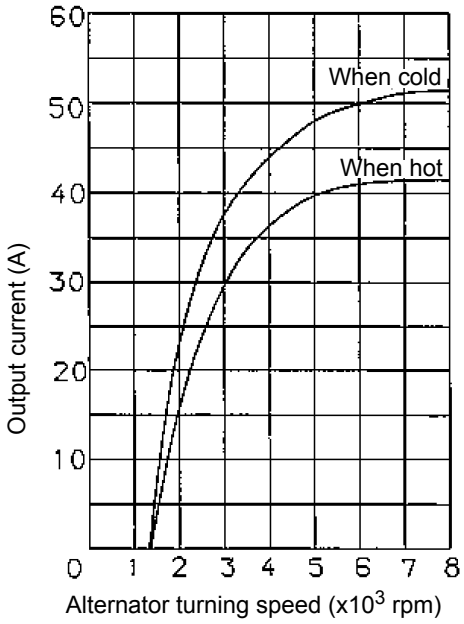
(1) Pulley
(2) Nut
(3) Collar, space
(4) Frame assembly, drive end
(5) Bearing, ball
(6) Plate, retainer
(7) Screw
(8) Bolt, stud
(9) Rotor assembly
(10) Bearing, ball
(11) Cover, bearing
(12) Frame, end, rear
(13) Holder subassembly, rectifier
(14) Holder subassembly, brush
(15) Regulator assembly
(16) Screw, with washer
(17) Screw with washer
(18) Bolt, with washer
(19) Screw with washer
(20) Bolt, with washer
(21) Cover, end, rear
(22) Insulation bushing, terminal
(23) Nut
(24) Nut
(25) Washer

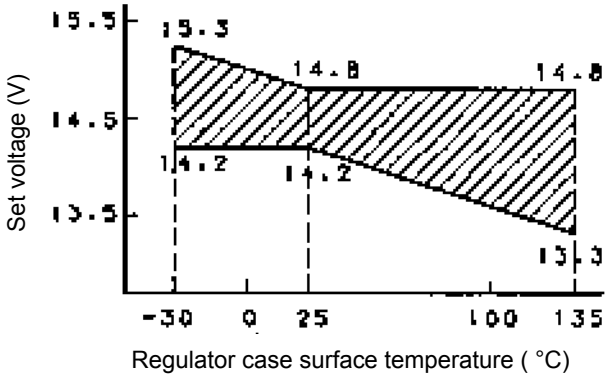
2) Circuit diagram



3) Specifications

Standard characteristics
(3.5V constant, ambient temperature 25 °C)



Rated voltage	12 V
Rated output (13.5 V when hot)	40 A (500rpm)
Startup rpm (13.5 V when hot)	1350 rpm
Allowable maximum rpm	15000 rpm
Allowable ambient temperature	-30 °C ~ 90 °C
Turning direction	Right (when viewed from pulley)
Polarity	Negative-side grounding
Weight	About 2.75 kg
Initial excitation function	Total excitation
Allowable input load at terminal L	Lamp 12V: 3.4W x 6 pcs.
Potential at terminal L	Generation off: Below 1.5V (With alarm on) (12V applied at terminal IG)
Output current at terminal P	Average current: Below 0.5A
Vibration proof (overall value of alternator itself)	Up/down, right/left: 290 m/s^2 To-and-fro (axial): 250 m/s^2
Belt tension (Type HM)	270 ~ 444 N
Regulator set voltage	14.2 ~ 14.8 V / 500rpm, 10A, 25 °C
Set voltage vs. temperature  	
Alarm function: Broken rotor coil	Charge lamp light-up

4. Charging system malfunction

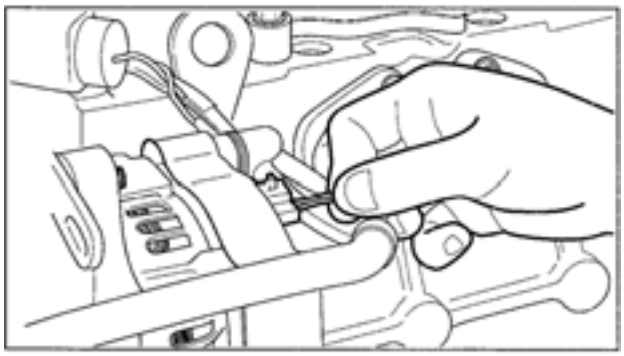
1) Check charge lamp condition.

Engine Condition	Lamp condition		
	Normal	Trouble case (1)	Trouble case (2)
Engine stops	ON	ON	OFF
Engine starts	OFF	ON	OFF

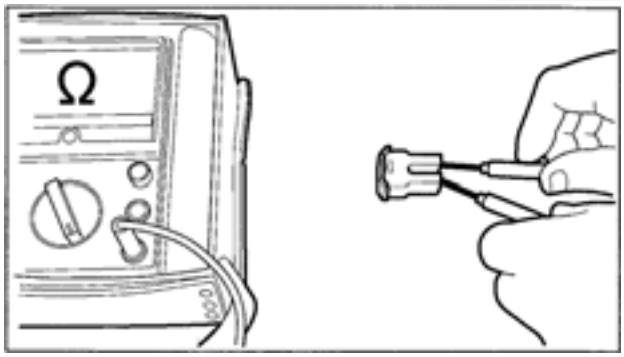
Trouble case (1):Fan belt breakage, B-terminal failure charging system malfunction.
Trouble case (2):Wireharness problem, L-terminal failure

2) Pull the harness to see if the alternator coupler is not out of position. Be sure that the coupler harness is tightly connected. (Pull by a 3 kg or less force.)

   • If out of position, attach the coupler tightly and check the lamp.

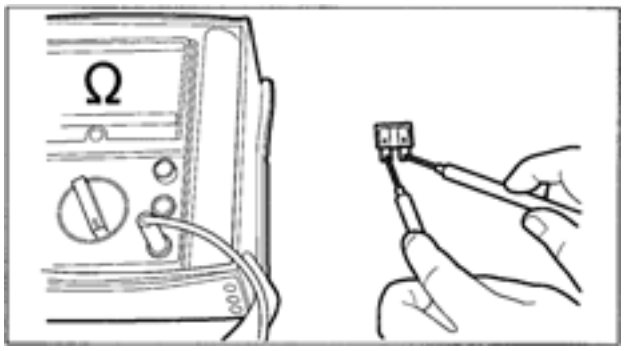


3) Check for continuity to make sure the 60A slow-blow fuse (60A) is not blown out.



4) Check for continuity to make sure the 15A fuse is not blown out. (For the travel hi-speed and fuel pump)

   • If this fuse is blown out, both the fuel pump and travel hi-speed control do not work.



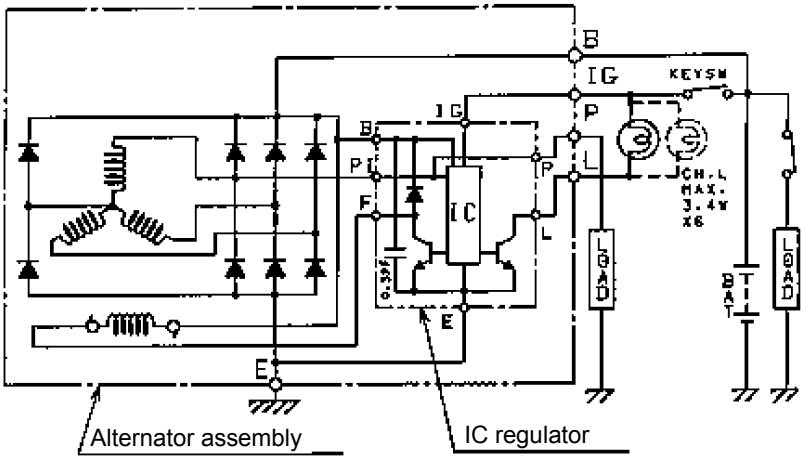
5) Check battery voltage at B-terminal of wireharness coupler.
If no battery voltage, check the fuse and continuity of wireharness.

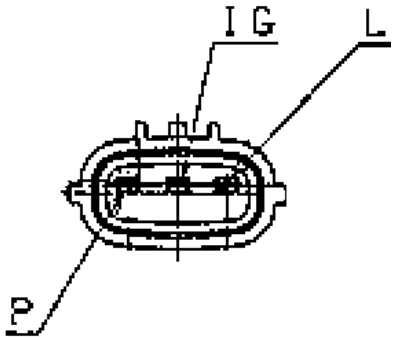
6) Alternator B-terminal check

1)Measure the voltage between the alternator's terminal B and the body ground. Make sure the measurement is 12 V or so. If the measured voltage is lower than this, it means that the battery capacity may be low or that the wire connections before the alternator may be loose.

2)Next start the engine and measure the voltage being generated while the alternator is running. For this, measure the voltage between the alternator's terminal B and the body ground. Make sure the measurement goes up to 14 V or so (alternator-generated voltage). If the measurement is still the battery voltage (12 V or so), it means that the alternator or the regulator may be in trouble.

7) P-terminal check
P-terminal signal indicates the alternator speed.
This pulse signal is sent to the auto release controller terminal (CN-310-1) to detect the engine rotating condition.

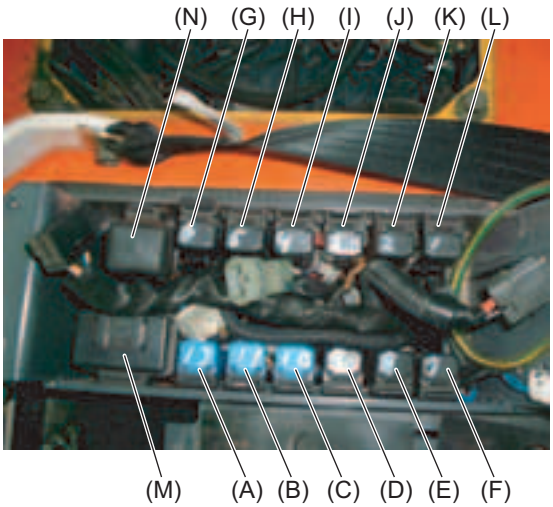




t. Relay

1. Relays location

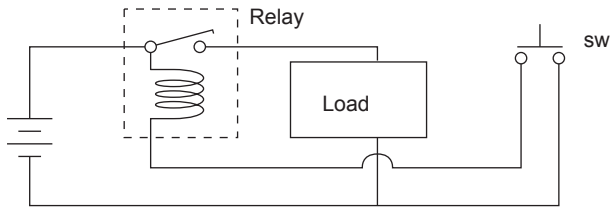
(A) Starter lock relay
(B) Auto release relay
(C) Auto release stabilizer relay
(D) ESS relay
(E) Lever lock relay
(F) Cab relay
(G) First self hold relay
(H) Reverse relay
(I) Second self hold relay
(J) Self hold release relay
(K) Travel high relay
(L) Horn relay
(M) Auto release controller
(N) Auto glow controller
(D)·(E) Anti theft version only



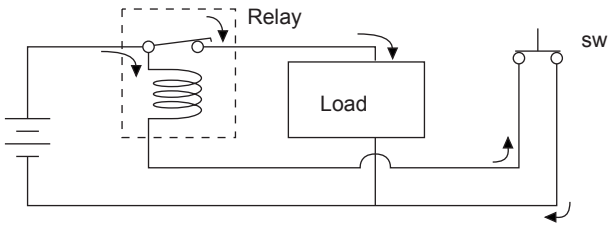
2. Purpose of relays

Electrical devices on the load side - heater, glow plug, cab instruments, for example - tend to require large current. This means that the wire harnesses running the power source up to the switches and loads must involve thick, large-capacity cables. This is disadvantageous in costs, weight and safety. What's worse, turning on and off a large-current circuit with a manual switch may cause a spark and get the switch in trouble.
Here come the relays in the switching circuits. The relays can be on/off-controlled using fine, small-current cables, and the switches can last longer. These switches may also be conveniently located.
A large-capacity harness may be connected from the power source via the relay to the load. In this design, the harness is made shorter, less expensive, and safer.

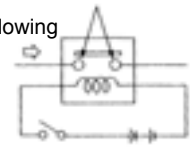
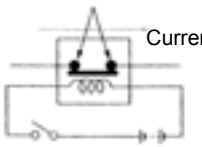
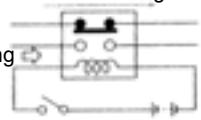
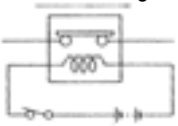
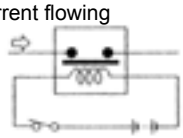
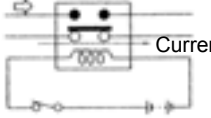
1) Switch OFF



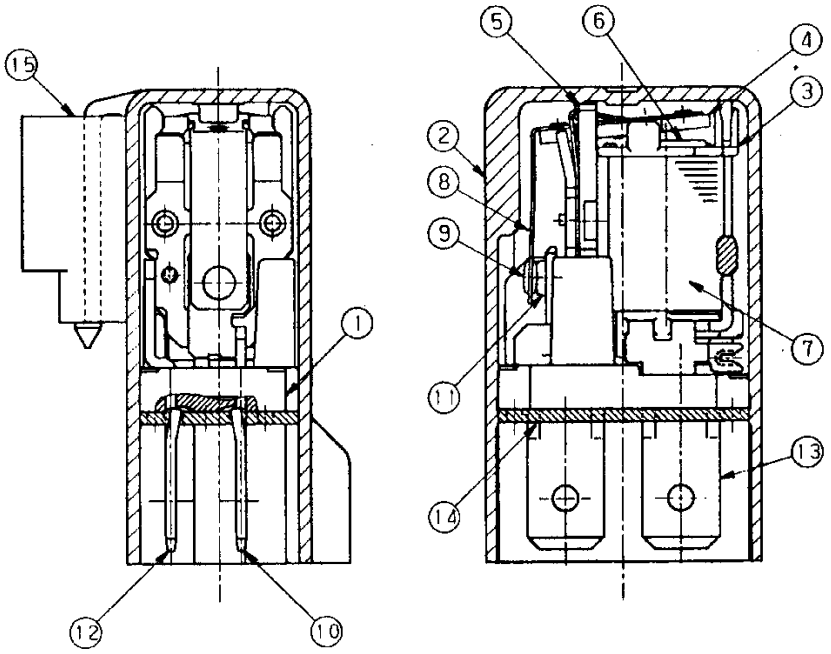
2) Switch ON



Type of relay

	Normal open relay (a-type)	Normal close relay (b-type)	Combined relay
Normal state	Contacts marked with white dots No current flowing 	Contacts marked with black dots Current flowing 	Current flowing No current flowing 
Power-on state	Current flowing 	No current flowing 	No current flowing Current flow 

3. Structure of relay



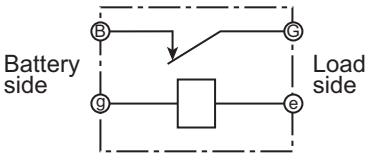


Fig. in the left shows the sample of relay
Starter lock relay (N.C)
Code No. : RB419-5371-1

(1) Body
(2) Case
(3) Coil bin
(4) Terminal
(5) Iron
(6) Core
(7) Coil
(8) Spring
(9) Contact
(10) Terminal
(11) Terminal
(12) Common
(13) Terminal
(14) Adhesive
(15) Rubber bracket

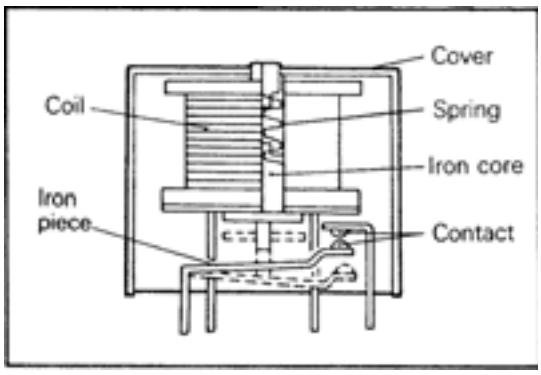
4. Specifications

(Sample relay : starter lock relay)

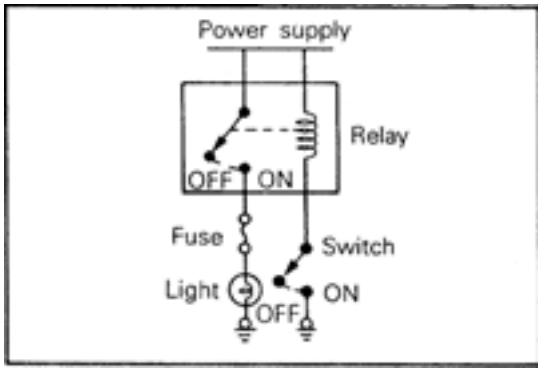
1) Product name: CA relay
2) Code: CA1b-12V-□-5
3) Type: 1b, Brushseal, 12V
4) Performance
   (1) Coil ratings
      1. Rated operating voltage : DC 12 V
      2. Operating voltage (initial, at 20 °C) : Below DC 8 V
      3. Open-circuit voltage (initial, at 20 °C) : DC 0.6 ~ 6.0 V
      4. Coil resistance (at 20 °C) : 80 Ω ± 10 %
      5. Rated excitation current (at 20 °C) : 150 mA ± 10 %
      6. Rated power consumption : 1.8 W

   (2) Contact ratings
      1. Contact type : 1b
      2. Contact material : Special silver alloy
      3. Contact resistance (initial) : Below 50 mΩ (DC6V, 1A, fall-of-potential method)
      4. Contact voltage drop (after electrical service life) : Below 0.3 V (DC12V, 20A, fall-of-potential method)
      5. Rated control capacity : 20A, 12 VDC, resistance load
      6. Maximum duty current (at 20 °C, for 1 minute) : 12A (coil-applied voltage DC 14V)

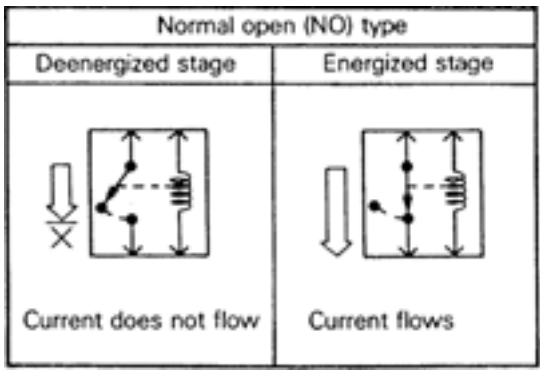
5. Checking relays



1) When current flows through the coil of a relay, its core is magnetized to attract the iron piece, closing (ON) the contact at the tip of the iron piece. When the coil current is turned off, the iron piece is made to return to its original position by a spring, opening the contact (OFF).

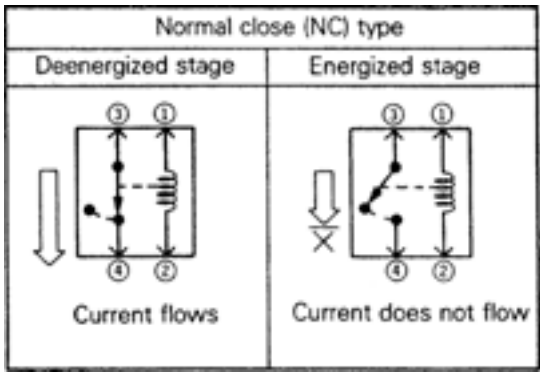


2) By using a relay, a heavy current can by turned on and off by a switch of small capacity. For example, in the circuit shown here, when the switch is turned on (closed), current flows to the coil of the relay. Then, its contact is turned on (closed) and the light comes on. The current flowing at this time to the switch is the relay coil current only and is very small.



3) The relays may be classified into the normal open type and the normal close type by their contact construction.

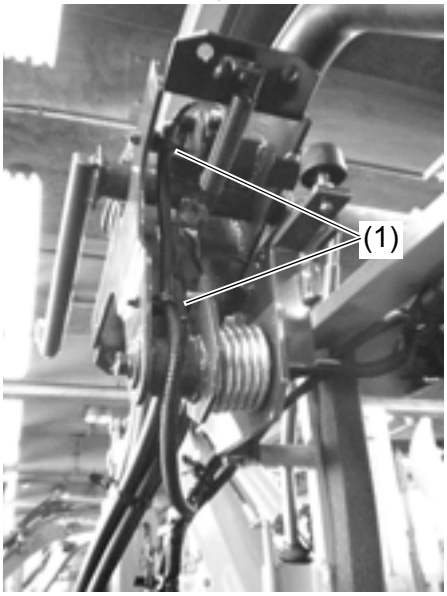
NOTE
The deenergized state means that no current is flowing through the coil and the energized state means that current is flowing through the coil.

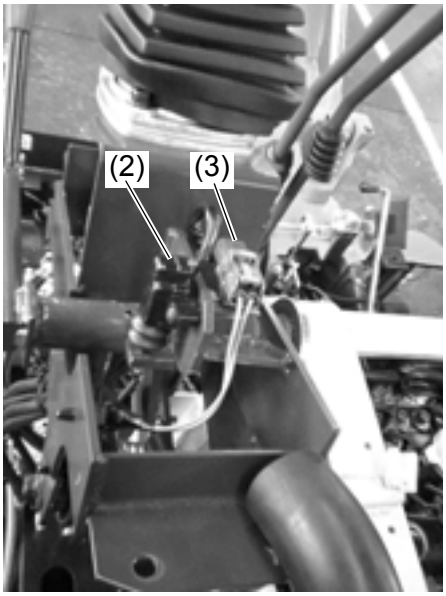


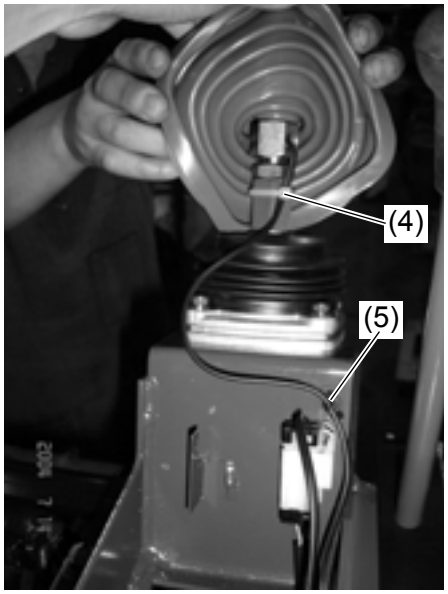
When a normal close type relay as illustrated here is checked, there should be continuity between terminals (1) and (2) and between terminals 3 and 4 when the relay is deenergized, and the continuity should be lost between terminals 3 and 4 when the battery voltage is applied to the terminals I and 2. A relay can be checked in this manner and it cannot be determined if a relay is okay or faulty by checking its state only when it is deenergized (or energized).

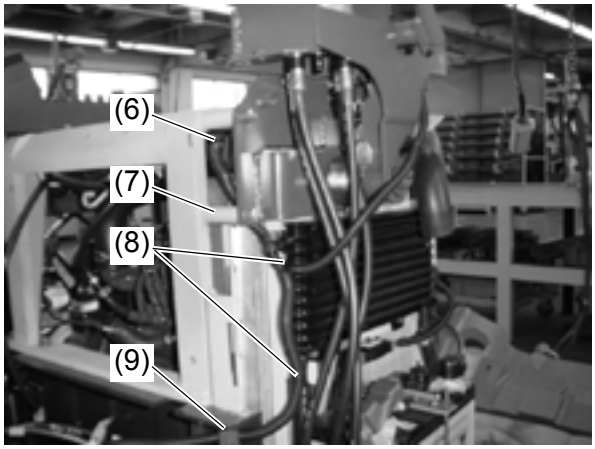
u. Route of Electric Wiring

1. Unloading, horn



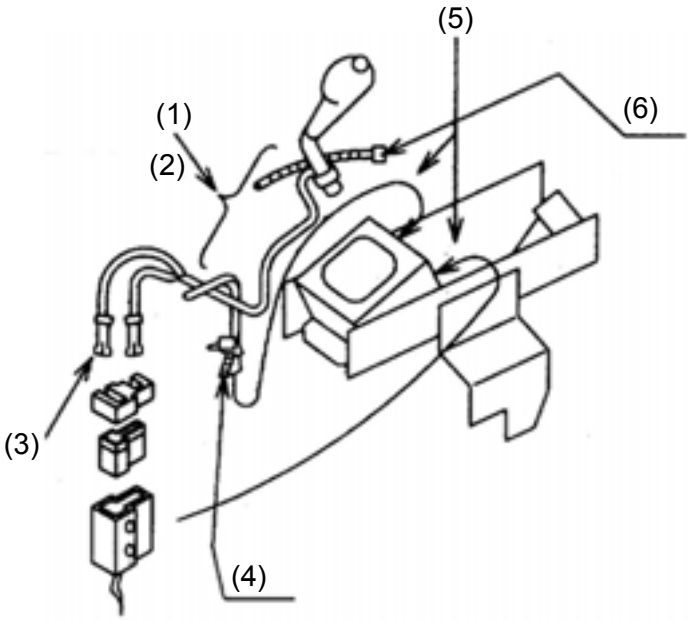






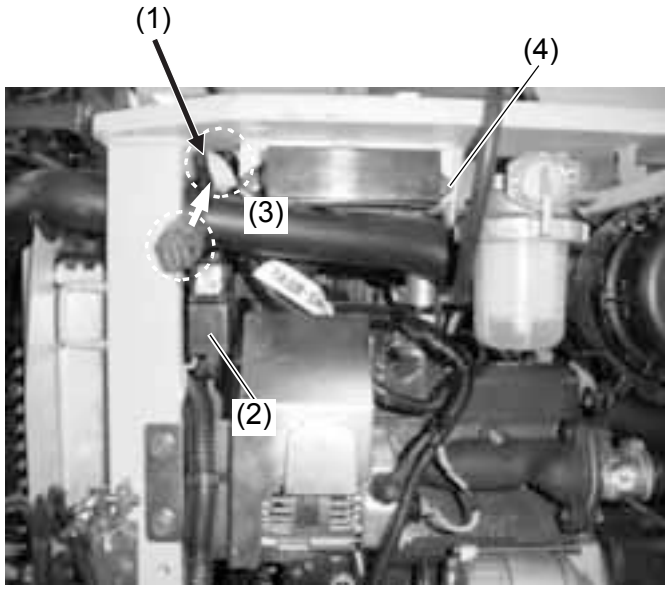
(1) Fix it at 2 positions from inside.
(2) Unloading switch
(3) Connector
(4) Clamp the cable once when it comes out of the hole.
(5) Clamp and pass it through the hole 5.5.
(6) Branch of wire harness
(7) Pass it behind the round bar.
(8) Clamp it at 2 positions.
(9) Insert a clip into the swivel frame.

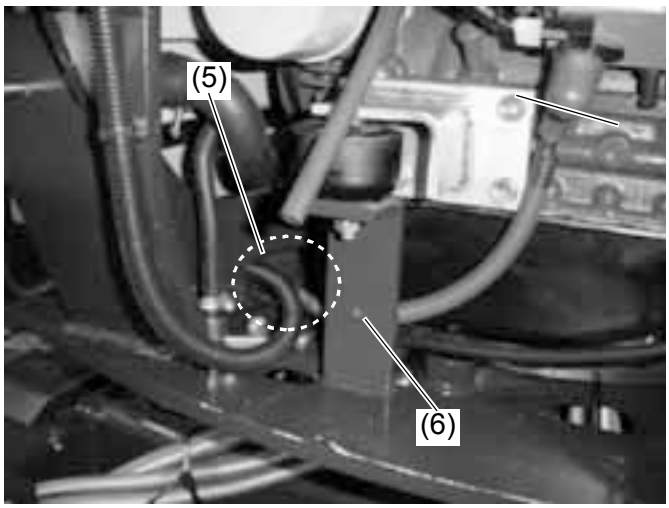
Wiring of the horn switch at the right of the operation stand

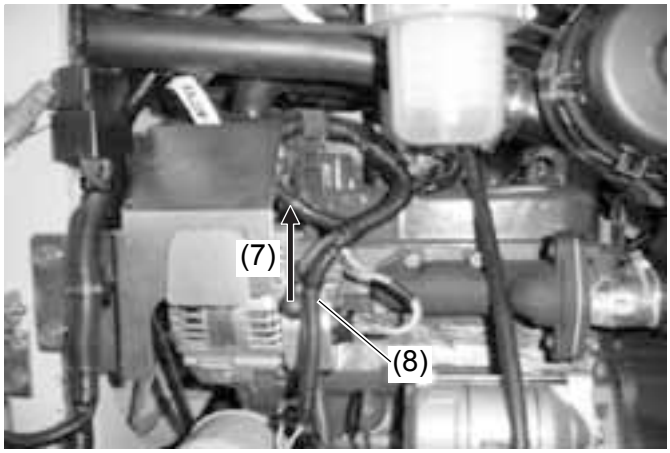


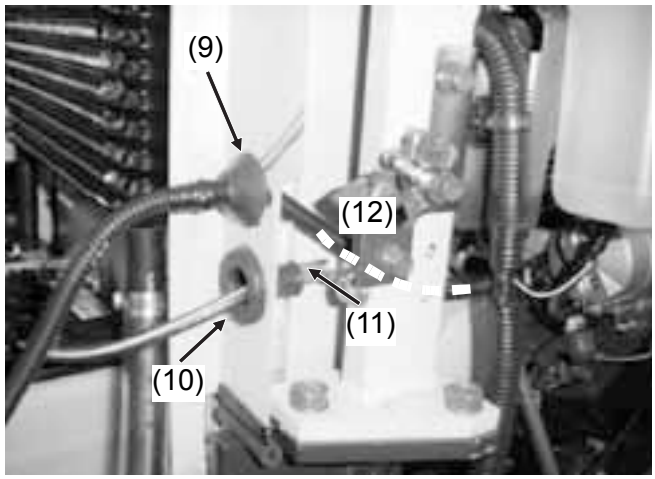
(1) One-finger clearance should be secured after clamping the cables and turning the lever in every direction.
(2) Length to the clamp: 200 mm
(3) Caulk it by caulking tool.
(4) Clamp (134L)
(5) The connector at main wire harness side and the clamp at wiring side should be fixed firmly to the bracket.
(6) Clamp (112L, 2-3. 2T)

2 Route of Electric Wiring (Engine Rear)



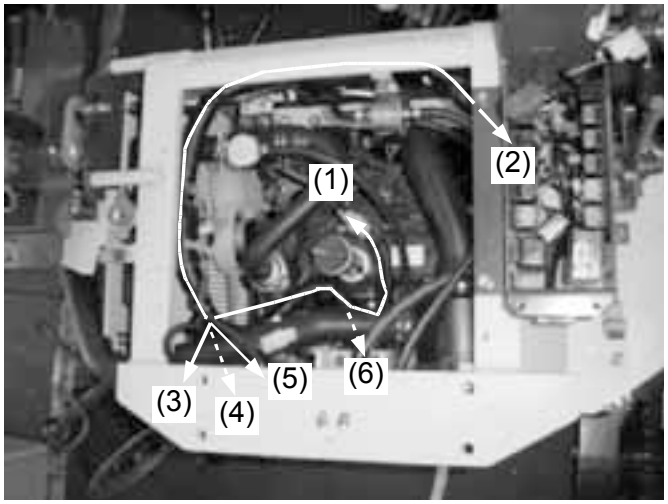


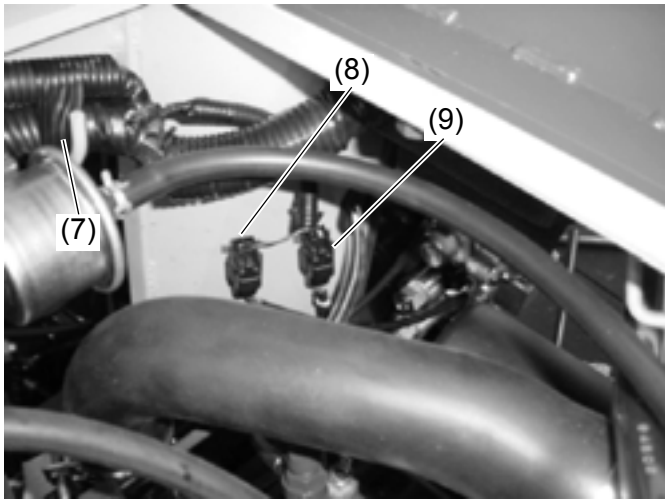


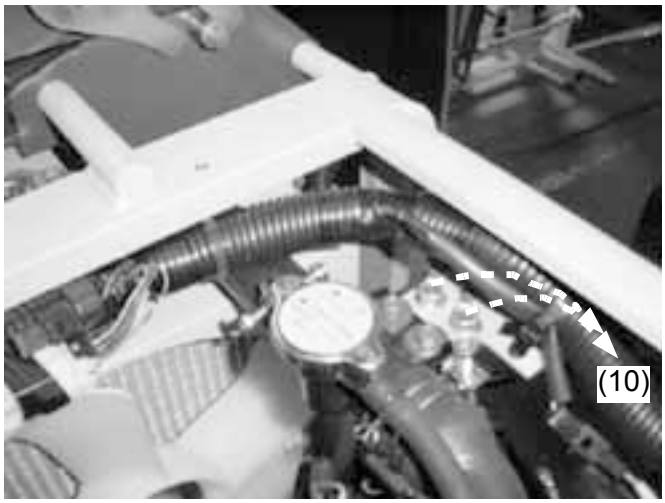


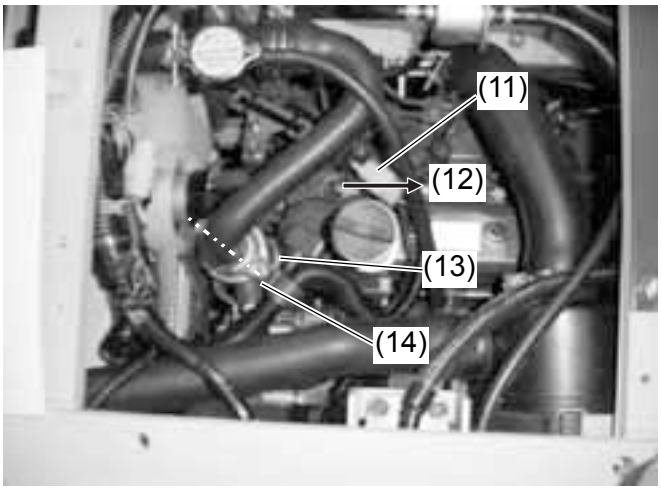
(1) Theft-proof key setting terminal
(2) Key setting connector
(3) Slow-blow fuse
(4) Direct the fuse box so that the slot comes to the right.
(5) Pass the battery cord, dozer cable and wire harness to the theft-proof unit through the hole of the vertical rib.
(6) Insert RA221-5322Δ battery cord (Plus) into the threaded hole from the front side of the mount.
(7) Facing directly above
(8) Clamp the wire harness and the rubber cap after assembling the terminal.
(9) Pass the power cord through the upper hole.
(10) Pass the minus cord through the lower hole.
(11) The minus terminal should be directed abeam at the machine front.
(12) Pass the plus power cord behind the arch.

3. Route of Electric Wiring (Engine Upper Side)



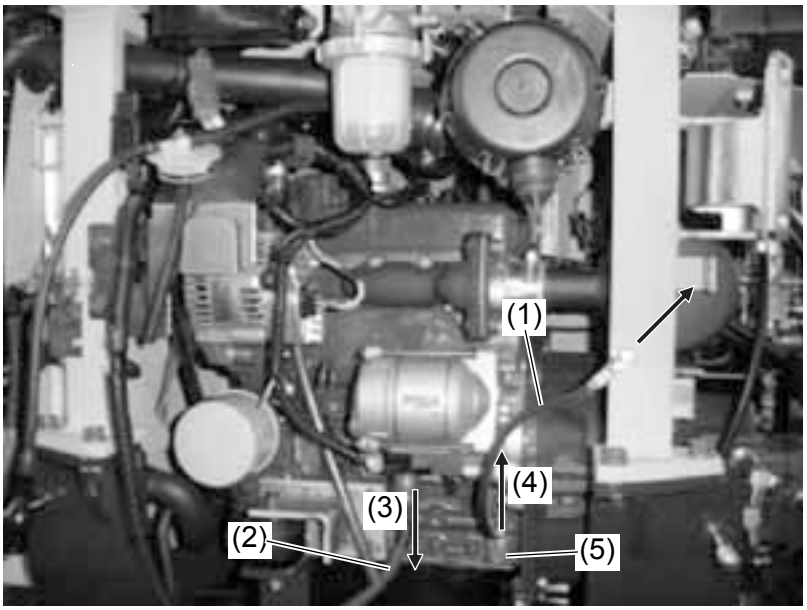


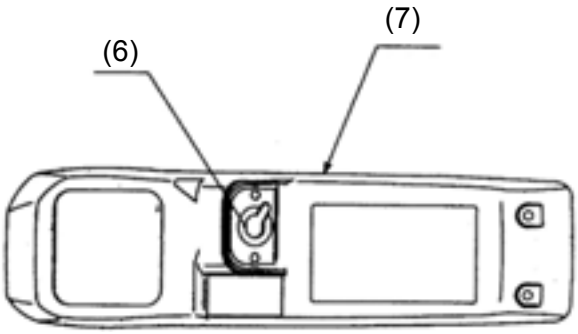


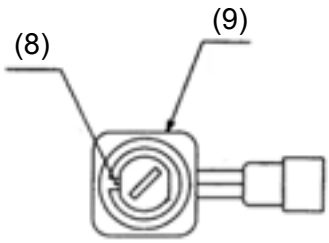


(1) Glow, engine stop solenoid
(2) Unloading valve, meters, relays, etc.
(3) Key setting
(4) (Downwards) Power supply, theft-proof unit
(5) Fuse
(6) Alternator, starter motor
(7) Facing directly above
(8) Unloading: Left hole
Green-colored wire harness
Upper solenoid
(9) 2-speed: Right hole
Yellow-colored wire harness
Lower solenoid
(10) Ground wire
(11) Connect the engine stop solenoid.
(12) Glow terminal:Tighten it to face the right side of the machine.
(13) Tighten the clamp (RP821-6738Δ) to the water flange together with the stay (wire harness 1, boom 3).
(14) Insert a clip.

4. Route of Electric Wiring (Starter Motor, Body Grounding)



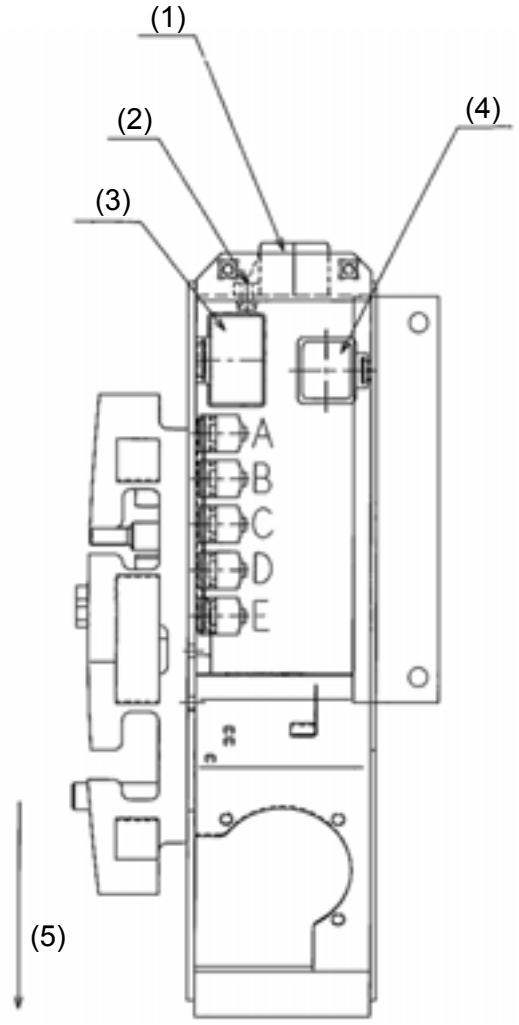




(1) Cord (Body grounding)
(2) Battery cord (Plus)
(3) Facing directly below
(4) Facing directly above
(5) Mount it into the lower hole.
(6) Projection (Rear side)
(7) Cover (Right)
(8) Groove
(9) Starter switch

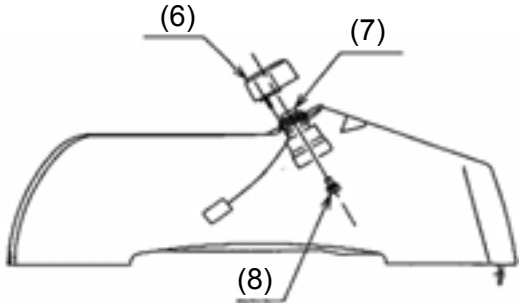
5. Route of Electric Wiring (Right Side of the Operation Stand)

Connect the black relay (T1060-3372Δ Relay (Starter)) to the black connector and the blue relay (RB419-5371Δ Relay (Starter, NC)) to the blue connector.



(1) Controller (Auto-glow)
(2) Bolt x 1
(3) Controller (Safety)
(4) Relay (Glow)
(5) Machine Front

Note : Mount the starter switch after passing the antenna cable.



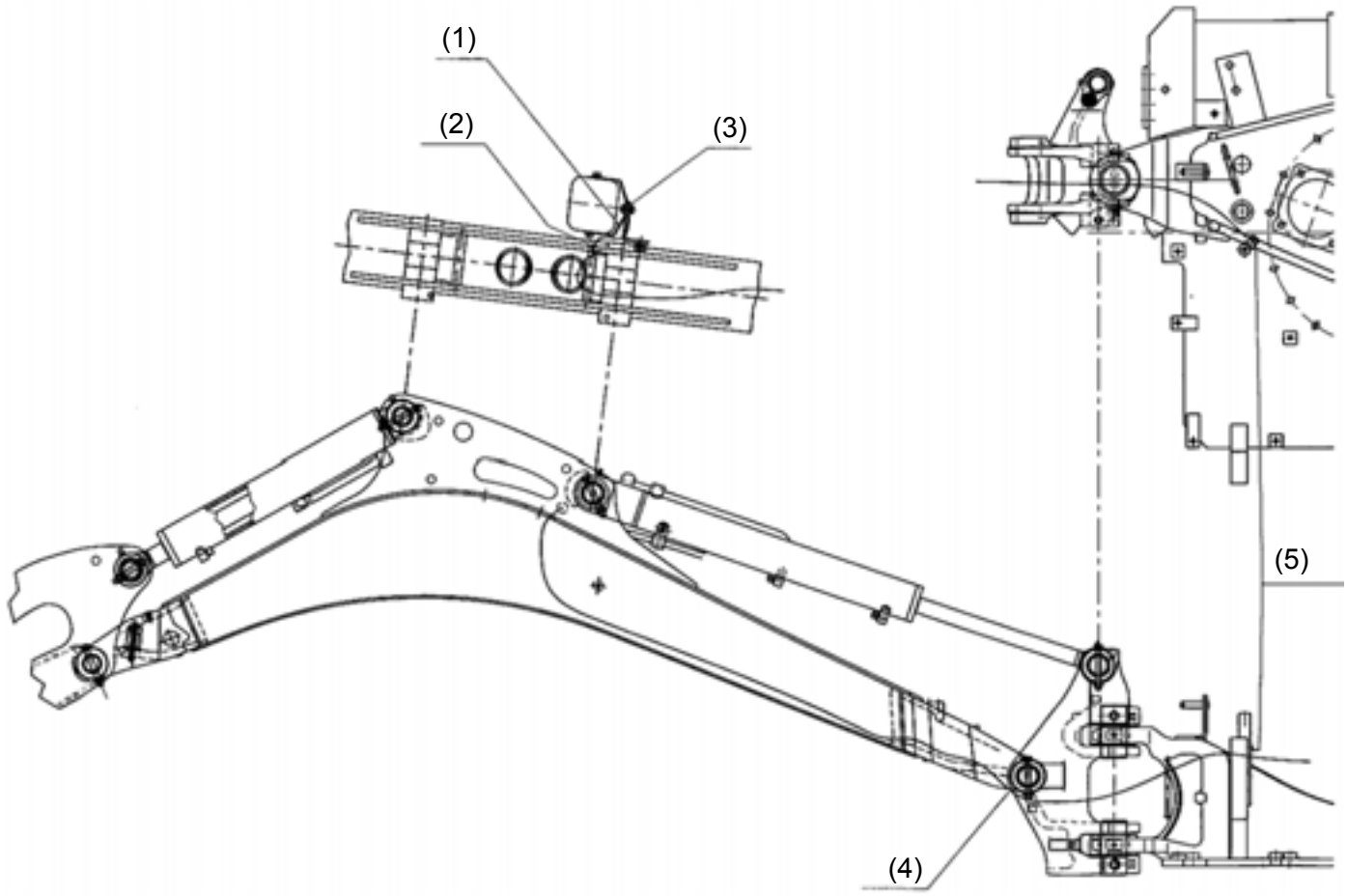
(6) Antenna (Theft-proof)
(7) Starter switch
(8) Bolt

The parts shown in the frame are provided for theft-proof specification only.

	Application of Relays	Color	Wire color
A	Starter lock relay	Blue	Green/White wire, Yellow, Black/White wire, Red/Black wire
B	Automatic release relay	Black	Yellow, Black/White wire, Black/White wire, Black/White wire
C	Automatic release stabilizing relay	Black	Black/White wire, Red/Black wire, Black/White wire, Black/White wire
D	ESS relay	Black	Red/White wire, Red/White wire, Red/Black wire, Red/White wire
E	Lever lock relay	Black	Red/White wire, Green/White wire, Red/Black wire, Blue/White wire
F	Cab relay	Black	
G	First self hold relay	Blue	
H	Reverse relay	Blue	
I	Second self hold relay	Black	
J	Self hold release relay	Black	
K	Travel high speed relay	Black	
L	Horn relay	Black	

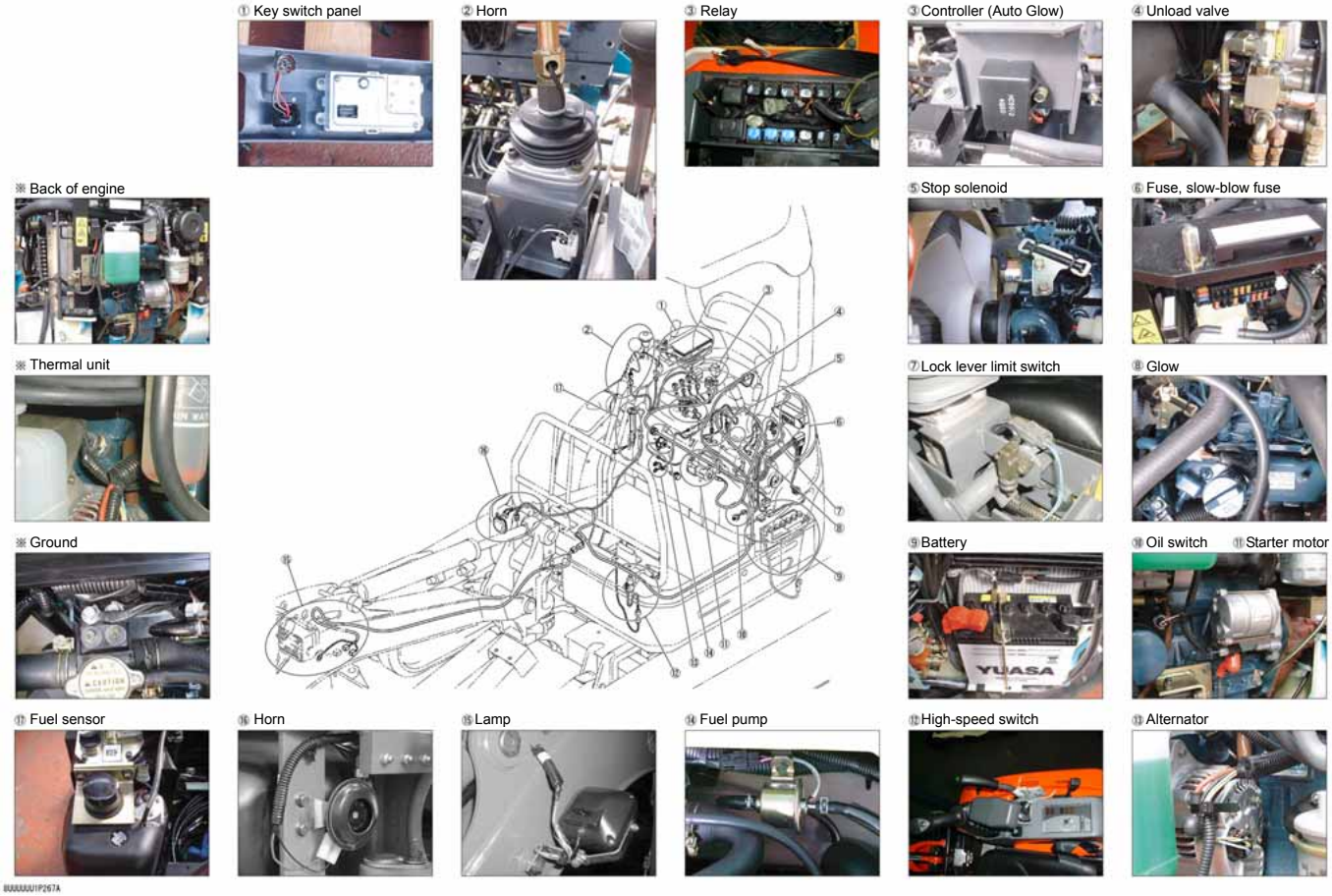
The relays shown in the frame are provided for theft-proof specification only.

6. Route of Electric Wiring (Front)

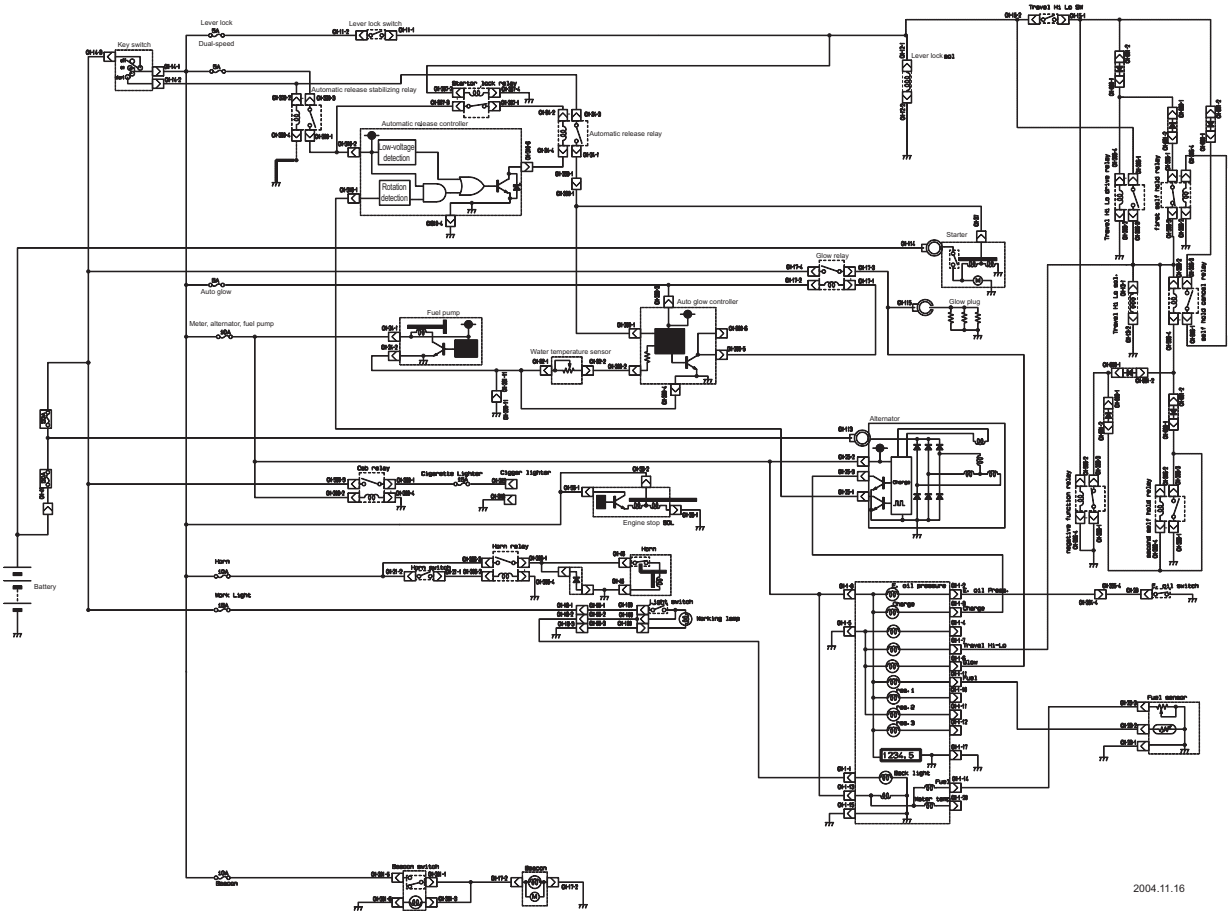


(1) Connect the red wires and yellow wires in their respective groups and fix them to the working light frame by cord clamps.
(2) Clamp the position marked with white tape outside the hole.
Use care so that the wire harness should not be drawn into the hole.
(3) Tighten the black wire together with the bolt.
(4) Pass it under the boom pin.
(5) Fix the clip to the metal.

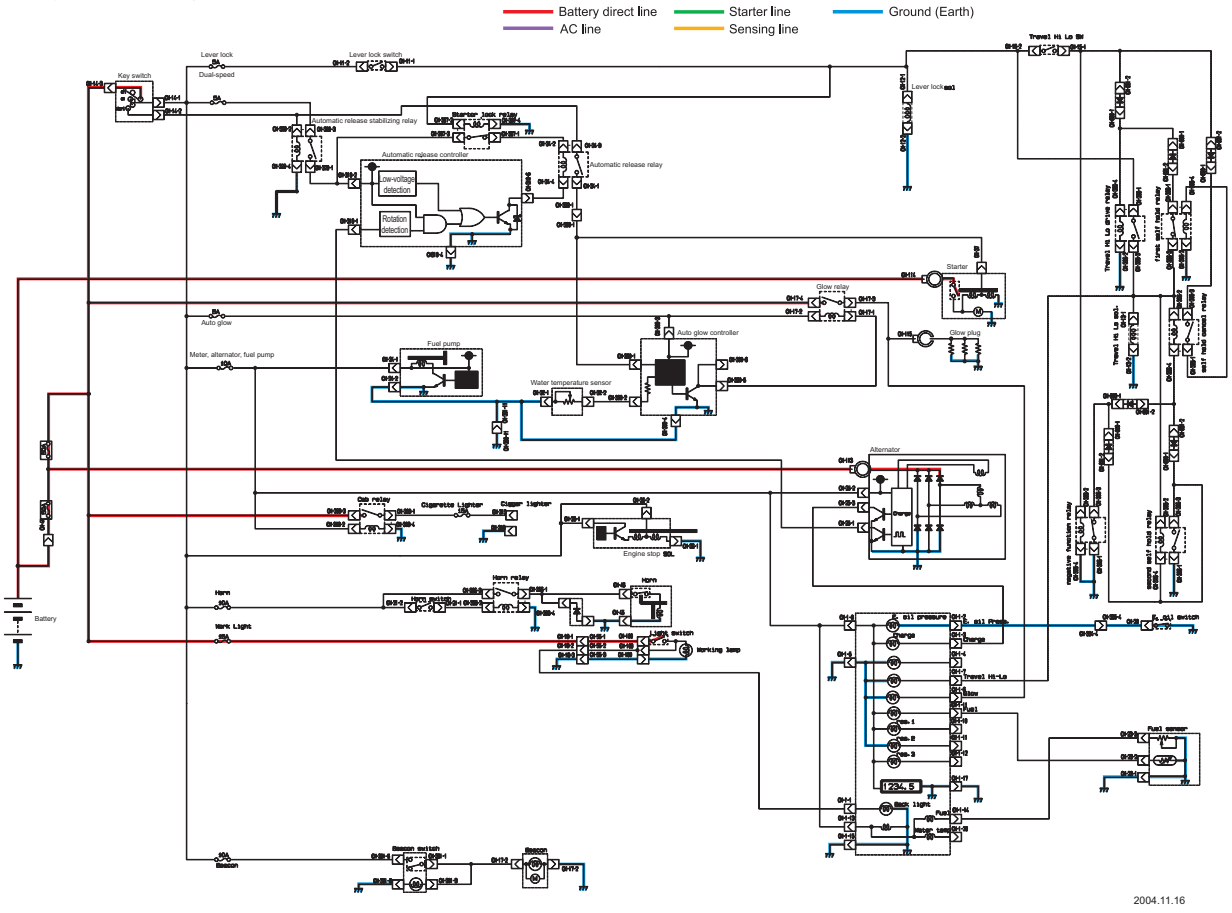
v. Electrical component layout



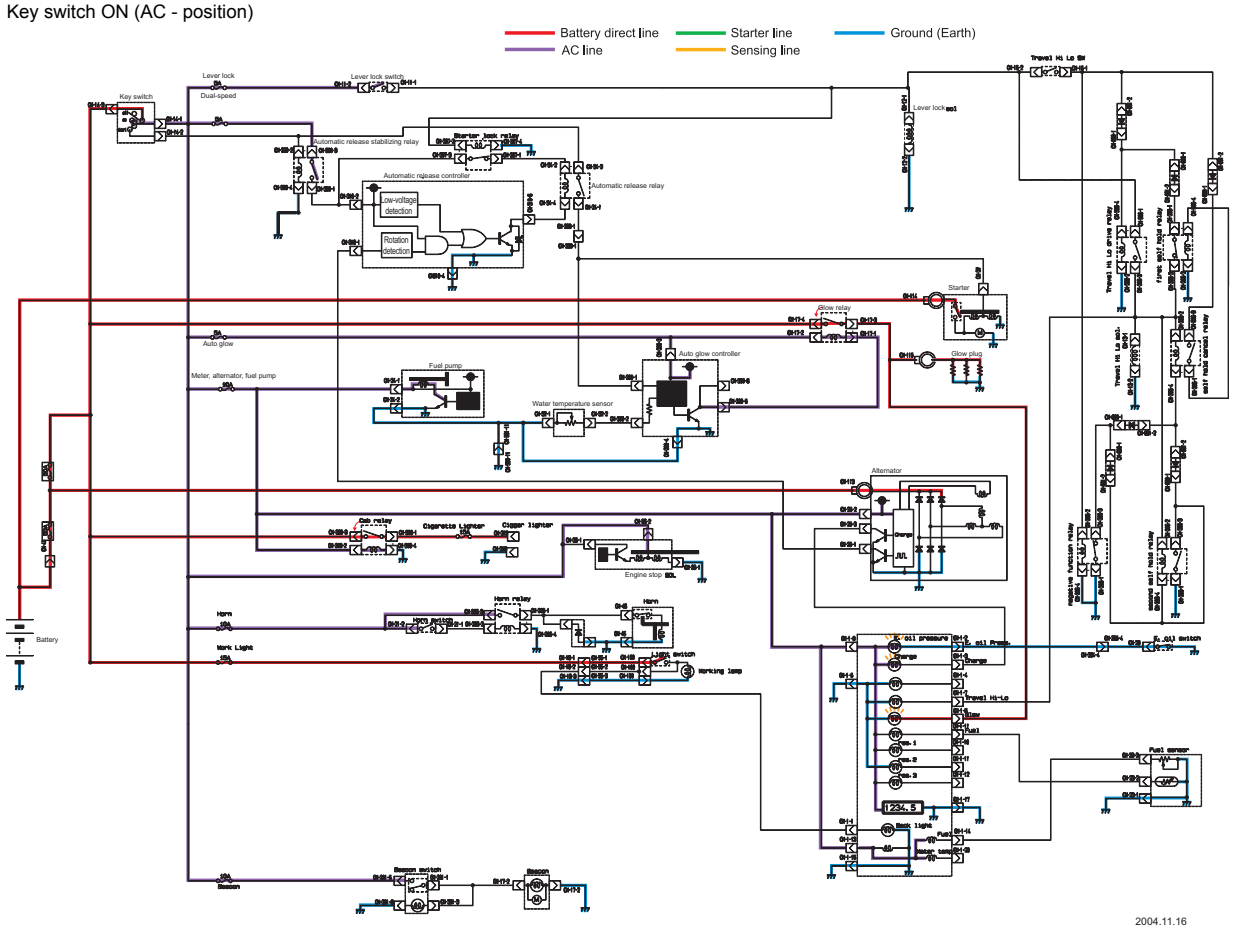
w. Electric Circuit



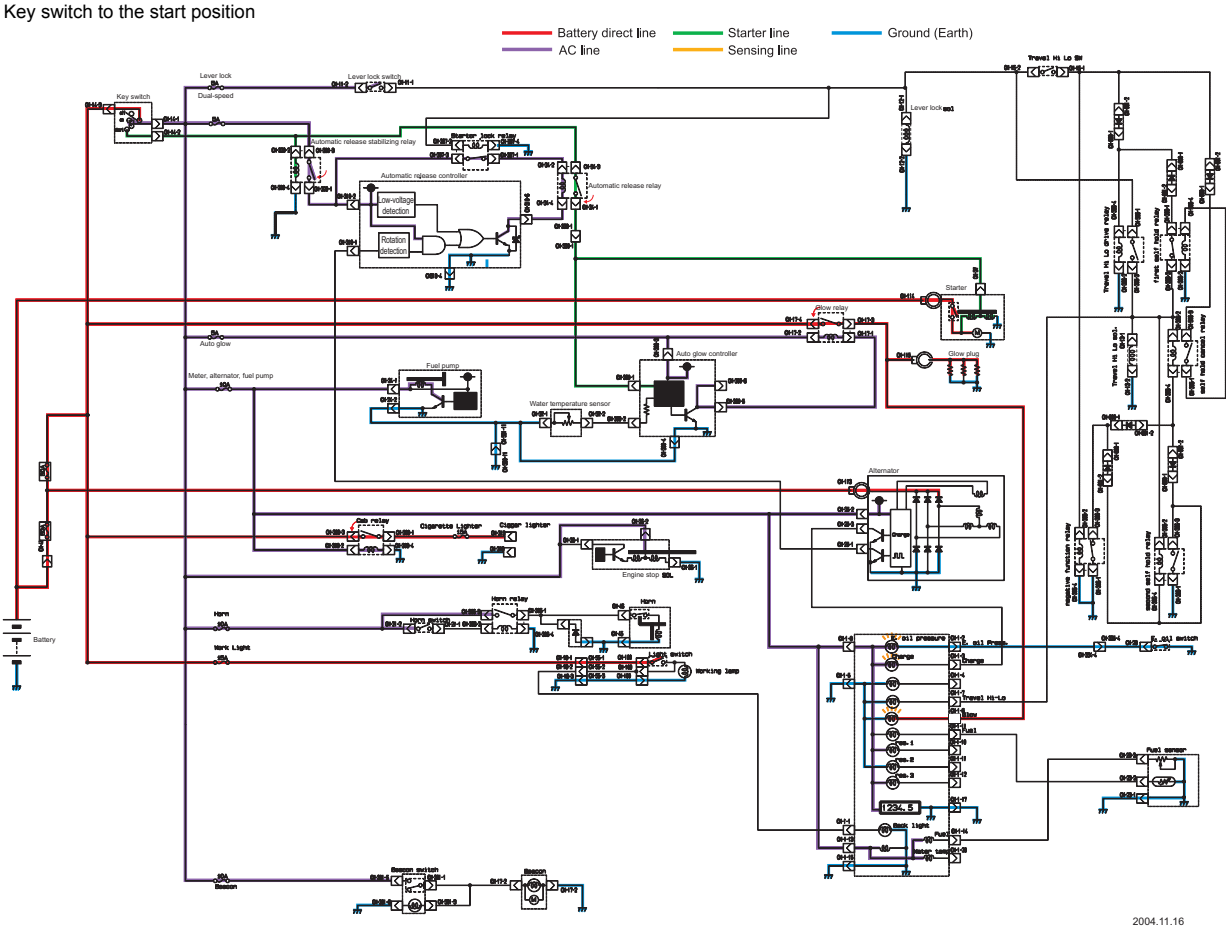
1. Battery direct line and ground (Earth) line



2. Key switch ON (AC - position)

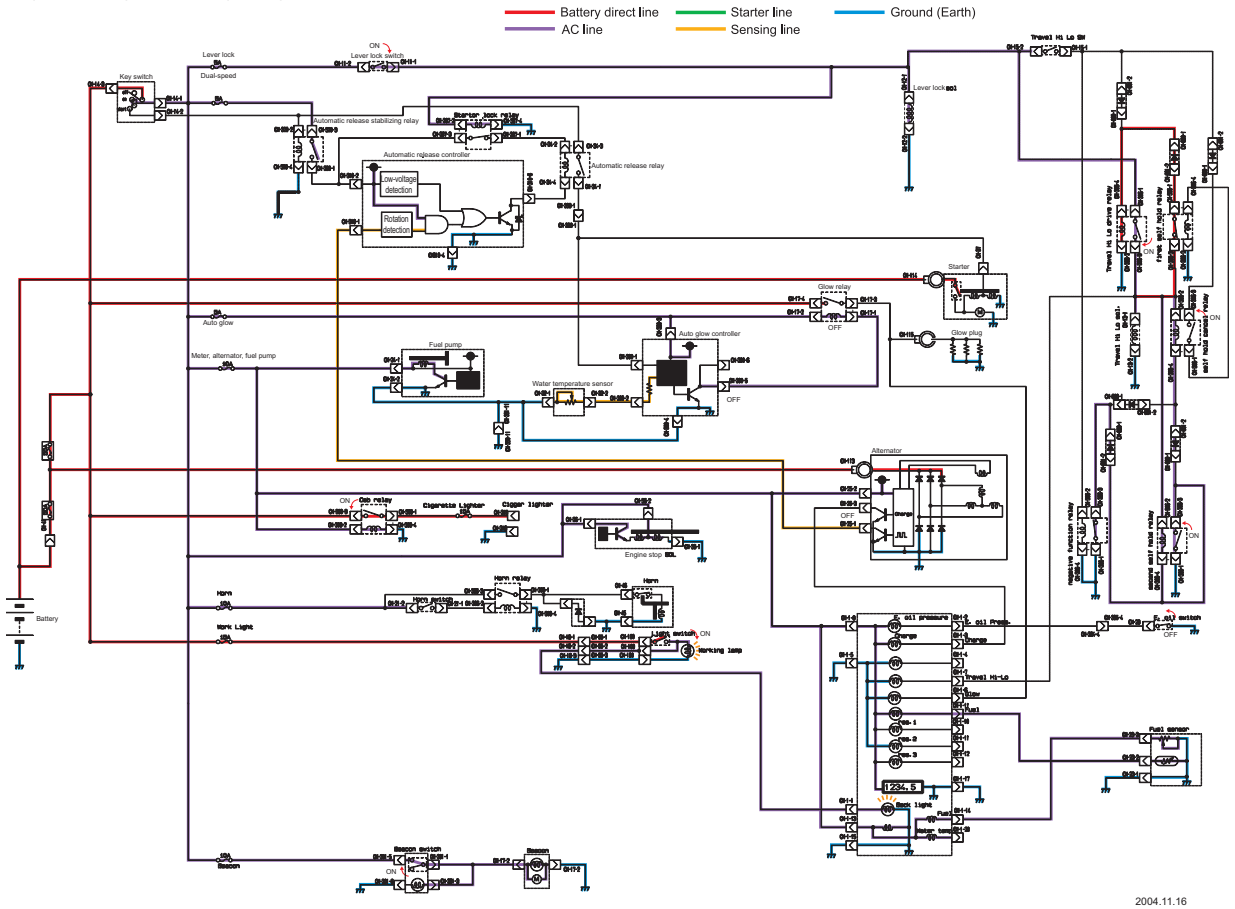


3. Key switch to the start position



2004.11.16

4. Engine running at travel high renge



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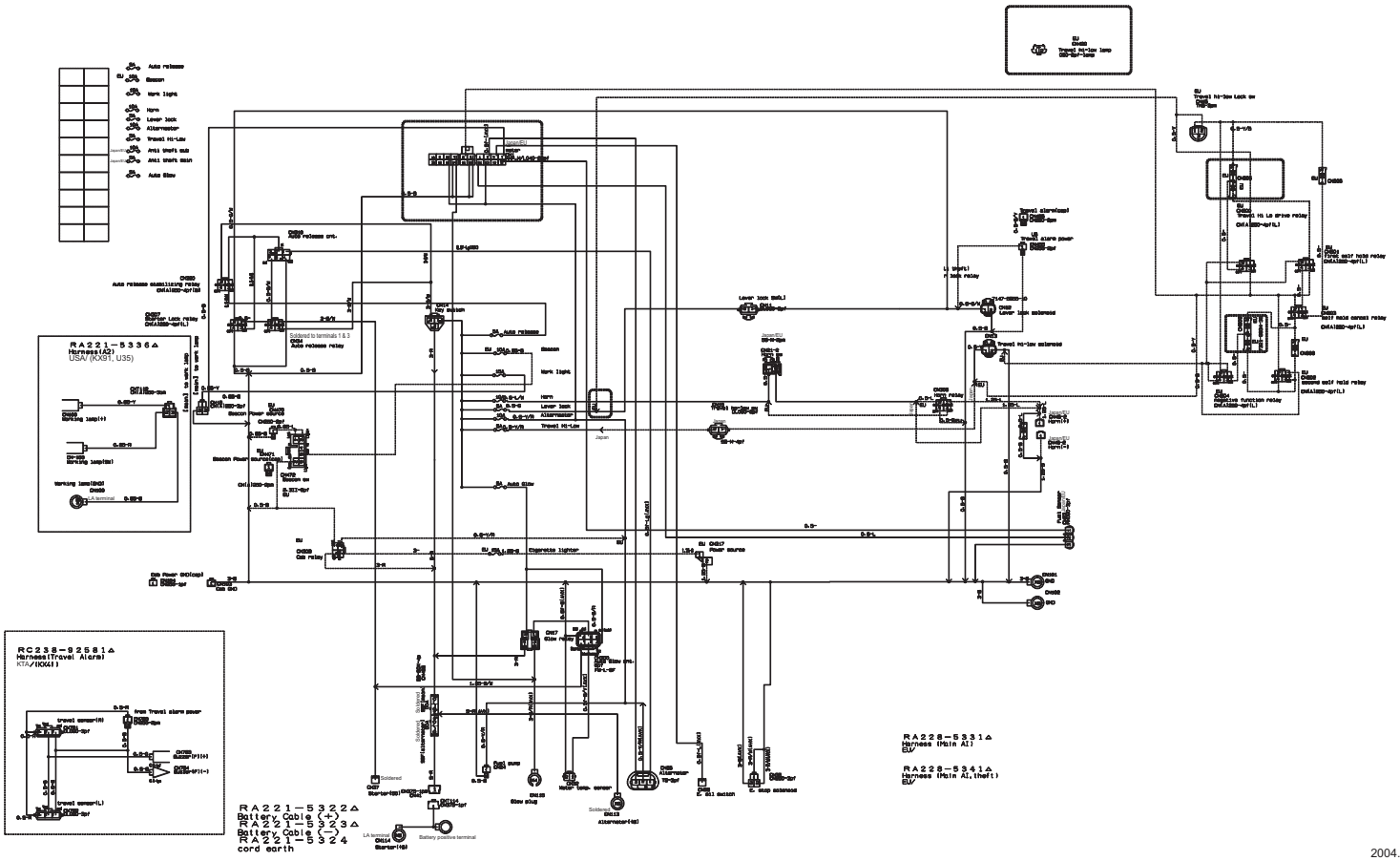
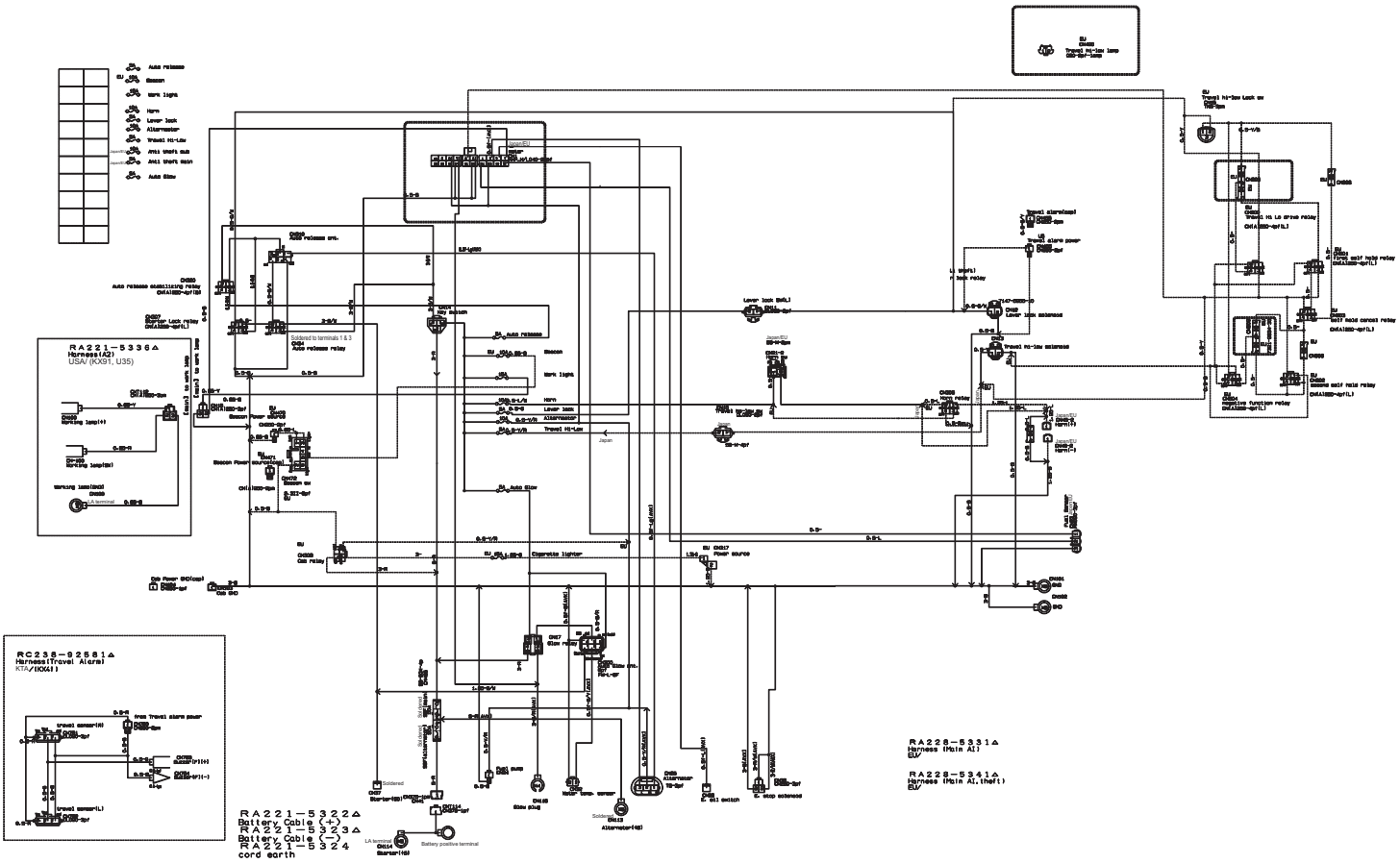
x. Electrical Wiring diagram



2004.11.16



Conversion Tables

Conversion Tables, *Tableaux Conversions,* Umrechnungstabelle

a. Length *Longueur* Loenge

mm	cm	m	inch	ft	yd
1	0.1	0.001	0.03937	0.0032808	0.001094
10	1	0.01	0.39370	0.0328080	0.010940
1000	100	1	39.370	3.2808	1.0936
25.400	2.540	0.02540	1	0.083333	0.02778
304.800	30.480	0.30480	12	1	0.3333
914.4	91 44	0.9144	36	3	1

Ex. 1mm=0.03937in 120mm=120×0.03937=4.7244in 1mile = 1.609km

b. Area *Aire* Areal

cm^2	m^2	sq.in	sq.ft	sq.yd
1	0.0001	0.15500	0.0010764	0.0001196
10000	1	1550.0	10.764	1 1960
6.4516	0.00064516	1	0.006944	0.0007716
929.03	0.092903	144	1	0.11111
8361.0	0.8361	1296	9	1

Ex. 1㎡=1.1960 sq.yd 1.2㎡=1.2×1.1960=1.4352 sq.yd

c. Volume *Volume* Volume

dm^3(l)	m^3	cu.in	cu.ft	cu.yd	Imperial gal	US gal
1	0.001	61.027	0.035317	0.0013	0.21998	0.26418
1000	1	61027	35.317	1.3079	219.98	264.18
0.016387	0.00001639	1	0.578697	0.0000214	0.003605	0.00433
28.3153	0.028315	0.000464	1	0.037026	6.22786	7 4006
764.584	0.764584	46656	27	1	168.152	199.816
4.5465	0.0045465	277 4207	0.16057	0.0059	1	1.20114
3.7852	0.0037852	231.005	0.13368	0.0050	0.83254	1

Ex. 0.04㎥=0.04×1.3097=0.052316 cu.yd 1liter=1000cc=1000㎤

d. Flow amount *Decharge internes* Entladung

L/sec	m^3/min	m^3/h	Inp.gal/min	US gal/min	cu.yd/min	L/min
1	0.060	3.6	13.197	15.8514	21 192	60
16.666	1	60.0	219.98	264.1833	35.3165	999.96
0.2778	0.016668	1	3.6658	4.4032	0.58806	16.668
0.075775	0.0045465	0.27279	1	1.2011	0.16065	4.5465
0.06309	0.0037824	0.2271	0.8325	1	0.17768	3.7854
0.47192	1.6989	0.02832	6.22787	7 4855	1	28.3152
0.016667	0.001	0.06	0.21995	0.264173	0.035317	1

Ex. 25.6l/sec=25.6×0.06=1.53㎥/min=25.6×15.8514=405.79584Usgal/min

e. Force(Weight) *Foece(Contrepoids)* Kraft(Gewicht)

N	dyn	kgf	lbw
1	1×10^5	1.01972×10^{-1}	2.24809×10^{-1}
1×10^{-5}	1	1.01972×10^{-6}	2.24809×10^{-6}
9.80665	9.80665×10^5	1	2.20462
4.44822	4.44822×10^5	4.53592×10^{-1}	1

Ex 1.2kgf=1.2×9.80665=11.76798N=11.76798×2.24809×10⁻¹=2.64555lbw

f. Stress ***Emphase*** **Betonen**

Pa	MPa or N/mm²	kgf/mm²	kgf/cm²
1	1×10^{-6}	1.01972×10^{-7}	1.01972×10^{-5}
1×10^{6}	1	1.01972×10^{-1}	1.01972×10
9.80665×10^{6}	9.80665	1	1×10^{2}
9.80665×10^{4}	9.80665×10^{-2}	1×10^{-2}	1

Ex. 1.2kgf/cm²=1.2×9.80665×10⁻²=0.1176798 MPa

g. Pressure ***Pression*** **Pruefdruck**

MPa	Pa	Bar	kgf/cm²	atm	mmH²O	psi(lbw/in²)
1×10^{-6}	1	1×10^{-5}	1.01972×10^{-5}	9.86923×10^{-6}	1.01972×10^{-1}	1.45038×10^{-4}
1	1×10^{6}	10	10.1972	9.86923	1.01972×10^{5}	1.45038×10^{2}
0.0980665	9.80665×10^{4}	9.80665×10^{-1}	1	9.67841×10^{-1}	1.0×10^{4}	1.42233×10
1.01325×10^{-1}	1.01325×10^{5}	1.01325	1.03323	1	1.03324×10^{4}	1.46959×10
9.80665×10^{-6}	9.80665	9.80665×10^{-5}	1.0×10^{-4}	9.67841×10^{-5}	1	1.42233×10^{-3}
1.33322×10^{-4}	1.33322×10^{2}	1.33322×10^{-3}	1.35951×10^{-3}	1.31579×10^{-3}	1.35951×10	1.93368×10^{-2}
6.89474×10^{-3}	6.89474×10^{3}	6.89474×10^{-2}	7.03070×10^{-2}	6.80460×10^{-2}	7.03070×10^{2}	1

Ex. 120 kgf/cm²=120×9.80665×10⁴=11767980Pa=11.76798MPa 1Pa=1N/m², 1MPa=1×10⁶Pa

h. Work energy amount ***Equivalent travail mecanique de lachaleur*** **Leistung**

J	kW.h	kgf.m	kcal	ft.lb
1	2.77778×10^{-7}	1.01972×10^{-1}	2.38889×10^{-4}	7.37555×10^{-1}
3.6×10^{5}	1	3.67098×10^{5}	8.6×10^{2}	2.65519×10^{5}
9.80665	2.72407×10^{-6}	1	2.34270×10^{-3}	7.23292
4.18605×10^{3}	1.16279×10^{-3}	4.26858×10^{2}	1	3.08743×10^{3}
1.35583	3.76621×10^{-4}	1.38257×10^{-1}	3.23899×10^{-4}	1

Ex. 12kgf.m=12×9.80665=117.6798J, 1J=1W·S, 1W·h=3600W·S, 1cal=4.1865J

ı.Work efficiency ***Puissance*** **Wirkungsgrad**

kW	kgf.m/s	PS	HP	kcal/h
1	1.01922×10^{2}	1.35962	1.34048	8.6000×10^{2}
9.80665×10^{-3}	1	1.33333×10^{-2}	1.31456×10^{-2}	8.43371
7.355×10^{-1}	7.5×10	1	9.85925×10^{-1}	6.32529×10^{2}
7.46×10^{-1}	7.60707×10	1.01428	1	6.41564×10^{2}
1.16279×10^{-3}	1.18572×10^{-1}	1.58095×10^{-3}	1.55869×10^{-3}	1

Ex. 10.2PS=10.2×7.355×10⁻¹=7.5021kW

j.Torque ***Couple*** **Drehmoment**

kgf.m	ft.lbs	N.m
1	7.233	9.80665
0.1383	1	1.35582
0.1020	0.7376	1

Ex. 12kgf.m=12×9.80665=117.6798N.m

k.Velocity ***Vitesse*** **Geschwindigkeit**

m/sec	km/h	ft/min	mile/h
1	3.6	3.2808	2.2370
0.2778	1	54.68	0.6214
0.00508	18.288	1	11.639
0.447	1.6093	0.19398	1

l. Temperature
Temperature
Temperatur

°F	°C
0	-17.8
10	-12.2
20	-6.7
30	-1.1
32	0
40	4.4
50	10.0
60	15.6
70	21.1
80	26.7
90	32.2
100	37.8
110	43.3
120	48.9
130	54.4
140	60.0
150	65.6
160	71.1
170	76.7
180	82.2
190	87.8
200	93.3
210	98.9
212	100.0
220	104.4
230	110.0
240	115.6

F=32+9/5×C
C=5/9×(F−32)

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KUBOTA Corporation Printed in Japan 0503.CMC.e.12 Code No.97899-61270