KOBELCO

SHOP MANUAL

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10.	HYDRAULIC PUMP (NV)

7055

7065

APPLICABLE : 7055:GB-00002～
: 7065:GG-00002～

Book Code No. S5GG0001E

Read and understand these instructions.
Faillure to do so will increase risk of injury.

KOBELCO

SHOP MANUAL

10. HYDRAULIC PUMP (NV)
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7055

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APPLICABLE : 7055:GB-00002～
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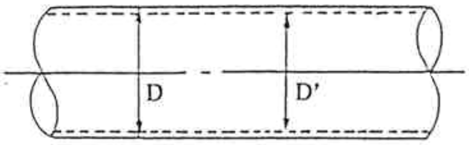
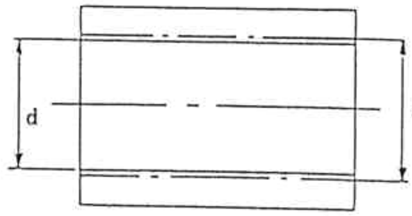
1. MAINTENANCE STANDARD

1.1 PIN, BUSHING, SPRING AND LINING, SHEAVE

1.1.1 Pin and Bushing



Pin

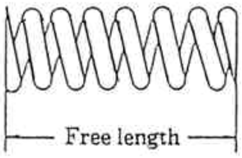


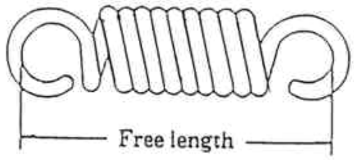
Bushing

Unit:mm

Name	Use		Item	Part No.	S.T.D. dimention D	S.T.D. dimention d	Limit of use D'	Limit of use d'	Remedy	Reference
Pin	Front, Rear drum brake		10 - 1	2419T4287D1	30.0		29.711		Replace	Fig.1 - 1
			10 - 2	2419T4288D6	20.0		19.741			
			10 - 3	2419T4291D1	28.0		27.717			
			10 - 4	2419T4288D5	20.0		19.741			
			10 - 5	2419T2775	18.0		17.747			
			10 - 6	2419T4288D1	20.0		19.741			
			10 - 7	2419T4291D2	28.0		27.717			
	Front, Rear drum clutch		6 - 1	2419T4246	19.5		19.392		Replace	Fig.1 - 2
			6 - 2	2420T5202	25.374		25.274			
			6 - 3	19F54D48	19.05		18.942			
	Pawl	Front, Rear drum	2	2419T4237	31.75		31.579		Replace	Fig.1 - 3
		Boom drum	2	2419T4218	31.75		31.579			Fig.1 - 5
	Brake pedal		7	2419T3053D2	38.1		37.924		Replace	Fig.1 - 7
			8, 9	2419T2337D2	13.0		12.851			
			10	2419T2337D4	13.0		12.851			
	7055	Boom, Tower foot	2	2419P1738D1	36.75		86.267		Replace	Fig.1 - 8 Fig.1 - 10
		Tower jib foot	9	2419P2819	80.0		79.6			
		Strut foot	9	2419P2820	80.0		79.6			
	7065	Boom, Tower foot	2	2419P1902	99.75		99.102		Replace	Fig.1 - 8 Fig.1 - 9
		Tower jib foot	8	19T3938	63.461		63.043			
		Strut foot	9	2419P1045D2	63.475		63.043			
Bushing	Front, Rear drum clutch		7 - 2	2405T67		25.447		25.578	Replace	Fig.1 - 2
	Pawl (Front, Rear, Boom)		3	C05T0014		31.826		31.973	Replace	Fig.1 - 3 Fig.1 - 5
	7055	Boom, Tower foot	3	C05T0004D2		87.035		87.505	Replace	Fig.1 - 8
		Tower jib foot	8 - 1	2405R275D1		80.144		80.591		Fig.1 - 10
		Strut foot	9 - 1	2405R275D2		80.144		80.591		
	7065	Boom, Tower foot	3	2405T1118		100.035		100.670	Replace	Fig.1 - 8
		Tower jib foot	8 - 1	2405T541D7		63.755		64.200		Fig.1 - 10

1.1.2 Spring

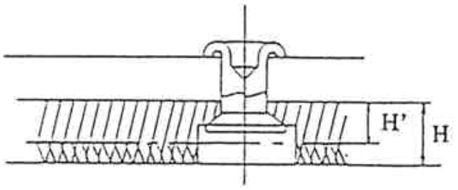




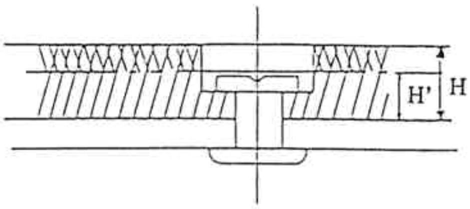
Unit:mm

Use	Item	Part No.	S.T.D. dimension	Limit of use	Remedy	Reference
Front, Rear drum brake	5 - 1	2417T455	207	196.7	Replace	Fig.1 - 1
	5 - 2	2417T456	209	198.6		
	5 - 3	17H28	71	74.5		
Front, Rear drum clutch	5	17Z351	155.6	147.8		Fig.1 - 2
Front, Rear drum pawl	5 - 1	2417T186	55	52.3		Fig.1 - 3
	5 - 2	2417T428	55	52.3		
Boom drum pawl	5	2417T173	70	66.5		Fig.1 - 5
Brake pedal	15	17H286	61.5	64.6		Fig.1 - 7

1.1.3 Lining



Brake

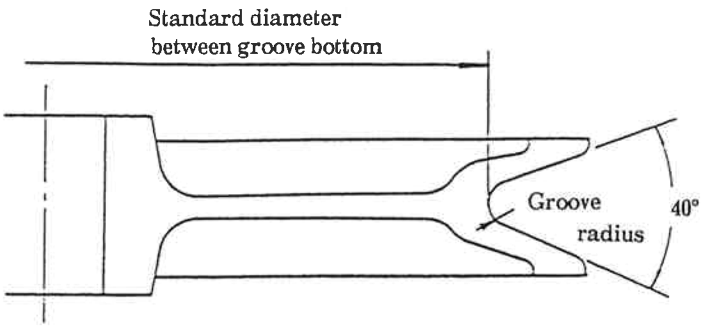


Clutch

Unit:mm

Use	Item	Part No.	S.T.D. Dimension (H)	Limit of use (H')	Remedy	Reference
Front, Rear drum brake	2	2415Z261D1	9.5	6.0		Fig.1-1
		2415Z185D1				
		2415Z186D1				
		2415Z187D1				
Front, Rear drum clutch	2	2415P216D3	9.5	6.0		Fig.1-2
		2415P216D6				

1.1.4 Sheave



Unit:mm

<table>
<tr><th colspan="2">Use</th><th>Item</th><th>Part No.</th><th>S.T.D. dia. betw. g.b.</th><th>Limit of use</th><th>Remedy</th><th>Groove radius</th><th>Referance</th></tr>
<tr><td colspan="2">Boom point</td><td>8</td><td>2407U138</td><td>495^{+3}_{-0}</td><td>492</td><td rowspan="14">Replace or repair by building up</td><td>12.5</td><td rowspan="5">Fig.1-8</td></tr>
<tr><td colspan="2">Idler</td><td>9</td><td>2407P609</td><td>428^{+3}_{-0}</td><td>425</td><td>12.5</td></tr>
<tr><td colspan="2">Auxiliary sheave</td><td>10</td><td>2407U138</td><td>495^{+3}_{-0}</td><td>492</td><td>12.5</td></tr>
<tr><td colspan="2">Upper spreader</td><td rowspan="2">11</td><td rowspan="2">2407P564</td><td rowspan="2">272^{+2}_{-0}</td><td rowspan="2">269</td><td rowspan="2">9.0</td></tr>
<tr><td colspan="2">Equalizer</td></tr>
<tr><td colspan="2">Lower spreader</td><td>5</td><td>2407P722</td><td>272^{+2}_{-0}</td><td>269</td><td>9.0</td><td>Fig.1-11</td></tr>
<tr><td colspan="2">Jib point</td><td>8</td><td rowspan="2">2407P722</td><td rowspan="2">428^{+3}_{-0}</td><td rowspan="2">425</td><td rowspan="2">12.5</td><td rowspan="2">Fig.1-9</td></tr>
<tr><td colspan="2">Jib strut</td><td>9</td></tr>
<tr><td rowspan="4">Tower</td><td>Tower point</td><td>10</td><td>2407P609</td><td>428^{+3}_{-0}</td><td>425</td><td>12.5</td><td rowspan="4">Fig.1-10</td></tr>
<tr><td rowspan="2">Upper & Lower spreader</td><td rowspan="2">11</td><td>※1 2407P564</td><td>272^{+2}_{-0}</td><td>269</td><td>9.0</td></tr>
<tr><td>※2 2407P1061</td><td>332^{+3}_{-0}</td><td>329</td><td>12.5</td></tr>
<tr><td>Jib point</td><td>12</td><td>2407P1609</td><td>428^{+3}_{-0}</td><td>425</td><td>12.9</td></tr>
<tr><td colspan="2">Gantry peak sheave</td><td>6</td><td>2407P719</td><td>320^{+2}_{-0}</td><td>317</td><td>9.0</td><td>Fig.1-11</td></tr>
<tr><td colspan="2">Hook</td><td>–</td><td>–</td><td>428^{+3}_{-0}</td><td>425</td><td>12.5</td><td>–</td></tr>
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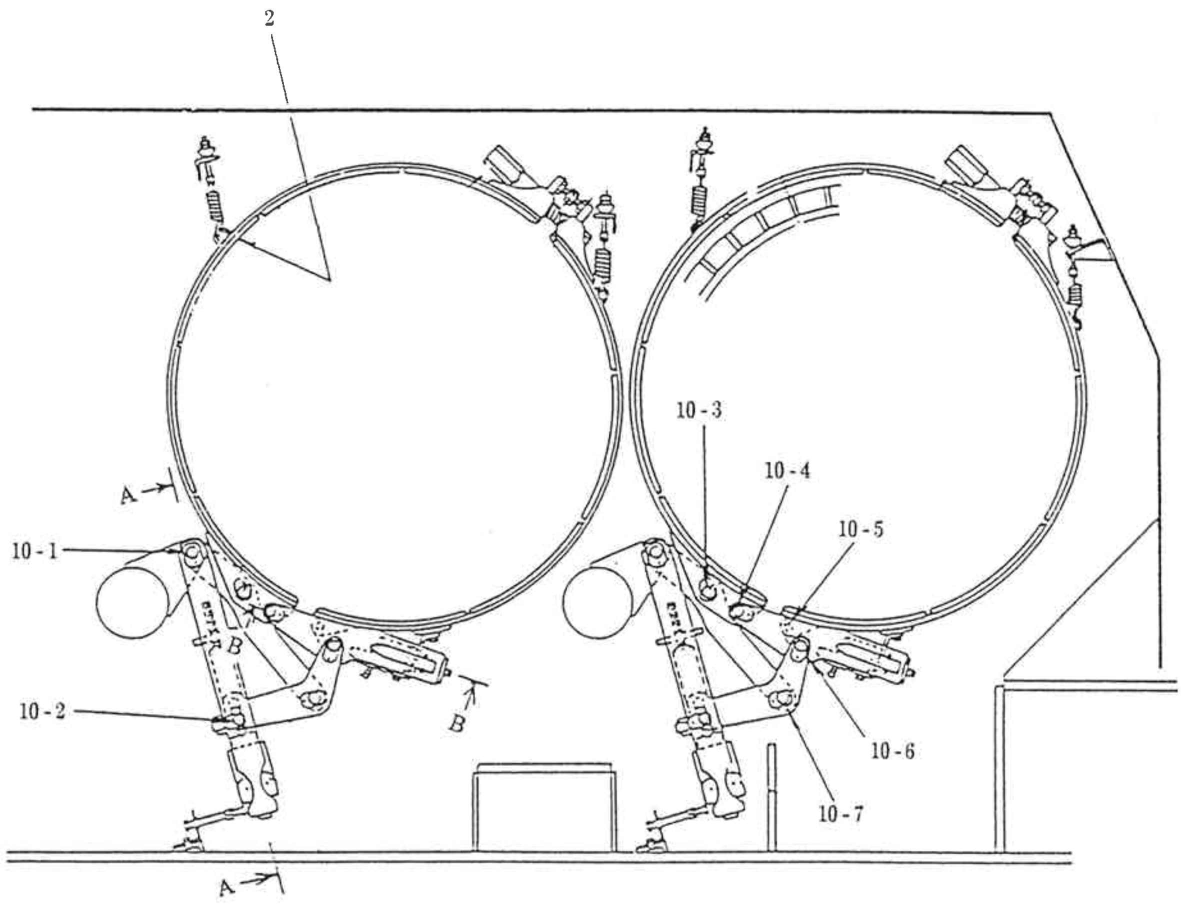
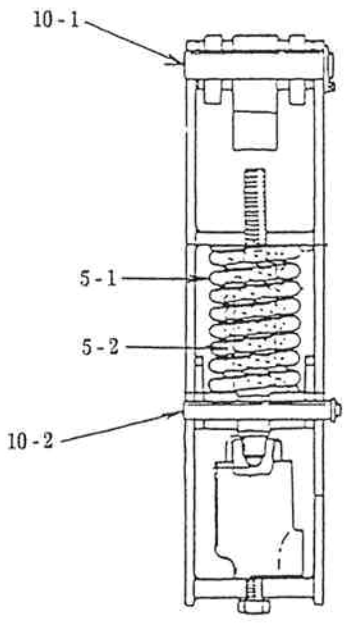
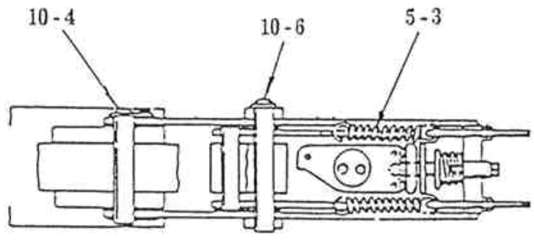
※1 7055: ~GB-00109 7065: ~GG-00024

※2 7055: GB-00110~ 7065: GG-00025~





Section A - A



Section B - B

Fig. 1 - 1 Hoist brake assembly

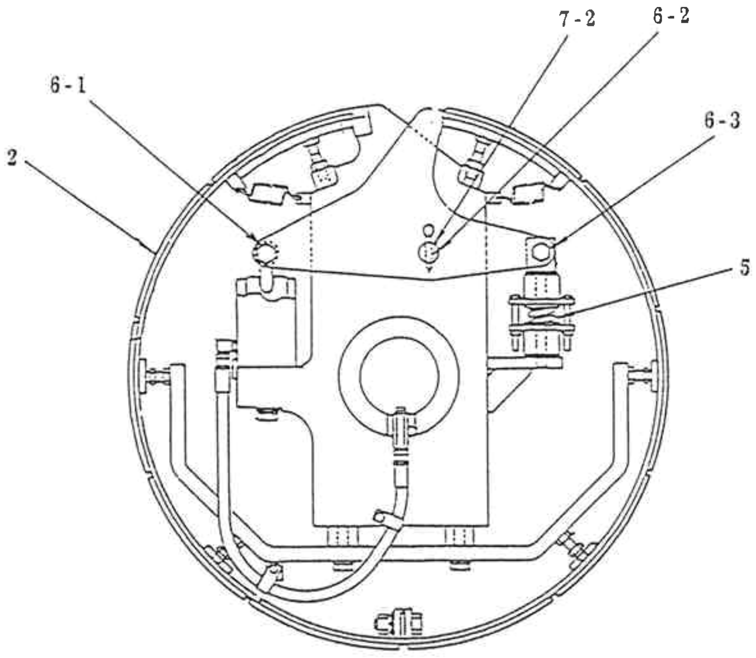


Fig. 1-2 Clutch assembly

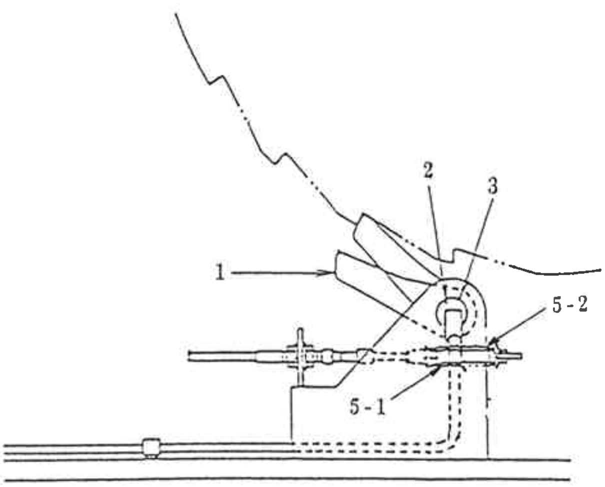


Fig. 1-3 Front, Rear drum pawl assembly

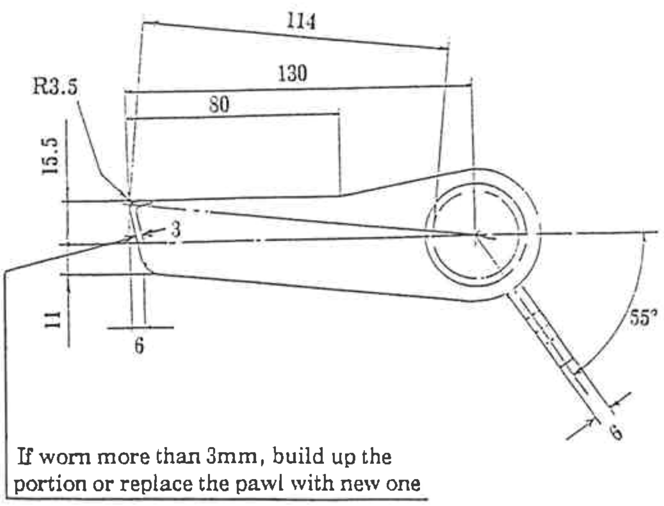


Fig. 1-4 Pawl

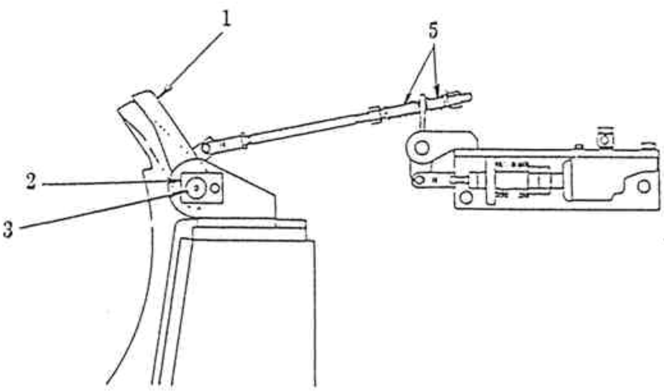


Fig. 1 - 5 Boom drum pawl assembly

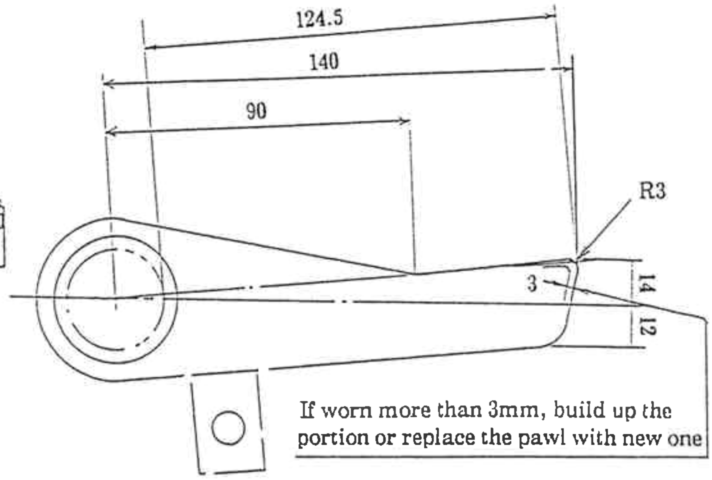


Fig. 1 - 6 Pawl

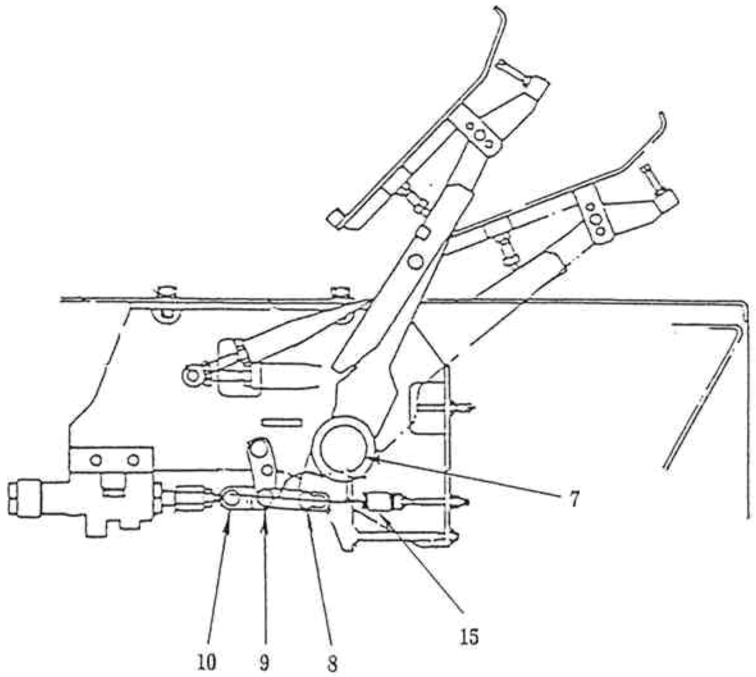


Fig. 1 - 7 Brake pedal

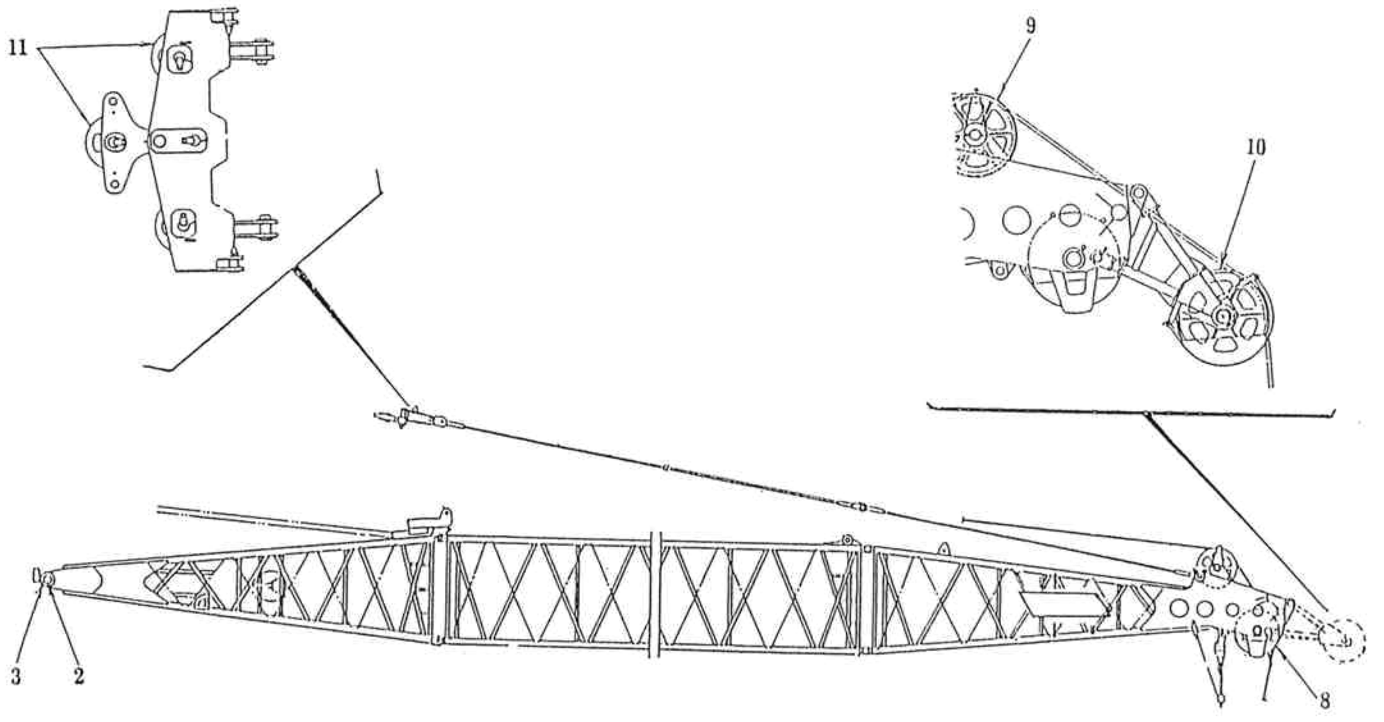


Fig. 1 - 8 Crane assembly

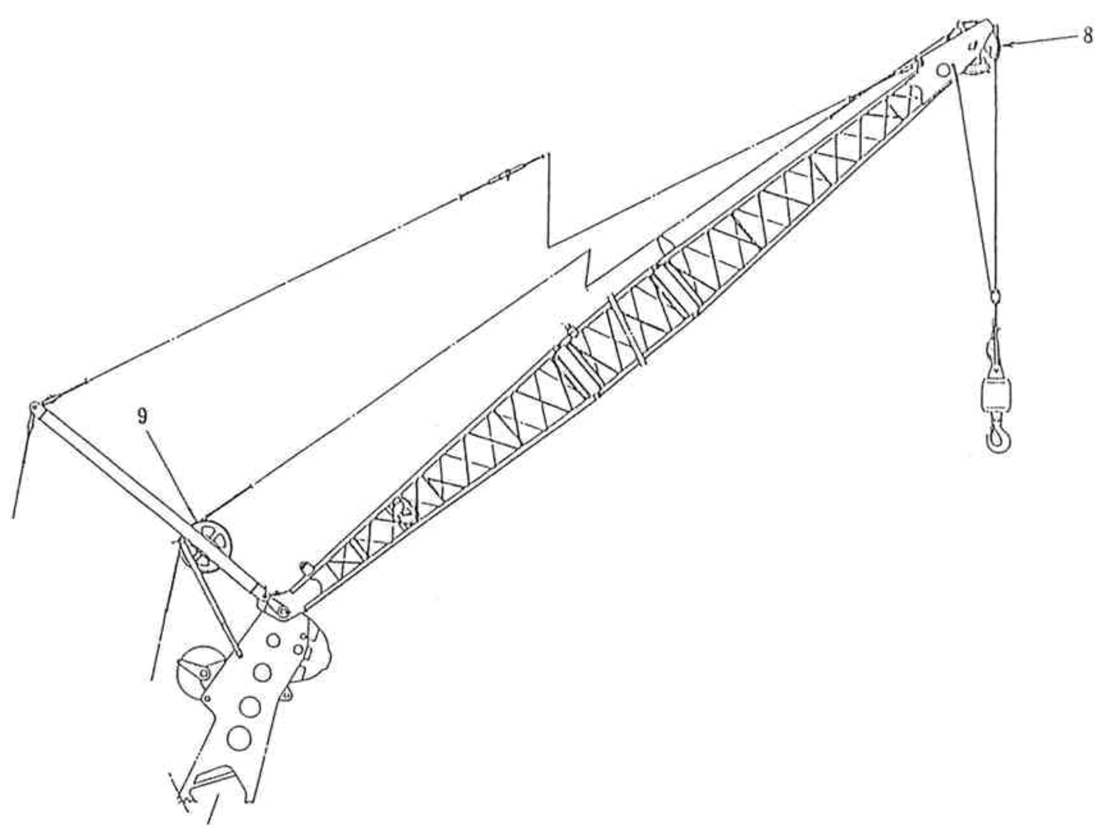


Fig. 1 - 9 Jib assembly

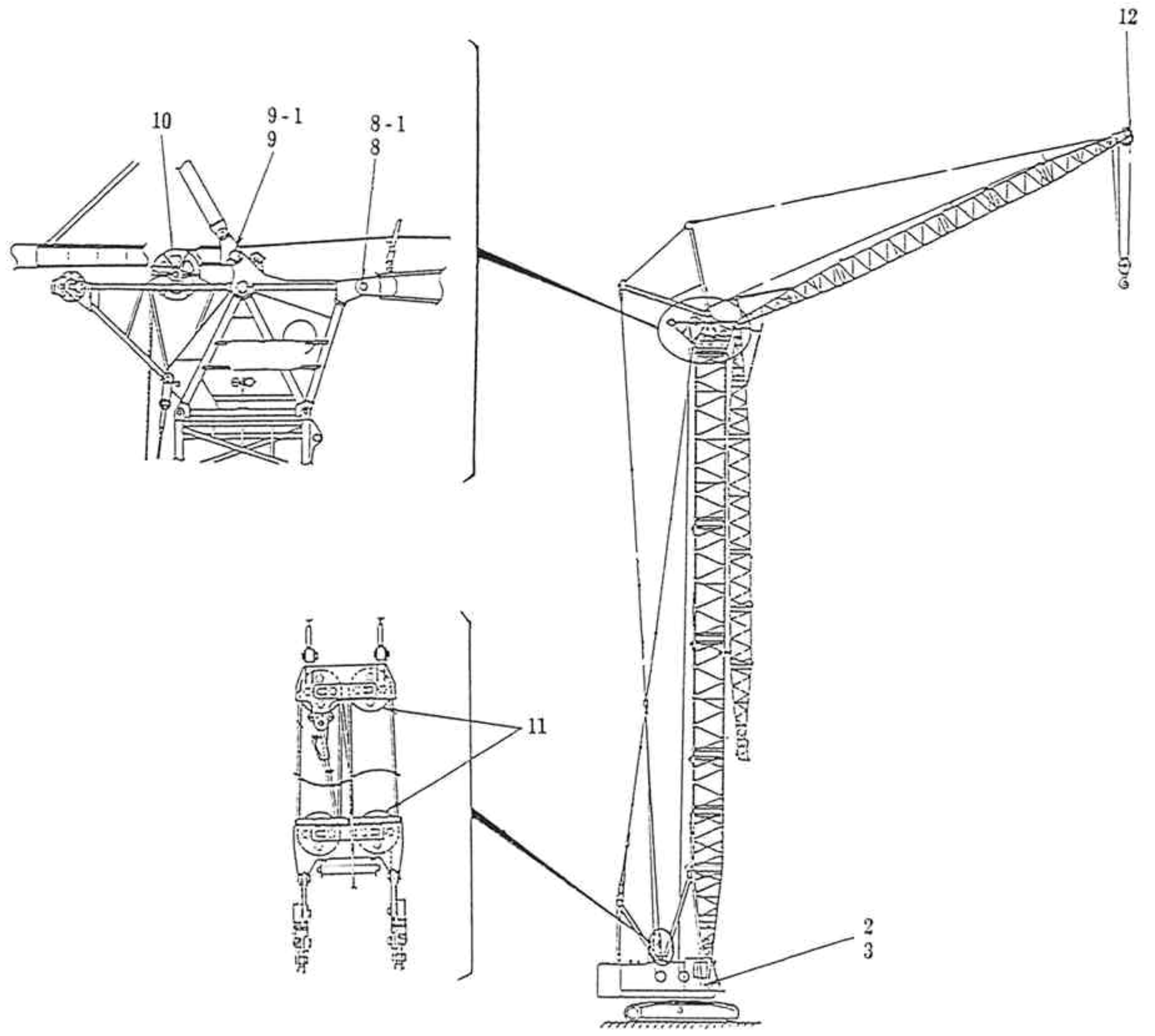


Fig. 1 - 10 Tower crane assembly

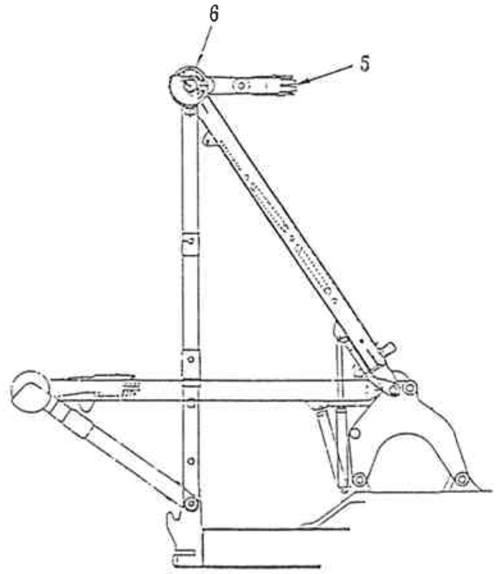
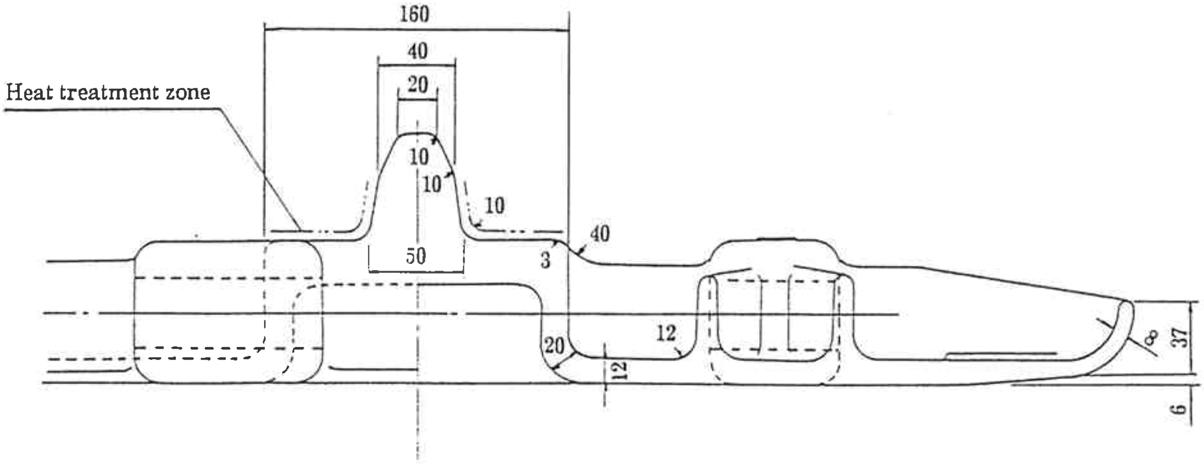
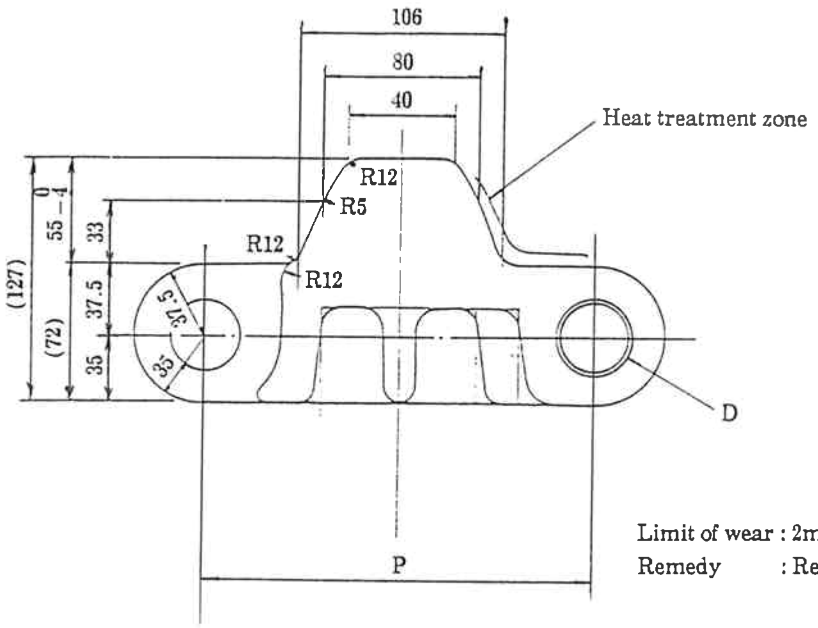


Fig. 1 - 11 Gantry assembly

1.2. PROPEL SYSTEM

1.2.1 Crawler shoe

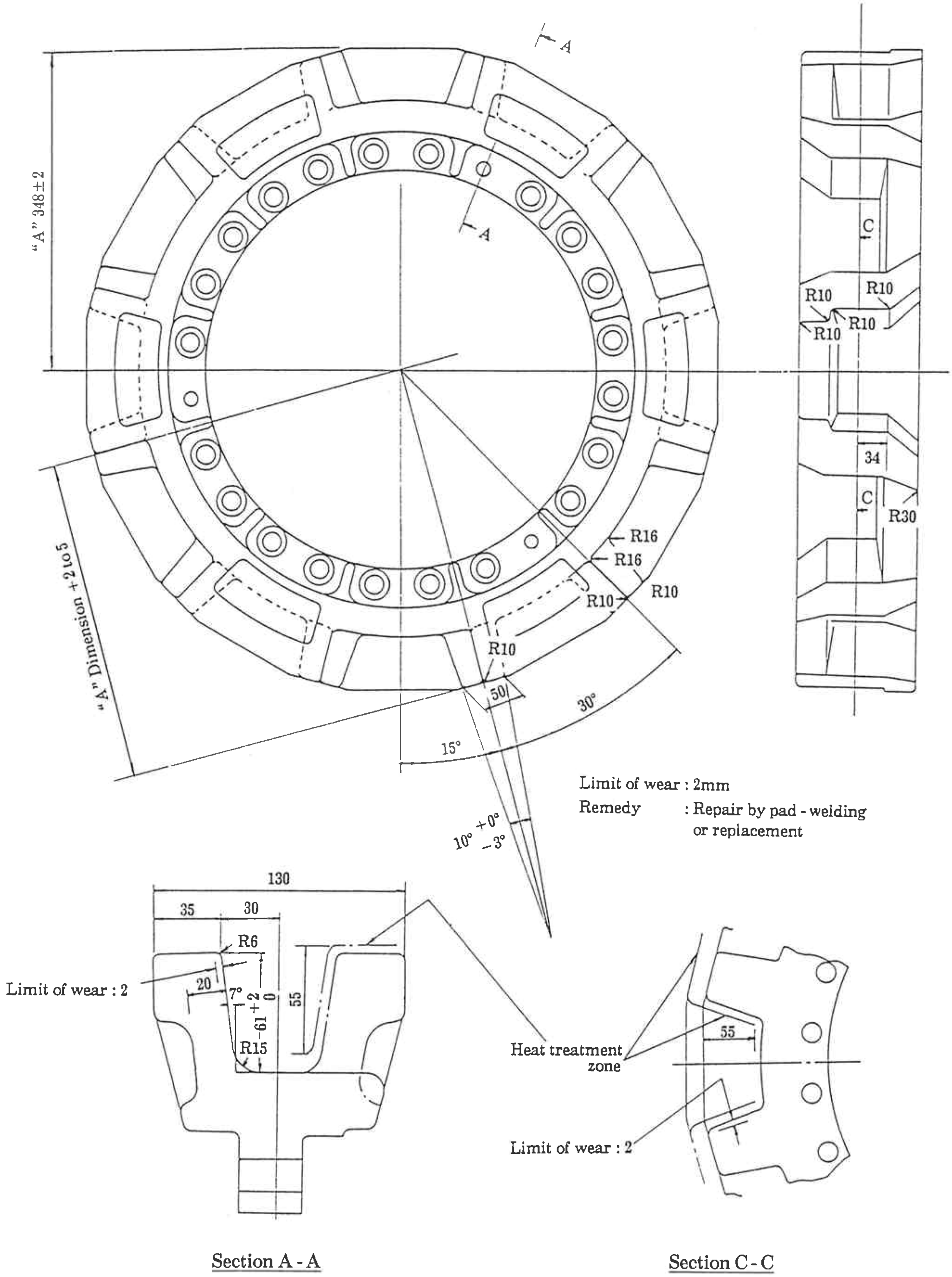




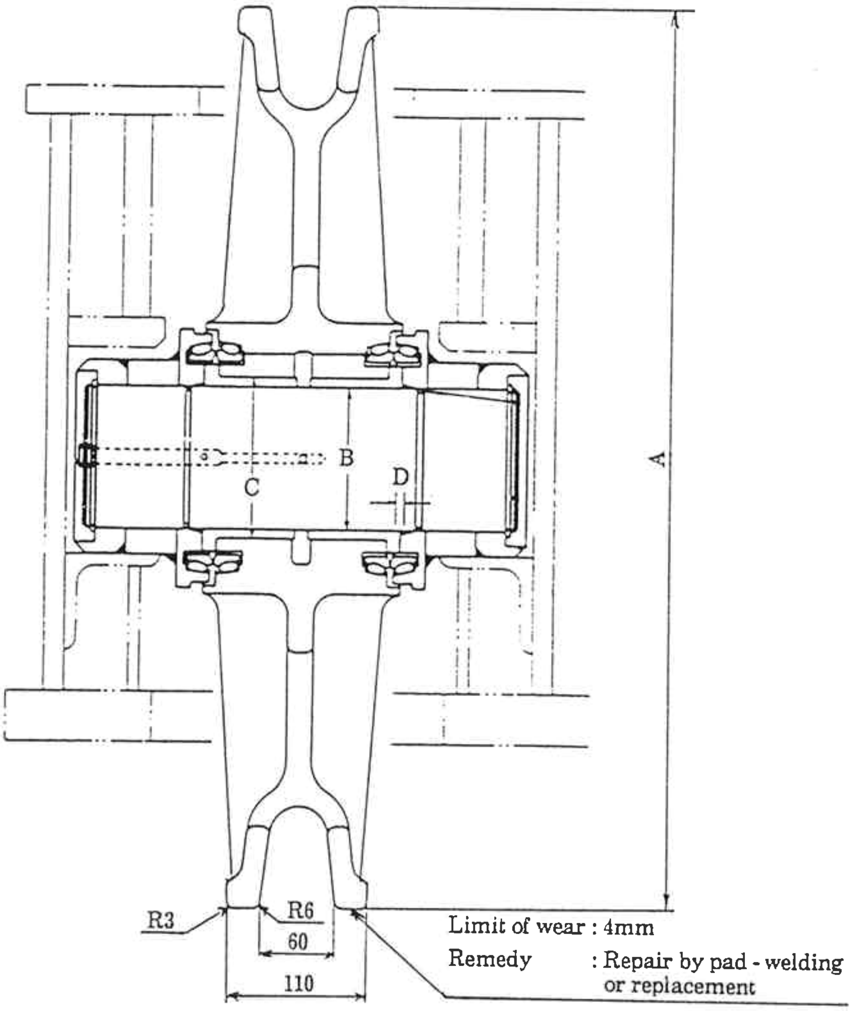
Limit of wear : 2mm
Remedy : Repair by pad - welding or replacement

	S.T.D. dimension	Limit of use	Remedy
Pin hole (D)	37 ± 1	40 ± 1	Repair pad - welding or replacement
Pin	$36^{\ 0}_{-0.4}$	$34^{\ 0}_{-0.4}$	
Pitch (P)	$203.2^{\ 0}_{-2}$	$209^{\ 0}_{-2}$	

1.2.2. Drive tumbler



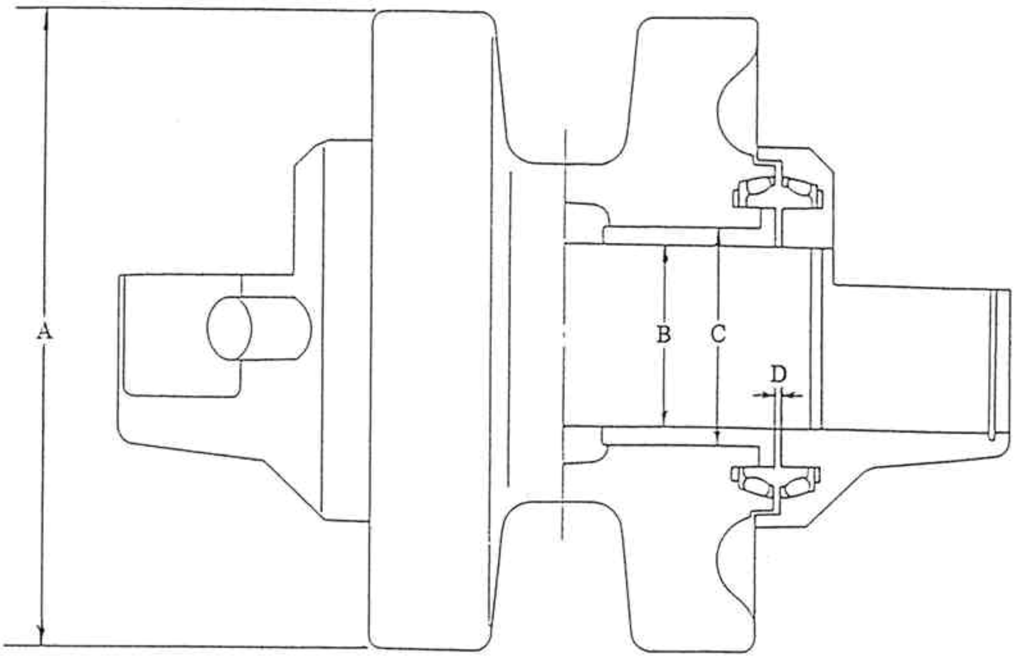
1.2.3. Idler



Unit:mm

Symbol	Item	Standard dimension				Limit of use	Remedy
A	Outer diameter	700				692	Repair by pad - welding or replacement
		S.T.D. dimension	Tolerance		Standard	Allowable	
B	Gap between shaft and bushing	ϕ110	Shaft	−0.036 −0.071	Gap 0.175~0.232	Gap 1.0	Replacement of bushing
			Hole	+0.161 +0.139			
C	Tightening tolerance of sprocket and bushing	ϕ125	Shaft	+0.117 +0.092	Tightening tolerance 0.057~0.117	Tightening tolerance 0	
			Hole	+0.040 0			
D	Side clearance of idler (one side)	0.02~0.74				1.2	

1.2.4. Track Roller



Unit:mm

<table>
<tr><th>Symbol</th><th>Item</th><th colspan="4">Standard dimension</th><th>Limit of use</th><th>Remedy</th></tr>
<tr><td>A</td><td>Outer diameter of roller</td><td colspan="4">ϕ 260</td><td>ϕ 252</td><td>Repair by pad - welding or replacement</td></tr>
<tr><td rowspan="3">B</td><td rowspan="3">Gap between shaft and bushing</td><td>S.T.D. dimension</td><td colspan="2">Tolerance</td><td>Standard</td><td>Allowable</td><td rowspan="3">Replacement of bushing</td></tr>
<tr><td rowspan="2">ϕ 75</td><td>Shaft</td><td>−0.03
−0.06</td><td rowspan="2">Gap
0.15~0.21</td><td rowspan="2">Gap
0.8</td></tr>
<tr><td>Hole</td><td>+0.15
+0.12</td></tr>
<tr><td rowspan="2">C</td><td rowspan="2">Tightening tolerance of roller and bushing</td><td rowspan="2">ϕ 90</td><td>Shaft</td><td>+0.110
+0.080</td><td rowspan="2">Tightening tolerance
0.045~0.11</td><td rowspan="2">Tightening tolerance
0</td><td rowspan="2">Replacement</td></tr>
<tr><td>Hole</td><td>+0.035
0</td></tr>
<tr><td>D</td><td>Side clearance of roller (one side)</td><td colspan="4">0.02~0.053</td><td>1.2</td><td>Replacement of bushing</td></tr>
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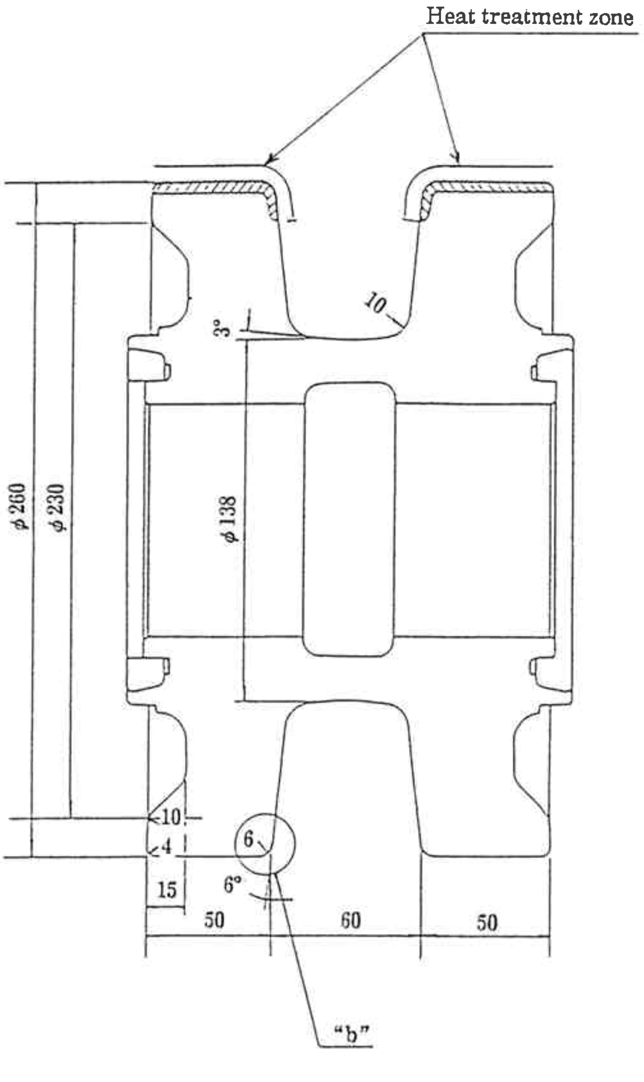
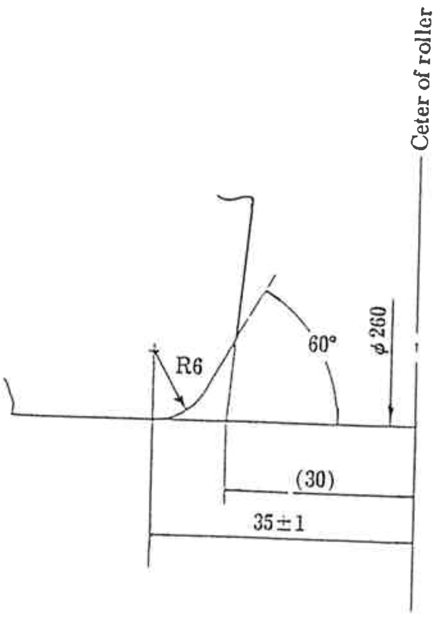
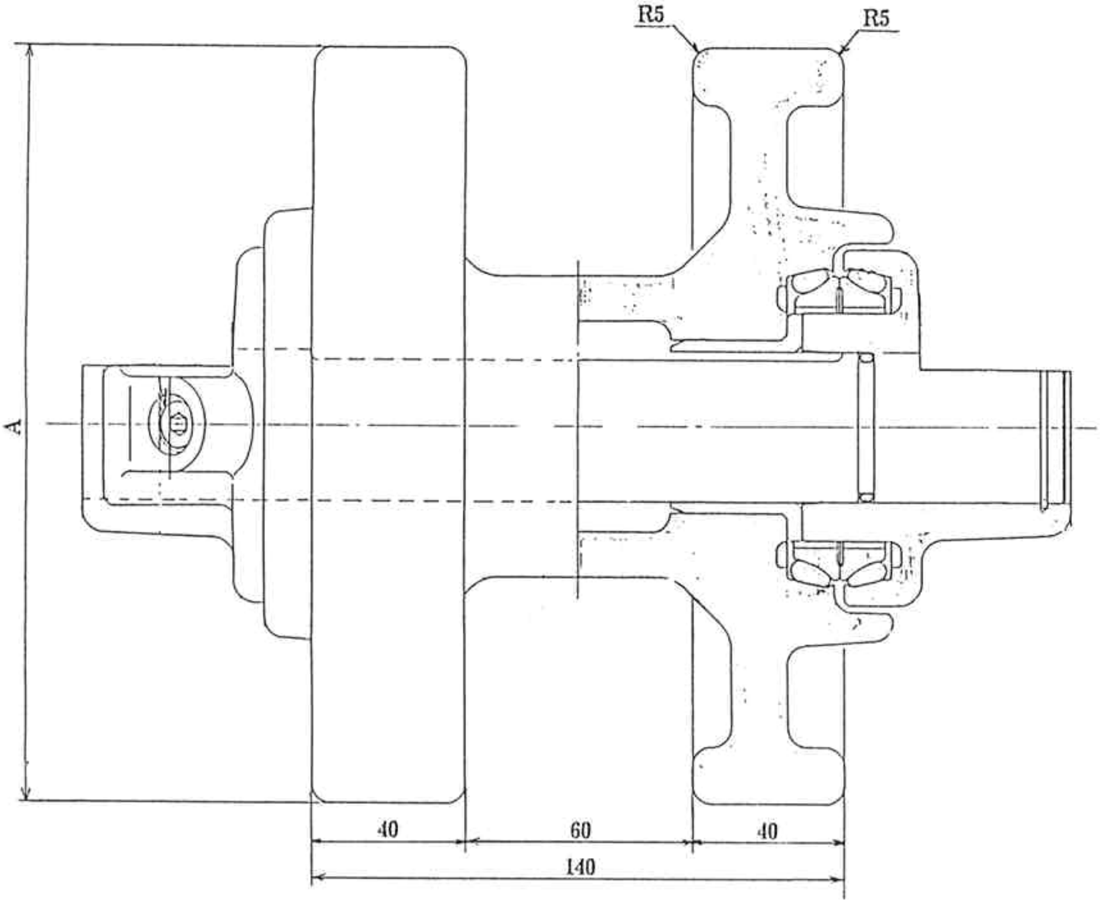

Heat treatment zone
10
3°
φ 260
φ 230
φ 138
10
4
6
6°
15
50
60
50
"b"


Ceter of roller
R6
60°
φ 260
(30)
35±1

Detail "b"

1.2.5. Guide Roller

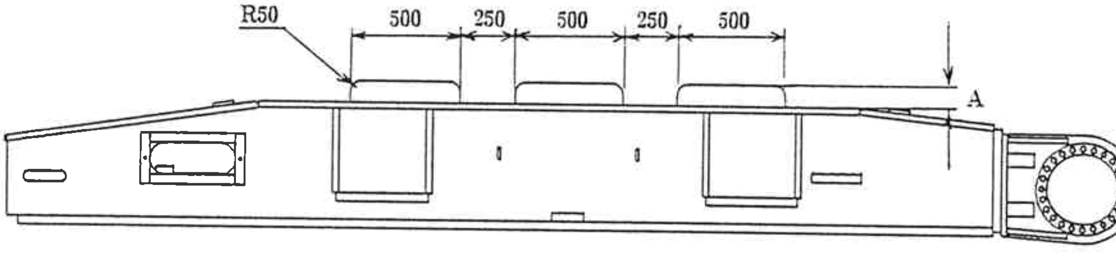


Unit:mm

Symbol	Item	Standard dimension	Limit of use	Remedy
A	Diameter of roller	ϕ 200	ϕ 192	Repair by pad - welding or replace

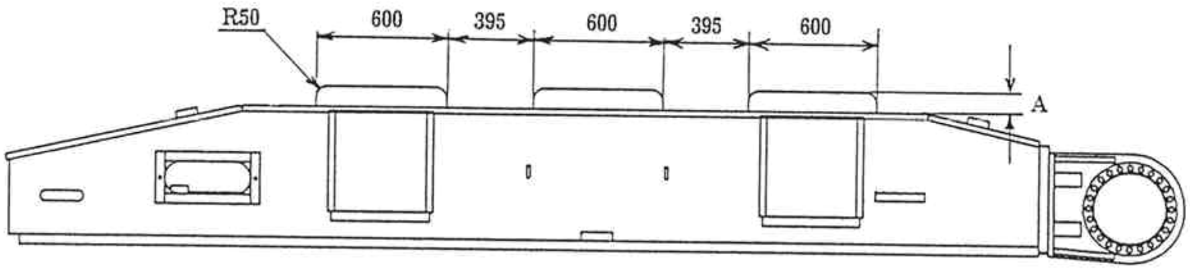
1.2.6. Guide Bar

7055



t = 45mm

7065



t = 45mm

Unit:mm

Symbol	Item		S.T.D. dimension	Limit of use	Remedy
A	Height of guide bar	7055	100	70	Repair by pad - welding or replace
		7065	95	65	

2. PERFORMANCE STANDARD AND TEST PROCEDURE

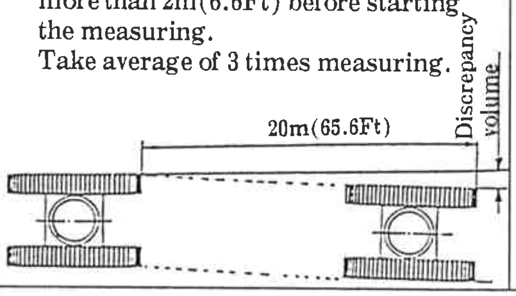
① TERMINOLOGY

Standard value : Standard of assembling new machine.
When the value exceeds the standard, repair or replace the part as required to maintain machine performance and or safety.

Temperature of oil: It means temperature of hydraulic oil.

② As to the items of which limit of use is not shown, referring to standard value as the guidance, repair or replace the part as required.

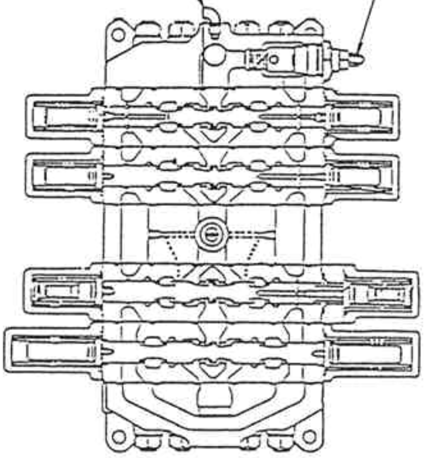
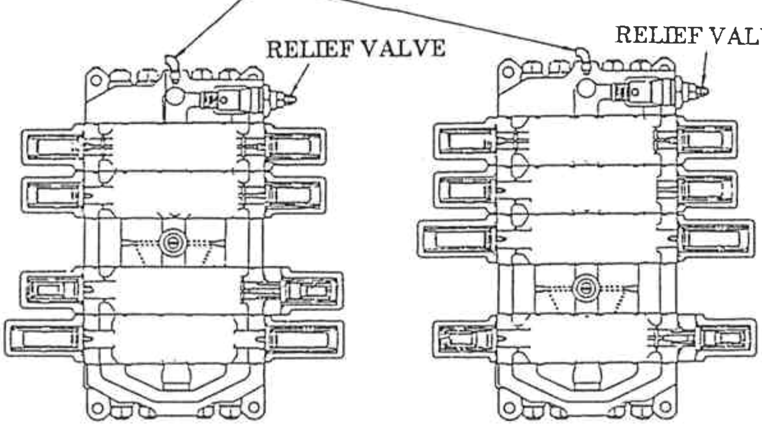
2.1 OPERATING SPEED

No.	Item	Test Condition	Test Procedure	Standard Value
1	Boom Hoisting and Lowering wire rope speed	• Engine R.P.M.: High idling • Temperature of Hyd. oil: 50℃±5° (122° F ±41°) • Boom Length	Measure the time taken to rotate drum 10 times. (Start measuring when the rotation of the drum becomes stable)	50m/min 12.7sec.
2	Main and Aux. hoisting wire rope	• Engine R.P.M.: High idling • Temperature of Hyd. oil: 50℃±5° • Loading: No load	Measure the time taken to rotate drum 10 times (Start measuring when the rotation of the drum becomes stable)	1st speed L=29.6sec H=19.3sec 2nd speed L=14.5sec H=9.7sec
3	Swing Speed	• Engine R.P.M.: High idling • Temperature of Hyd. oil: 50℃±5° (122° F ±41°) • Boom Length: Standard Boom • Loading: No load	Measure the time taken to rotate machine one time Measure the time for 2nd ratation after 1st preliminary rotation. Take average of 3 times measuring.	7055: 16.2 to 17.0sec 7065: 20.0 to 21.0sec
4	Prepel Speed	• Engine R.P.M.: High idling • Temperature of Hyd. oil: 50℃±5° (122° F ±41°) • Boom Length: Standard Boom	Measure the time taken to propel machine the distance of 20m(65.6Ft) Propel machine first preliminary more than 2m(6.6Ft) before starting the measuring. Take average of 3 times measuring.	7055: L= 65.5 to 68.8sec H= 45.0 to 47.3sec 7065: L= 80.0 to 84.0sec H= 60.0 to 63.0sec
5	Propelling Discrepancy	• Engine R.P.M.: High idling • Temperature of Hyd. oil: 50℃±5° (122° F ±41°) • Boom Length: Standard Boom	Measure the discrepancy volume resulted from propelling the distance of 20m.(65.6Ft) Propel machine first preliminary more than 2m(6.6Ft) before starting the measuring. Take average of 3 times measuring.  	600mm (23.62")

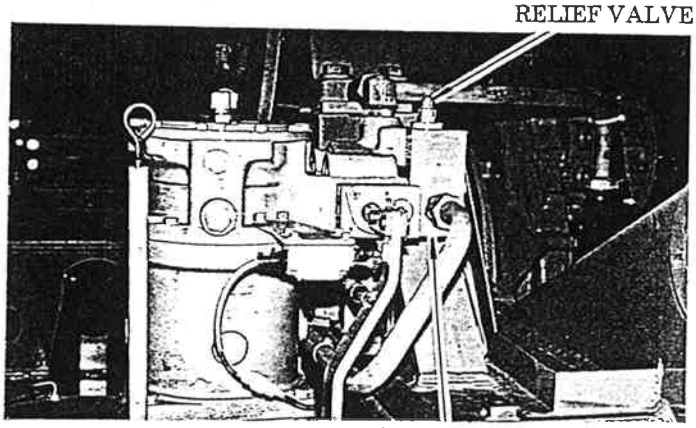
2.2 HYDRAULIC PRESSURE

Use a pressure gauge which has a surplus of more than 100kg/cm² (1422psi) for pressures to be measured and which has passed the inspection.

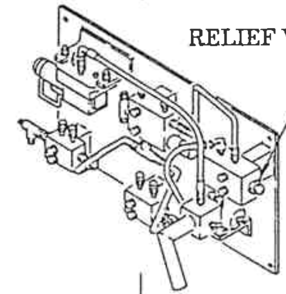
Prior to pressure measurement, clean the port for pressure measurement so as to be free from oil and dust.

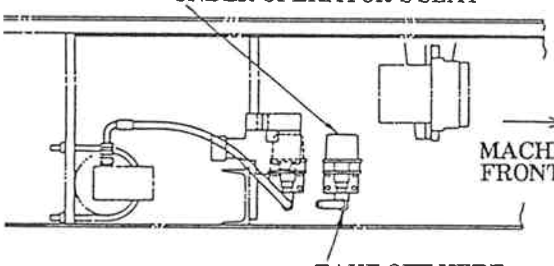
No.	Item	Test Condition	Test Method	Standard value
1	Boom	• Engine revolution (rpm): High idling • Temperature of Hydraulic oil: 45 to 55℃(113 to 131° F)	(1) Lower the boom onto the ground. (2) Romove the hose of the pawl lock cylinder so that the pawl is not disengaged even by operating the lever. (Take steps so that oil does not spout from the removed hose and plug.) (3) Relieve the valve by boom lowering operation. 	280kg/cm² (3982 psi)
2	Main	• Engine revolution (rpm): High idling • Temperature of Hydraulic oil: 45 to 55℃(113 to 131° F)	(1) Set the propelling speed in the HIGH SPEED condition. (2) Main winch: Relieves by left propelling operation only (pivot turn). Auxiliary winch: Relieves by right propelling operation only(pivot turn). NOTE: Set the boom angle at approx.60°, and perform the test being careful not to allow the hook to swing. 	280kg/cm² (3982 psi)

<table>
<tr><th>No.</th><th>Item</th><th>Test Condition</th><th>Test Method</th><th>Standard value</th></tr>
<tr><td rowspan="2">3</td><td rowspan="2">Swing</td><td>· Engine revolution (rpm): High idling
· Temperature of Hydraulic oil: 45 to 55℃(113 to 131° F)</td><td>(1) Lock the upper not to turn with the swing lock pin and parking brake.
(2) Make the valve relieve by swing operation.</td><td rowspan="2">250kg/cm²
(3555 psi)</td></tr>
<tr><td colspan="2">



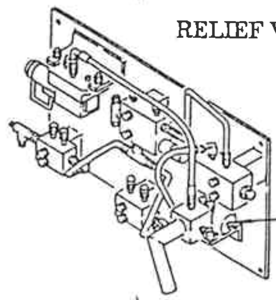
</td></tr>
<tr><td rowspan="2">4</td><td rowspan="2">Brake
(Hi - Fix)</td><td>· Engine revolution (rpm): High idling
· Temperature of Hydraulic oil: 45 to 55℃(113 to 131° F)</td><td>(1) Lower the hook onto the ground, and set the drum lock.
(2) Remove the hose connected to the pressure switch for the brake, and install the pressure gauge.</td><td rowspan="2">110 to 120kg/cm²
(1564 to 1706 psi)</td></tr>
<tr><td colspan="2">

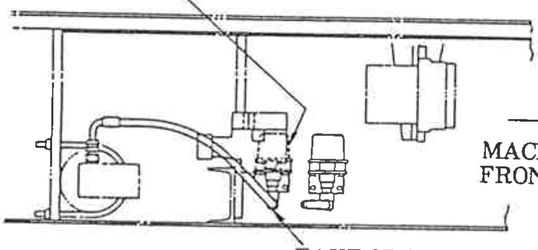




REFERENCE:
(Male of PT 1/4 and PF 1/4, Male Connector = ZH22Z04000
Female of PT 1/4 and PT 1/4, Female Connector = ZG22U04000)</td></tr>
<tr><td rowspan="2">5</td><td rowspan="2">Control Circuit
(Primary pressure)</td><td>· Engine revolution (rpm): High idling
· Temperature of Hydraulic oil: 45 to 55℃(113 to 131° F)</td><td>(1) Lower the hook onto the ground, and set the drum lock.
(2) Remove the hose connected to the pressure switch for control, and install the pressure gauge.</td><td rowspan="2">7055:
～#297:50kg/cm²
#298～:80kg/cm²

7065:
～#76:50kg/cm²
#77～:80kg/cm²</td></tr>
<tr><td colspan="2">





REFERENCE:
(Male of PT 1/4 and PF 1/4, Male Connector = ZH22Z04000
Female of PT 1/4 and PT 1/4, Female Connector = ZG22U04000)</td></tr>
</table>

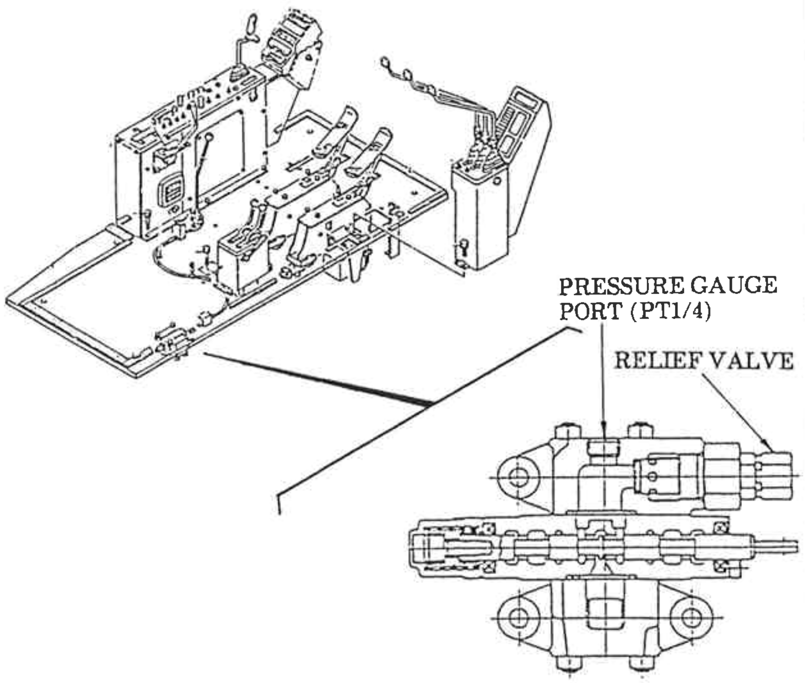
<table>
<tr><th>No.</th><th>Item</th><th>Test Condition</th><th>Test Method</th><th>Standard value</th></tr>
<tr><td>6</td><td>Control Circuit (Secondary pressure)</td><td>• Engine revolution (rpm): ——
• Temperature of Hydraulic oil: 45 to 55℃(113 to 131° F)</td><td>(1) Lower the boom and hook onto to the ground.
(2) Operate the control lever for the section to be measured.

Take pressure out from the quick coupler of the control valve spool end.

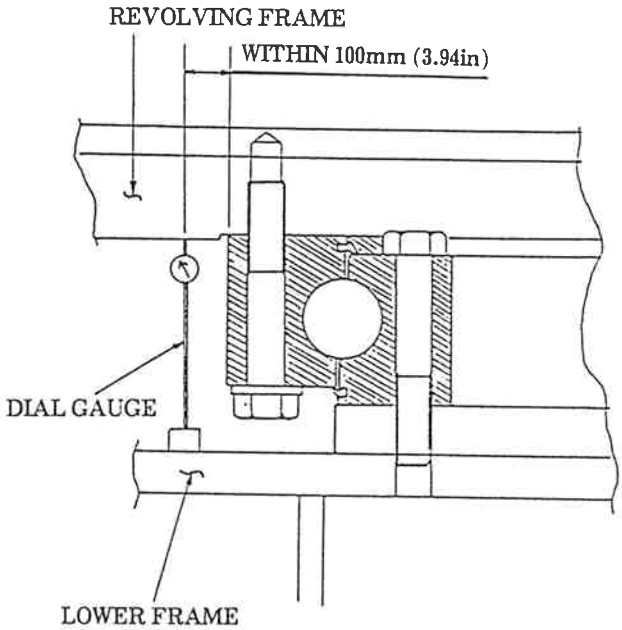
<table>
<tr><th></th><th colspan="2">Standard value</th></tr>
<tr><th></th><th>1st speed</th><th>2nd speed</th></tr>
<tr><td>Main winch
Auxiliary winch</td><td>14 to 16kg/cm^2
(199 to 228 psi)</td><td>28kg/cm^2
(398 psi)</td></tr>
<tr><td>Boom
Propel
Third drum</td><td colspan="2">15kg/cm^2
(213 psi)</td></tr>
</table>
</td><td></td></tr>
<tr><td>7</td><td>Crawler Extending</td><td>• Engine revolution (rpm): ——
• Temperature of Hydraulic oil: 45 to 55℃(113 to 131° F)</td><td>(1) Insert the crawler fixing pins to fix the crawlers.
(2) Make the valve relieve by operating crawler extension or retraction.</td><td>210kg/cm^2
(2986 psi)

7055 : #298～
7065 : #77～

<table>
<tr><th>EXT.</th><th>RET.</th></tr>
<tr><td>235kg/cm
(3342 psi)</td><td>260kg/cm
(3697 psi)</td></tr>
</table>
</td></tr>
</table>



2.3 PLAY OF SLEWING RING



FIGURES IN ( ) ARE FOR 7065

Condition for measurement			Amount of play
Boom length	:	12.19m - 40′	Less than 3mm (0.118in)
Boom angle	:	80°	
Load	:	55t - 121,254 lbs (65t - 143,300 lbs)	

1. TIGHTENING TORQUE OF CAPSCREWS AND NUTS

Unless otherwise specified, torque all screws and nuts on this machine to the values shown in the following tables.

1. 1 METRIC COARSE THREADS

Unit: kg-m (ft-lbs)

Classification / Nominal size	Metric Coarse Threads					
	4T		7T		10T	
	Dry	Lubricated	Dry	Lubricated	Dry	Lubricated
M 6	0.45 (3.25)	0.38 (2.75)	0.9(6.51)	0.8(5.79)	1.7(12.3)	1.5(10.9)
M 8	1.09 (7.88)	0.9 (6.51)	2.4(17.4)	2.0(14.5)	4.3(31.1)	3.6(26.0)
M 10	2.2 (15.9)	1.8 (13.0)	4.7(34.0)	4.0(28.9)	8.5(61.5)	7.2(52.1)
M 12	3.7 (26.8)	3.2 (23.2)	8.1(58.6)	6.8(49.2)	14.6(106)	12.3(89.0)
M 14	5.9 (42.7)	5.0 (36.2)	12.8(92.6)	10.8(78.1)	23.0(166)	19.5(141)
M 16	9.0 (65.1)	7.6 (55.0)	19.5(141)	16.4(119)	35.0(253)	29.0(210)
M 18	12.4 (89.7)	10.5 (76.0)	27.0(195)	23.0(166)	49.0(354)	41.0(297)
M 20	17.5 (127)	14.7 (106)	38.0(275)	32.0(232)	68.0(492)	57.0(412)
M 22	23.0 (166)	19.6 (142)	51.0(369)	43.0(311)	92.0(665)	77.0(557)
M 24	30.0 (217)	24.0 (174)	65.0(470)	53.0(383)	118.0(854)	96.0(964)
M 27	44.0 (318)	36.0 (260)	96.0(694)	78.0(564)	173.0(1251)	140.0(1012)
M 30	60.0 (434)	50.0 (362)	131.0(948)	110.0(796)	–	–
M 33	81.0 (586)	68.0 (492)	176.0(1273)	148.0(1070)	–	–
M 36	105.0 (760)	88.0 (637)	–	–	–	–

1. 2 METRIC FINE THREADS

Unit: kg-m (ft-lbs)

Classification / Nominal size	Fine Threads					
	4T		7T		10T	
	Dry	Lubricated	Dry	Lubricated	Dry	Lubricated
M 6	1.1 (7.96)	0.4 (2.89)	2.5(15.2)	2.1(15.2)	4.5(32.6)	3.8(27.5)
M 10	2.3 (16.6)	1.9 (13.7)	4.9(35.4)	4.2(30.4)	8.9(64.4)	7.5(54.3)
M 12	4.0 (28.9)	3.4 (24.6)	8.7(62.9)	7.3(52.8)	15.7(114)	13.2(95.5)
M 16	9.0 (65.1)	7.3 (52.8)	20.0(145)	17.2(124)	37.0(268)	31.0(224)
M 20	19.0 (137)	15.8 (114)	41.0(297)	34.0(246)	74.0(535)	62.0(448)
M 24	32.0 (232)	27.0 (195)	70.0(506)	56.0(405)	126.0(911)	105.0(760)
M 30	65.0 (470)	54.0 (391)	142.0(1027)	118.0(854)	–	–
M 36	109.0 (788)	91.0 (658)	–	–	–	–

1. TIGHTENING TORQUE OF CAPSCREWS AND NUTS

Unless otherwise specified, torque all screws and nuts on this machine to the values shown in the following tables.

1. 1 METRIC COARSE THREADS

Unit : kg-m (ft-lbs)

Nominal size \ Classification	Metric Coarse Threads					
	4T		7T		10T	
	Dry	Lubricated	Dry	Lubricated	Dry	Lubricated
M 6	0.45 (3.25)	0.38 (2.75)	0.9(6.51)	0.8(5.79)	1.7(12.3)	1.5(10.9)
M 8	1.09 (7.88)	0.9 (6.51)	2.4(17.4)	2.0(14.5)	4.3(31.1)	3.6(26.0)
M 10	2.2 (15.9)	1.8 (13.0)	4.7(34.0)	4.0(28.9)	8.5(61.5)	7.2(52.1)
M 12	3.7 (26.8)	3.2 (23.2)	8.1(58.6)	6.8(49.2)	14.6(106)	12.3(89.0)
M 14	5.9 (42.7)	5.0 (36.2)	12.8(92.6)	10.8(78.1)	23.0(166)	19.5(141)
M 16	9.0 (65.1)	7.6 (55.0)	19.5(141)	16.4(119)	35.0(253)	29.0(210)
M 18	12.4 (89.7)	10.5 (76.0)	27.0(195)	23.0(166)	49.0(354)	41.0(297)
M 20	17.5 (127)	14.7 (106)	38.0(275)	32.0(232)	68.0(492)	57.0(412)
M 22	23.0 (166)	19.6 (142)	51.0(369)	43.0(311)	92.0(665)	77.0(557)
M 24	30.0 (217)	24.0 (174)	65.0(470)	53.0(383)	118.0(854)	96.0(964)
M 27	44.0 (318)	36.0 (260)	96.0(694)	78.0(564)	173.0(1251)	140.0(1012)
M 30	60.0 (434)	50.0 (362)	131.0(948)	110.0(796)	—	—
M 33	81.0 (586)	68.0 (492)	176.0(1273)	148.0(1070)	—	—
M 36	105.0 (760)	88.0 (637)	—	—	—	—

1. 2 METRIC FINE THREADS

Unit : kg-m (ft-lbs)

Nominal size \ Classification	Fine Threads					
	4T		7T		10T	
	Dry	Lubricated	Dry	Lubricated	Dry	Lubricated
M 6	1.1 (7.96)	0.4 (2.89)	2.5(15.2)	2.1(15.2)	4.5(32.6)	3.8(27.5)
M 10	2.3 (16.6)	1.9 (13.7)	4.9(35.4)	4.2(30.4)	8.9(64.4)	7.5(54.3)
M 12	4.0 (28.9)	3.4 (24.6)	8.7(62.9)	7.3(52.8)	15.7(114)	13.2(95.5)
M 16	9.0 (65.1)	7.3 (52.8)	20.0(145)	17.2(124)	37.0(268)	31.0(224)
M 20	19.0 (137)	15.8 (114)	41.0(297)	34.0(246)	74.0(535)	62.0(448)
M 24	32.0 (232)	27.0 (195)	70.0(506)	56.0(405)	126.0(911)	105.0(760)
M 30	65.0 (470)	54.0 (391)	142.0(1027)	118.0(854)	—	—
M 36	109.0 (788)	91.0 (658)	—	—	—	—

1. 3 COARSE THREDS UNC

Unit: kg-m (ft-lbs)

Nominal size \ Classification	Coarse Threads UNC					
	Grade 2		Grade 5		Grade 8	
	Dry	Lubricated	Dry	Lubricated	Dry	Lubricated
1/4	0.8(5.79)	0.7(5.06)	1.3(9.40)	1.1(7.96)	1.8(13.0)	1.5(10.8)
5/16	1.6(11.6)	1.4(10.1)	2.6(18.8)	2.2(15.9)	3.6(26.0)	3.1(22.4)
3/8	2.9(21.0)	2.4(17.4)	4.5(32.6)	3.8(27.5)	6.3(45.6)	5.3(38.3)
7/16	4.5(32.5)	3.8(27.5)	7.0(50.6)	5.9(42.7)	9.9(71.6)	8.3(60.0)
1/2	7.0(50.6)	5.9(42.7)	10.8(78.1)	9.1(65.8)	15.2(110)	12.8(92.6)
9/16	10.0(72.3)	8.4(60.8)	15.5(112)	13.0(94.0)	22.0(159)	18.4(133)
5/8	14.0(101)	11.8(85.3)	22.0(159)	18.2(132)	31.0(224)	26.0(188)
3/4	25.0(181)	21.0(152)	38.0(275)	32.0(232)	54.0(391)	45.0(325)
7/8	29.0(210)	25.0(181)	61.0(441)	51.0(369)	86.0(622)	72.0(521)
1	35.0(253)	30.0(217)	91.0(658)	76.0(550)	128.0(926)	108.0(781)
1 1/8	51.0(369)	43.0(311)	114.0(825)	95.0(687)	184.0(1331)	154.0(1114)
1 1/4	71.0(514)	59.0(427)	159.0(1150)	133.0(962)	257.0(1859)	216.0(1562)
1 3/8	93.0(673)	78.0(564)	209.0(1512)	175.0(1266)	338.0(2445)	284.0(2054)
1 1/2	124.0(897)	104.0(752)	277.0(2004)	232.0(1678)	449.0(3248)	376.0(2720)

1. 4 FINE THREADS UNF

Unit: kg-m (ft-lbs)

Nominal size \ Classification	Fine Threads UNF					
	Grade 2		Grade 5		Grade 8	
	Dry	Lubricated	Dry	Lubricated	Dry	Lubricated
1/4	0.9 (6.51)	0.8 (5.79)	1.4(10.1)	1.2(8.68)	2.1(15.2)	1.7(12.3)
5/16	1.8 (13.2)	1.5 (10.8)	2.8(20.3)	2.4(17.4)	4.0(28.9)	3.4(24.6)
3/8	3.2 (23.1)	2.7 (19.5)	4.9(35.4)	4.1(29.7)	7.0(50.6)	5.8(42.0)
7/16	5.0 (36.2)	4.2 (30.4)	7.7(55.7)	6.4(46.3)	10.8(78.1)	9.1(65.8)
1/2	7.7 (55.7)	6.4 (46.3)	11.9(86.1)	9.9(71.6)	16.8(122)	14.0(101)
9/16	10.9 (78.8)	9.2 (66.5)	16.9(122)	14.1(102)	24.0(174)	19.9(144)
5/8	15.5 (112)	12.9 (93.3)	24.0(174)	20.0(145)	34.0(246)	28.0(203)
3/4	27.0 (195)	22.0 (159)	42.0(304)	35.0(253)	58.0(420)	49.0(354)
7/8	31.0 (224)	25.0 (181)	66.0(477)	55.0(398)	93.0(673)	77.0(557)
1	38.0 (275)	31.0 (224)	98.0(709)	82.0(593)	138.0(998)	115.0(832)
1 1/8	56.0 (405)	46.0 (333)	124.0(897)	104.0(752)	201.0(1454)	168.0(1215)
1 1/4	77.0 (557)	64.0 (463)	153.0(1107)	143.0(1034)	279.0(2018)	232.0(1678)
1 3/8	103.0 (745)	86.0 (622)	231.0(1671)	192.0(1389)	374.0(2705)	311.0(2249)
1 1/2	136.0 (984)	113.0 (817)	304.0(2199)	253.0(1830)	493.0(3566)	410.0(2966)

1. 3 COARSE THREDS UNC

Unit : kg-m (ft-lbs)

Nominal size \ Classification	Coarse Threads UNC					
	Grade 2		Grade 5		Grade 8	
	Dry	Lubricated	Dry	Lubricated	Dry	Lubricated
1/4	0.8(5.79)	0.7(5.06)	1.3(9.40)	1.1(7.96)	1.8(13.0)	1.5(10.8)
5/16	1.6(11.6)	1.4(10.1)	2.6(18.8)	2.2(15.9)	3.6(26.0)	3.1(22.4)
3/8	2.9(21.0)	2.4(17.4)	4.5(32.6)	3.8(27.5)	6.3(45.6)	5.3(38.3)
7/16	4.5(32.5)	3.8(27.5)	7.0(50.6)	5.9(42.7)	9.9(71.6)	8.3(60.0)
1/2	7.0(50.6)	5.9(42.7)	10.8(78.1)	9.1(65.8)	15.2(110)	12.8(92.6)
9/16	10.0(72.3)	8.4(60.8)	15.5(112)	13.0(94.0)	22.0(159)	18.4(133)
5/8	14.0(101)	11.8(85.3)	22.0(159)	18.2(132)	31.0(224)	26.0(188)
3/4	25.0(181)	21.0(152)	38.0(275)	32.0(232)	54.0(391)	45.0(325)
7/8	29.0(210)	25.0(181)	61.0(441)	51.0(369)	86.0(622)	72.0(521)
1	35.0(253)	30.0(217)	91.0(658)	76.0(550)	128.0(926)	108.0(781)
1 1/8	51.0(369)	43.0(311)	114.0(825)	95.0(687)	184.0(1331)	154.0(1114)
1 1/4	71.0(514)	59.0(427)	159.0(1150)	133.0(962)	257.0(1859)	216.0(1562)
1 3/8	93.0(673)	78.0(564)	209.0(1512)	175.0(1266)	338.0(2445)	284.0(2054)
1 1/2	124.0(897)	104.0(752)	277.0(2004)	232.0(1678)	449.0(3248)	376.0(2720)

1. 4 FINE THREADS UNF

Unit : kg-m (ft-lbs)

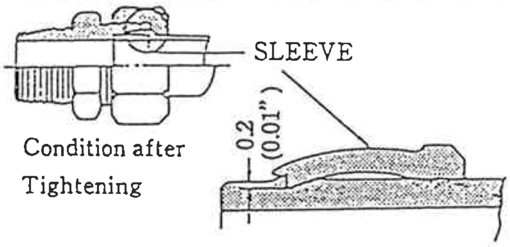
Nominal size \ Classification	Fine Threads UNF					
	Grade 2		Grade 5		Grade 8	
	Dry	Lubricated	Dry	Lubricated	Dry	Lubricated
1/4	0.9 (6.51)	0.8 (5.79)	1.4(10.1)	1.2(8.68)	2.1(15.2)	1.7(12.3)
5/16	1.8 (13.2)	1.5 (10.8)	2.8(20.3)	2.4(17.4)	4.0(28.9)	3.4(24.6)
3/8	3.2 (23.1)	2.7 (19.5)	4.9(35.4)	4.1(29.7)	7.0(50.6)	5.8(42.0)
7/16	5.0 (36.2)	4.2 (30.4)	7.7(55.7)	6.4(46.3)	10.8(78.1)	9.1(65.8)
1/2	7.7 (55.7)	6.4 (46.3)	11.9(86.1)	9.9(71.6)	16.8(122)	14.0(101)
9/16	10.9 (78.8)	9.2 (66.5)	16.9(122)	14.1(102)	24.0(174)	19.9(144)
5/8	15.5 (112)	12.9 (93.3)	24.0(174)	20.0(145)	34.0(246)	28.0(203)
3/4	27.0 (195)	22.0 (159)	42.0(304)	35.0(253)	58.0(420)	49.0(354)
7/8	31.0 (224)	25.0 (181)	66.0(477)	55.0(398)	93.0(673)	77.0(557)
1	38.0 (275)	31.0 (224)	98.0(709)	82.0(593)	138.0(998)	115.0(832)
1 1/8	56.0 (405)	46.0 (333)	124.0(897)	104.0(752)	201.0(1454)	168.0(1215)
1 1/4	77.0 (557)	64.0 (463)	153.0(1107)	143.0(1034)	279.0(2018)	232.0(1678)
1 3/8	103.0 (745)	86.0 (622)	231.0(1671)	192.0(1389)	374.0(2705)	311.0(2249)
1 1/2	136.0 (984)	113.0 (817)	304.0(2199)	253.0(1830)	493.0(3566)	410.0(2966)

1. 5 TIGHTENING TORQUE OF HYDRAULIC FITTINGS

Excessive or insufficient tightening of hose or tube fittings can cause oil leak and deformation or damage to the metal fittings.

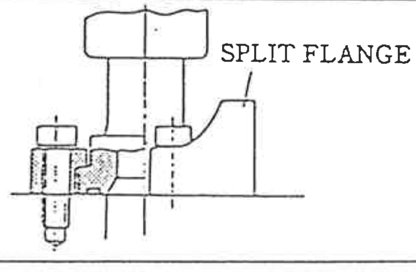
Therefore, to secure and obtain good fixing and performance of fittings it is necessary to tightin to the proper torque. The follows are the recommended torques.

(1) BITE TYPE TUBE FITTINGS.

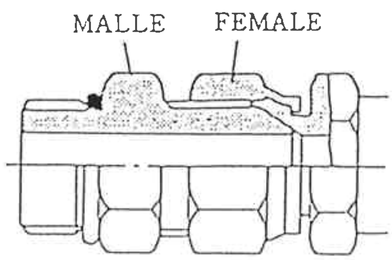
Size in mm (inch) (Outside diameter × thicknes	Tightening torque in kg-m (ft-lbs)	Remarks
10 (0.364) × 1.5 (0.059)	5 to 7 (36 to 51)	
15 (0.591) × 2.0 (0.079)	13 to 16 (94 to 116)	
18 (0.709) × 2.5 (0.098)	16 to 17 (116 to 123)	
22 (0.866) × 3.0 (0.118)	20 to 22 (145 to 159)	
28 (1.102) × 4.0 (0.157)	25 to 29 (181 to 210)	
35 (1.378) × 5.0 (0.197)	33 to 36 (239 to 260)	

(2) SPLIT FIANGES

(From SAE Standard)

Size	Tightening torque in kg-m (ft-lbs)		Remarks
	3000 psi (210 kg/cm²)	6000 psi (420 kg/cm²)	
1/2"	2 to 2.6 (14.5 to 19)	—	
3/4"	2.9 to 4.0 (21 to 29)	3.45 to 4.6 (25 to 33)	
1"	3.75 to 4.9 (27 to 35)	5.75 to 6.9 (42 to 50)	
1 1/4"	4.9 to 6.3 (35 to 45)	8.6 to 10.3 (62 to 74)	
1 1/2"	6.3 to 8.0 (45 to 58)	16.1 to 18.4 (116 to 133)	
2"	7.5 to 9.5 (54 to 69)	27.6 to 30.0 (200 to 217)	

(3) FLARE TYPE TUBE FITTINGS (30° FLARE, PF THREADS)

Size	Tightening torque in kg-m (ft-lbs)	Remarks
1/4"	2.5 to 3.5 (18 to 25)	
3/8"	5 to 7 (36 to 51)	
1/2"	6 to 8 (43 to 58)	
3/4"	12 to 16 (87 to 116)	
1"	15 to 19 (108 to 137)	
1 1/4"	17 to 23 (123 to 166)	
1 1/2"	22 to 28 (159 to 202)	
2"	26 to 34 (188 to 246)	

(4) Jubilee Clip (Low Pressure and Suction)

Nominal cord	Diameter		Recomended torque		Working pressure range	
BS5315	inches	m·m	kg·cm	in·lbs.	kg/cm^2	psi
12	3/8" − 1/2"	9.5 − 12	34.5	29.9	56.0	796
16	1/2" − 5/8"	11 − 16	34.5	29.9	56.0	796
20	1/2" − 3/4"	13 − 20	34.5	29.9	56.0	796
22	5/8" − 7/8"	16 − 22	45.7	39.7	56.0	796
25	3/4" − 1"	18 − 25	45.7	39.7	56.0	796
30	7/8" − 1 1/8"	22 − 30	45.7	39.7	56.0	796
35	1" − 1 3/8"	25 − 35	45.7	39.7	56.0	796
40	1 1/8" − 1 5/8"	27 − 40	45.7	39.7	35.0	498
50	1 1/4" − 1 7/8"	35 − 50	45.7	39.7	35.0	498
55	1 1/2" − 2 1/8"	40 − 55	60.4	52.4	21.0	299
60	1 3/4" − 2 3/8"	45 − 60	60.4	52.4	21.0	299
70	2" − 2 3/4"	55 − 70	60.4	52.4	16.8	239
80	2 3/8" − 3 1/8"	60 − 80	60.4	52.4	16.8	239
90	2 3/4" − 3 1/2"	70 − 90	69.0	59.9	16.8	239
100	3 1/4" − 4"	85 − 100	69.0	59.9	16.8	239
120	3 3/4" − 4 1/2"	90 − 120	69.0	59.9	10.5	149
140	4 1/8" − 5 1/2"	110 − 140	69.0	59.9	10.5	149
150	5" − 5 3/4"	130 − 150	69.0	59.9	10.5	149
165	5 1/4" − 6 1/2"	135 − 165	69.0	59.9	9.8	139
190	6 1/4" − 7 1/2"	160 − 190	69.0	59.9	9.8	139
215	7 1/4" − 8 1/2"	185 − 215	78.0	67.7	9.0	128
240	8 1/4" − 9 1/2"	205 − 240	78.0	67.7	9.0	128
270	9 1/4" − 10 1/2"	235 − 270	78.0	67.7	9.0	128
290	10 1/4" − 11 1/2"	255 − 290	78.0	67.7	9.0	128
320	11 1/4" − 12 1/2"	285 − 320	78.0	67.7	9.0	128

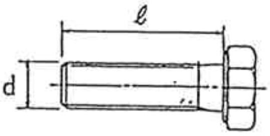
2. STANDARD PARTS

2. 1 BOLT

Size and kind of bolt can be identifid as shown below.

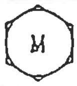
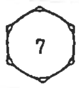
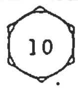
ZS ●● C ●●●●●

- ●●●●● — Showing the length of bolt. (ℓ)
- ●● (after C) — Showing nominal dimension. (d)



- C : Shows coarse screw threads.
  F : Shows fine screw threads.
- ●● (after ZS) — Showing strength and kind of bolt
  - 11 : shows 4T
  - 12 : shows 7T
  - 13 : shows 10T
  - shows hexagon socket head bolt.

Some bolts are stamped strength class on the heads.

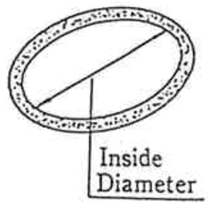
4T		7T		10T	
ZS11F ZS51F		ZS12F ZS52F		ZS13F ZS53F	

2. 2 O-RING

Size and kind of O-Ring are identified as shown below.

Z D ●● P ●●● 0 0

- Showing inside diameter.
- Classifing thickness of the ring.
  P : Shows for the use of moving part.
  G : For the use of stationary part.
- Classifing quality of rubber.
  Not figures but points of blue, red, green and or yellow colours are put on
  Colour and quantity of points classify as follows ;
  11 : 1point of blue colour mean Hs70.
  12 : 2point of blue colour mean Hs90.



Colour of point shows

· Both blue and red to be of nitril rubber and blue to be used in the range of temperature of minus 25℃ to 120℃ (77°F to 248°F)
Red for gasoline proof not to be used nomally.

· Green to be of fluorine rubber and used in the range of temperature of minus 15℃ to 200℃ (59°F to 392°F)

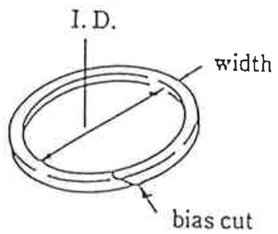
1point of blue : ZD11······nitril rubber Hs70
2point of blue : ZD12······nitril rubber Hs90
1point of red : nitril rubber Hs70
1point of yellow : styrol rubber Hs70
1point of green : fluorince rubber Hs70

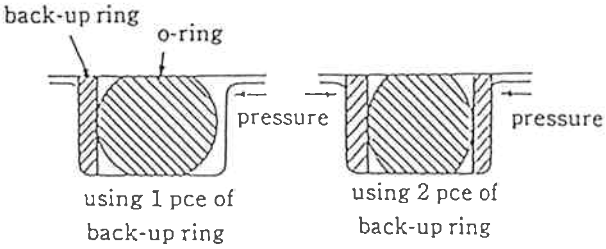
2. 3 BACK-UP RING

Size and kind of back-up ring are identified as shown below.

Z D ○○ P ○○○ 0 0

- Showing inside diameter
- Classifing width
- Showing shape
  75 : endless
  85 : bias cut
  95 : spiral



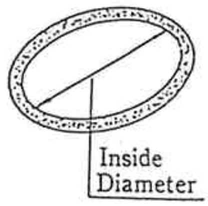


2. 2 O-RING

Size and kind of O-Ring are identified as shown below.

Z D ● ● P ● ● ● 0 0

- Showing inside diameter.
- Classifing thickness of the ring.
  P : Shows for the use of moving part.
  G : For the use of stationary part.



- Classifing quality of rubber.
  Not figures but points of blue, red, green and or yellow colours are put on
  Colour and quantity of points classify as follows ;
  11 : 1point of blue colour mean Hs70.
  12 : 2point of blue colour mean Hs90.

Colour of point shows

- Both blue and red to be of nitril rubber and blue to be used in the range of temperature of minus 25℃ to 120℃ (77°F to 248°F)
  Red for gasoline proof not to be used nomally.
- Green to be of fluorine rubber and used in the range of temperature of minus 15℃ to 200℃ (59°F to 392°F)

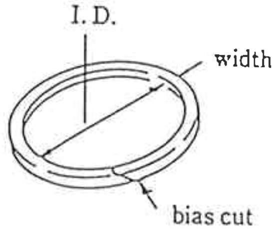
1point of blue : ZD11······	nitril rubber Hs70
2point of blue : ZD12······	nitril rubber Hs90
1point of red :	nitril rubber Hs70
1point of yellow :	styrol rubber Hs70
1point of green :	fluorince rubber Hs70

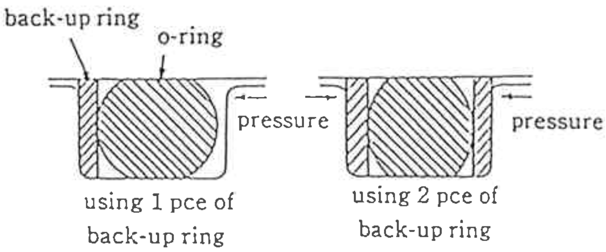
2. 3 BACK-UP RING

Size and kind of back-up ring are identified as shown below.

Z D ○ ○ P ○ ○ ○ 0 0

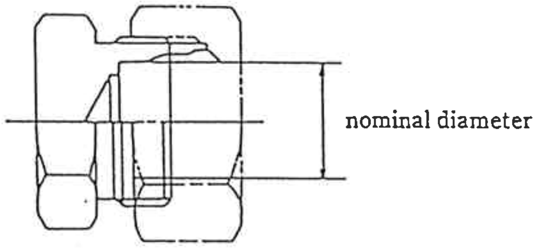
- Showing inside diameter
- Classifing width
- Showing shape
  75 : endless
  85 : bias cut
  95 : spiral





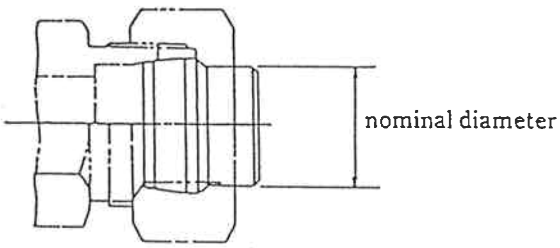
2．4　BITE FITTING

PLUG FOR TUBE



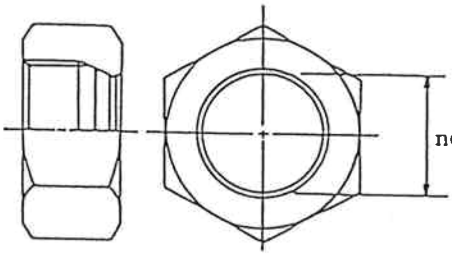
Nominal Diameter	Made by IHARA KOHATSU (ZF)	Made by NIHON AMC (ZA)	Made by NIHON AMC (ZK)
10	ZF83H10000	ZA82P10000	ZK82P10000
15	ZF83H15000	ZA82P15000	ZK82P15000
18	ZF83H18000	ZA82P18000	ZK82P18000
22	ZF83H22000	ZA82P22000	ZK82P22000
28	ZF83H28000	ZA82P28000	ZK82P28000
35	ZF83H35000	ZA82P35000	ZK82P35000

PLUG FOR CONNECTOR



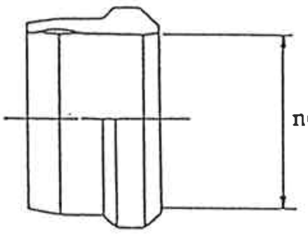
Nominal Diameter	Made by IHARA KOHATSU (ZF)	Made by NIHON AMC (ZA)	Made by NIHON AMC (ZK)
10	ZF83P10000	ZA83P10000	ZK83P10000
15	ZF83P15000	ZA83P15000	ZK83P15000
18	ZF83P18000	ZA83P18000	ZK83P18000
22	ZF83P22000	ZA83P22000	ZK83P22000
28	ZF83P28000	ZA83P28000	ZK83P28000
35	ZF83P35000	ZA83P35000	ZK83P35000

NUT



Nominal Diameter	Made by IHARA KOHATSU (ZF)	Made by NIHON AMC (ZA)	Made by NIHON AMC (ZK)
10	ZF93N10000	ZA93N10000	ZK93N10000
15	ZF93N15000	ZA93N15000	ZK93N15000
18	ZF93N18000	ZA93N18000	ZK93N18000
22	ZF93N22000	ZA93N22000	ZK93N22000
28	ZF93N28000	ZA93N28000	ZK93N28000
35	ZF93N35000	ZA93N35000	ZK93N35000

SLEEVE



Nominal Diameter	Made by IHARA KOHATSU (ZF)	Made by NIHON AMC (ZA)	Made by NIHON AMC (ZK)
10	ZF93S10000	ZA93S10000	ZK93S10000
15	ZF93S15000	ZA93S15000	ZK93S15000
18	ZF93S18000	ZA93S18000	ZK93S18000
22	ZF93S22000	ZA93S22000	ZK93S22000
28	ZF93S28000	ZA93S28000	ZK93S28000
35	ZF93S35000	ZA93S35000	ZK93S35000

Tightening torQue

ZE · ZA Type

Nominal Diameter	10	15	18	22	28	35
Tightening TorQue kg-m (ft-lbs)	6±1 (43±7)	15±2 (108±14)	18±2 (130±14)	22±2 (160±14)	28±3 (200±20)	35±3 (253±20)

ZK Type

Nominal Diameter	10	15	18	22	28	35
Tightening TorQue kg-m (ft-lbs)	6±1 (43±7)	9±1 (65±7)	12±2 (87±14)	17±2 (123±14)	22±2 (160±14)	28±3 (200±20)

3. CONVERSION TABLE

3. 1 UNIT CONVERSION

[Remarks] Figures in ( ) show number of zero down a decimal point

Example : 0. (2)1=0.001

(1) Length

Unit	㎜	㎝	m	㎞	in	ft	yd	mile
㎜	1	0.1	0.001	0.00001	0.03937	0.0032808	0.0010936	0.(6)6214
㎝	10	1	0.01	0.0001	0.3937	0.032808	0.010936	0.(5)6214
m	1000	100	1	0.001	39.37	3.28083	1.0936	0.(3)6214
㎞	…	100000	1000	1	39370	3280.83	1093.61	0.62137
in	25.40	2.540	0.0254	0.(4)254	1	0.0833	0.02778	0.(4)1578
ft	304.8	30.48	0.3048	0.(3)3048	12	1	0.3333	0.(3)1894
yd	914.4	91.44	0.9144	0.(3)9144	36	3	1	0.(3)5682
mile	1609347.0	160934.70	1609.35	1.60935	63360	5280	1760	1

(2) Capacity

Unit	㎤	㎥	ℓ	kℓ	in^3	ft^3	yd^3	gal
㎤	1	0.(5)1	0.001	0.(5)1	0.06102	0.(4)3531	0.(5)1308	0.(3)2642
㎥	1000000	1	1000	1	61020	35.31	1.308	264.2
ℓ	1000	0.001	1	0.001	61.02	0.03531	0.001308	0.2642
kℓ	1000000	1	1000	1	61020	35.31	1.308	264.2
in^3	16.39	0.(4)1639	0.01639	0.(4)1639	1	0.(3)5787	0.(4)2143	0.004429
ft^3	28320	0.02832	28.32	0.02832	1728	1	0.03704	7.48055
yd^3	764500	0.7645	764.5	0.7645	46660	27	1	201.974
gal	3785	0.003785	3.785	0.003785	231	0.1337	0.004951	1

(3) Weight

Unit	kg	oz	lb	(2000lbs) nt	(2240lbs) gt	mt
kg	1	35.2740	2.20462	0.001102	0.(3)9842	0.001
oz	0.02835	1	0.06250	0.(4)3125	0.(4)2790	0.(4)2835
lb	0.45359	16	1	0.00050	0.(3)4460	0.(3)4536
nt	907.185	32000	2000	1	0.89286	0.90719
gt	1016.05	35840	2240	1.12	1	1.01605
mt	1000	35274	2204.6	1.10231	0.98421	1

[Remakes] mt : ton (Metric) nt : ton (U. S. unit) gt : (British Unit)

3. 2 MILLIMETER : INCH CONVERSION TABLE

mm→in

(1) 1mm～99mm

25.4mm = 1in

mm	0	1	2	3	4	5	6	7	8	9
	in									
0	0.0000	0.0394	0.0787	0.1181	0.1575	0.1969	0.2362	0.2756	0.3150	0.3543
10	0.3937	0.4331	0.4724	0.5118	0.5512	0.5906	0.6299	0.6693	0.7087	0.7480
20	0.7874	0.8268	0.8661	0.9055	0.9449	0.9843	1.0236	1.0630	1.1024	1.1417
30	1.1811	1.2205	1.2598	1.2992	1.3386	1.3780	1.4173	1.4567	1.4961	1.5354
40	1.5748	1.6142	1.6535	1.6929	1.7323	1.7717	1.8110	1.8504	1.8898	1.9291
50	1.9685	2.0079	2.0472	2.0866	2.1260	2.1654	2.2047	2.2441	2.2835	2.3228
60	2.3622	2.4016	2.4409	2.4803	2.5197	2.5591	2.5984	2.6378	2.6772	2.7165
70	2.7559	2.7953	2.8346	2.8740	2.9134	2.9528	2.9921	3.0315	3.0709	3.1102
80	3.1496	3.1890	3.2283	3.2677	3.3071	3.3465	3.3858	3.4252	3.4646	3.5039
90	3.5433	3.5827	3.6220	3.6614	3.7008	3.7402	3.7795	3.8189	3.8583	3.8976

in→mm

(2) Inch Fraction-Milimeter

in	0	1	2	3	4	5	6	7	8	9
	mm									
0	0.000	25.400	50.800	76.200	101.600	127.000	152.400	177.800	203.200	228.600
1/64	0.397	25.797	51.197	76.597	101.997	127.397	152.797	178.197	203.597	228.997
1/32	0.794	26.194	51.594	76.994	102.394	127.794	153.194	178.594	203.994	229.394
1/16	1.588	26.988	52.388	77.788	103.188	128.588	153.988	179.388	204.788	230.188
3/32	2.381	27.781	53.181	78.581	103.981	129.381	154.781	180.181	205.581	230.981
1/8	3.175	28.575	53.975	79.375	104.775	130.175	155.575	180.975	206.375	231.775
5/32	3.969	29.369	54.769	80.169	105.569	130.969	156.369	181.769	207.169	232.569
3/16	4.763	30.163	55.563	80.963	106.363	131.763	157.163	182.563	207.963	233.363
7/32	5.556	30.956	56.356	81.756	107.156	132.556	157.956	183.356	208.756	234.156
1/4	6.350	31.750	57.150	82.550	107.950	133.350	158.750	184.150	209.550	234.950
9/32	7.144	32.544	57.944	83.344	108.744	134.144	159.544	184.944	210.344	235.744
5/16	7.938	33.338	58.738	84.138	109.538	134.938	160.338	185.738	211.138	236.538
11/32	8.731	34.131	59.531	84.931	110.331	135.731	161.131	186.531	211.931	237.331
3/8	9.525	34.925	60.325	85.725	111.125	136.525	161.925	187.325	212.725	238.125
13/32	10.319	35.719	61.119	86.519	111.919	137.310	162.719	188.119	213.519	238.919
7/16	11.113	36.513	61.913	87.313	112.713	138.113	163.513	188.913	214.313	239.713
15/32	11.906	37.306	62.706	88.106	113.506	138.906	164.306	189.706	215.106	240.506
1/2	12.700	38.100	63.500	88.900	114.300	139.700	165.100	190.500	215.900	241.300
17/32	13.494	38.894	64.294	89.694	115.094	140.494	165.894	191.294	216.694	242.094
9/16	14.288	39.688	65.088	90.488	115.888	141.288	166.688	192.088	217.488	242.888
19/32	15.081	40.481	65.881	91.281	116.681	142.081	167.481	192.881	218.281	243.681
5/8	15.875	41.275	66.675	92.075	117.475	142.875	168.275	193.675	219.075	244.475
21/32	16.669	42.069	67.469	92.869	118.269	143.669	169.069	194.469	219.869	245.269
11/16	17.463	42.863	68.263	93.663	119.063	144.463	169.863	195.263	220.663	246.063
23/32	18.256	43.656	69.056	94.456	119.856	145.256	170.656	196.056	221.456	246.856
3/4	19.050	44.450	69.850	95.250	120.650	146.050	171.450	196.850	222.250	247.650
25/32	19.844	45.244	70.644	96.044	121.444	146.844	172.244	197.644	223.044	248.444
13/16	20.638	46.038	71.438	96.838	122.238	147.638	173.038	198.438	223.838	249.238
27/32	21.431	46.831	72.231	97.631	123.031	148.431	173.831	199.231	224.631	250.031
7/8	22.225	47.625	73.025	98.425	123.825	149.225	174.625	200.025	225.425	250.825
29/32	23.019	48.419	73.819	99.219	124.619	150.019	175.419	200.819	226.219	251.619
15/16	23.813	49.213	74.613	100.013	125.413	150.813	176.213	201.613	227.013	252.413
31/32	24.606	50.006	75.406	100.806	126.206	151.606	177.006	202.406	227.806	253.206

3．3 METER-FOOT CONVERSION TABLE

Foot	Meter
5	1.52
10	3.05
15	4.57
20	6.10
25	7.62
30	9.14
35	10.67
40	12.19
45	13.72
50	15.24
55	16.76
60	18.29
65	19.81
70	21.34
75	22.86
80	24.38
85	25.91
90	27.43
95	28.96
100	30.48
105	32.00
110	33.53
115	35.05
120	36.58
125	38.10
130	39.62
135	41.15
140	42.67
145	44.20
150	45.72

Foot	Meter
155	47.24
160	48.77
165	50.29
170	51.82
175	53.34
180	54.86
185	56.39
190	57.91
195	59.44
200	60.96
205	62.48
210	64.01
215	65.53
220	67.06
225	68.58
230	70.10
235	71.63
240	73.15
245	74.68
250	76.20
255	77.72
260	79.25
265	80.77
270	82.30
275	83.82
280	85.34
285	86.87
290	88.39
295	89.92
300	91.44

Foot	Meter
355	108.20
360	109.73
365	111.25
370	112.78
375	114.30
380	115.82
385	117.35
390	118.87
395	120.40
400	121.92
405	123.44
410	124.97
415	126.49
420	128.02
425	129.54
430	131.06
435	132.59
440	134.11
445	135.64
450	137.16
455	138.68
460	140.21
465	141.73
470	143.26
475	144.78
480	146.30
485	147.83
490	149.35
495	150.88
500	152.40

3. 4 GRADIENT CONVERSION TABLE

Degree (°)	Percent (%)
1	1.8
2	8.5
3	5.2
4	7.0
5	8.8
6	10.5
7	12.3
8	14.1
9	15.8
10	17.6
11	19.4
12	21.3
13	23.1
14	24.9
15	26.8

Degree (°)	Percent (%)
16	28.7
17	30.6
18	32.5
19	34.4
20	36.4
21	38.4
22	40.4
23	42.5
24	44.5
25	46.6
26	48.8
27	51.0
28	53.2
29	55.4
30	57.7

Degree (°)	Percent (%)
31	60.1
32	62.5
33	64.9
34	67.5
35	70.0
36	72.7
37	75.4
38	78.1
39	81.0
40	83.9
41	86.9
42	90.0
43	93.3
44	96.6
45	100.0

4. TABLE OF UNIT WEIGHT

Material	Weight per Cub. Meter (t)
Lead	11.4
Copper	8.9
Steel	7.8
Cast iron	7.2
Aluminum	2.7
Concrete	2.3
Soil	2.0
Gravel	1.9

Material	Weight per Cub. Meter (t)
Sand	1.9
Coal cold	0.8
Coal powder	1.0
Coke	0.5
Oak	0.9
Cedar	0.4
Cypress	0.4
Paulownia	0.3

Remarks 1. Weight of wood is that of the dried.

2. Value swon in the table may well be taken for specific gravity.

1. LOCATION OF COMPONENTS

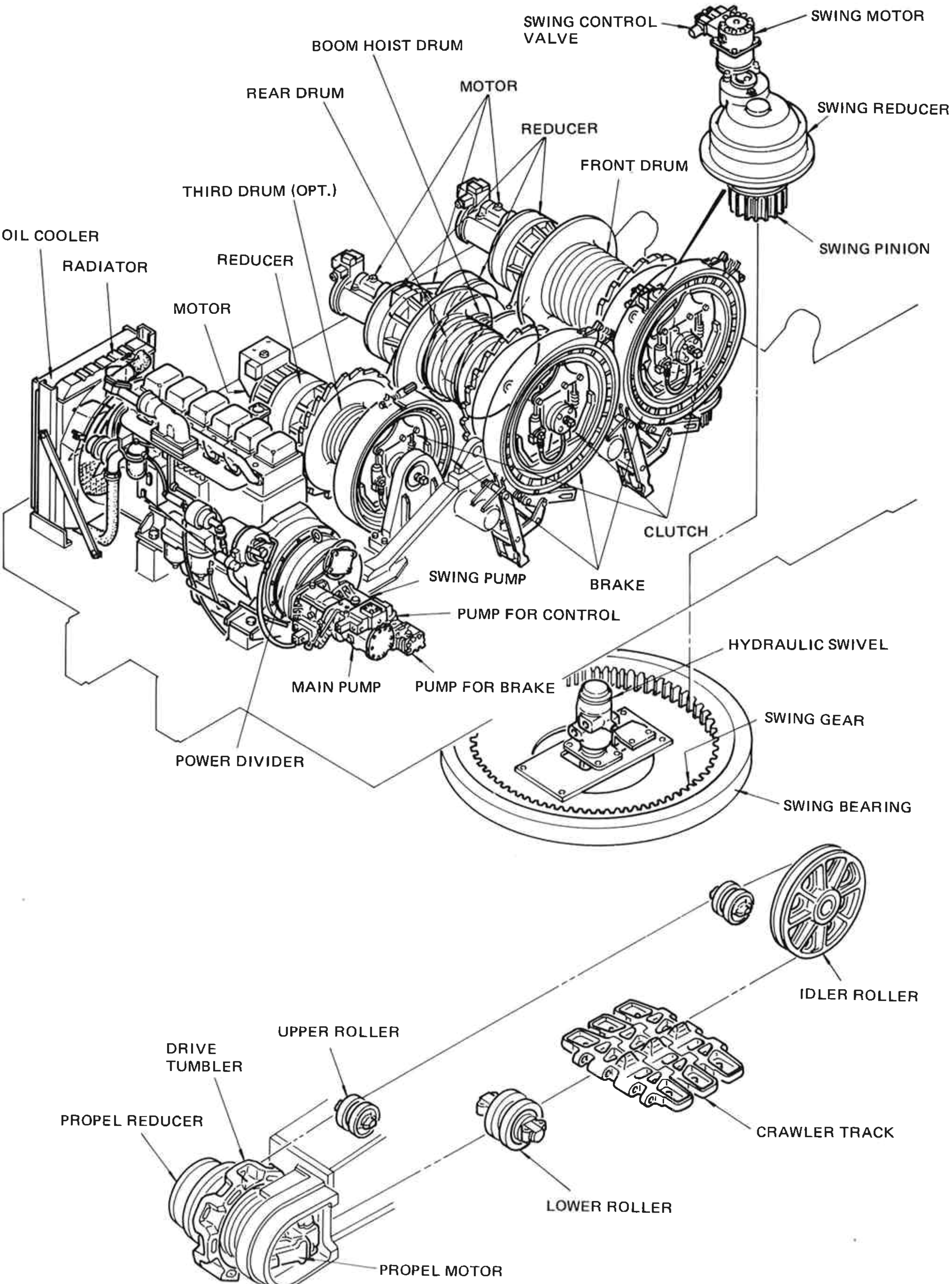


Fig. 1 Power Train

2. ENGINE

2.1 GENERAL

The information contained in this section is limited to removal, and installation of the engine. Information concerning the maintenance and repair of the engine can be obtained from the engine manufacturer's manual.

2.2 REMOVAL

If it is determined that the engine must be removed from the machine, proceed as follows (see Fig. 2-1 and 2-2):

NOTE

The pump connection assembly must be removed with the engine.

1) Lower the boom to the ground and pin the upper spreader to the boom base. Lower the gantry to the travel position and unreeve the boom hoist lines. Remove the gantry.
2) Disconnect the battery ground cable.
3) Disconnect the exhaust pipe from the exhaust manifold and remove the exhaust pipe from the muffler.
4) Remove the air inlet tube from the engine.
5) Remove all sheet metal over the engine and pump connection.
6) Drain the engine oil and coolant.
7) Remove the four radiator fan guard capscrews then remove the eight radiator mounting capscrews and remove the radiator (forward).
8) Disconnect and tag the hydraulic lines running to the pumps. Plug all ports and hoses to prevent the entry of dirt.
9) Disconnect and tag mechanical controls (engine throttle cable, fuel line, electrical wiring to the engine). Cap all fuel and hydraulic lines to prevent the entry of contaminants.
10) Make a thorough visual inspection of the engine and engine compartment to be sure that all necessary electrical, mechanical and fuel lines have been disconnected and are out of the way to allow removal of the engine.
11) Attach suitable lifting slings to the engine.
12) Remove the locknuts, nuts and mounting bolts from the engine mountings at the corners of the engine.
13) Slowly lift the engine and pump connection assembly out of the machine as a unit. The assembly weights approximately 1400 kg.
14) Tag the engine mounting shims so that they will be installed in their original location, if the mounting cushions have been removed.
15) Inspect the mountings and replace them if necessary.

2.3 REPAIRS AND ADJUSTMENTS

Engine repairs and adjustments are covered by a service manual prepared by the engine manufacturer.

Make = MITSUBISHI MOTORS CORPORATION
Model − 6D22C

2.4 INSTALLATION

To install an engine in this machine, proceed as follows: (see Fig. 2-1 and 2-2)

1) Make a thorough inspection of the engine compartment to be sure that all wiring, fuel and water lines and mechanical linkages are clear of the engine mounting and frame.
2) Lift the engine into the engine compartment using a suitable sling attached to the engine.
3) Apply Loctite #242 on the thread and tighten the engine mounting bolts, nuts and locknuts.
   Tighting Torque:
   Pump connection side capscrews . . . 52~62 kgf·m
   Radiator side capscrews . . . . 37~45 kgf·m
4) Install and connect the radiator and fan guard. At this time, confirm the clearance between the fan guard and fan is uniformly spaced.
   Tightening torque of the capscrews for radiator mounting is 11~13 kgf·m
5) Connect all electrical wiring that was disconnected when the engine was removed.
6) Connect all fuel lines and mechanical linkages that were disconnected when the engine was removed.
7) Replace all sheet metal and connect the battery cable.
8) Install the exhaust system on the exhaust manifold. Connect the air inlet tube.
9) Connect all hydraulic lines to the pumps.
10) Fill the cooling system and crankcase with coolant and oil respectively.

CAUTION

Before engine start-up, check all wiring, fuel, water, and mechanical connection. Be prepared to shut down the engine if there should be some malfunction.

11) Start and run the engine. Check for oil, water, and fuel leaks.

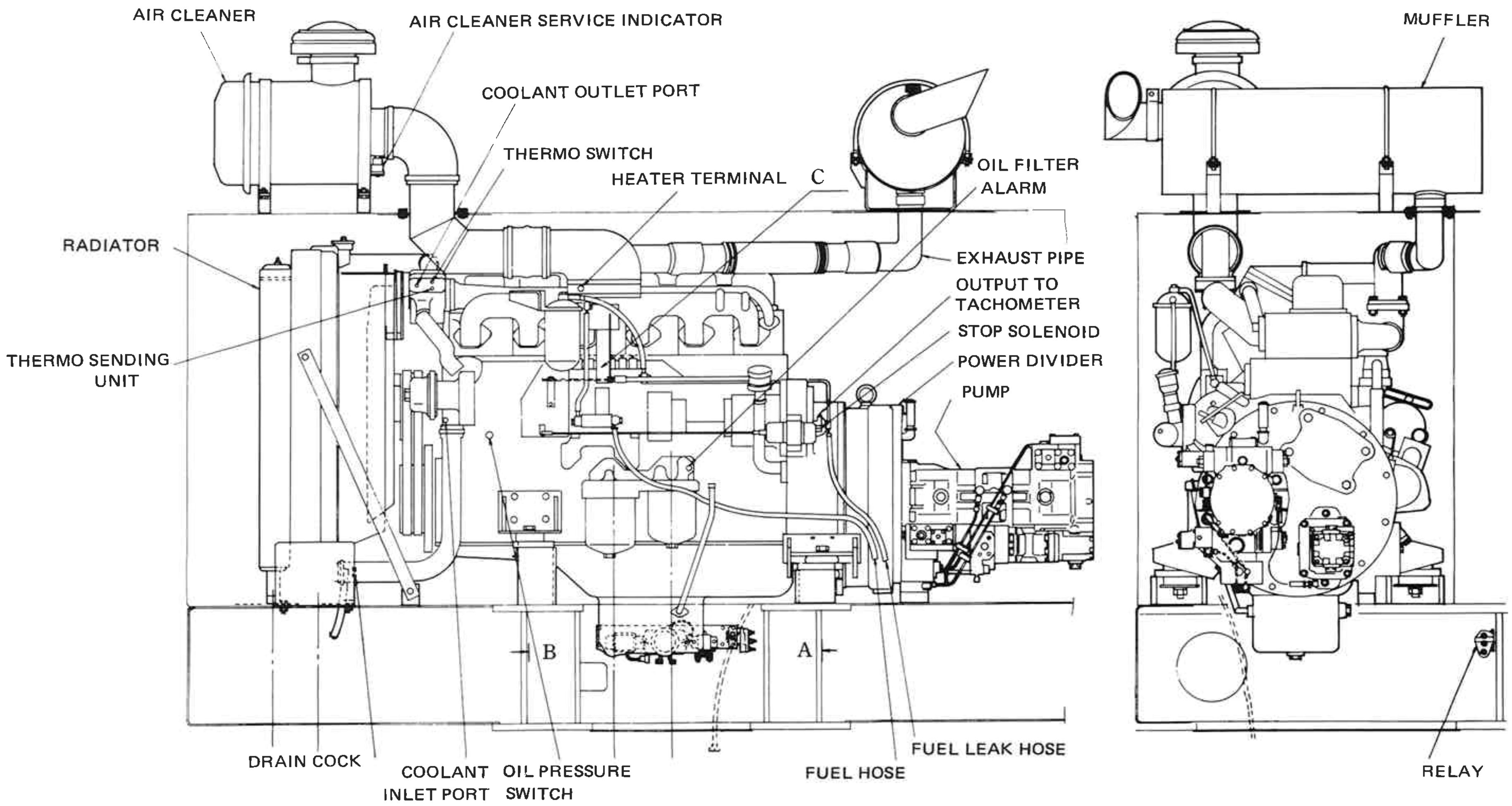
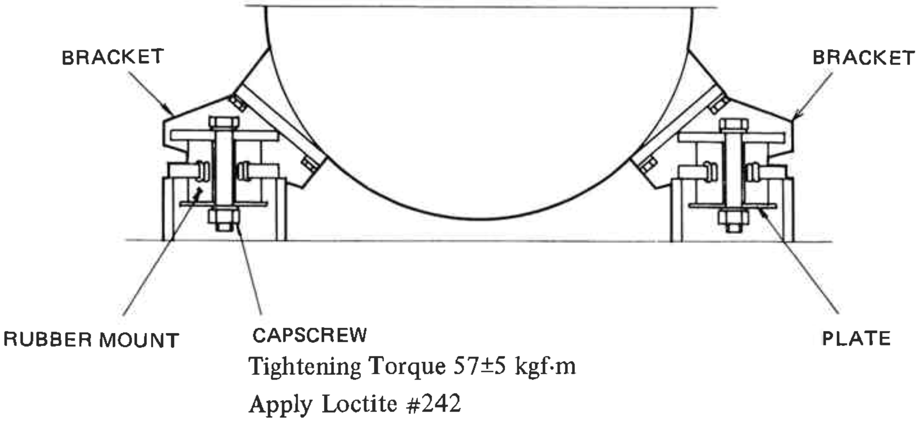
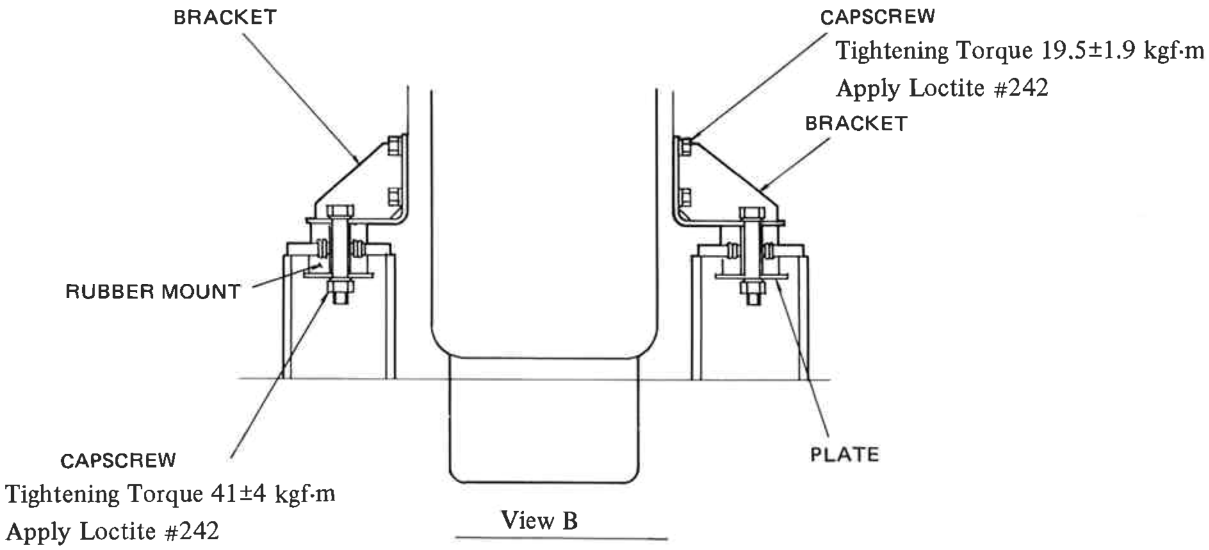


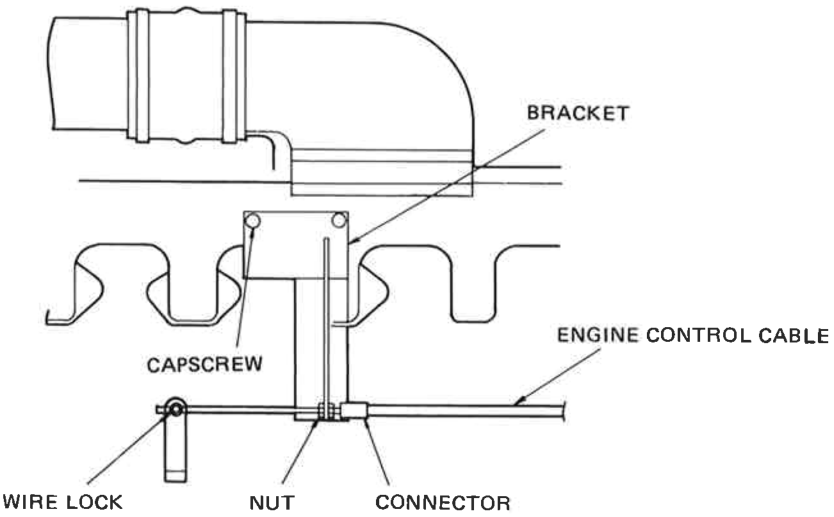
Fig. 2-1 Engine Removal and Installation



View A



View B



Detail C

Fig. 2-2 Engine Removal and Installation

3. PUMP CONNECTION ASSEMBLY

3.1 GENERAL

This section provides service information for the pump connection assembly that is driven directly by the engine. The information includes removal, disassembly, inspection assembly, and installation.

3.2 DESCRIPTION

The pump connection assembly is mounted directly to the rear of the engine and constructed coupling, power divider tandem type main pumps (hoist, boom hoist, propel), and three tandem pumps (swing, control, service brake).

Engine power is transmitted to the input shaft of the power divider via fly wheel and coupling, and divided by two gears for third in pump shaft and three tandem pump shaft.

3.3 REMOVAL

To remove the pump connection assembly from the machine, proceed as follows:

NOTE

The pump connection assembly can be removed either separately or attached to the engine. If the pump connection assembly is to be removed with the engine, refer to section 2.

1) Remove sufficient cab panels to allow removal of the pump connecting assembly.
2) Remove the plug on the bottom of the power divider and drain out all the oil. Screw the plug back in.
3) Put identification tags on all hydraulic pipes before removing them. Cap all pipes and oil holes in the pump to prevent the entry of foreign matter.
4) Remove the tandem-type main pump and the 3-tandem gear pump.
5) Fit the hook from a hoisting device with suitable capacity to the eyebolt on top of the power divider. Remove the cap screws holding the power divider to the engine flywheel housing; slowly move the power divider away from the engine to disengage the coupling; take the power divider out of the machine. The power divider weights about 100 kg.
6) The main part of the coupling, coupled with the central shaft of the power divider, may be taken out along with the powder divider.
   Remove the bushing or element of the coupling and the flange remaining on the flywheel side.

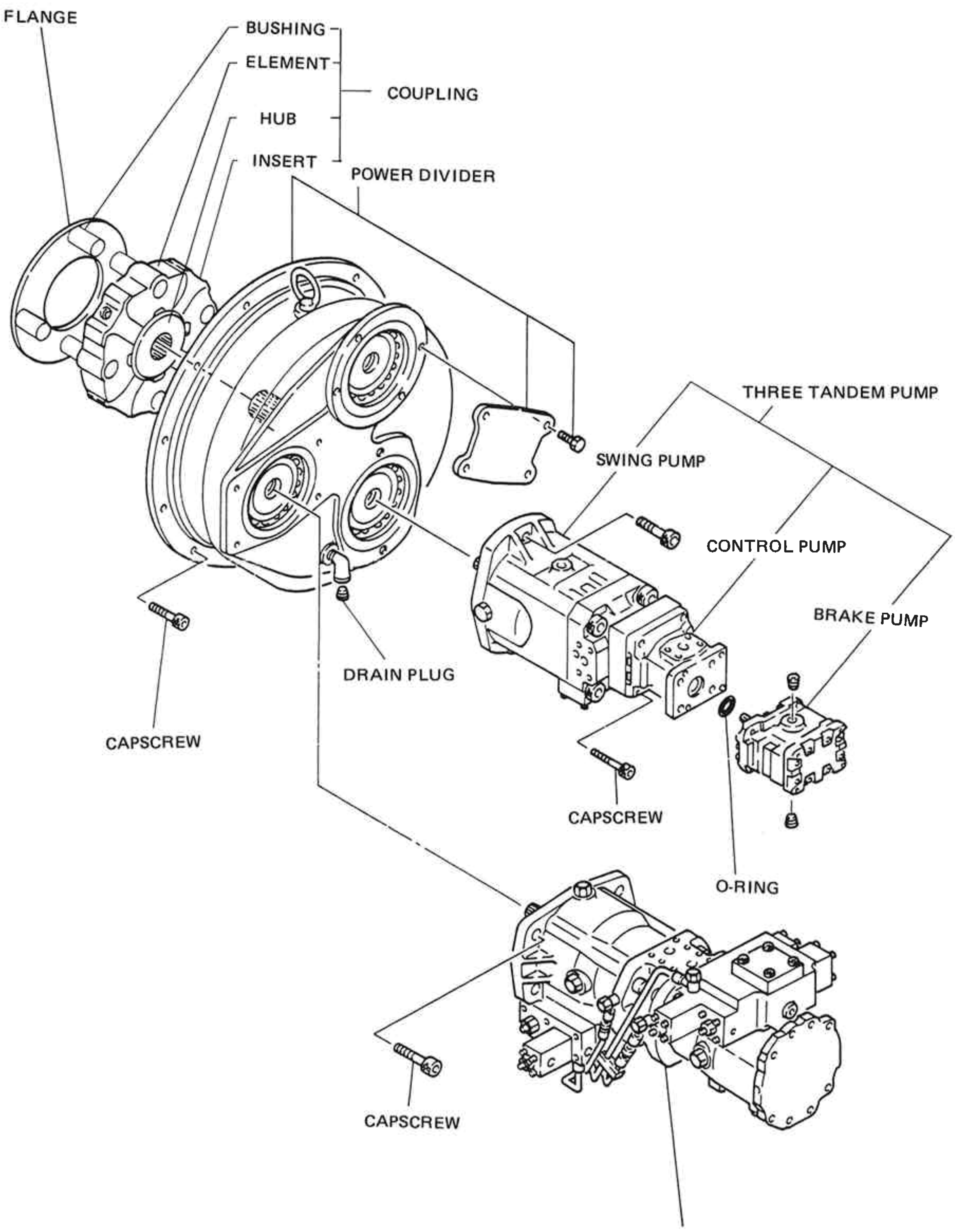


Fig. 3 Pump Connection Assembly

3.4 DISASSEMBLY

Disassemble the power divider as follows (See Fig. 5-1).

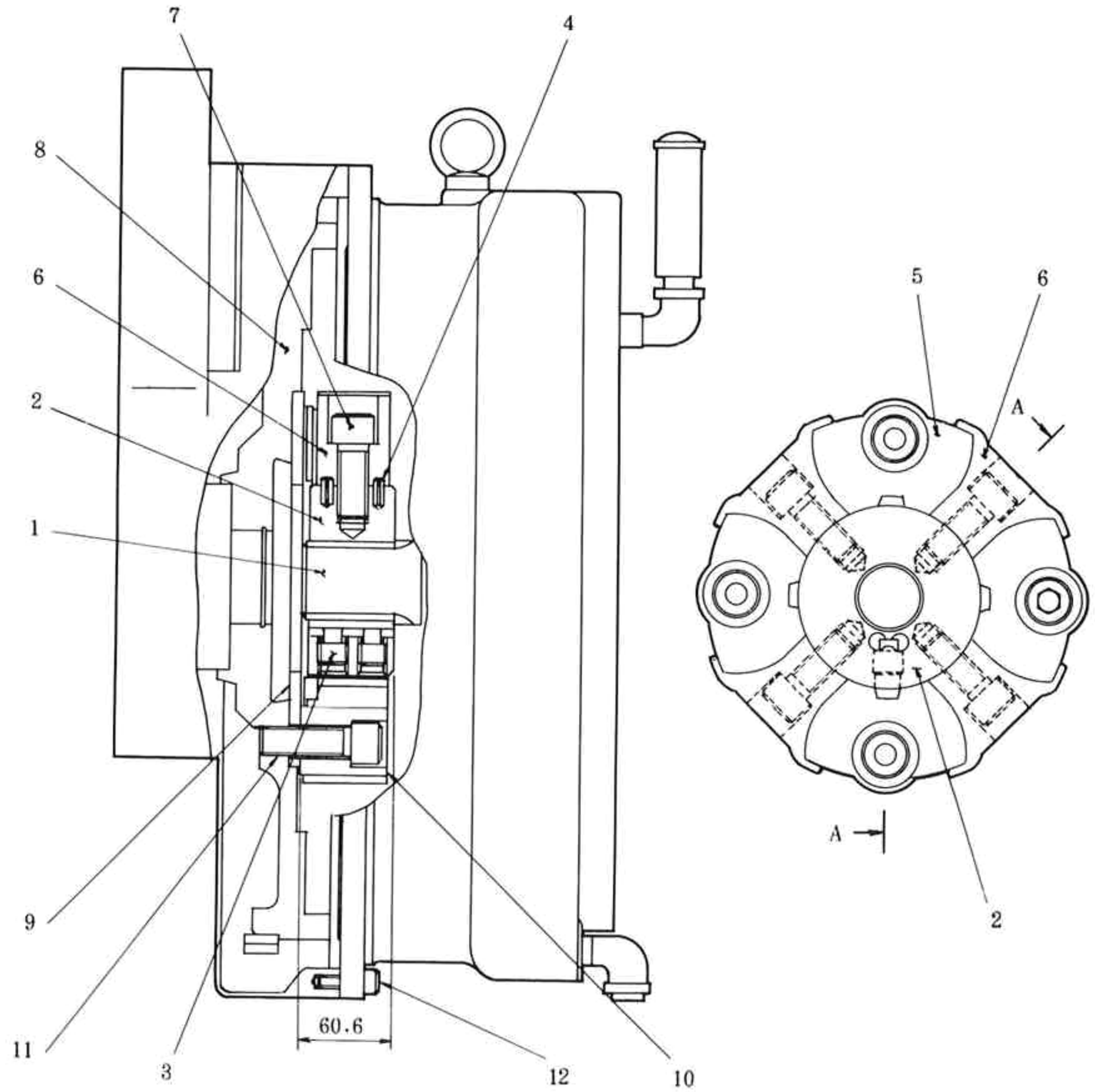
1) Put the power divider on a wooden block so that the pump fitting side faces upward.
2) Remove the bearing casing A (8) with a puller by using the draw-out thread hole (M8) on bearing casing A (8). Remove the O-rings (31,33).
3) Remove the driven gear A (5), and if necessary take out the bearings (27,28) on both sides.
4) Remove bearing casing B (2) with a puller by using the draw-out thread hole (M8) on bearing casing B (2). Remove the O-rings (33,34).
5) Remove the driven gear B (2), and if necessary take out the bearings (27,28) on both sides.
6) Remove the capscrew (23) and take out the cover (4).
7) Put the power divider on the block so that the flywheel side faces upward.
8) Remove the capscrews (22); insert a capscrew into the draw-out screw hole of bearing casing (C), and take out the bearing casing.
9) Remove the input shaft (6) and drive gear (7) assembly.
10) Take the oil seal (26), O-ring (25) and bearing (11) outer race out of bearing casing C (9).
    Keep the shims (15,16,17) as a set.
11) Take out the taper roller bearing (11) inner race, if necessary, from the input shaft (6). At this time, keep the shims as a set.

3.5 INSPECTION AND REPAIR

Before reassembling the power divider, check all component parts. Replace any part that may be faulty to prevent any accidents beforehand and to help the power divider work efficiently for as long as possible.

Check as follows.

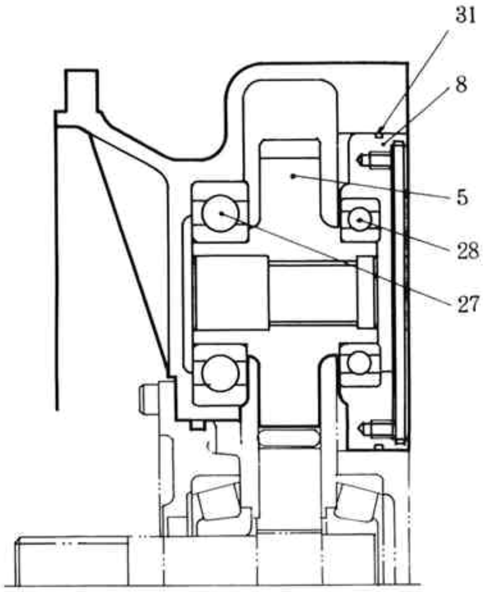
1) Clean all parts with cleansing oil and dry with compressed air.
2) Check bearing balls, rollers, inner race and outer race for pitchings or flaws; replace all faulty parts.
3) Apply a film of lubricant oil to all bearings free of pitching or flaws; replace those with a gap in the axial or circumferential direction, and those that rattle.
4) Check the fitting surface of the outer race and the inner race where the bearing is fit in. Replace if showing traces of sliding during rotation.
5) Check the gear tooth surface and replace if showing pitching, scoring (scratches), wear, burr, cracks, etc.
6) Check the shaft and replace if showing cracks, deformation, wear on bearing surface, slips at the bearing fitting part, etc.
7) Check the shaft and gear spline; replace or repair if showing cracks, wear or strong impact at limited parts.
8) Check the bearing casing; replace if showing slipping, wear or deformation on the bearing fitting surface.
9) Check the gear casing; replace or repair if showing cracks, deformation or flaws.
10) Replace all O-rings and oil seals.
11) Check the threads of cap screws and screw holes; replace or repair if showing burrs, wear, etc.



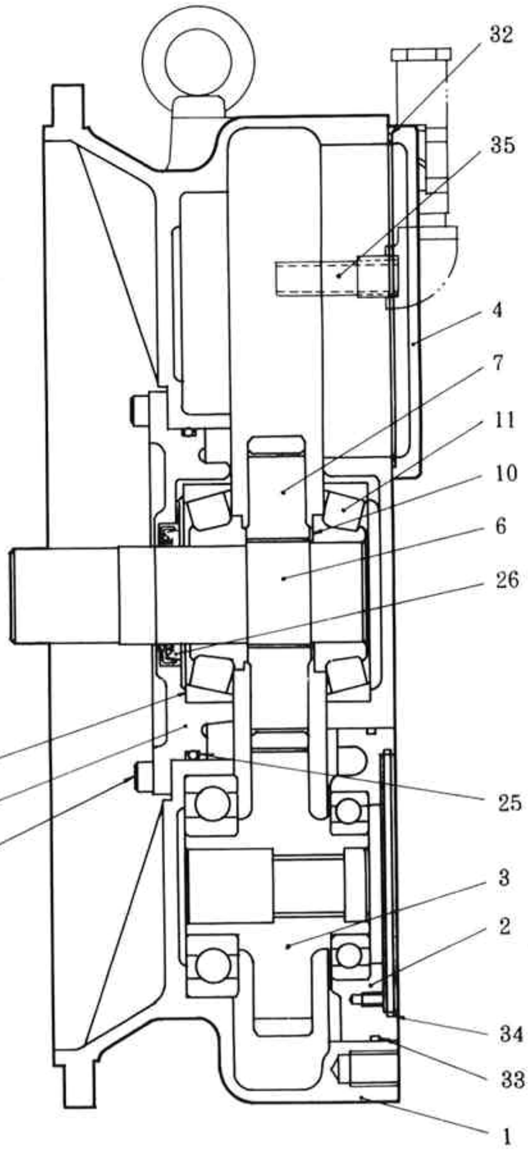
Section A–A

1.	INPUT SHAFT	7.	CAPSCREW
2.	COUPLING HAB	8.	FLY WHEEL
3.	SET SCREW	9.	FLANGE
4.	SPRING PIN	10.	BUSHING
5.	ELEMENT	11.	CAPSCREW
6.	INSERT	12.	CAPSCREW

Fig. 4 Coupling



Section C–I



Section A–B–C–D–E

1. GEAR CASE
2. BEARING CASE B
3. DRIVEN GEAR B
4. COVER
5. DRIVEN GEAR A
6. INPUT SHAFT
7. DRIVEN GEAR
8. BEARING CASE A
9. BEARING CASE C
10. SHIM
11. ROLLER BEARING
12. EYE BOLT
13. PIPE
14. ELBOW
15. SHIM
16. SHIM
17. SHIM
18. LEVEL GAUGE
19. CAP
20. PLUG
22. CAPSCREW (M10)
23. CAPSCREW (M20)
24. LOCK WASHER
25. O-RING
26. OIL SEAL
27. BALL BEARING
28. BALL BEARING
29. (OPT. GEAR A)
30. (OPT. GEAR B)
31. O-RING
32. O-RING
33. O-RING
34. O-RING
35. SLEEVE

Fig. 5-1 Power Divider (Sectional View)

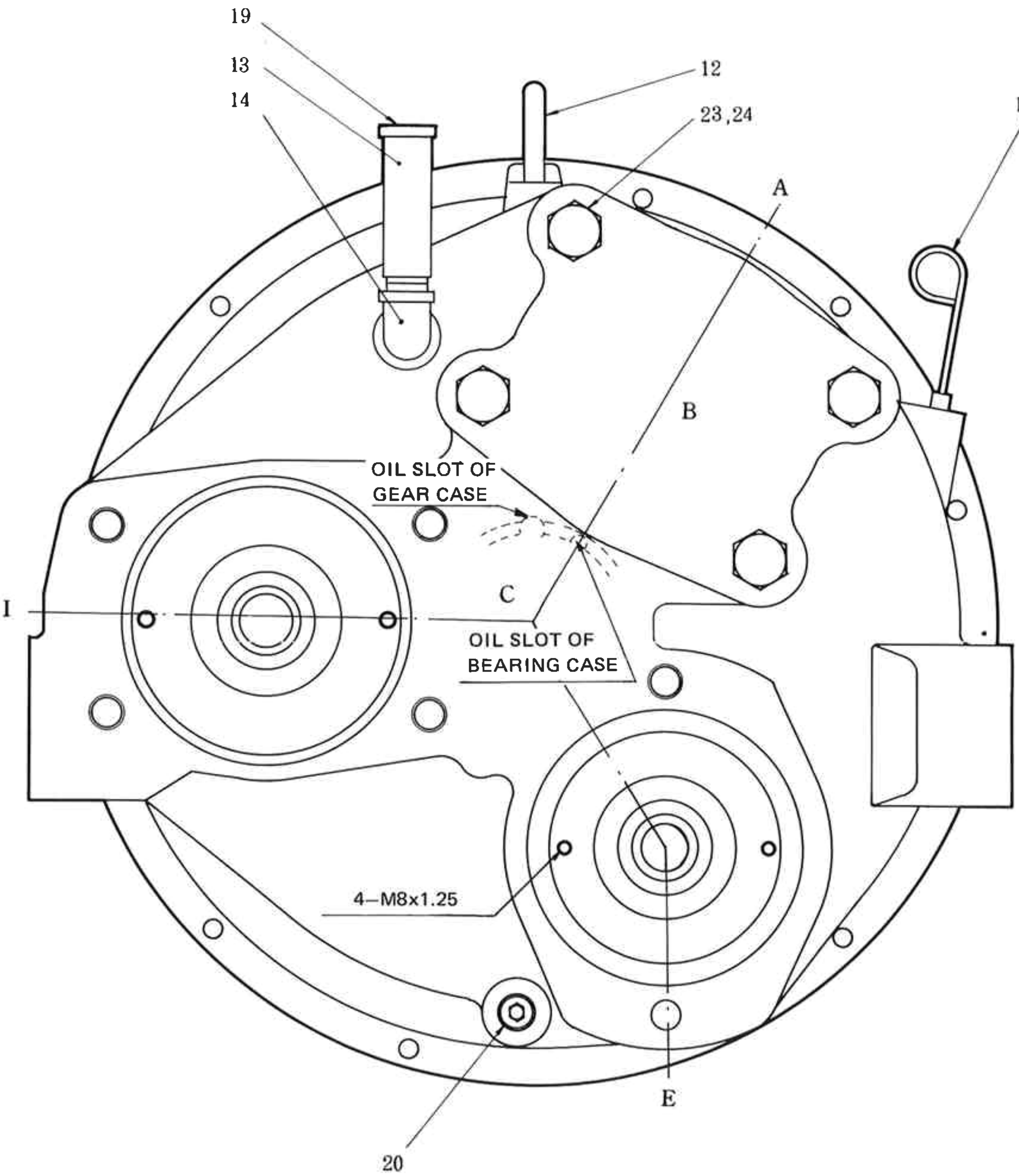


Fig. 5-2 Power Divider (Overall View)

3.6 ASSEMBLY

To assemble, reverse the order of disassembly, paying attention to the following (Fig. 5-1 and 5-2).

1) Apply clean oil to all parts before reassembly.
2) For assembling the input shaft (6), drive gear (7), taper roller bearing (11) and bearing casing C (9), measure the setting dimensions between the taper roller bearing (11) and the drive gear (7), and the fitting dimensions between the gear casing (1) and the bearing casing C (9); adjust the thickness of the shims (10, 15, 16, 17) so that the clearance is 0.05 mm or less.
3) Set the bearing C (9) to the gear casing (1) so that its oil groove is positioned as shown in Fig. 5-2.
4) Tighten the capscrew (22) holding the bearing casing C (9) to 5.8 kg·m.
   Tighten the capscrew (23) holding the cover (4) to 44 kg·m.
5) Upon completing assembly, check that the input shaft turns easily (turning torque: 1~15 kg-cm).

3.7 INSTALLATION

Proceed as follows to install the pump connection assembly.

1) Apply Shell Retinax AM grease or equivalent to the spline of the input shaft (1); insert the coupling hub (2) up to 60.6 mm from the tip of the shaft as shown in Fig. 4 and tighten the set screw (3) to 20~22 kgf·m.
2) Set the spring pin (4) to the coupling hub (2), assemble the coupling in the order of element (5) and insert (6).
3) Tighten the cap screws (7) to 43~49 kgf·m.
4) Fit flange (9) and bushing (10) to the side of the flywheel (8); tighten cap screws (11) to 43~49 kgf·m.
5) Fit the hook of a hoisting device with suitable capacity to the eyebolt of the power divider; insert the element at the coupling side of the power divider into the bushing at the flywheel and thus set the power divider assembly to the flywheel housing.
6) Apply Loctite #242 to the capscrews (12) and tighten to 6.3~7.7 kgf·m.
7) Apply Loctite #242 to every cap screw and tighten the tandem-type main pump to 40~48 kgf·m, and the 3-tandem pump to 22~26 kgf·m.
8) Attach all hydraulic pipes.
9) Supply the specified #90 gear oil to the power divider to the specified level (about 2.5ℓ is needed).
10) Attach all guards and panels that were removed when taking out the pump connection assembly.
11) Start the engine, and check that there is no abnormal noise, oil leakage, etc.

1. TROUBLESHOOTING

1.1 GENERAL

The troubleshooting charts and maintenance hints that follow are of a general nature, but should provide an intuitive feeling for a specific system.

1.2 KNOWING THE SYSTEM

Probably the greatest aid to troubleshooting is knowing the system. Every component has a purpose in the system. The construction and operating characteristics of each should be understood. Know how the system works and what the valve settings and pump output should be.

The crawler extension circuit has a relief valve pressure gauge port to allow checking of pressure. Always set and check the pressure with a gauge that is known to be accurate. The question may arise as to what the correct operating pressure of this circuit is. If it is not specified, the correct operating pressure is the lowest pressure which will allow adequate performance of the system function and still remain below the maximum rating of the components. Once the correct pressures have been determined, note them for future references.

1.3 DEVELOPING SYSTEMATIC PROCEDURES

Analyze the system and develop a logical sequence of looking for trouble. Ask the operator how the machine performed when it started to malfunction or if there is anything unusual about it. Operate the machine to see if guages are reading properly, that all controls operate smoothly, and check for unusual noises. Visually inspect the machine looking for oil leaks. Examine filters and all lines checking for heat, loose connections, or collapsed hoses. Develop a cause and effect trouble-shooting guide similar to the one shown in Table 1 through Table 5. The initial time spent on such a project could save hours of downtime.

1.4 RECOGNIZING TROUBLE INDICATIONS

The ability to recognize trouble indications in a specific system is usually acquired with experience. However, a few general indications can be discussed.

- Excessive heat means trouble. A misaligned pump places an excessive load on bearings and can be readily identified by the heat generated. A warmer than normal return line indicates that the system is operating at the unloading valve (or relief valve) setting. Hydraulic oils which have a low viscosity will increase the internal leakage of components resulting in a heat rise. Cavitation and slippage in a pump will also generate heat.
- Excessive noise means wear, misalignment, cavitation or air in the oil. Contaminated oil can cause an unloading valve (or relief valve) to stick and chatter. These noises may be the result or dirty filters or fluid, high fluid viscosity, excessive drive speed, low reservoir level, or loose intake lines.

EXCESSIVE HEAT

A	B	C
PUMP HEATED	UNLOADING VALVE RELIEF VALVE	FLUID HEATED
1. Fluid heated Remedy: See column C	1. Fluid heated Remedy: See column C	1. Accumulator pre-charge pressure too high Remedy: d
2. Cavitation Remedy: a	2. Valve setting incorrect Remedy: d	2. Unloading valve set too high Remedy: d
3. Air in fluid Remedy: b	3. Worn or damaged valve Remedy: g	3. Fluid dirty or low supply Remedy: f
4. Unloading valve set too high Remedy: d		4. Incorrect fluid viscosity Remedy: f
5. Excessive load Remedy: c		5. Worn pump, accumulator valve, cylinder or other component Remedy: e
6. Worn or damaged pump Remedy: e		

REMEDIES:

a. Any or all of the following: Replace dirty filters – Clean clogged inlet line – Clean reservoir breather vent – Change system fluid

b. Any or all of the following: Tighten leaky inlet connections – Fill reservoir to proper level – Replace pump shaft seal

c. Check drive belt and condition of seals and bearings – Locate and correct mechanical binding

d. Install pressure gauge and adjust to correct pressure

e. Overhaul or replace

f. Change filters and also system fluid if of improper viscosity – Fill reservoir to proper level

g. Replace

Table 1. Excessive Heat

EXCESSIVE NOISE

A — PUMP NOISY
1. Cavitation
   Remedy: a
2. Air in Fluid
   Remedy: b
3. Pump Worn or Damaged
   Remedy: d

B — RELIEF VALVE NOISY
1. Setting too close to operating pressure
   Remedy: c
2. Worn poppet and/or seat
   Remedy: d

C — UNLOADING VALVE NOISY
1. Setting too close to operating pressure
   Remedy: c
2. Worn valve
   Remedy: e

REMEDIES:

a. Any or all of the following: Replace dirty filters – Clean clogged inlet line – Clean reservoir breather vent – Change system fluid
b. Any or all of the following: Tighten leaky inlet connections – Fill reservoir to proper level – Replace pump shaft seal
c. Install pressure gauge and adjust to correct pressure
d. Overhaul or replace
e. Replace

Table 2. Excessive Noise

INCORRECT FLOW

A

NO FLOW

1. Pump not receiving fluid
   Remedy: a
2. Pump drive not operating
   Remedy: f
3. Pump drive shaft sheared
   Remedy: c
4. Entire flow passing over unloading valve
   Remedy: d
5. Damaged pump
   Remedy: c
6. Entire flow passing over relief valve
   Remedy: h or e

B

LOW FLOW

1. Unloading valve set too low
   Remedy: d
2. External leak in system
   Remedy: b
3. Accumulator pre-charge pressure low
   Remedy: g
4. Worn pump, accumulator, cylinder, or other component
   Remedy: e

REMEDIES:

a. Any or all of the following: Clean dirty filters in tank – Clean clogged inlet line – Clean reservoir breather vent – Fill reservoir to proper level
b. Tighten leaky connections
c. Check for damaged pump or pump drive
d. Replace unloading valve
e. Overhaul or replace
f. Check pump drive – Repair if necessary
g. Check accumulator precharge
h. Adjust

Table 3. Incorrect Flow

INCORRECT PRESSURE

A. NO PRESSURE

1. No flow
   Remedy: See Chart 3, column A

B. LOW PRESSURE

1. Pressure relief path exists
   Remedy: See Chart 3, columns A and B
2. Excessive external leakage
   Remedy: b

C. ERRATIC PRESSURE

1. Air in fluid
   Remedy: b
2. Worn unloading valve
   Remedy: d
3. Contamination in fluid
   Remedy: a
4. Worn pump, accumulator, or cylinder
   Remedy: e

D. EXCESSIVE PRESSURE

1. Unloading valve or relief valve, accumulator misadjusted
   Remedy: c
2. Unloading valve or accumulator damaged
   Remedy: d

REMEDIES:

a. Replace dirty filters and system fluid
b. Tighten leaky connections – Fill reservoir to proper level
c. Adjust
d. Replace
e. Overhaul or replace

Table 4. Incorrect Pressure

FAULTY OPERATION

- **A — NO MOVEMENT**
  1. No flow or pressure
     Remedy: See Chart 3
  2. Limit or control device electrical, or hydraulic, inoperative or misadjusted
     Remedy: c
  3. Mechanical bind
     Remedy: b
  4. Worn or damaged cylinder
     Remedy: c
- **B — SLOW MOVEMENT**
  1. Low flow
     Remedy: See Chart 3
  2. Fluid viscosity too high
     Remedy: a
  3. Insufficient control pressure for valves
     Remedy: See Chart 4
  4. No lubrication of machine ways or linkage
     Remedy: d
  5. Worn or damaged cylinder
     Remedy: c
- **C — ERRATIC MOVEMENT**
  1. Erratic pressure
     Remedy: See Charg 4
  2. Air in fluid
     Remedy: See Chart 1
  3. No lubrication of linkage
     Remedy: d
  4. Worn or damaged cylinder
     Remedy: c

REMEDIES:

a. Fluid may be too cold or should be changed to clean fluid of correct viscosity
b. Locate bind and repair
c. Overhaul or replace
d. Lubricate

Table 5. Faulty Operation

2. SYSTEM DESCRIPTION

2.1 GENERAL

Fig. 1 shows the hydraulic circuit of the machine. Table 6 provides the meaning of the terminology of components used in this hydraulic circuit. Table 7 describes the hydraulic components used in the hydraulic system of the machine.

2.2 CONTROL CIRCUIT (see Fig. 1)

The hydraulic control circuits comprises the reservoir, suction strainer (34), control pump (14-1), in-line strainer (21), control valve for extension/retraction of crawler frames (18), relief valve (19) and accumulator (13).

The pump is installed on the power divider and is driven by the engine. When the pump is being driven, the hydraulic oil from the reservoir passes through the suction strainer (34) and is sucked into the pump (14-1) for delivery to the hydraulic control circuit. The oil from the pump (14-1) flows through the in-line strainer (21), the control valve for extension/retraction of crawler frames (18) and the relief valve (19), then into the accumulator (13). If the control valve for crawler frame extension/retraction is in the extension or retraction position, the hydraulic oil is sent to the crawler extension cylinders (17,40), located at the right and left sides of the machine, for simultaneous extension or retraction of the right- and left-hand crawler frames.

If the control valve for crawler frame extension (18) is in the neutral position, the pressure of the oil from the control valve (18) is kept constant by the relief valve (19). It is stored in the accumulator (13) and is also fed to the remote control valves (11,12), solenoid valve blocks (9,10) and shuttle valve block (8). The relief valve is set at 45~50 kgf/cm^2.

If the pressure of the hydraulic oil for control falls below the set value, the control hydraulic pressure warning lamp, located near the operator's seat, comes on and a buzzer sounds.

2.3 MAIN PUMP CIRCUIT

The main pump (3-1) is a 2-tandem variable displacement piston pump installed on the power divider. Hydraulic oil from the pumps goes to the respective 4-spool main control valves. One 4-spool control valve (7) is fitted with spools for main hoist 1st speed, auxiliary hoist 2nd speed, third drum, and propel (left). The other 4-spool main control valve is fitted with spools for main hoist 2nd speed, auxiliary hoist 1st speed, boom hoist, and propel (right).

When the hoist, boom hoist or propel control lever near the operator's seat is in neutral, the corresponding spool is closed. If any of these levers is operated, the pilot pressure of the corresponding remote control valve oepns the spools in the main control valves (6,7) according to the stroke of the control lever, and oil from the main pump (1-3) is sent to the corresponding hydraulic motor. Hoist, boom hoist and propel can thus be accomplished independently.

The main pump (3-1) is fitted with a total summation control type regulator. This type of regulator varies the delivery pressure of the main pump according to the load on the swing pump (3-2) in order to provide stable composite operations by making effective use of the total horsepower of the single engine. This prevents the engine from being overloaded.

The hydraulic system of the machine is of the swing priority type in which power from the engine is supplied to the swing pump (3-2) first and the remaining power is then fed to the main pump (3-1). Moreover, the hydraulic system of the machine is provided with a creeping system and a feathering system.

The creeping system operates as follows: When the creeping switch on the instrument panel is turned ON, a solenoid valve (33) operates to close off the pilot pressures (Pi1, Pi2), which automatically vary the delivery quantity of the main pump, so that the delivery quantity of the main pump is minimized and fixed there to reduce the operating speed to approximately one-fifth that of normal operating speed.

The feathering system operates as follows: When all the hoist, boom hoist and propel control levers are in neutral, the pilot pressure of the main pump becomes zero, thereby minimizing the flow of the pump and reducing the consumption of fuel.

When any of the above levers is operated, the rise in the corresponding pilot pressure is transmitted to the pump, and the flow from it is increased.

2.4 HOIST CIRCUIT

The hoist circuit comprises the main pump (3-1), main control valves (6,7), main, auxiliary and third (opt.) hoist motors (1,29), clutches, and negative brakes. The hoist motors (1) used on the main and auxiliary hoist drums are of the same type. These hoist motors are two-speed swash-plate type axial piston motors in which the mode can be changed between variable and fixed displacement. They are fitted with a counterbalance valve for power fall and a two-speed motor regulator for use in changing between high and low speed ranges. When the drum speed selector switch on the side console is turned to High or Low, this regulator operates to change the hoist motor to the variable displacement (High) or fixed displacement (Low) mode.

When the hoist control lever is operated through a half stroke, the pilot pressure is changed to about 14 kgf/cm^2. When it is operated through a full stroke, the pressure is changed to about 26 kgf/cm^2.

The hoist 1st speed spool in one of the two main control valves starts to open at a pilot pressure of about 2 kgf/cm^2, while the hoist 2nd speed spool in the other valve does not start to open until the pilot pressure rises to about 15 kgf/cm^2. Consequently, before the hoist control lever is operated through a half stroke, oil from only one of the pumps flows to the hoist motor and rotates it at low (1st) speed. When the hoist control lever is further operated through a full stroke, the hoist spool in the other main control valve also starts to open, and oil from both pumps enters the hoist motor, rotating it at high (2nd) speed. Therefore, the hoist speed of the main and auxiliary drums can be steplessly selected from 4 speeds by operating the drum speed selector switch and changing the hoist control lever stroke.

The third drum hoist motor (29) (optional) is a fixed displacement piston motor with counterbalance valve. The hoist speed can be changed in one range by operating the hoist control lever.

Moreover, the hoist circuit includes a hydraulic circuit for control of the clutches and brakes. When the operator pulls the hoist control lever towards him, the pilot pressure from the remote control valve (11) is fed through the solenoid blocks (9,10) to the clutch wheel cylinder (25) and negative brake wheel cylinder (25), the hoist clutch is engaged and the negative brake released, and the hoist drum rotates in the hoist direction. Two drum stopping and fall methods are available by operating the drum brake selector switch; one in which free fall is available with the hoist control lever in neutral and the other in which the negative brake is operated with the hoist control lever in neutral.

When free fall is possible, the operator depresses the foot brake and shifts the hoist control lever to neutral to disengage the negative brake and clutch, and this causes the foot brake to stop drum rotation. As the operator gradually releases the foot brake pedal, the oil in the foot brake cylinder (27) returns to the master cylinder (32) and the brake is gradually released for free fall of the load.

In the other method in which the negative brake operates with the hoist control lever in neutral, when the operator shifts the hoist control lever to neutral, the clutch is engaged, the oil in the negative brake cylinder (25) returns to the tank, and the negative brake automatically operates to stop the rotation of the drum. When the operator pushes the hoist control lever away from him, oil enters the negative brake cylinder (25), the negative brake is released, and the load accomplishes power lowering.

2.5 DRUM FOOT BRAKE CIRCUIT

The foot brake circuit comprises the brake pump (14-2), in-line strainer (21), relief valve (20), control valve (32), thermal relief valve (30) and brake cylinders (24,27).

The brake circuit is under the static/dynamic hydraulic pressure control system. When the operator depresses the brake pedal under normal conditions, hydraulic oil in the control valve and hydraulic line is sent to the hydraulic cylinders (24,27) according to the stroke of the control valve (32), and the brake is operated under the static hydraulic pressure control system. If the braking force of the lining is deteriorated due to advanced wear of the lining or the like, the pump port of control valve (32) is opened immediately before the stroke of the control valve reaches its maximum, and oil under pressure from the pump (14-2) is sent through the control valve (32) to the brake cylinders (24,37), generating braking force under the static/dynamic hydraulic pressure control system.

If the frequency of brake application is high and the brake drum swells due to heat, the clearance between brake drum and brake lining is reduced and the braking force is reduced as the distance through which the brake is depressed becomes smaller. If, in such a case, the brake pedal is depressed strongly to generate in the control valve an oil pressure higher than that on the pump side, the oil passes through the supply port (c) of the thermal relief valve (30) or check valve (41) and enters the thermal relief valve (30). The oil then opens the overload valve in the thermal relief valve and lets the hydraulic oil in the control valve (32) and brake cylinders (24,27) escape to the pump circuit. Consequently, the distance through which the brake pedal is depressed is restored for normal braking effect.

2.6 BOOM HOIST CIRCUIT

When the operator pulls toward him or pushes away from him the boom hoist control lever, the pilot pressure from the boom hoist remote control valve (11) is fed to the solenoid valves (Sol-1, Sol-2) for boom raise/stop or lower/stop located in the solenoid block (10), and one of the parting pressures operates the control valve. Operation of the remote control valve causes the control oil to release the boom hoist drum lock (24) and boom hoist drum brake built into the boom hoist motor (5). The other pilot pressure passes through the shuttle valve block (8) and opens the boom hoist spools in the main control valves (6,7) and the oil from the main pump (3-1) is sent to the boom hoist motor (5) to rotate the boom hoist drum.

When the operator returns the boom hoist control lever to the neutral position, the pilot pressure drops, the boom hoist spool in the main control valves (6,7) closes, and the boom hoist motor (5) stops rotating. At the same time, the pilot valve returns to neutral, allowing the oil that released the boom hoist drum lock (24) and boom hoist brake to return to the tank, causing the drum lock and brake to operate.

2.7 SWING CIRCUIT

The swing pump (3-2) is of the fixed displacement axial piston type and is installed on the power divider.

When the operator operates the swing control lever, hydraulic oil from the swing pump (3-2) flows through the direct control type swing control valve and rotates the fixed displacement axial piston motors (4,39).

The hydraulic circuit of the machine is the swing priority type. In this type, some of the oil under pressure from the swing pump (3-2) is directed to the regulator of the main pump (3-1) which controls the output of the main pump by reducing horsepower. Consequently, the power of the engine is supplied to the swing pump (3-2) on a priority basis, and even during composite operations, stable swing is provided.

Control of swing is provided by controlling the flow of hydraulic oil to the swing motors (4,39) via the swing control valve.

When the operator returns the swing control lever to the neutral position, oil stops flowing to the swing motors but the upper frame continues to swing by inertia. Reverse operation of the swing control lever stops this swing.

Each of the swing motors has a spring set and hydraulic wet multidisk brake built into it. When the swing brake switch on the swing control lever is operated, the solenoid valve (Sol-9) in the solenoid valve block (9) operates to apply or release this swing brake.

2.8 PROPEL CIRCUIT

The propel circuit comprises the main pump (3-1), main control valves (6,7), swivel joint (2), and propel motors and propel brakes (15).

The propel motors (15) are variable displacement axial piston motors and are installed on the right- and left-hand crawler frames.

Each propel motors (15) has a spring set and hydraulic propel brake built into it. A counterbalance valve and High/Low selector valve are also installed on it.

When the operator operates the propel control lever, oil from the control pump (14-1) flows through the remote control valve (12) and shuttle valve block (8) to the main control valves (6,7), and opens the propel spools there. Oil from the main pump (3-1) then passes through the main control valves (6,7) and enters the counterbalance valves of the propel motors (15), branching into two circuits.

The oil in one circuit flows through the shuttle valve and releases the propel brakes. The oil in the other circuit flows through the spool of the counterbalance valve and reaches the propel motors, rotating them.

The propel speed can be selected from two ranges: High and Low.

When the operator turns the propel speed selector switch on the side console to the High side, control oil reaches the High/Low selector valve of the propel motor (15) through the High/Low selector solenoid valve (Sol-8), located in the solenoid valve block (9), and changes the speed range of the variable displacement axial piston motor to the High side. When the propel speed selector switch is turned to the Low side, the spool in the solenoid valve (Sol-8) closes, the High/Low selector valve is moved by a spring in the Low position, and the propel motor (15) rotates at low speed.

Table 6. Terminology of Hydraulic Schematic

NBB	Negative Brake, Boom
CLA	Clutch, Aux.
PBA	Positive Brake, Aux.
NBA	Negative Brake, Aux.
CLM	Clutch, Main
PBM	Positive Brake, Main
NBM	Negative Brake, Main
CLT	Clutch, Third
PBT	Positive Brake, Third
NBT	Negative Brake, Third
PRF	Propel Right Forward
PRB	Propel Right Backward
PLF	Propel Left Forward
PLB	Propel Left Backward
PMS	Propel Motor Speed Shift
SBP	Swing Brake Parking
PSS	Pressure Servo Source
Pi1~4	Pilot Port 1~4
PS1~3	Pressure Servo 1~3
DR1~11	Drain 1~11
a11&a21	Propel Backward
b11& b21	Propel Forward
a12&a22	Drum Lower (Boom & Third)
b12&b22	Drum Raise (Boom & Third)
a13&a23	Drum Lower (Aux., Low & High)
b13&b23	Drum Raise (Aux., Low & High)
a14&a24	Drum Lower (Main, High & Low)
b14&b24	Drum Raise (Main, High & Low)

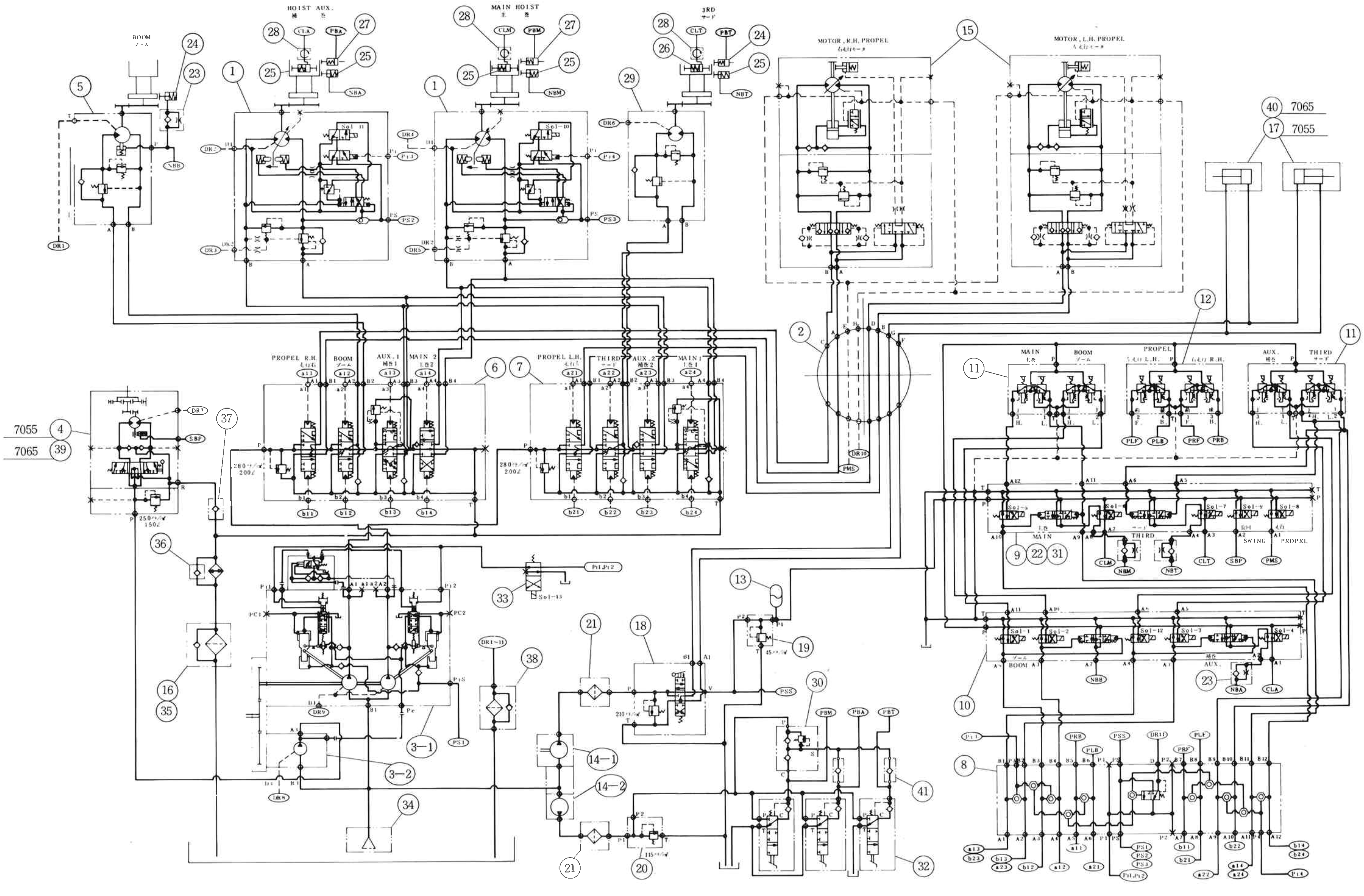


Fig. 1 Hydraulic Schematic

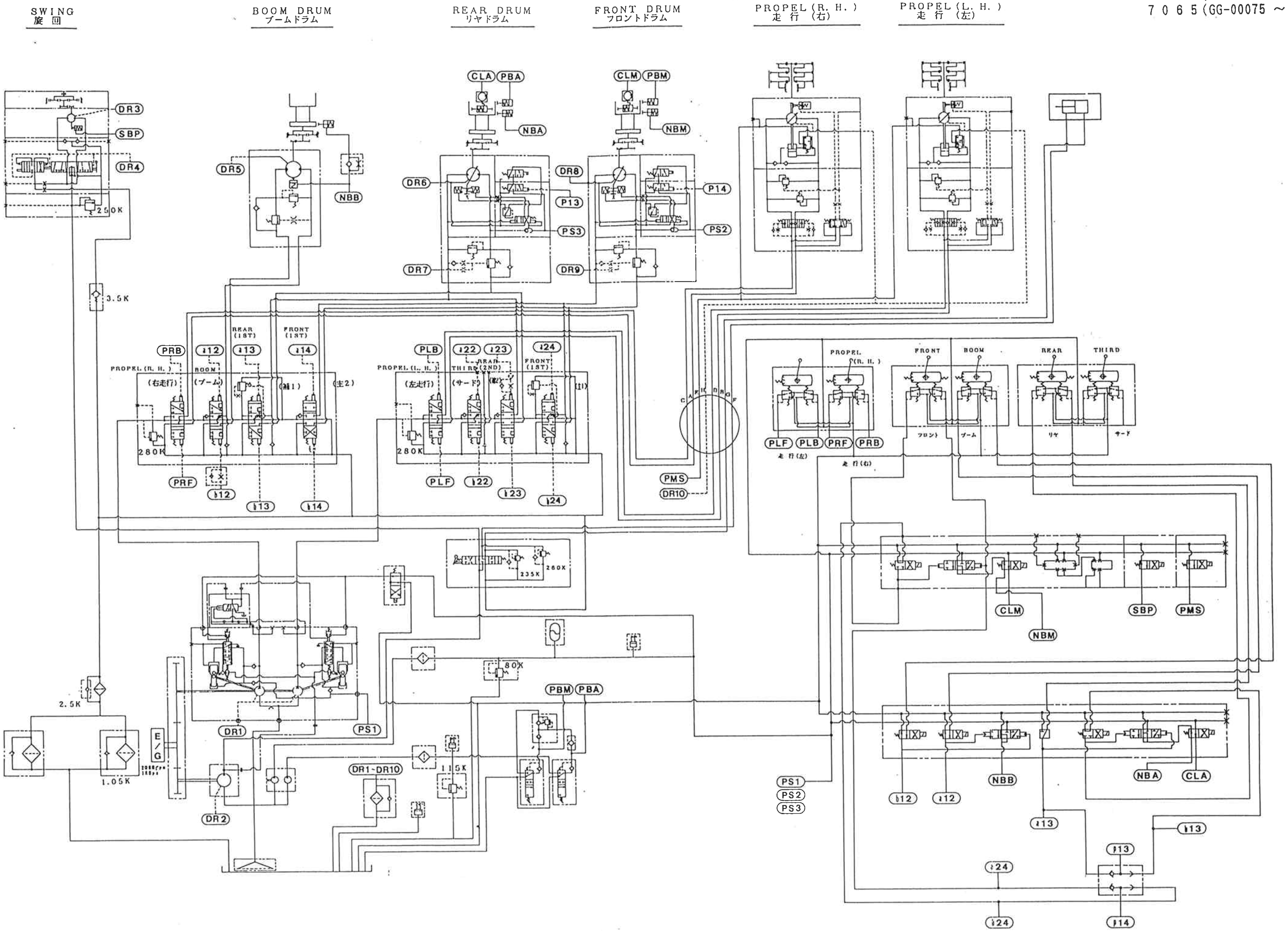

SWING
旋回
BOOM DRUM
ブームドラム
REAR DRUM
リヤドラム
FRONT DRUM
フロントドラム
PROPEL (R. H.)
走行 (右)
PROPEL (L. H.)
走行 (左)
CLA
PBA
NBA
CLM
PBM
NBM
DR3
SBP
DR4
DR5
NBB
DR6
DR7
DR8
DR9
P13
P14
PS3
PS2
250K
3.5K
PRB
PRF
PLB
PLF
PROPEL (R. H.)
PROPEL (L. H.)
REAR (1ST)
FRONT (1ST)
REAR (2ND)
BOOM
THIRD
(右走行)
(ブーム)
(左走行)
(サード)
280K
PMS
DR10
PROPEL
FRONT
BOOM
REAR
THIRD
フロント
ブーム
リヤ
サード
235K
260K
80K
E/G
DR1
PS1
DR2
2.5K
1.05K
DR1~DR10
115K
CLM
NBM
SBP
PMS
NBB
NBA
CLA

Table 7. Hydraulic Components List

Item	Name	Type	Used
1	Hoist Motor	MB500	Main and Aux. Hoist
2	Swivel		
3	Main Pump (3–1), Swing Pump (3–2)	NV111DT+NX70	Main, Aux., Boom Hoist and Propel+Swing
4	Swing Motor Assembly	MX250BO–RG26C23A1	for 7055
5	Boom Hoist Motor	A2F250	
6	Main Control Valve		Main, Aux., Boom Hoist and Propel, Third
7	Main Control Valve		
8	Shuttle Valve Block		
9	Solenoid Valve Block		Main Hoist, Swing, Propel, Third
10	Solenoid Valve Block		Boom and Aux. Hoist
11	Remote Control Valve		Hoist
12	Remote Control Valve		Propel
13	Accumulator		
14	2-tandem Gear Pumps (14–1, 14–2)	PHS2519+GN206	Control + Brake
15	Propel Motor Assembly	A6V107	
16	Return Filter		
17	Crawler Extension Cylinder		for 7055
18	Crawler Extension Control Valve		
19	Relief Valve	CP–PV–30	Control Circuit
20	Relief Valve		Brake Circuit
21	In-line Strainer		
22	Pilot Valve		
23	Slow Return Check Valve		Negative Brake
24	Cylinder		
25	Wheel Cylinder		
26	Wheel Cylinder		
27	Wheel Cylinder		
28	Swivel Joint Drum Shaft		Dram Shaft
29	Third Drum Motor	A2F250	
30	Thermal Relief Valve		Foot Brake
31	Solenoid Valve		
32	Control Valve		Foot Brake
33	Solenoid Valve		
34	Suction Strainer		
35	Relief Valve		
36	Check Valve		
37	Check Valve		
38	Drain Filter		
39	Swing Motor Assembly	M250BO–RG26C26A1	for 7065
40	Crawler Extension Cylinder		for 7065
41	Check Valve		

3. HYDRAULIC SYSTEM MAINTENANCE

3.1 GENERAL

This subsection includes the necessary information to insure that maximum service life is provided by the hydraulic components on this machine. These procedures are generally used during required servicing of a component or group of components in the system. Scheduled preventive maintenance procedures are covered in the operator's manual.

3.2 GENERAL MAINTENANCE

The following points should be kept in mind when working on the hydraulic system or any hydraulic component:

1) Any structure has limits of strength and durability. To prevent the failure of structural parts in hydraulic components, relief valves, which limit pressure to safe operating values are included in the hydraulic circuits. The setting of these relief valves must never be set above the values specified on the hydraulic pressure decal.
2) Tolerances of working parts in the hydraulic system are very close. Even small amounts of dirt or foreign material in the system can cause wear or damage to components. Every precaution must be taken to assure absolute cleanliness of the hydraulic oil. Filter changes at the intervals stated in maintenance manual are essential for hydraulic system cleanliness.
3) Samples of hydraulic oil should be drawn from the reservoir at regular intervals using ISO Standard 4021 or an equivalent method of sampling. In this procedure, fluid is removed from highly active oil mixing zones, through fully opened and appropriately flushed ball valves and sterile tubing. The oil is then analyzed to determine if it is suitable for further use.
4) When there is a hydraulic component failure which gives reason to believe that there are metal particles or other foreign materials in the system, drain and flush the entire system and replace the filter elements. A complete change of hydraulic oil must be made under these circumstances.
5) Whenever the hydraulic system is drained, check the magnetic drain plug, if so equipped, for metal particles. If metal particles are present, flush the system and add a new change of oil. The presence of metal particles also may indicate the possibility of imminent component failure.
6) Do not use synthetic or fire resistant oils in this machine. The packings in this system are designed for a good grade hydraulic oil.

CAUTION

Engine oil was at one time, an acceptable alternate for hydraulic oil, this is no longer true. Engine oil does not contain all of the additives required for proper hydraulic system operation and must not be mixed with, or used as, a substitute for hydraulic oil.

7) The presence of water in the hydraulic system is harmful to the entire hydraulic system. Water will corrode hydraulic components and if in significant quantities, will also cause filter elements to swell and plug. At regular intervals, drain a sufficient amount of hydraulic oil to remove any water which has settled to the bottom of the reservoir.
8) All containers and funnels used in handling hydraulic oil must be absolutely clean. Use a funnel with a 200 mesh screen for filling the hydraulic oil reservoir, and fill the reservoir only through the filler opening. The use of cloth to strain the oil should be avoided to prevent lint from getting into the system.
9) When removing any hydraulic component, be sure to cap and tag all hydraulic lines involved. Also plug the ports of the removed component.
10) All hydraulic components must be disassembled and assembled in clean surroundings. During disassembly, pay particular attention to the identification of parts to assure proper assembly. Clean all metal parts in a clean solvent. Be sure to thoroughly clean all internal passages. After the parts have been dried thoroughly, lay them on a clean, lint-free surface for inspection.
11) Be sure to replace any lost hydraulic oil when completing the installation of the repaired component, and bleed any air from the system when required.
12) All hydraulic connections must be kept tight. A loose connection in a hydraulic line will permit the oil to leak out or air to be drawn into the system. Air in the system can cause damage to the components and noisy or erratic system operation.

3.3 FLUSHING THE HYDRAULIC SYSTEM

If there is evidence of a contaminated hydraulic system, caused by a pump or motor shelling out, water causing milkiness of oil, or vandalism, it will be necessary to flush the hydraulic system. If the cause of the contamination is due to a faulty component, the component must be repaired or replaced before the hydraulic system is flushed.

NOTE

Since hydraulic system flushing is expensive, time consuming and the results not totally assured, flushing should be done only when absolutely necessary.

1) Warm the hydraulic oil to normal operating temperature.
2) Remove the hydraulic reservoir drain plug and drain the oil into a suitable container. Allow sufficient time for all the oil to drain from the walls of the reservoir.
3) Install the drain plug. Fill the reservoir with clean hydraulic oil.
4) Cycle the machine through all crane functions and operate the propel and crawler extend/retract systems several times to circulate the flushing oil throughout the hydraulic system.
5) Circulate the oil through the system until inspection shows the equipment to be in satisfactory condition, or until it is obvious that the system will have to be disassembled and cleaned manually.
6) Remove the drain plug and drain the flushing oil from the reservoir. Remove the covers from the top of the reservoir and clean the inside of the reservoir manually. Replace the return filter and clean the suction screen. Install the drain plug and the reservoir cover and refill the reservoir with clean hydraulic oil. Be sure to replace the line filter.
7) Disconnect the hoses attached to the retract side of the crawler frame cylinders, and then extend the crawler frames, this will force the flushing oil from the cylinders.
8) Reconnect the hoses to the cylinders, and retract the crawler frames. Add oil to the reservoir as required to maintain the proper oil level.
9) Swing the upper of the machine in both directions several times, operate the drums, and propel the machine forward and backward to force the flushing oil back to the reservoir.
10) Replace the filter elements. Cycle the machine through all crane functions.

4. HYDRAULIC PUMPS

4.1 GENERAL

This section provides a discription and information necessary to remove and install the hydraulic pumps. Concerning to the detailed information to disassemble and reassemble the pumps, refer to the separate component manuals.

The main pump and 3-tandem pump are installed on the power divider. The main pump is a 2-tandem variable displacement piston pump and drives the motors for main and auxiliary hoist, third drum (option), boom hoist, and propel. The 3-tandem pump consists of a fixed displacement axial piston pump for swing, a gear pump for control oil pressure, and a gear pump for foot brake (see Fig. 2).

Fig. 2 Pump Location

4.2 REMOVAL

To remove the pumps, proceed as follows (see Fig. 2):

1) Stop the engine and disconnect the ground cable from the battery.
2) Relieve any residual pressure from the hydraulic circuits by moving the control levers back and forth.
3) Remove the engine hood cover, door, etc. Which may interfere with pump removal.
4) Drain the oil from the power divider into an appropriate container.
5) Clean the connections of the pumps and hydraulic lines and disconnect all hydraulic lines. Cap the hydraulic lines and plug oil ports to prevent the entry of foreign matter.
6) Support the pump with a lifting device of appropriate capacity and remove the capscrews with which the pump is fastened to the power divider.
7) Remove the pump from the machine.

4.3 INSTALLATION

To install the pumps, proceed as follows:

1) Clean the contact faces of the power divider and pump and coat the faces with Loctite #515 or equivalent.
2) Apply a thin coat of grease to the O-ring and insert it into the groove located in that part of the power divider on which the pump is installed.
3) Support the pump with a lifting device of appropriate capacity and insert the drive shaft of the pump into the splined portion of the power divider.
4) Coat the threads of the capscrews with Loctite #242 or equivalent and tighten to the following torque:
   Main pump: 40 ~ 48 kg·m
   3-tandem pump: 22 ~ 26 kg·m
   Before tightening the capscrews, make certain the shafts are aligned properly so as not to overstrain them.
5) Make certain that hydraulic oil is filled in the hydraulic oil tank to the specified level.
6) Make certain again that the suction pipe is not loose.
7) Be sure to fill the casing of the piston pump with hydraulic oil.
8) Make certain that the delivery side is not loaded.
9) Connect the battery cable, and by inching the pump, check to see if oil comes out and if the direction of rotation is correct. Also bleed air from the delivery port.
10) Operate the machine without load for some time to check for excessive rise in oil temperature, abnormal noise and vibration, and oil leakage.

5. CONTROL VALVES

5.1 GENERAL

This subsection contains the information necessary to remove, disassemble, assemble, and install the operator control valves.

5.2 GENERAL REMOVAL

Prior to removing any of the components in this section, shut down the engine and disconnect the battery ground cable to prevent machine operation while the item is being serviced. Operate the controls to relieve all pressure in the system and clean the area around the component being removed to prevent contaminants from entering the system.

Tag the hydraulic lines to the valve, remove them and put them in a place where they do not interfere with valve removal. Cap the lines and plug the valve ports to prevent the entry of foreign matter.

5.3 GENERAL INSTALLATION

1) Put the valve in place and then attach it with capscrews and lock washers.
2) Connect the hydraulic lines.
3) Connect the battery cables. Operate the control lever to check the operation of the valve. Check for oil leakage from the hydraulic lines.

5.4 DRUM CONTROL VALVES

5.4.1 DESCRIPTION

The remote control valves used for the main and auxiliary hoist, boom hoist, and third drum (option) are of the same type.

These valves are installed under the floor of the operator's cab. The movement of the hoist control levers is transmitted to these valves through rods.

The remote control valve housing for each hoist lever has two pressure reducing valves for raising and lowering.

When a hoist control lever is moved back or forth from the neutral position, the remote control oil pressure proportional to the stroke of the lever is fed to the corresponding hydraulic component (see Fig. 3).

For details on the remote control valves, see the separate shop manual.

5.4.2 REMOVAL

To remove the valve, proceed as follows (see Figure 3):

1) See General Removal at the beginning of this section.
2) Stop the engine, and by moving the hoist levers back and forth several times, relieve the residual pressure in the hydraulic circuits.
3) Remove the under cover from the cab deck.
4) By removing nuts and washers, remove the rod end from the remote control valve.
5) Clean the area around the valve and the connections of the hydraulic lines.
6) Disconnect all hydraulic lines. To prevent the entry of foreign matter, cap the hydraulic lines and plug the valve ports.
7) Remove the capscrews securing the valve to the floor plate bracket, and remove the valve from the bracket.

5.4.3 INSTALLATION

To install the remote control valve for hoist, proceed as follows:

1) Install the valve on the bracket located on the floor plate.
2) Connect all hydraulic lines.
3) Fasten the rod end to the valve spool with nuts and lock washers.
4) Start the engine and operate the hoist levers, and check for smooth operation of the remote control valve and oil leakage from the connections of the hydraulic lines.
5) Install the under cover on the cab deck.

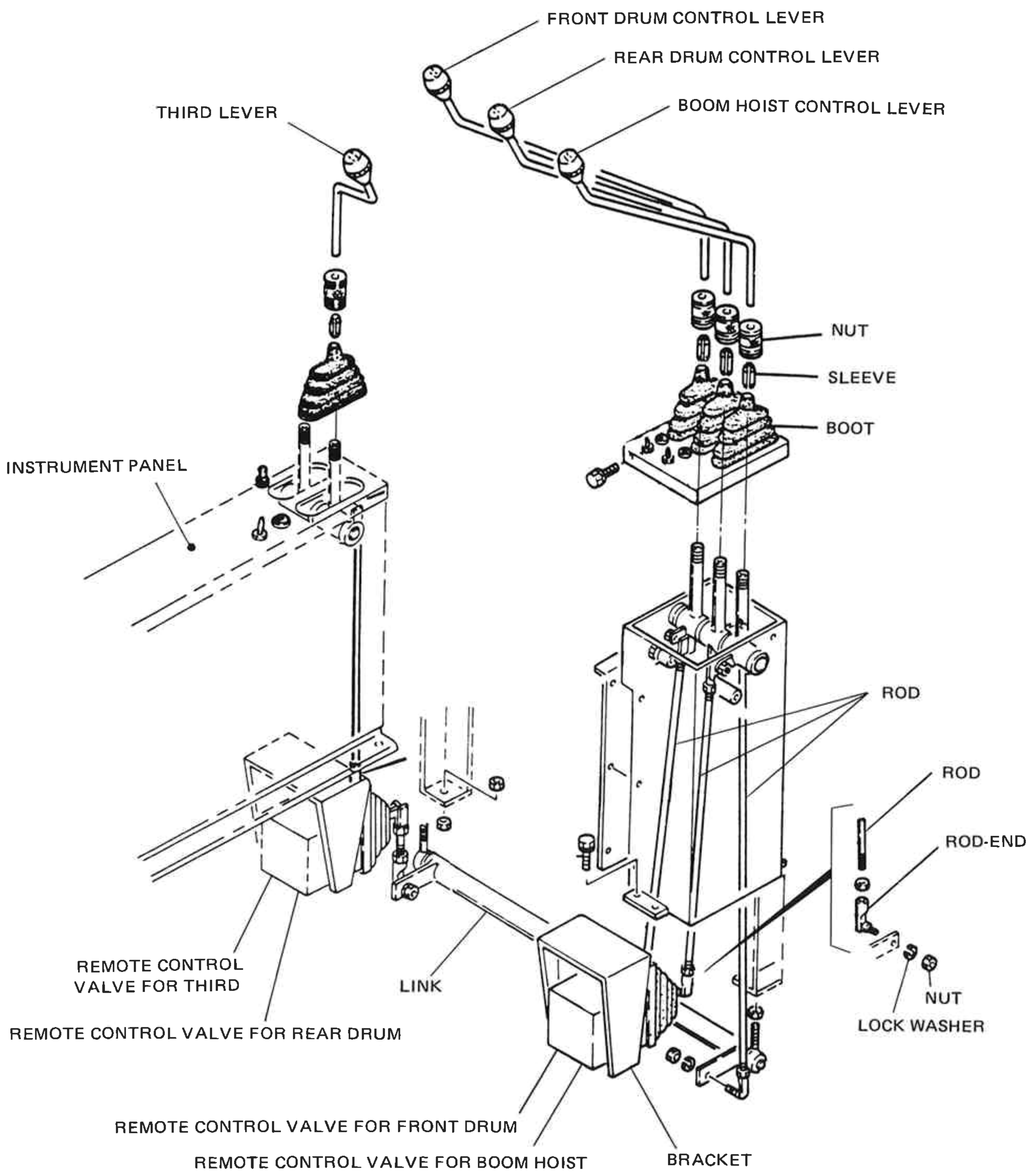


Fig. 3 Drum Controls

5.5 PROPEL CONTROL VALVE

5.5.1 DESCRIPTION

The propel control levers are located in the right stand to the right of the operator's seat, and their remote control valves are installed on the floor plate under the right stand. Each of the right- and left-hand propel remote control valves is pressure reducing valves for forward and backward propel.

When a propel control lever is moved back or forth from neutral, the remote control oil pressure proportional to the stroke of the lever is fed to the corresponding hydraulic components. For details on the remote control valves, see the separate shop manual (see Fig. 4).

5.5.2 REMOVAL

To remove the propel remote control valves, proceed as follows:

1) See General Removal at the beginning of this section.
2) Stop the engine and move the lock lever to the release position. Operate the propel lever back and forth several times to relieve residual pressure in the hydraulic circuit.
3) Remove the grip from the tip of the lever.
4) Remove the capscrews securing the right stand to the floor plate and pull out the right stand assembly.
5) Remove the under cover from the cab deck.
6) Clean the area around the valve and the connections of the hydraulic lines.
7) Disconnect all hydraulic lines, and cap the lines and plug the valve ports to prevent the entry of foreign matter.
8) Remove the capscrews securing the valve to the floor plate, and remove the valve from the floor plate.

5.5.3 INSTALLATION

To install the propel remote control valve, proceed as follows (see Fig. 4):

1) Install the valve on the floor plate.
2) Connect all the hydraulic lines.
3) Install the right stand assembly on the floor plate.
4) Install the grip on the tip of the lever.
5) Start the engine and operate the propel control levers, and check for smooth operation of the remote control valves and oil leakage from the connections of the hydraulic lines. Operate the lock lever to check to see if the propel control levers can be locked securely and released.
6) Install the under cover on the cab deck.

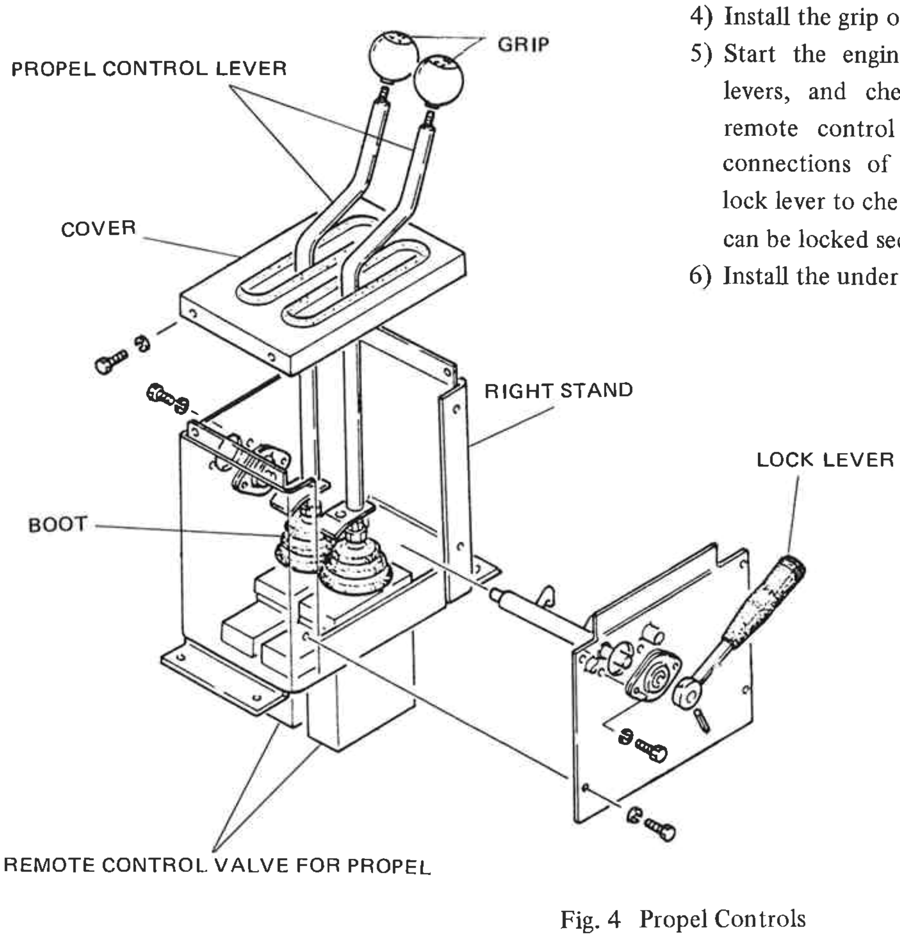


Fig. 4 Propel Controls

5.6 BRAKE CONTROL VALVE

5.6.1 DESCRIPTION

These valves send oil to the cylinders of the front, rear and third drum foot brakes. Oil from the valves is supplied to the brake cylinders in direct proportion to the amount of pedal pressure applied by the operator. During heavy braking applications, the valves are power assisted by high pressure oil (110~120 kgf/cm^2) from accumulator.

If the "forced in" phenomenon due to many hours of brake operation has occurred and it takes much effort to depress the brake pedal, depress the pedal through a full stroke once. The thermal relief valve will then eliminate this phenomenon, and the effort required for pedal depression will be restored.
For details on the brake pedal, see the separate shop manual.

5.6.2 REMOVAL

To remove the valve, proceed as follows (see Figure 5):

1) See General Removal at the beginning of this section.
2) Stop the engine and depress the brake pedal to release the residual pressure in the brake line.
3) Remove the under cover from the cab deck.
4) Tag and disconnect the hydraulic lines at the brake valve. Cap the lines and plug the ports of the brake valve.
5) Remove the cotter pin, washer and pin connecting the brake pedal link and brake valve eyebolt.
6) Remove the hardware securing the valve to the bracket. Remove the valve from the machine.

5.6.3 INSTALLATION

To install the valve, proceed as follows (see Figure 5):

1) Set the valve on the bracket. Make sure two O-rings are between the bracket and valve. Secure the valve to the bracket with the lockwashers and capscrews.
2) Install the eyebolt in the nut, and connect the link to the eyebolt with the washer and pin and secure them with the cotter pin.
3) Attach the hydraulic lines to the brake valve.
4) Start the engine and operate the brake pedal. Observe the valve for leaks, binding or other problems.

5.6.4 ADJUSTMENT

After the valve has been installed, check the linkage adjustment as follows (see Figure 5):

1) Start the engine and adjust the brake band linkage.
2) Bleed air from the system.
3) Depress the brake pedal until dimension S becomes 0 mm. Adjust to θ=180° by means of bolt (4).
4) In this state, apply adjusting bolt (4) to brake lever (2) and screw in this bolt 1.5 to 2.0 mm (1±0.15 turns). Make certain that dimension S is now 0.1 to 0.2 mm.
5) Release the brake pedal and make certain that dimension S is now 16.5 mm. Adjust by means of bolt (5) so that the pedal does not return excessively.
6) Engage pawl (6) with the final lock position, and adjust the pawl so that dimension S is within 0.8 mm when the pedal is returned. Lock this adjustment with nut (7).
7) The length of spring (8) should be 67 mm when the brake pedal is OFF.

NOTE

1. The final lock position is that where the pawl is engaged with the second lowest notch in the pedal arm.
2. Before adjusting brake pedal, be sure to engage the drum lock pawl and turn the hoist brake selector switch to the FREE FALL side.

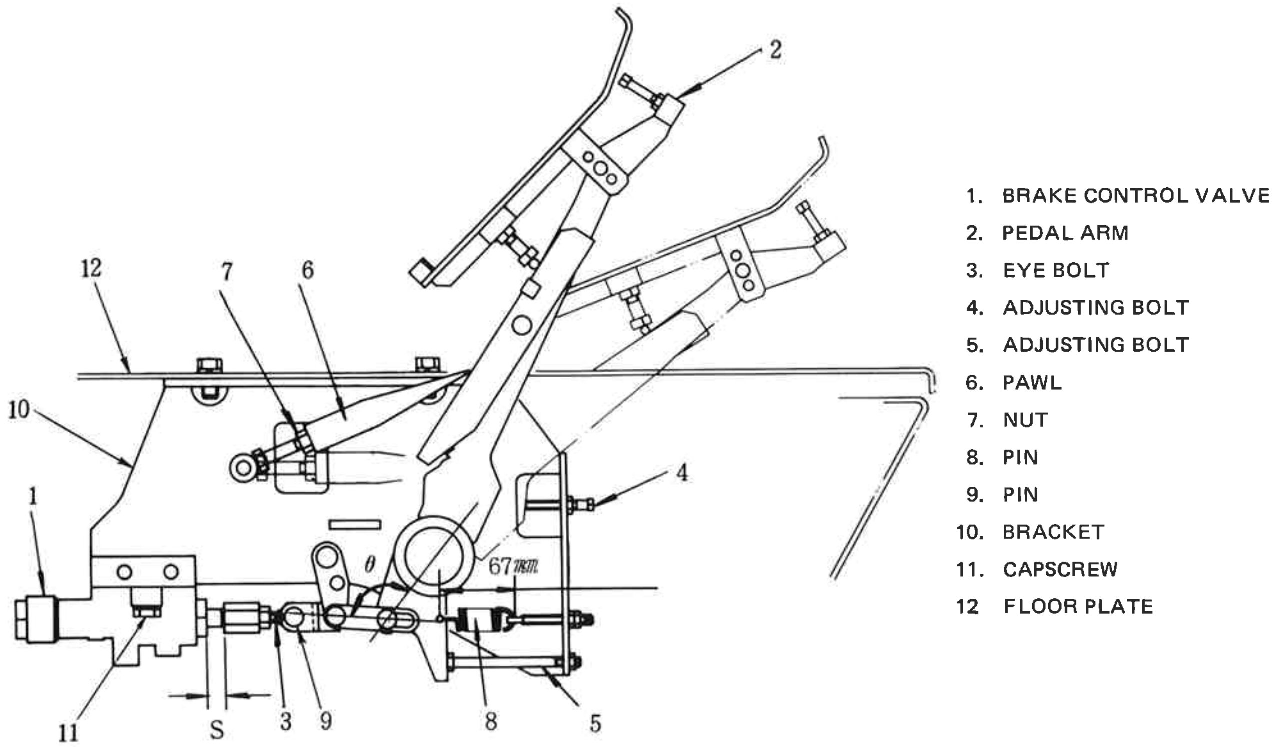


Fig. 5 Brake Control

5.7 CRAWLER EXTEND/RETRACT VALVE

5.7.1 DESCRIPTION

This control valve is composed of a manually operated, three position, 4-way diverter with a relief valve and is installed under the cab floor. When operated, it diverts the flow of oil from the hydraulic control circuit to the crawler extension/retraction cylinders.

5.7.2 REMOVAL

To remove the valve proceed as follows:

1) Remove the under cover from the cab deck.
2) Remove the pins and cotter pins from the control valve and remove the control cable.
3) See General Removal at the beginning of this section.
4) Loosen, but do not remove, the hydraulic lines to the valve to relieve any pressure. Tag and remove the lines. Cap the lines and plug and valve ports.
5) Remove the three capscrews and lockwashers securing the valve to the cab deck.

5.7.3 OVERHAUL

(1) DISASSEMBLY

To disassemble this valve, proceed as follows (see Figure 6):

1) Remove capscrews (17 and 23), then remove cap (16) and plate (22).
2) Holding spool (24) so that the spool will not rotate, remove capscrew (15), then remove spring retainer (14), return spring (12), spring retainer (11), spacer (13), seal retainer (10) and oil seals (09). Pull out spool (24).
3) Remove plug (18), O-ring (19), spring (20) and poppet (21).

CAUTION

Do not disassemble the relief valve cartridge, it may be adjusted but it must be replaced as a unit.

4) Remove relief valve (25) and O-ring (29).
5) Remove nuts (01) and pull out rod bolts (28), and separate the valve body assemblies. Remove O-rings (05, 06 and 08).

(2) CLEANING, INSPECTION AND REPAIR

Inspection, repair and cleaning of the valve must be done in an area free of dirt and corrosive materials. Clean, inspect and repair the valve as follows:

1) Discard all O-rings and oil seals. Renew these parts each time the valve is disassembled.
2) Thoroughly clean all parts in a suitable cleaning solvent, paying particular attention to the spool bore and the spool. Make sure they are free of foreign material.
3) Inspect all springs for distortion or cracks. Also inspect the valve ports and mating ports for excessive wear and scratches.
4) Inspect the spool and spool bore in the body for excessive wear, and scratches. If the spool or body are damaged, the entire valve must be replaced.

(3) ASSEMBLY

To assemble the valve, proceed as follows (see Figure 6):

1) Lubricate all parts with a light coat of clean hydraulic oil prior to assembly.
2) Assemble the three valve bodies with O-rings (05, 06, and 08) between the body assemblies.
3) Secure the body pieces with studs (28) and nuts (01).
4) Install oil seals (09) in valve body (07) and insert spool (24).
5) Assemble retainer (10), spring retainers (11 and 14), spring (12), and spacer (13) on spool (24). Hold the spool at the lever end to prevent the spool from turning and install capscrew (15).
6) Install cap (16) with capscrew (17) and plate (22) with capscrew (23).
7) Install O-ring (29) on relief cartridge (25) and O-ring (19) on plug (18).

NOTE

When installing O-rings, stretch them into the space, do not roll them on.

8) Install relief valve cartridge (25) and torque it to 6 kgf·m.
9) Install poppet (21), spring (20) and plug (18).

5.7.4 INSTALLATION

To install the valve, procced as follows:

1) Position the valve on the cab deck and install the lock washers and capscrews. Fully tighten the capscrews.
2) Reconnect the hydraulic lines.
3) Install the yoke attached on the control cable.
4) Connect the battery ground cable. Start the engine and operate the control valve to check the operation of the valve. Check all hydraulic lines for leakage.
5) Install the under cover.

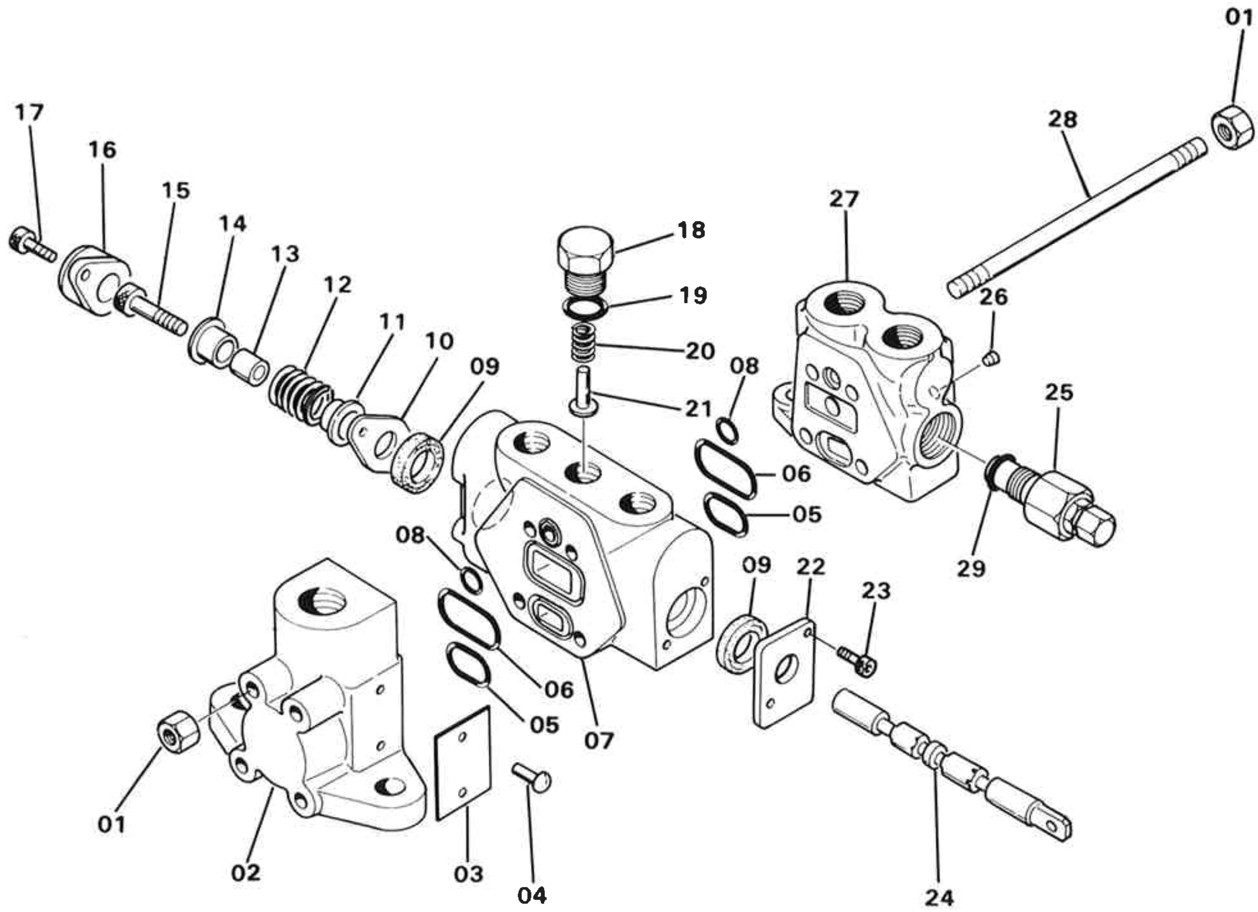
5.7.5 ADJUSTMENT

The relief valve has been adjusted at the factory and should retain its setting over an extended period of time, under normal conditions. The relief valve spring will eventually weaken with machine use, however, so periodic checking of the relief valve setting is recommended. To check the setting of the relief valve, proceed as follows:

CAUTION

The pressure setting of 210 kgf/cm^2 (2985 psi) must not be changed. Any attempt to change the setting will void any and all warranties, expressed or implied.

1) Operate the machine until the hydraulic oil temperature is a minimum of 50°C (122°F). Shut the engine down and reduce hydraulic pressure to zero by moving a control lever.
2) Obtain an accurate 0 to 350 kgf/cm^2 (0 to 5000 psi) pressure gauge.
3) Remove plug (26) and install the pressure gauge.
4) Increase engine speed to approximately 2000 rpm at no load.
5) Fully retract or extend one crawler side frame and observe the pressure gauge to determine the point at which the relief valve opens. The relief should open at approximately 210 kgf/cm^2 (2985 psi). The pressure gauge will instantly show a drop of pressure at the point when the relief valve opens.
6) If it is determined that the relief valve needs adjusting, remove the cap nut on the cartridge and loosen the lock nut. Turn the adjusting screw clockwise to raise the pressure setting and counterclockwise to lower the setting. Retighten the lock nut and replace the cap nut.
7) If the relief valve does not function as described, remove the replace the cartridge with a new one. Repeat the preceding steps to test the new relief valve for proper operation.



01.	NUT	11.	SPRING RETAINER	21.	POPPET
02.	BODY	12.	SPRING	22.	PLATE
03.	NAME PLATE	13.	SPACER	23.	CAPSCREW
04.	RIVET	14.	SPRING RETAINER	24.	SPOOL
05.	O-RING	15.	CAPSCREW	25.	RELIEF VALVE
06.	O-RING	16.	CAP	26.	PLUG
07.	BODY	17.	CAPSCREW	27.	BODY
08.	O-RING	18.	PLUG	28.	STUD
09.	OIL SEAL	19.	O-RING	29.	O-RING
10.	RETAINER	20.	SPRING		

Fig. 6 Crawler Extend/Retract Valve

6. HYDRAULIC COMPONENTS

6.1 GENERAL

This subsection contains the information necessary to repair the hydraulic components other than the control valves.

6.2 GENERAL REMOVAL

Prior to removing any of the components in this section, shut down the engine and remove the battery ground cable to prevent operation of the machine while the item is being serviced. Operate the controls to relieve all pressure in the system and also clean the area around the item being removed to prevent the entry of contaminants.

6.3 RELIEF VALVE (I)

6.3.1 GENERAL

The function of this relief valve is to keep constant the oil pressure in the control circuit. If the oil pressure from the pump exceeds the set pressure of the relief valve, the excess oil is returned directly to the tank to keep constant the oil pressure in the control circuit. The constant oil pressure, stored in the accumulator, is fed to the remote control valves and solenoid valve blocks for operations.

This relief valve is installed on the bracket for the valve assembly panel (see Fig. 5-1).

6.3.2 FUNCTION (see Fig. 8)

This relief valve is of the pilot-operated type, and its function is as follows:

Some of the oil from the control pump flows through the orifice in the relief valve plunger, and the secondary chamber, and acts on the poppet.

If the pressure in the pump circuit rises to the cracking value, it forces the poppet open and the oil in the secondary chamber passes around the poppet to the tank. This generates a large pressure difference before and after the plunger, and the oil under pressure on the pump side forces open the plunger and flows to the tank. This relief valve is adjusted to 45~50 kgf/cm^2.

6.3.3 REMOVAL

To remove the relief valve, proceed as follows (see Fig. 7):

1) See General Removal at the beginning of this section.
2) Disconnect all hydraulic lines. Cap the lines and plug the valve ports to prevent the entry of foreign matter.
3) Remove capscrews securing the valve to the bracket.

6.3.4 REPAIR

Observe the following precautions in relief valve disassembly and reassembly (see Fig. 8):

1) Use a clean workbench and tools for disassembly and reassembly.
2) After disassembly, clean all parts with cleaning solvent, being careful to check that there is no foreign matter remaining in grooves and orifices particularly. Dry the cleaned parts.
3) Check all parts for burrs, scratches, abnormal wear, etc.
4) Replace all O-rings with new ones.
5) Coat parts with clean hydraulic oil at reassembly.
6) After reassembly, check that all parts operate smoothly.

6.3.5 INSTALLATION

To install the relief valve, proceed as follows:

1) Install the relief valve on the bracket with two capscrews.
2) Connect all hydraulic lines.
3) Connect a pressure gauge to the control circuit and adjust the circuit to a cracking pressure of 40 kgf/cm^2 or more and a set pressure of 45~50 kgf/cm^2.
4) Start the engine and check for oil leakage. Check by means of the control oil pressure warning lamp and buzzer that the relief valve operates properly.

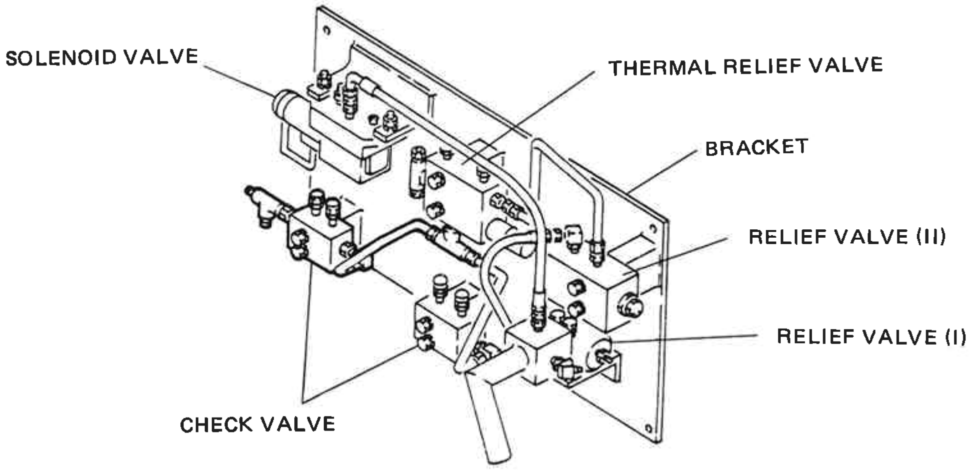


Fig. 7 Valves Panel

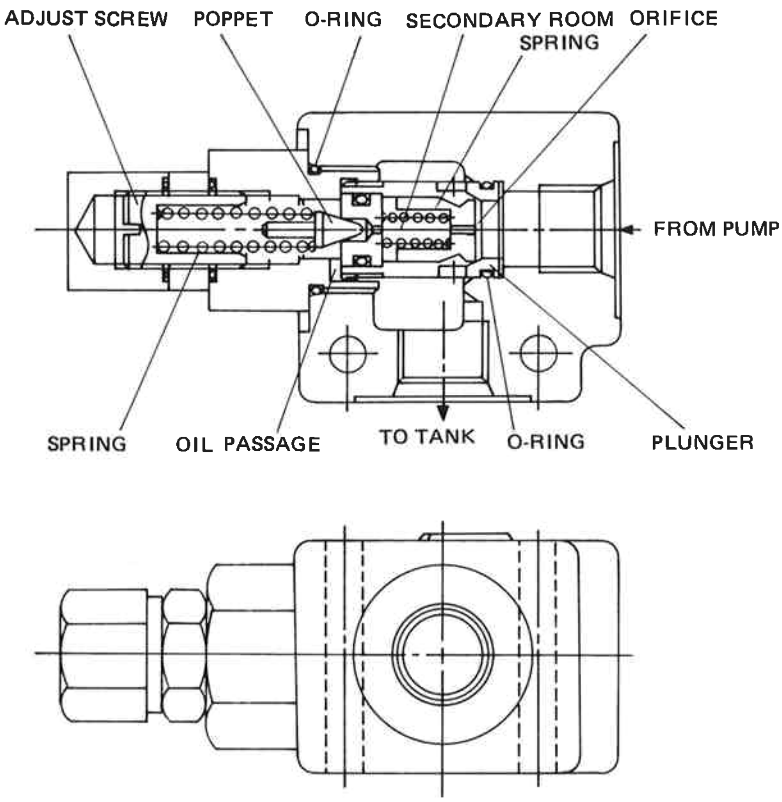


Fig. 8 Relief Valve (I)

6.4 RELIEF VALVE (II)

6.4.1 DESCRIPTION

This relief valve is installed on the bracket of the valve assembly panel. It is the pilot operated type and is used to keep constant the oil pressure in the foot brake circuit. Its set pressure is 110 to 120 kgf/cm^2.

6.4.2 REMOVAL

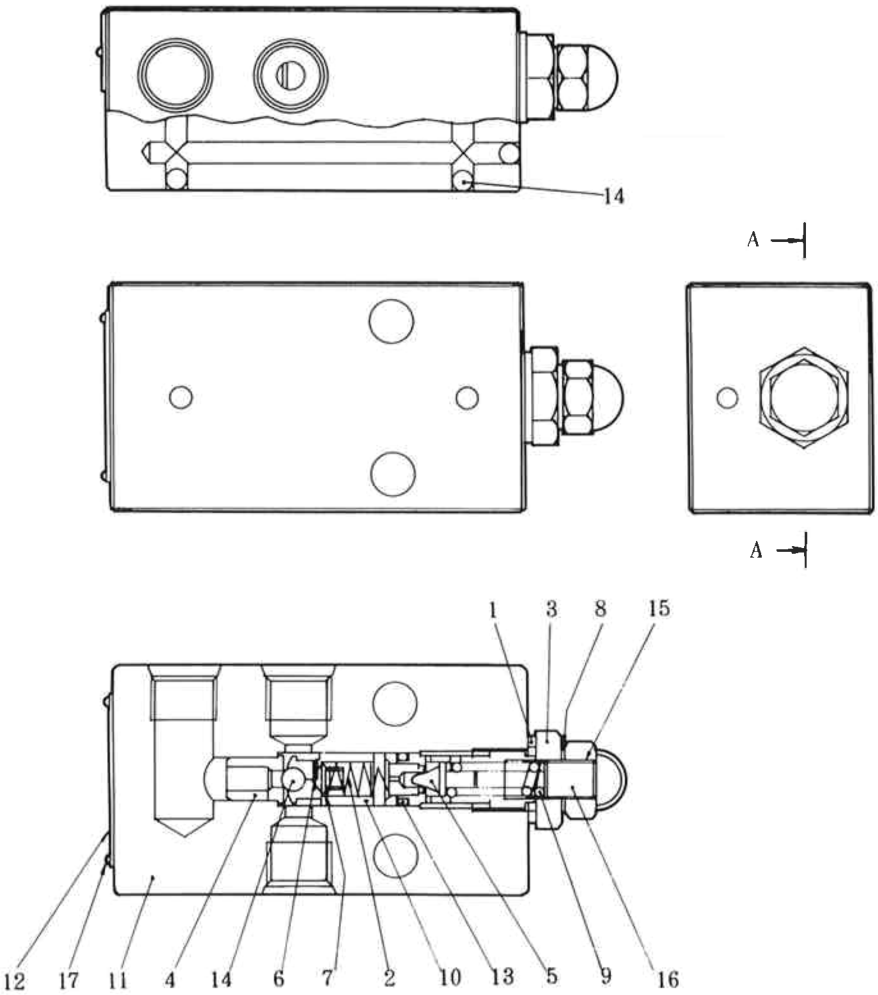
To remove the relief valve, proceed as follows (see Fig. 7):

1) See General Removal at the beginning of this section.
2) Disconnect all hydraulic lines. Plug the valve ports and cap the hydraulic lines to prevent the entry of foreign matter.
3) Remove the capscrews securing the valve to the bracket.

6.4.3 REPAIR

Observe the following precautions for relief valve disassembly and reassembly (see Fig. 9):

1) Use a clean workbench and tools for disassembly and reassembly.
2) After disassembly, clean all parts with cleaning solvent, being careful to check that there is no foreign matter remaining in grooves and orifices in particular.
   Dry all the cleaned parts.
3) Check all parts for burrs, scratches, abnormal wear, etc.
4) Replace all O-rings, seals and gaskets with new ones.
5) Coat all parts with clean hydraulic oil at reassembly.
6) After reassembly, check that all parts operate properly.



1. SEAL
2. SPRING
3. PILOT SLEEVE
4. VALVE SEAT
5. POPPET
6. ORIFICE
7. GUIDE
8. GASKET
9. SPRING
10. PLUNGER
11. BODY
12. NAME PLATE
13. O-RING
14. BALL
15. NUT
16. ADJUST SCREW
17. RIVET SCREW

Fig. 9 Relief Valve (II)

6.4.4 INSTALLATION

To install the relief valve, proceed as follows (see Fig. 9):

1) Install the relief valve on the bracket with two capscrews.
2) Connect all hydraulic lines.
3) Connect a pressure gauge to the foot brake circuit and adjust the circuit to a set pressure of 110 to 120 kgf/cm^2.
4) Start the engine and check for oil leakage. By means of the brake and oil pressure warning lamps and buzzer located on the monitor near the operator's seat, check that the relief valve operates properly.

6.5 THERMAL RELIEF VALVE

6.5.1 DESCRIPTION

The thermal relief valve is installed on the valve panel. It is used to release to the pump circuit some of the hydraulic oil trapped between control valve and wheel cylinder if enough stroke of the brake control valve is not available due to thermal expansion of the brake drum (see Fig. 7).

Port C in Fig. 10 is connected to the control valve, and port P, to the pump. If the oil pressure on the port C side is lower than that on the port P side, supply valve (4) opens and supply valve (6) closes. If the oil pressure on the port C side is higher than that on the port P side, supply valve (6) opens and supply valve (4) closes, and oil flows in from the control valve side. If the oil pressure on the port C side rises about 10 kg/cm^2 above that on the port P side, overload valve (10) opens and lets the oil under pressure on the port C side escape to the port P side (see Fig. 10).

6.5.2 REMOVAL

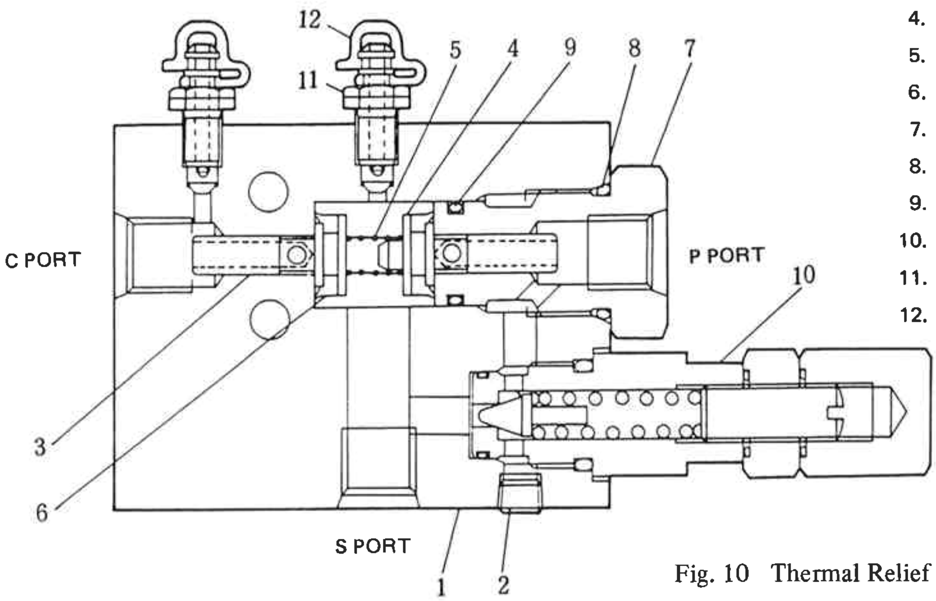
To remove the relief valve, proceed as follows (see Fig. 7).

1) See General Removal at the beginning of this section.
2) Disconnect all hydraulic lines. Plug the valve ports and cap the hydraulic lines.
3) Remove the capscrews securing the valve to the bracket.

6.5.3 REPAIR

Observe the following precautions in the disassembly and reassembly of the relief valve (see Fig. 10).

1) Use a clean workbench and tools for disassembly and reassembly.
2) After disassembly, clean all parts with cleaning solvent, being careful to check that there is no foreign matter remaining in grooves and orifices in particular.
   Dry the cleaned parts.
3) Check all parts for burrs, scratches, abnormal wear, etc.
4) Replace all O-rings and supply valves with new ones. If the overload valve is found faulty, replace it as an assembly.
5) Apply a thin coat of clean hydraulic oil to all parts at reassembly.



1. BODY
2. PLUG
3. SUPPLY VALVE ROD
4. SUPPLY VALVE
5. SPRING
6. SUPPLY VALVE
7. ROD GUIDE
8. O-RING
9. O-RING
10. OVER LOAD RELIEF VALVE
11. BLEEDER SCREW
12. CAP

Fig. 10 Thermal Relief Valve

6.5.4 INSTALLATION

To install the relief valve, proceed as follows (see Fig. 7).

1) Install the relief valve on the bracket with two capscrews.
2) Connect all hydraulic lines.
3) Adjust the overload valve to a set pressure of 120 to 130 kgf/cm^2.
4) Start the engine and by operating the foot brake, check that the relief valve operates properly.

6.6 SOLENOID VALVE BLOCK

There are two solenoid valve blocks mounted under the operator's cab floor (see Figure 10 and 11). Each valve block contains a set of solenoid and pilot valves and a manifold. One valve block controls the front drum, third drum (Opt.), swing brake and propel speed shift. The other valve block controls the boom hoist drum and rear drum. (See Fig. 10 and 11.)

6.7 SOLENOID VALVE

Solenoid valves are electrically actuated hydraulic valves that control the flow of hydraulic oil to the brakes, clutches and propel motors. The solenoids can be energized by moving a switch or control lever and will spring set if they are de-energized or if there is a loss of power.

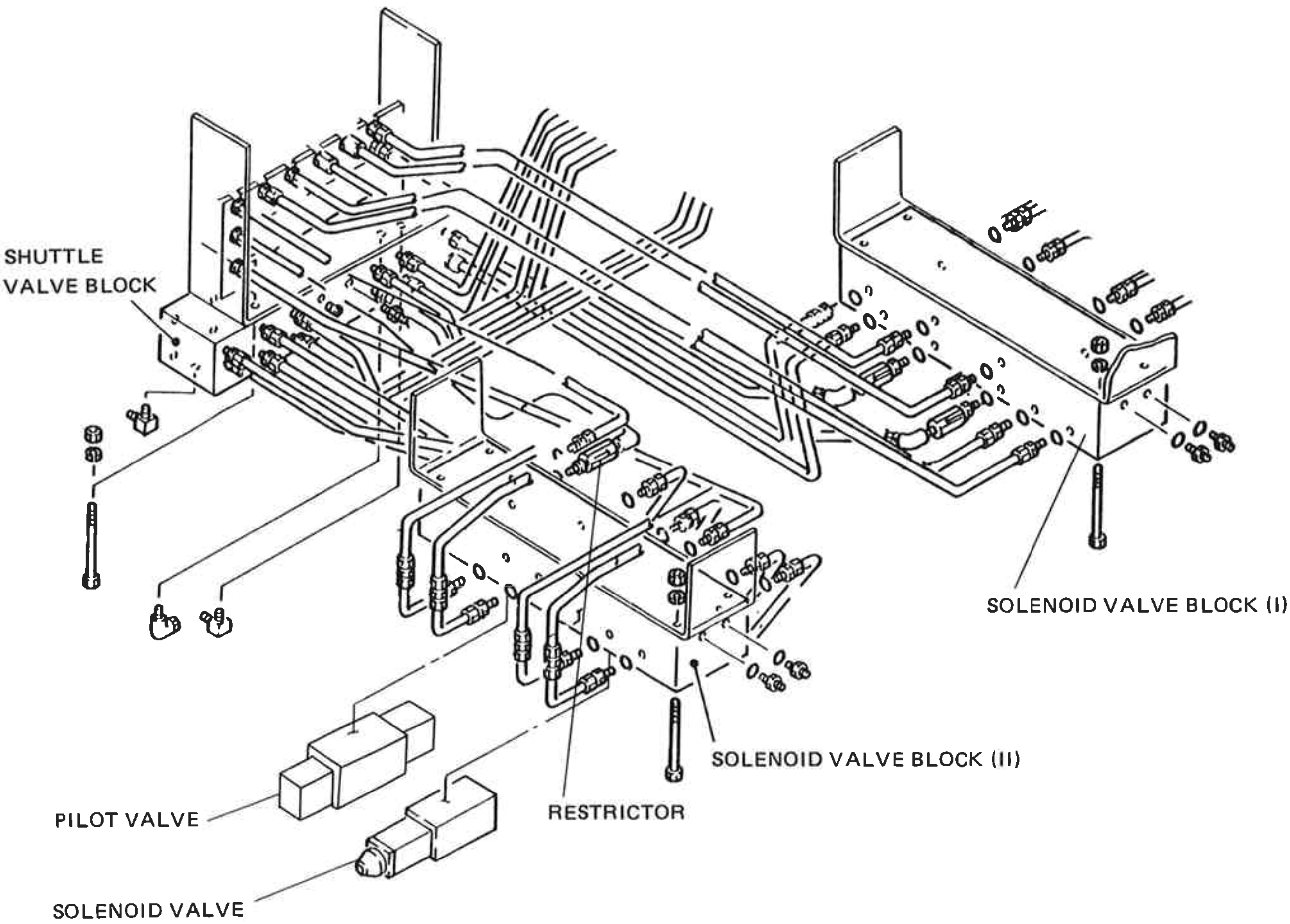


Fig. 10 Valve Blocks

6.8 PILOT VALVE

6.8.1 DESCRIPTION

The pilot valves are installed on their respective solenoid valve blocks (see Fig. 10 and 11). They control the control oil pressure fed to the clutch cylinders and negative brakes from the accumulator by shifting their spools according to the pilot pressures fed from the remote control valves for main and auxiliary hoist, third drum, and boom hoist.

6.8.2 REMOVAL

To remove the pilot valve, proceed as follows (see Fig. 10 and 11):

1) See General Removal at the beginning of this section.
2) Stop the engine and by operating the control levers at the operator's seat, bleed air remaining in the hydraulic circuits.
3) Remove the under cover from the cab deck.
4) Clean the area around the pilot valve.
5) Matchmark the pilot valve and the solenoid valve block to facilitate installation.
6) Remove the 4 capscrews securing the pilot valve to the solenoid valve block, and remove the pilot valve from the solenoid valve block.
7) Plug each valve port to prevent the entry of foreign matter.

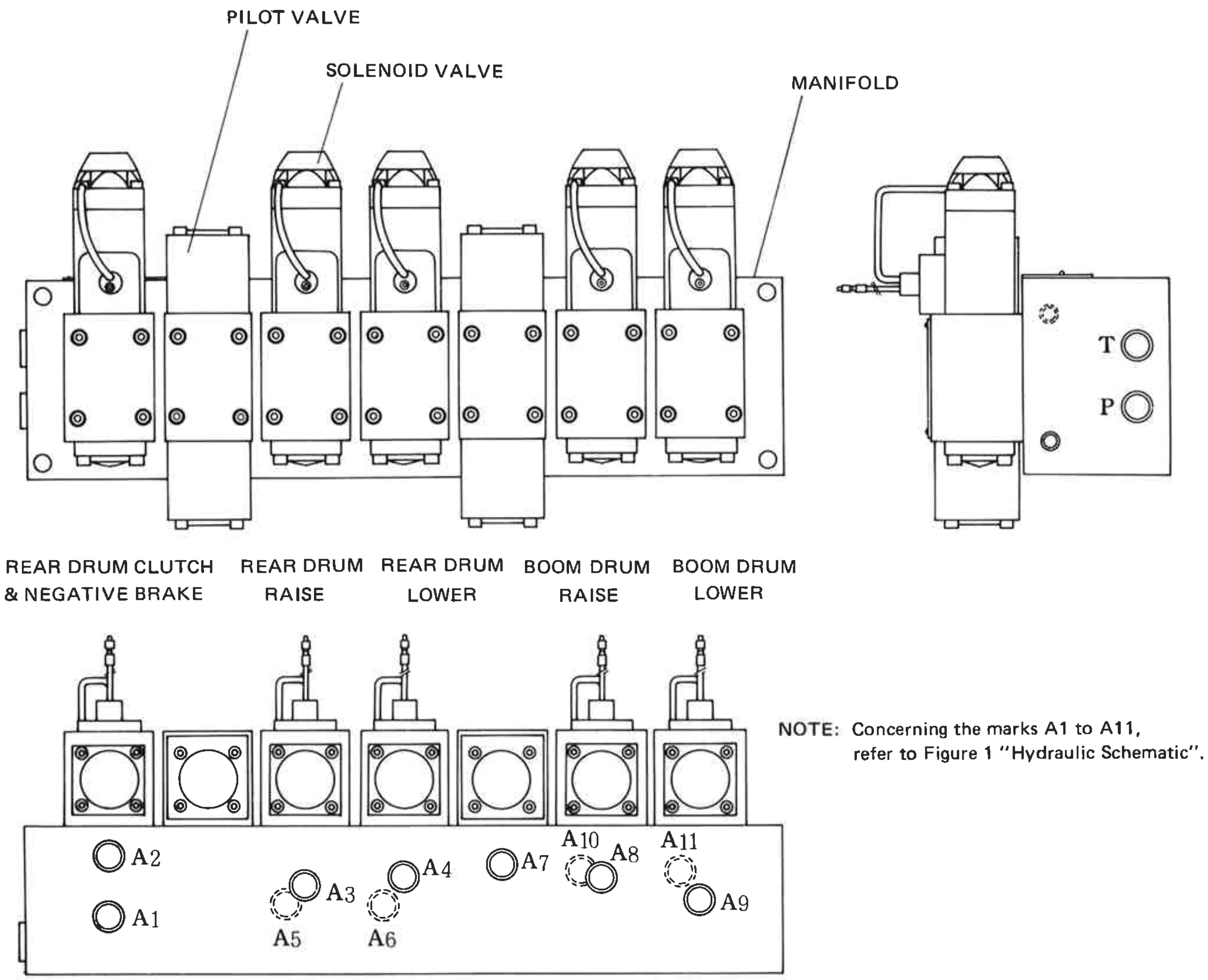


Fig. 11 Solenoid Valve Block (II)

6.8.3 DISASSEMBLY

To disassemble the pilot valve, proceed as follows (see Fig. 12):

1) Matchmark covers (2), spool (3) and casing (1) so that the cover and spool can be reassembled in the same direction as they were with respect to the casing.
2) Remove capscrew (15), and remove right- and left-hand covers (2) and O-ring (11).
3) Remove plug (4) and O-ring (7) from cover (2).
4) Remove spring (6) and spring seat (5).
   If necessary, remove orifice (1).
5) Pull out spool (3) from casing (1).

6.8.4 REPAIR

1) Clean all parts with cleaning solvent, paying special attention to grooves and orifice hole, and dry them.
2) Replace all O-rings with new ones.
3) Carefully check each part for scratches, abnormal or uneven wear, etc. Check the hole in the casing as well.

6.8.5 ASSEMBLY

To reassemble the pilot valve, proceed as follows:

1) Insert spool (3) into casing (1), matching up the matchmarks.
2) If orifice (12) was removed, coat the threaded portion of orifice (12) with Loctite #241, and tighten it to cover (2).
3) Insert spring seat (5) and spring (6) into each cover (2), replace O-ring (7) with a new one, and tighten plug (4).
4) Install cover (2) on casing (1) to fit the matchmarks, and tighten capscrew (15) to 25 to 35 kgf-cm.

6.8.6 INSTALLATION

To install the pilot valve, proceed as follows:

1) Install 6 new O-rings in the pilot valve.
2) Put the pilot valve on the solenoid valve block to fit the matchmarks, and tighten diagonally opposite cap screws to 80 kgf-cm alternatively (a total of 4).

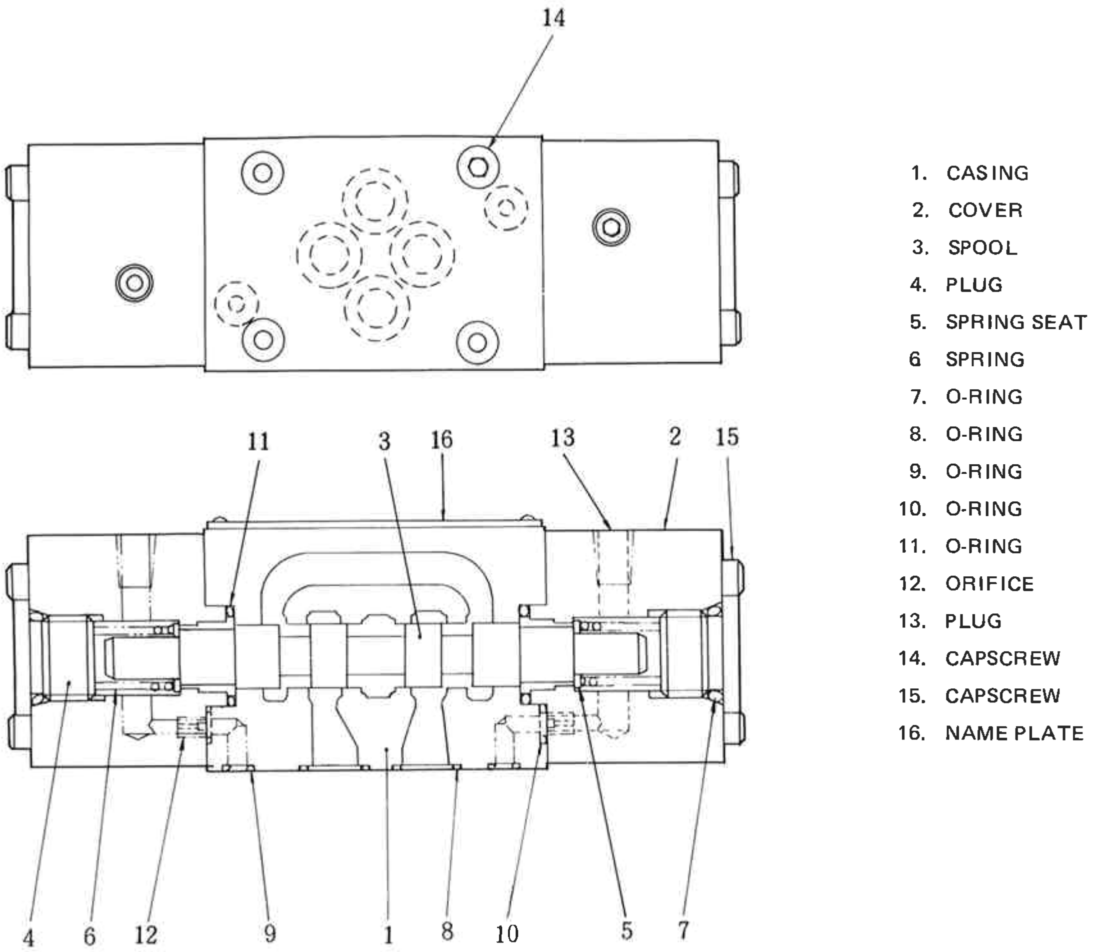


Fig. 12 Pilot Valve

6.9 SHUTTLE VALVE BLOCK

The shuttle valve block is installed under the cab deck (see Fig. 10). It comprises the casing containing 11 shuttle valves, and a pilot valve.

When a control lever is operated, the control oil pressure from the solenoid valve block or remote control valve is fed to the shuttle valve block.

This control oil pressure is diverted by the shuttle valves and pilot valve to feed the desired pilot pressure to the main control valve, main pump, hoist motor, etc. (see Fig. 13).

6.10 SHUTTLE VALUE

6.10.1 DESCRIPTION

Each shuttle valve has two oil inlets on the opposite sides of a ball, and an oil outlet between them. When oil under pressure appears at one or both of the inlets. The oil of higher pressure pushes the ball in the opposite direction, closing off the oil of lower pressure, and comes out the oil outlet (see Fig. 13).

6.10.2 REPAIR

To remove and install the shuttle valve, proceed as specified below. If any part is found defective, replace the shuttle valve as an assembly (see Fig. 13).

1) See General Removal at the beginning of this section.
2) Remove the plug from the shuttle valve casing. Remove the O-ring from the plug.
3) Remove the seat.
4) Remove the ball.
5) Wash all parts and check for scratches, wear and rust.
6) Before installation, replace the O-ring with a new one, and apply oil to all parts including the valve casing. Reverse the removal procedure.
7) Start the engine, and by operating the control valve, check the shuttle valve for oil leakage and malfunction.

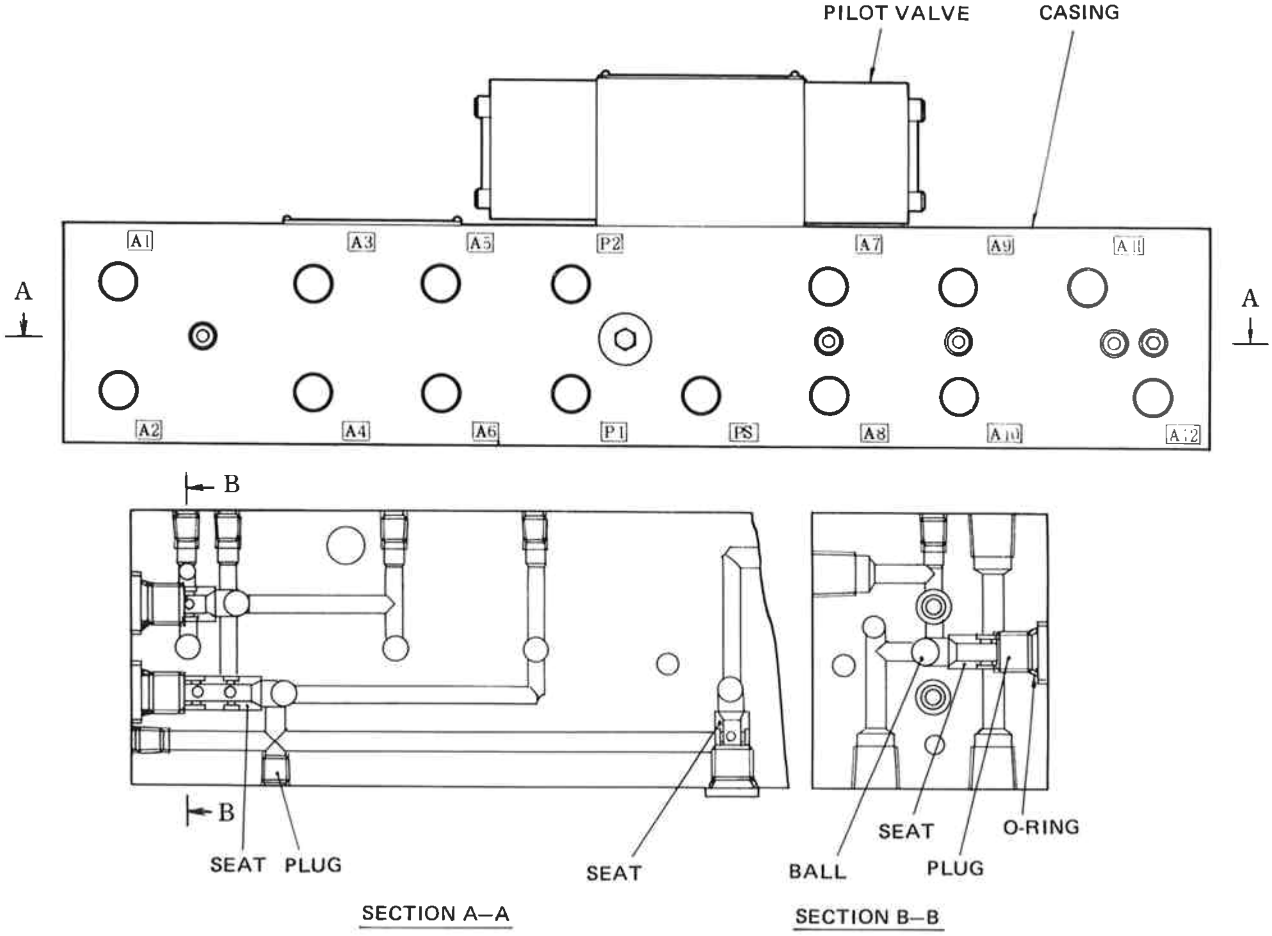


Fig. 13 Shuttle Valve Block

6.11 ACTUATING CYLINDERS

6.11.1 DESCRIPTION

The actuating cylinders are those hydraulic cylinders that set or release the drum brake bands and clutches. All the actuating cylinders get hydraulic oil pressure from the hydraulic control pump and are controlled by the operator control valves. Since the functions and internal parts of these cylinders are very similar, the following procedures were written to apply to every cylinder and therefore, several steps may not apply to all cylinders. Refer to the Parts Manual to identify the function of each cylinder.

6.11.2 REMOVAL

To remove the actuating cylinder, proceed as follows:

1) See General Removal at the beginning of this section.
2) Disconnect the hydraulic line to the cylinder. Cap the line and install a dust cap in the cylinder to prevent the entry of contaminants.
3) Relieve any tension of the brake, clutch or pawl operating mechanism springs. Disconnect the cylinder from the linkage, yoke or pushrod.

NOTE

See the particular brake or clutch instructions on how to relieve spring tension in the operating mechanism and how to disconnect the linkage, yoke or pushrod.

4) Remove the capscrew and lockwasher securing the cylinder to the operating mechanism.

6.11.3 OVERHAUL

(1) DISASSEMBLY

Use the following procedure to disassemble the cylinder (see Figure 14):

1) Remove the piston and spring, if used, from the cylinder body.
2) Remove the seal, back-up ring, packing, and O-ring from the cylinder body. Note the position of the seals when removing them.

(2) INSPECTION AND REPAIRS

Inspect the piston and cylinder bore for excessive wear, nicks or scratches. If either of these parts are damaged, the entire cylinder must be replaced.

NOTE

A service kit is available. See the Replacement Parts Manual.

(3) ASSEMBLY

To reassemble the cylinder, proceed as follows (see Figure 14):

1) Generously coat all parts to be assembled with clean hydraulic oil.
2) Install the packing, back-up ring, O-ring, and outer seal.
3) Install the spring, if used, and piston in the cylinder body.

6.11.4 INSTALLATION

To install the actuating cylinder, proceed as follows:

1) Secure the cylinder to the operating mechanism with the lockwasher and capscrew. Attach the cylinder to the linkage, yoke or pushrod.

NOTE

See the particular brake or clutch instructions on how to install the cylinder in the operating mechanism and attach the linkage, yoke or pushrod.

2) Remove the dust cap from the cylinder and remove the cap from the hydraulic line. Connect the hydraulic line to the cylinder.
3) Bleed the hydraulic cylinder to remove any air trapped in the hydraulic line.
4) Connect the battery cable. Start the engine and operate the controls. Observe the cylinder for leaks, binding or other defects.

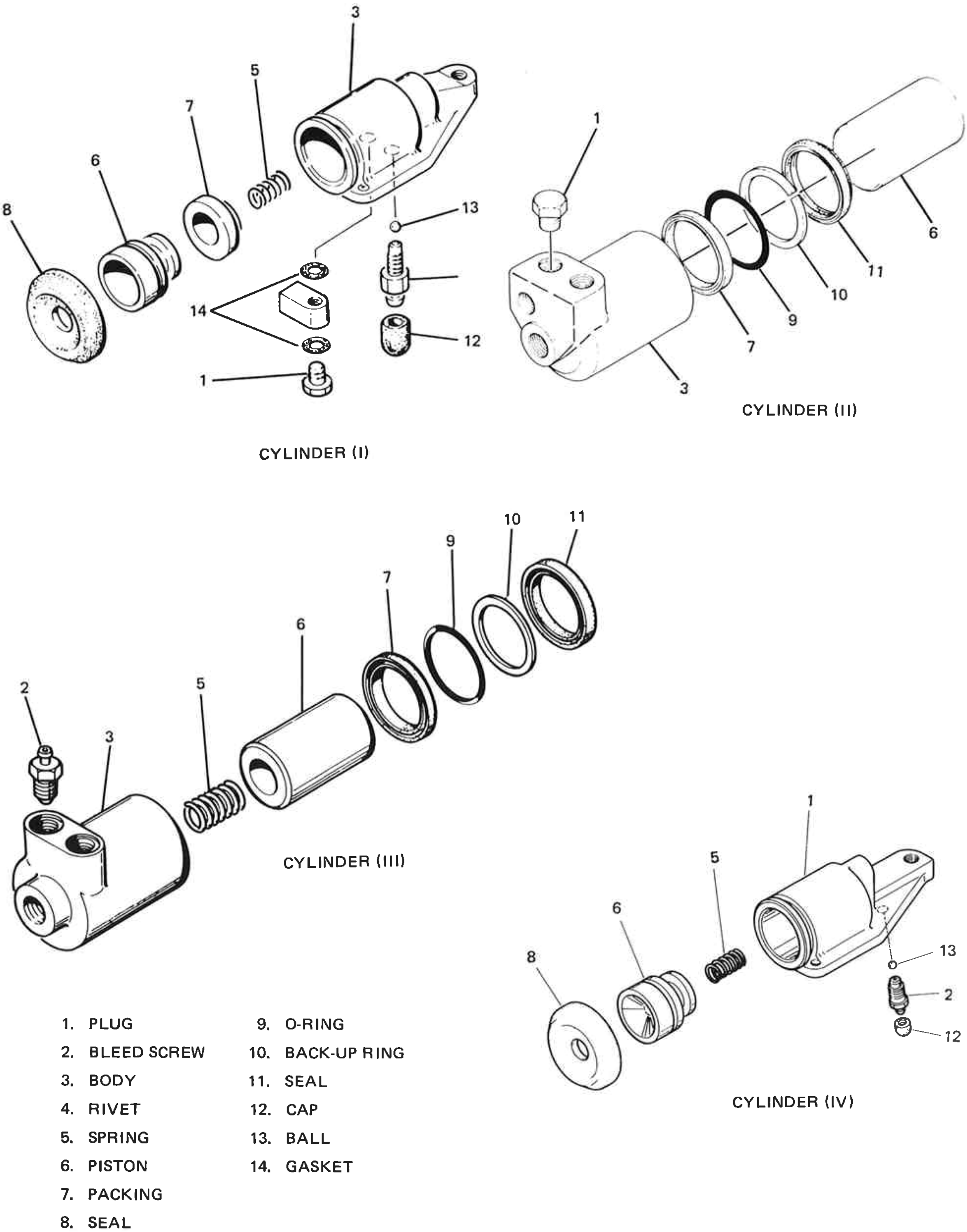


Fig. 14 Actuating Cylinders

6.12 SWIVEL FITTING

6.12.1 DESCRIPTION

All drum clutches are hydraulically actuated and the hydraulic oil used, is delivered to the cylinder through the drumshaft. Since the drumshaft always rotates, a swivel fitting is needed to deliver hydraulic fluid from the staitionary drum support to the rotating drumshaft.

6.12.2 REPAIRS

The swivel is considered non-repairable. If the swivel is faulty, the complete swivel should be removed and replaced.

6.12.3 REMOVAL

To remove the swivel, proceed as follows:

1) See General Removal at the beginning of this section.
2) Disconnect the hydraulic line at the swivel and position the line to avoid interference as the swivel is removed. Cap the line to prevent the entry of contaminants.
3) Remove the swivel by backing it out of the shaft.

6.12.4 INSTALLATION

To install the swivel, proceed as follows:

1) Install the O-ring on the swivel. Thread and tighten the swivel into the shaft.
2) Remove the protective cap and connect the hydraulic line to the swivel.
3) Connect the battery cable. Start the engine and operate the controls. Observe the swivel for leaks or other defects.

6.13 SWIVEL

6.13.1 DESCRIPTION

The swivel is the coupling through which hydraulic oil is transfered between the upper machine and the lower. The swivel makes it possible to rotate the upper a full 360 degrees without interfering with pipe or hose connections.

The swivel consists of a swivel body which engages with the bracket on the bottom of the revolving frame and a stem which is fixed to the carbody (see Figure 15). All of the hydraulic lines from the upper, required for the propel circuit, are connected to the swivel body. Each port on the swivel body corresponds to a segment on the swivel stem. Hydraulic lines connected to the bottom of the stem direct oil to and from the propel motors and brakes.

6.13.2 REMOVAL

If leakage between the swivel body and the stem is detected, the swivel must be removed from the machine for repair. To remove the swivel for seal replacement or other maintenance, proceed as follows (see Figure 15):

1) See General Removal at the beginning of this section.
2) Swing the upper so that the attachment is over the front of the lower, lower the boom, set the swing brake, and stop the engine.
3) Tag and disconnect all the hydraulic lines attached to the stem. The stem is marked to correspond with marks stamped on the swivel body. Cap the lines to prevent the entry of contaminants.

NOTE

Access to the stem and swivel body can be gained from below the carbody.

4) Tag and disconnect all the hydraulic lines attached to the swivel body.
5) Using a suitable jacking arrangement, support the swivel stem from below. Remove the capscrew securing the swivel body to the bracket on the revolving frame.
6) Remove the four attaching capscrews, lockwashers, and nuts securing the swivel stem to the support on the carbody.
7) Swing the stem 90 degrees and slowly lower the swivel out of the carbody. Set the swivel aside for disassembly.

6.13.3 OVERHAUL

(1) DISASSEMBLY

Disassemble the swivel as follows (see Figure 16):

1) Remove the capscrews securing the cover to the body. Remove the cover and O-ring.
2) Remove the capscrews securing the cover plate to the stem and remove the plate.
3) Slide the stem out of the swivel body.
4) Remove the slipper seals, and O-rings from the body. Discard the seals and O-rings.

(2) INSPECTION AND REPAIR

After the swivel has been disassembled, proceed as follows to inspect and repair it:

1) Thoroughly wash the swivel body and stem with a suitable cleaning solvent or diesel fuel.
2) Inspect all parts for wear or damage. Carefully inspect the swivel body and stem for excessive scoring or deep scratches. Replace worn or damaged parts.

NOTE

Excessive scoring or deep scratches are usually caused by foreign material in the hydraulic system. If these defects are found, the hydraulic system should be checked for foreign material.

(3) ASSEMBLY

To assemble the swivel, proceed as follows (see Figure 16):

1) Generously lubricate the swivel body, stem and all O-rings and seals with clean hydraulic oil.
2) Starting at the lower end of the body, carefully install the O-rings in the first and second grooves of the body. Carefully install the slipper seals over the O-rings. Knead the slipper seals by hand to squeeze them into the grooves.
3) Install a new slipper seal in each groove of the body as described in the preceding step.
4) Place the swivel body in a vertical position with the bottom of the body facing up. Insert the top of the stem into the bore of the swivel body.
5) When the stem is installed, install the cover plate with the two capscrews.
6) Install the upper O-ring and set the cover on the body. Fasten the cover with the capscrews.

6.13.4 INSTALLATION

To install a new or repaired swivel, proceed as follows (see Figure 15):

1) Position the swivel such that it will fit through the opening of the carbody support. Slowly lift or jack the swivel up until the swivel can be turned and rested on the carbody support.

NOTE

Position the swivel so that the marks stamped on the body and stem face the respective hoses tagged earlier.

2) When the swivel is in position, secure the stem to the carbody with the appropriate capscrews, lockwashers, and nuts. Tighten securely. Secure the swivel body to the body bracket with the capscrew and nut.

3) Reconnect the hydraulic lines from the upper to the appropriate ports in the swivel body.

4) Reconnect the hydraulic lines from the lower to the appropriate ports on the stem.

5) Connect the battery ground cable. Start the engine and check for leaks while operating the propel functions. Check the hydraulic oil reservoir and add oil if necessary.

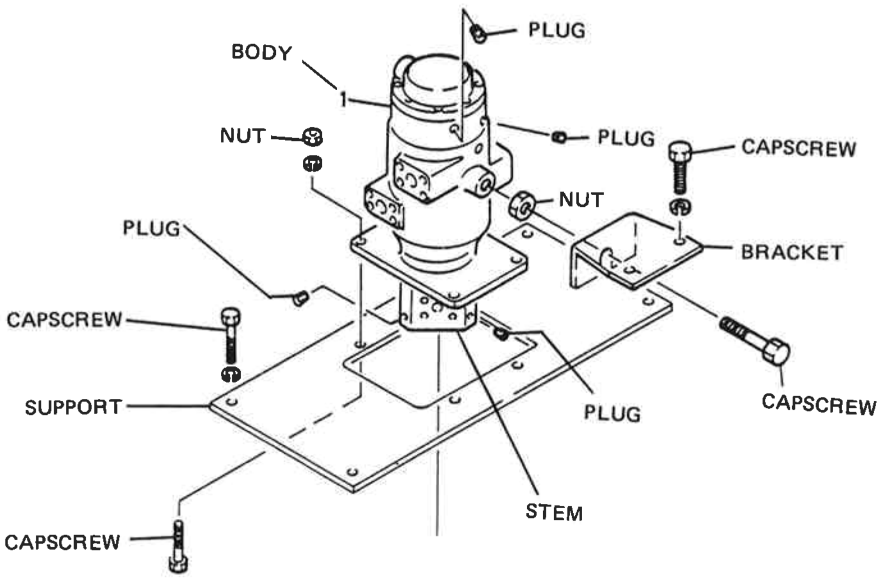


Fig. 15 Removal/Installation of Swivel Joint

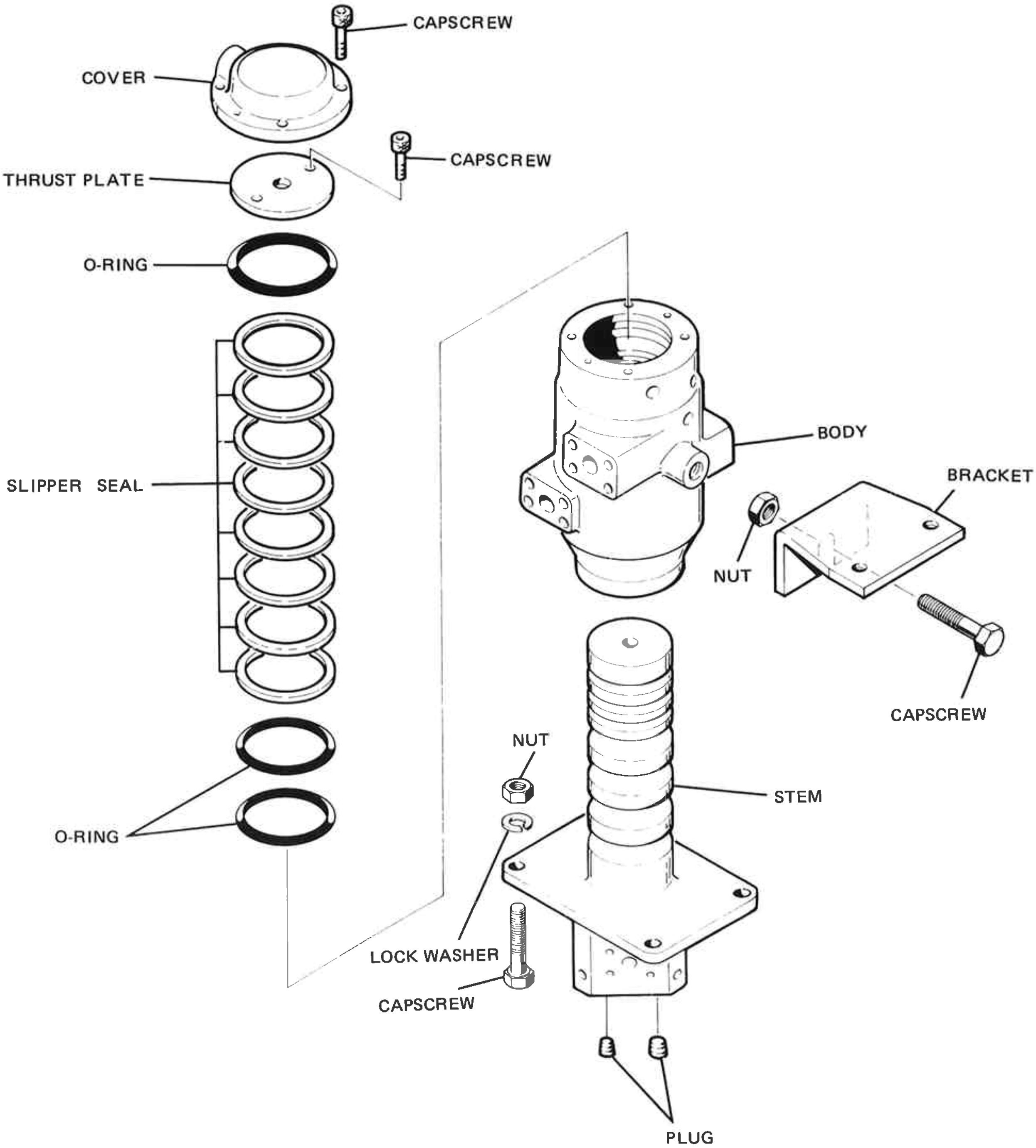


Fig. 16 Swivel

6.14 CRAWLER FRAME EXTENSION/ RETRACTION CYLINDER

6.14.1 DESCRIPTION

This cylinder is a double acting cylinder used for extending and retracting the crawler side frame.

The crawler extension/retraction hydraulic cylinders are pin-installed on the bracket mounted on the car body and crawler frames.

These cylinders are used to extend the crawler frames to the side for greater stability during crane operations. The crawler frames are retracted for ease of transportation on board a trailer.

For details on the hydraulic cylinders, see the separate shop manual.

6.14.2 REMOVAL

To remove the crawler extension cylinder, proceed as follows:

1) Perform the General Removal procedures, as they apply to this function, as stated at the beginning of the subsection.
2) Tag and remove hydraulic lines.
3) Pull the cotter pins and pins at either end of the cylinder.
4) Remove the ten capscrews and lockwashers that secure the pushrod pinning plate to the outside of the crawler frame. Remove the plate and slide the cylinderout through the frame.
5) Move the cylinder to a clean, dust free work area for disassembly.

6.14.3 INSTALLATION

To install the crawler extension cylinder, proceed as follows:

1) Slide the cylinder through the crawler frame and place the head end of the cylinder in the bracket on the carbody and insert the pin and cotter pin. Mount the rod end of the cylinder body on a support to provide free movement of the pushrod.
2) Fully retract the cylinder by hand.
3) Connect the hydraulic line for extending the cylinder first.
4) Connect the battery ground and start the engine. Gradually operate the control valve to fill the head end of the cylinder with hydraulic oil.
5) With the rod fully extended, connect the other hydraulic line and operate the control valve to fully retract the rod. Cycle the cylinder several times to remove any trapped air.
6) Install the pushrod pin bracket to the crawler frame.
7) Place the rod end of the cylinder in the bracket and insert the pin and cotter pin.
8) Check the oil level of the hydraulic reservoir and add oil if necessary.

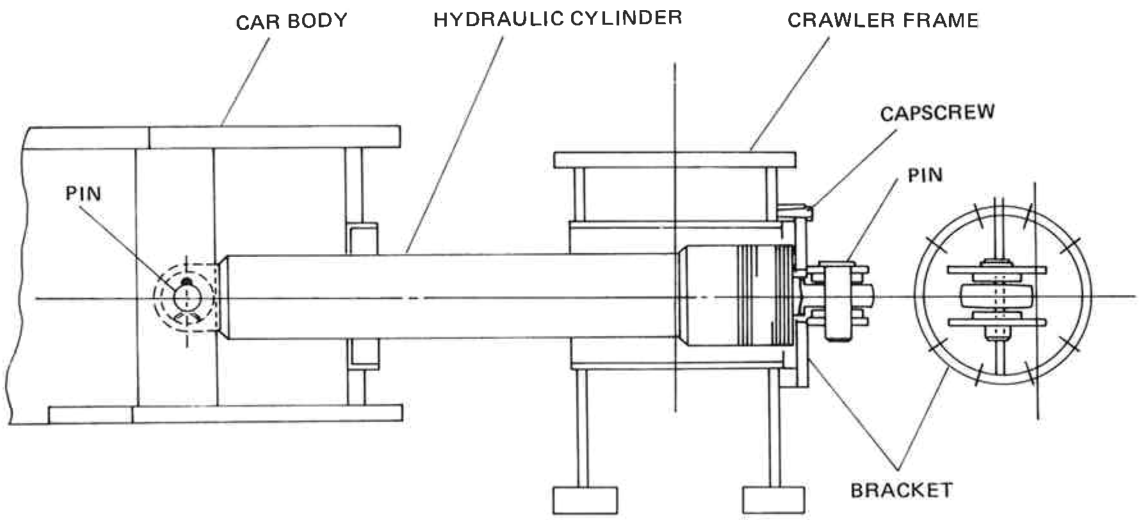


Fig. 17 Crawler Frame Extension/Retraction Cylinder (Retracted)

1. LOCATION OF COMPONENTS

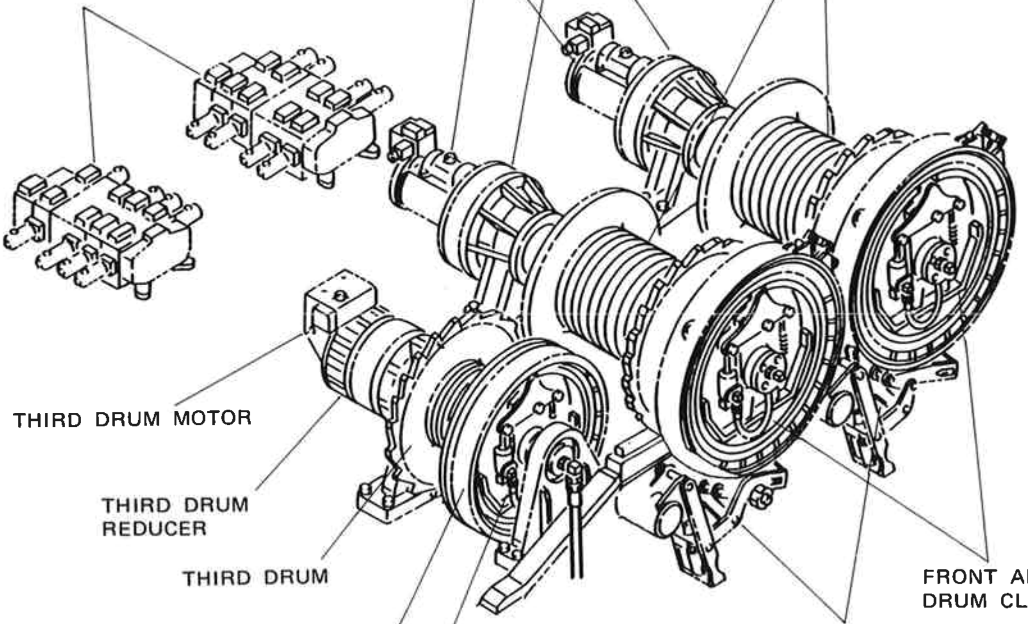


Fig. 1 Hoist System

2. DRUM MOTORS

2.1 GENERAL

This section contains information necessary to remove and install the front and rear drum motors installed on the front and rear drums respectively, and the third drum motor installed on the third drum. For details of these motors, see the separate shop manual.

2.2 FRONT AND REAR DRUM MOTORS

2.2.1 DESCRIPTION

Fig. 2 gives views of the front and rear drum motors. These motors are 2-speed swash plate type fixed/variable displacement axial piston motors on which high/low selector regulators and counterbalance valves are installed. They are installed on the front and rear drum reducers, which are installed on the front and rear drum shafts (See Fig. 2).

2.2.2 REMOVAL

To remove the front or rear drum motor, proceed as follows (See Fig. 2 and 3).

1) Remove the guards and panels which must be removed in order to remove the front or rear drum motors.
2) Start the engine and lower the hook block onto the ground. Place the brake selector switch in the neutral brake position, and engage the drum lock.
3) Stop the engine, and relieve the pressure trapped in the hoist circuit by operating the hoist control lever several times.
4) Remove the drain plug from the reducer and drain all the oil into an appropriate container.
5) Before removing the front or rear drum motor, clean the motor and its hydraulic line connections.
6) Remove the pressure, control and drain lines from the front or rear drum motor, and tag each line. Cap each line and plug each port to prevent the entry of foreign matter.
7) Attach a lifting device of suitable capacity to the eyebolt hole provided in the top of the motor.
8) Remove the 4 motor mounting capscrews, and remove the motor from the reducer by tightening jack bolts into the jack bolt holes. The motor assembly weighs about 175 kg.

2.2.3 INSTALLATION

When installing a new or repaired motor, take care to align the shaft with the mating part as precisely as possible to prevent excessive wear.

To install the motor, proceed as follows (See Fig. 6).

1) Check the spline of the motor output shaft for notches and burrs to ensure proper installation of the motor on the reducer. If any are found, remove them.
2) Apply a thin coat of grease to the output shaft spline.
3) Insert spacer (19) and sun gear (7) onto the output shaft and install O-ring (21) on the reducer.
4) Lift the motor with a lifting device attached to the lifting eyebolt, insert the output shaft into the reducer, and engage the motor sun gear and the reducer pinion.
5) Coat 4 capscrews with Loctite #242, and tighten them alternately to 44 kgf·m.
6) Install the pressure, control and drain lines.
7) Feed oil to the reducer and motor casing.
8) Install the guards and panels removed for motor removal.
9) Start the engine, and with the engine idling check for oil leaks, direction of rotation, heavy vibration during engine or control valve operation, abnormal oil temperature rise in a short time, etc.

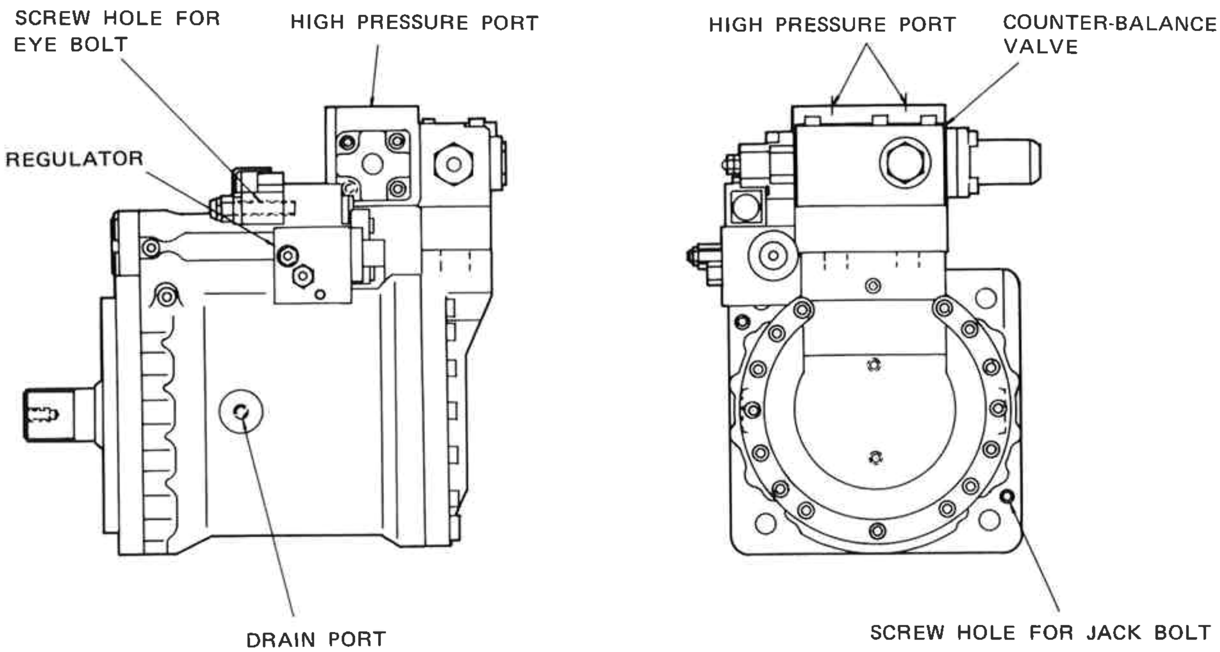


Fig. 2 Main Drum Motor

2.3 THIRD DRUM MOTOR

2.3.1 DESCRIPTION

The third drum motor (option) is a fixed displacement piston motor with a counterbalance valve, and is installed on the reducer for the third drum.

2.3.2 REMOVAL

To remove the third drum motor, proceed as follows (See Fig. 7).

1) Remove the guard and panel which must be removed in order to remove the third drum motor.
2) Remove the drain plug from the reducer and drain all the oil into an appropriate container.
3) Before removing the third drum motor, clean the motor and its hydraulic line connections.
4) Remove the high pressure and drain lines from the third drum motor, and tag the tubes. Cap all the lines and plug the all the oil ports to prevent the entry of foreign matter.
5) Attach a lifting device of suitable capacity to the third drum motor.
6) Remove the motor mounting capscrews, and remove the third drum motor from the reducer.

2.3.3 INSTALLATION

When installing a new or repaired motor, take care to align the shaft center with the mating part as precisely as possible to prevent excessive wear.

To install the third drum motor, proceed as follows (See Fig. 7).

1) Check the output shaft spline of the motor for notches and burrs to ensure proper installation of the motor on the reducer. If any are found, remove them.
2) Apply a thin coat of grease to the output shaft spline.
3) Insert spacer (26) and sun gear (8) onto the output shaft, and install O-ring (25) on the reducer.
4) Lift the motor, and insert the motor output shaft into the reducer.
5) Coat 8 capscrews with Loctite and tighten them alternately to 6.7 kgf·m.
6) Connect the pressure and drain lines.
7) Feed oil to the reducer and motor casing.
8) Install the guard and panel which were removed for motor removal.
9) Start the engine, and with the motor idling check for oil leaks, direction of rotation, heavy vibration during motor and control valve operation, abnormal oil temperature rise in a short time, etc.

3. DRUMSHAFTS

3.1 GENERAL

This section contains information necessary to remove, disassemble, inspect and repair, reassemble, and install the front, rear and third drumshafts.

3.2 FRONT AND REAR DRUMSHAFTS

3.2.1 REMOVAL

To remove the front or rear drumshaft, proceed as follows (See Fig. 3).

1) Remove the guards which must be removed in order to remove the main winch assembly.
2) Disconnect all hydraulic lines from the main winch assembly. Cap the hydraulic lines and plug the connections. Remove all other parts which may interfere with the removal of the main which assembly.
3) Remove the gantry compression member and A frame.
4) Referring to "5. Drum Brakes", remove all the brake bands installed on the front and rear drums.
5) Remove the swivel joint installed on the right end of the drumshaft.
6) Remove the drain plug from the reducer, drain all the oil into an appropriate container, then screw the drain plug back in.
7) Remove capscrews (30,31) mounting the right- and left-hand stands on the revolving frame.
8) Remove the main winch assembly from the machine using a lifting device of suitable capacity, and place the assembly horizontally on a block. The assembly weighs about 1,120 kg.
9) Remove capscrew (4) mounting retainer (8) on reducer (5).
10) Attach a lifting device of suitable capacity to the reducer (5) assembly with front or rear drum motor on it, and pull the reducer from the drumshaft (6).

3.2.2 DISASSEMBLY

To remove the front or rear drumshaft, proceed as follows (See Fig. 3).

1) Remove bearing lock nut (24) and lock washer (25).
2) Remove bearing (23), retainer (8), collar (10),
3) Remove capscrew (4) and plate (9) from drum (1).
4) Remove capscrew (35), washer (36), end plate (13) and shims (14,15,16,17) from shaft (6). Retain shims (14,15,16,17) as a set.
5) Remove clutch assembly (18) and spacer (12).
6) Support the flange side of drum (1) on a block with brake rim (2) facing upwards, to stand the drumshaft assembly.
7) Push shaft (6) with a press to force out shaft (6) and bearings (21,22).
8) Pull bearing (22) from drum (1), and bearing (21) from shaft (6).

NOTE

Pin (33), which fixes the positional relation between drum (1) and brake rim (2), is crimped on the brake rim. Do not attempt to disassemble drum (1) and brake rim (2), except when it is necessary to replace bearing (20).

3.2.3 INSPECTION AND REPAIR

Before installing the front or rear drumshaft, inspect all parts while observing the following instructions.

1) Replace all O-rings and oil seals.
2) Clean bearings in pure cleaning solvent. Dry them with compressed air and inspect for flaws and pitting. Apply a thin coat of lubricant to bearings, and inspect for smooth rotation, excessive axial and circumferential clearance or play and signs of rolling slippage on the faces onto which the inner and outer races are inserted. If faulty, replace.
3) Inspect the splined portion of the shaft for cracks, excessive wear and localized dents. Repair or replace any faulty parts.
4) Inspect the threads of capscrews and screw holes for burrs and deformation. Repair or replace any faulty parts.
5) Inspect the clutch and brake linings, and replace if necessary.
6) Inspect the drum ratchet and rim cooling fin for cracks and damage. Repair or replace any faulty parts.
7) Inspect the rim faces of the brake and clutch for cracks, scratches and deformation. Repair or replace any faulty parts.

3.2.4 ASSEMBLY

To assemble the front or rear drumshaft, proceed as follows (See Fig. 3).

1) Coat each capscrew with Loctite #242 or equivalent before tightening.
2) Apply Loctite #515 or equivalent to the periphery of each oil seal before assembly.
   Fill one third of the gap between the seal lip and dust lip of oil seal with grease.
3) Apply a thin coat of grease to each O-ring and its mating surface.
4) Press bearings (21,22) onto both ends of shaft (6) until they contact the steps.
5) Place the drum and rim assembly on a block, the drum side facing upwards.
6) Press shaft (6) into drum (1) until bearings (21,22) inserted onto shaft (6) completely contact the shoulder of the drum inside diameter.
7) Install plate (9) on drum (1) with capscrew (4).
8) Insert spacer (11), O-ring (29) and collar (10) onto shaft (6), being careful that O-ring (10) is not damaged by the threaded portion of shaft (6).
9) Insert oil seal (26) into retainer (8). Do not push the oil seal to its bottom, but leave a 0.2~1.0 mm gap between retainer (8) and oil seal (26).
10) Apply a thin coat of grease to collar (10) and insert retainer (8).
11) Heat bearing (23) in oil to about 120°C, and insert it onto shaft (6).
12) Insert bearing lock washer (25) and tighten bearing lock nut (24).
13) Reverse the drumshaft assembly, and place it on a block with the brake rim side facing upwards.
14) Insert spacer (12) onto shaft (6).
15) Install clutch assembly (18) on shaft (6), being careful to align the oil holes in shaft (6) and the clutch spider inside diameter.
16) Install shims (14,15,16,17) and tighten end plate (13) to the end face of shaft (6) with capscrew (35). The tightening torque should be 10.5~12.9 kgf·m. Adjust the thickness of shims (14,15,16,17) so that the clearance between clutch spider end face and end plate (13) is 0.05~0.1 mm.

NOTE

If brake rim (2) was removed from drum (1), tighten capscrew (34) at 50~60 kgf·m. Crimp the brake rim end of pin (33) after insertion to prevent it from working off.

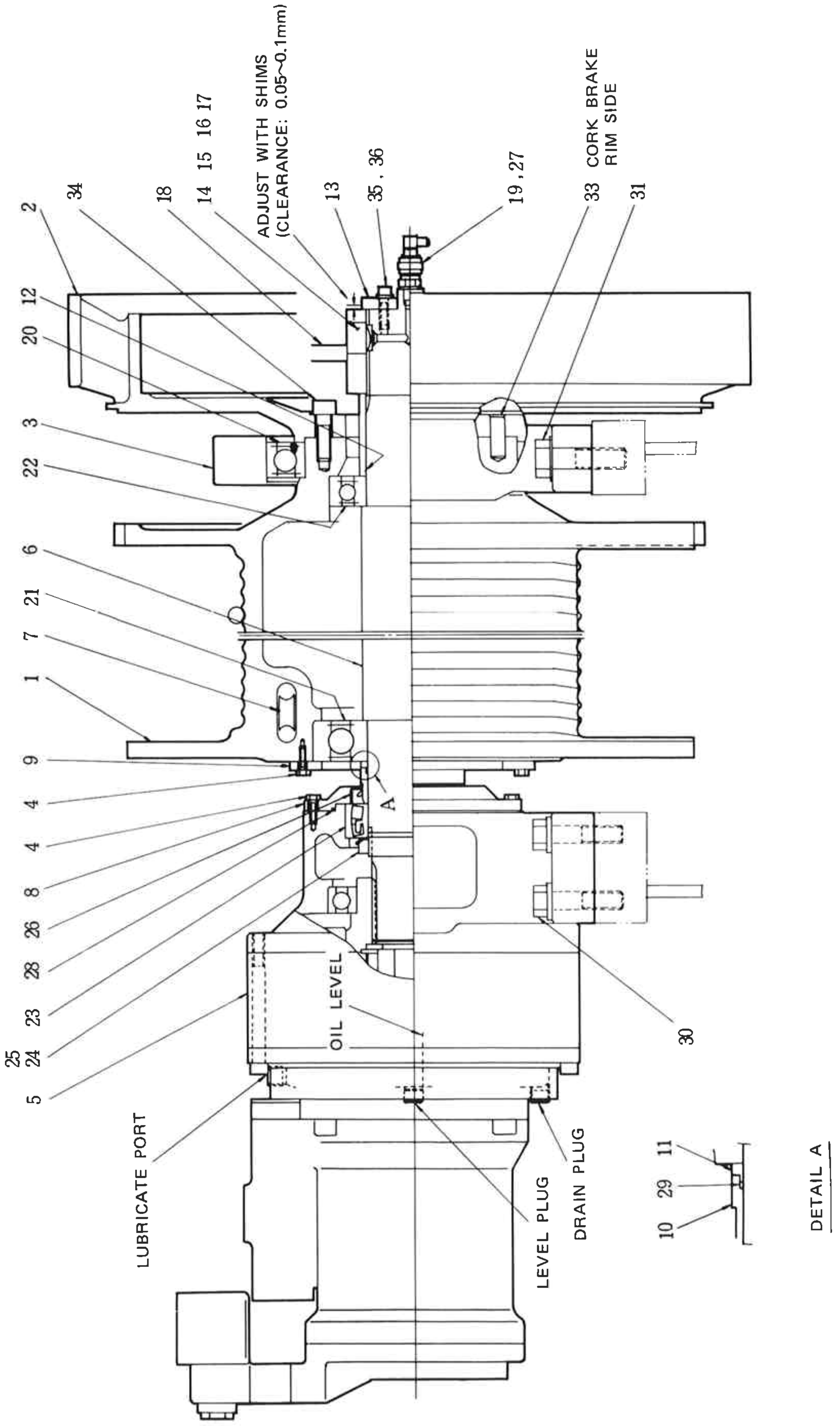


Fig. 3-1 Front and Rear Drum Assembly (1)

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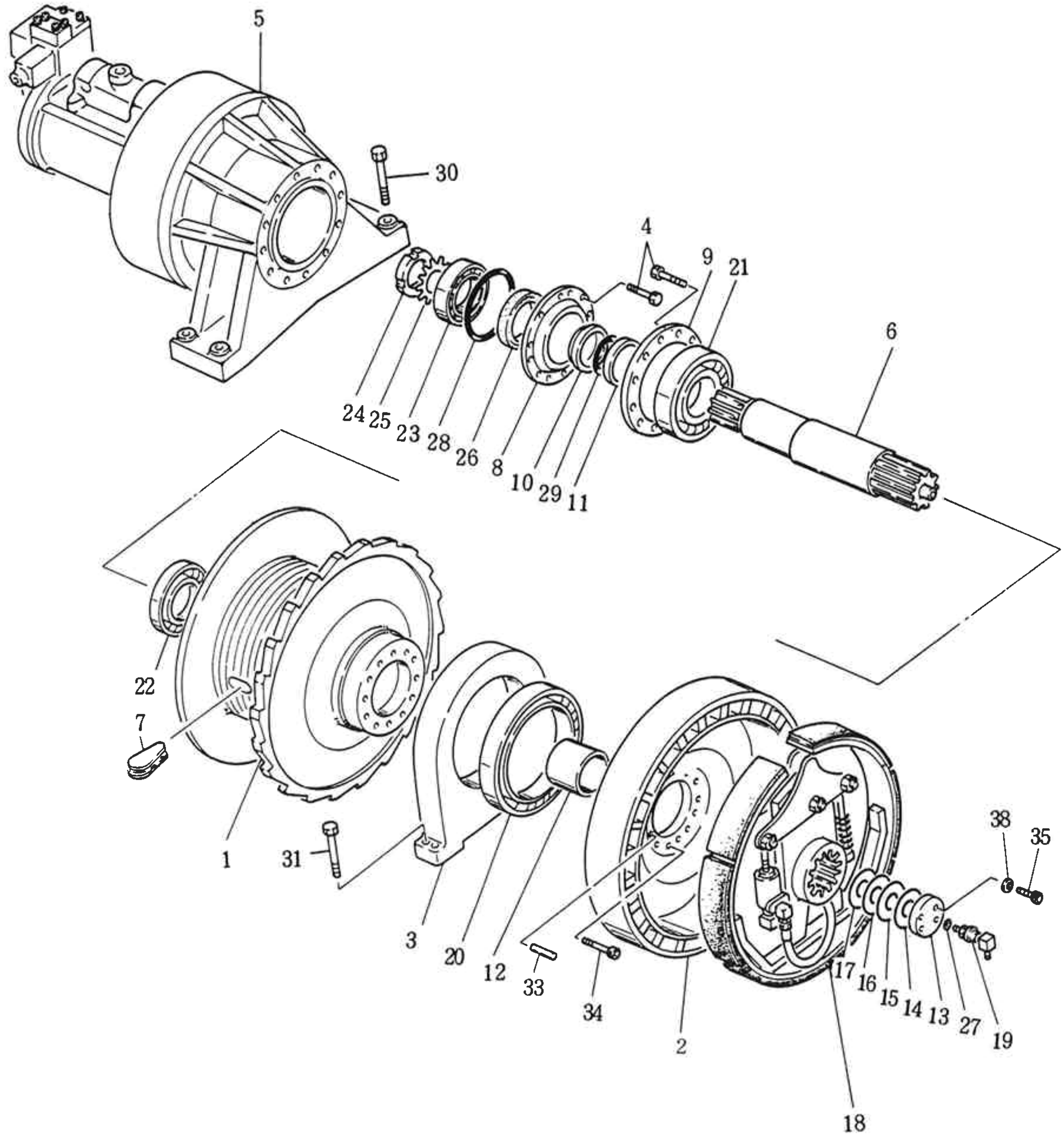
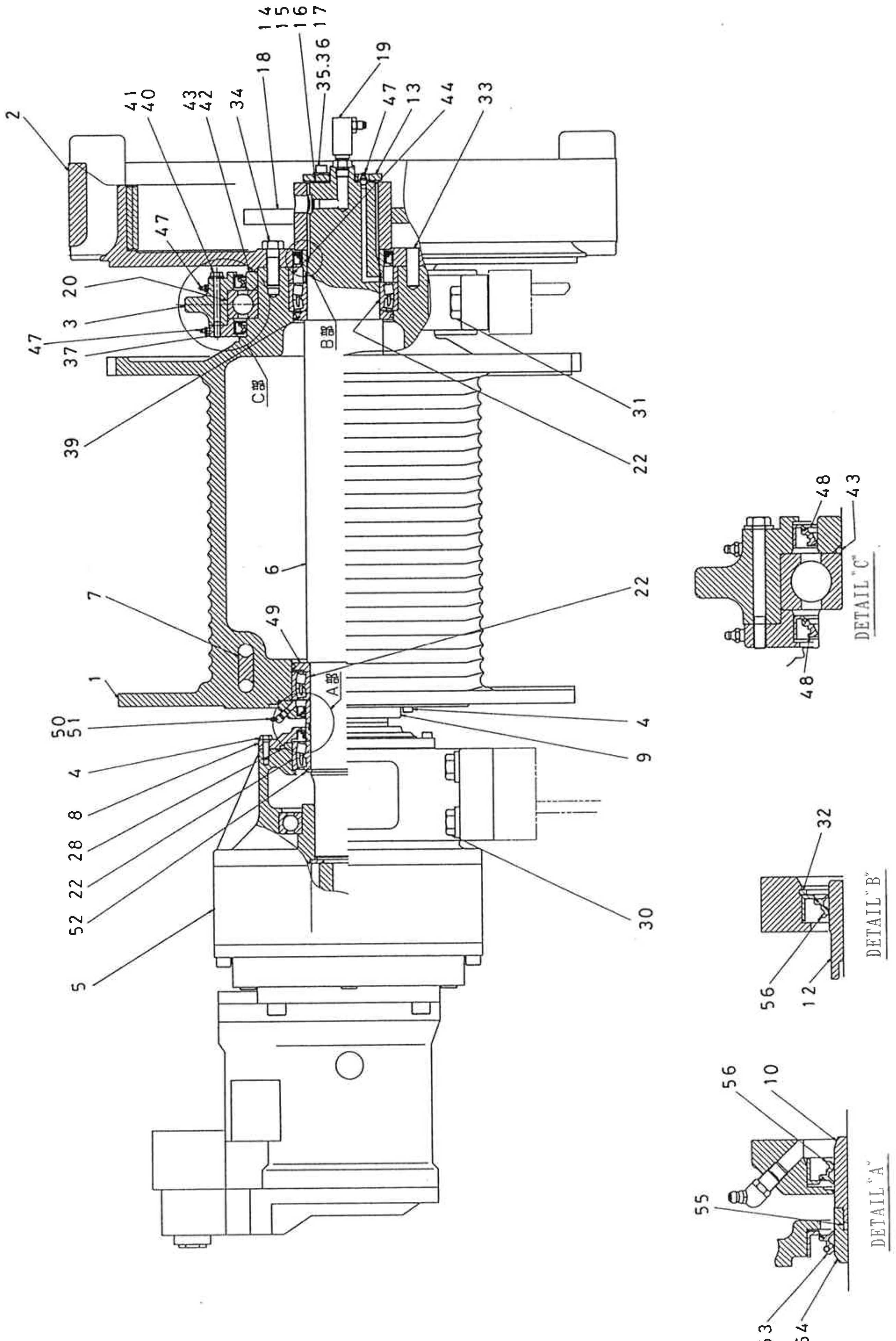
GG−00002～GG−00076)



1. DRUM	13. END PLATE	25. LOCK-WASHER
2. RIM	14. SHIM 0.1	26. OIL SEAL
3. STAND	15. SHIM 0.2	27. PACKING
4. CAPSCREW	16. SHIM 0.5	28. O-RING
5. REDUCER	17. SHIM 1.0	29. O-RING
6. DRUMSHAFT	18. CLUTCH ASSEMBLY	30. CAPSCREW
7. WEDGE	19. SWIVEL JOINT	31. CAPSCREW
8. RETAINER	20. BEARING	33. PIN
9. PLATE	21. BEARING	34. CAPSCREW
10. COLLAR	22. BEARING	35. CAPSCREW
11. SPACER	23. BEARING	38. WASHER
12. SPACER	24. LOCK-NUT	

Fig. 3-2 Front and Rear Drum Assembly (2)

(GB−00002～GB−00297
GG−00002～GG−00076)



(GB−00298～
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1. DRUM
2. BRAKE RIM
3. STAND
4. CAPSCREW
5. REDUCTION UNIT
6. SHAFT
7. WEDGE, ROPE
8. RETANER
9. RETANER, SEAL
10. SLEEVE
12. SLEEVE
13. PLATE, END
14. SHIM, 0.1
15. SHIM, 0.2
16. SHIM, 0.5
17. SHIM, 1.0
18. CLUTCH ASSY
19. SWIVEL JOINT
20. BEARING
22. BEARING
28. O-RING
30. CAPSCREW
31. CAPSCREW
32. RING, RETAINER
33. PIN
34. KAPSCREW
35. KAPSCREW
36. WASHER
37. RETAINER
39. PLATE
40. KAPSCREW
41. WASHER
42. SLEEVE
43. O-RING
44. SPACER
46. CAPSCREW
47. GREASE FITTING
48. SEAL
49. PLATE
50. GREASE FITTING
51. GREASE NIPPLE
52. RING, RETAINER
53. OIL SEAL
54. SLEEVE
55. O-RING
56. OIL SEAL

3.2.5 INSTALLATION

To install the front or rear drumshaft assembly, proceed as follows (See Figure 3 and 4).

1) Place the drumshaft assembly horizontally on a block.
2) Using a lifting device of appropriate capacity, insert reducer (5) onto drumshaft (6).
3) Install retainer (8) on reducer (5) with capscrew (4). Tighten capscrew (4) to 6.0~7.4 kgf·m.
4) Lift the main winch assembly with the lifting device of suitable capacity, and position it on the revolving frame so that the machined faces of the right and left stands contact the steps of the revolving frame, as shown in Fig. 4.
5) Tighten 4 capscrews (30) alternately to 85~105 kgf·m to mount the left stand to the revolving frame.
6) Tighten 2 capscrews (31) alternately to 171~209 kgf·m to mount the right stand to the revolving frame.
7) Fill the reducer with extreme pressure oil #90 to the level plug level.
8) Install swivel joint (19) on shaft (6).
9) Referring to "5. Drum Brakes", install all brake bands on the drum.
10) Connect all hydraulic lines to the main winch assembly.
11) Install the guard, gantry compression member and A frame which were removed for the removal of the drumshaft assembly.

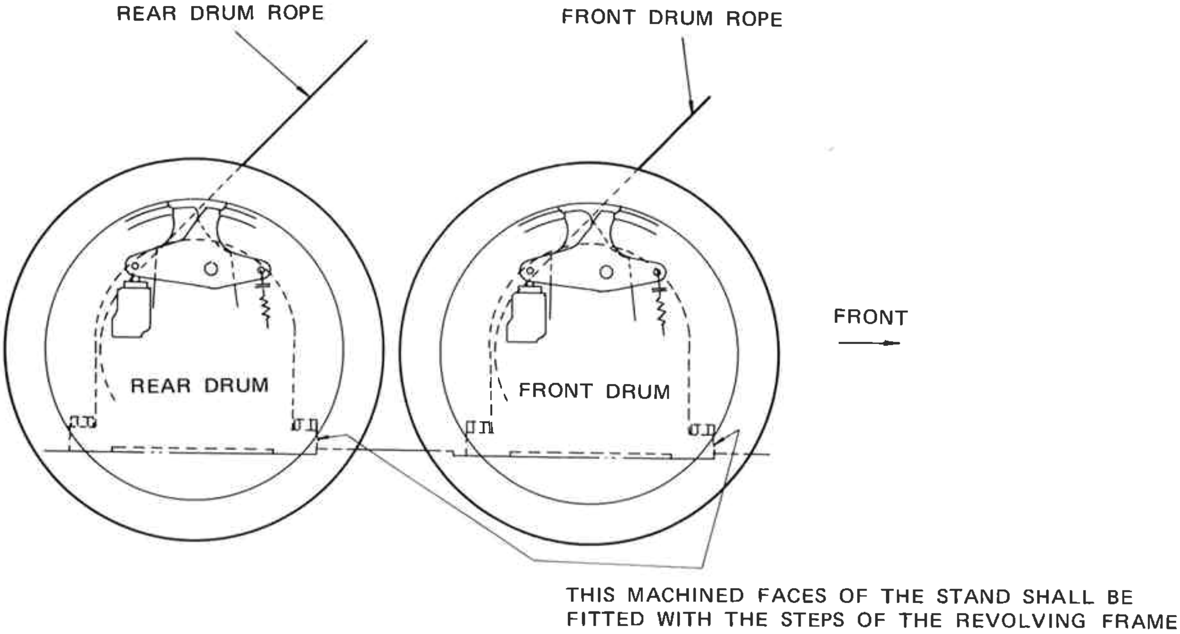


Fig. 4 Installation of the Front and Rear Clutches and Drum Assemblies

3.3 THIRD DRUM SHAFT

3.3.1 REMOVAL

To remove the third drumshaft (option), proceed as follows (See Fig. 5).

1) Remove the guard which must be removed in order to remove the third drumshaft.
2) Remove all hydraulic lines from the third winch assembly; cap the disconnected hydraulic lines and plug the connections.
   Remove all other parts which may interfere with the removal of the third winch assembly.
3) Remove the gantry compression member and A frame.
4) Referring to "5. Drum Brakes" remove all brake bands from the third drum.
5) Remove the swivel joint, which is installed on the right-hand end of the drumshaft.
6) Remove the drain plug from the reducer. After draining all the oil into an appropriate container, screw the drain plug back in.
7) Remove the capscrews (28) holding the right and left stands on to the revolving frame.
8) Using a lifting device of suitable capacity, remove the third winch assembly from the machine, and place it horizontally on a block. The third winch assembly weighs about 870 kgf-m.
9) Remove the capscrew (30) holding the retainer (8) on to the reducer (4).
10) Attach a lifting device of suitable capacity to the reducer with the third drum motor on it, and pull the reducer from drumshaft (5).

3.3.2 DISASSEMBLY

To disassemble the third drumshaft, proceed as follows (See Fig. 5).

1) Remove bearing lock nut (23) and lock washer (24).
2) Pull bearing (20), retainer (8), collar (9), O-ring (26) and spacer (10) from shaft (5).
3) Remove capscrew (29), end plate (12) and shims (13,14,15,16) from shaft (5). Retain shims (13,14, 15,16) as a set.
4) Using a puller, remove bearing (22) from righ stand (2).
5) Remove spacer (11) and clutch assembly (7).
6) Support the drumshaft assembly on a block with the brake rim side of drum (1) facing downwards.
7) Push shaft (5) with a press to pull shaft (5) and bearing (21) from drum (1).
8) Pull bearing (19) from drum (1), and bearing (21) from shaft (5).

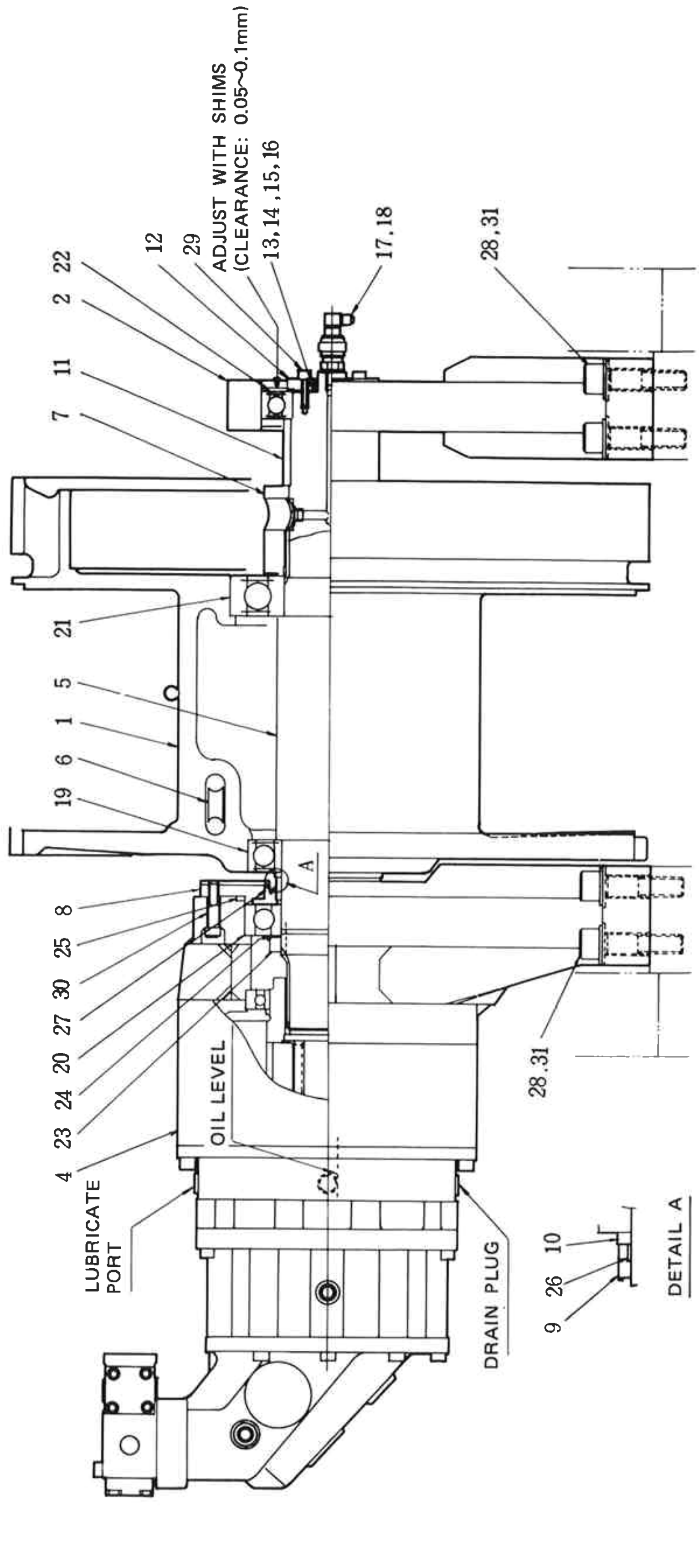
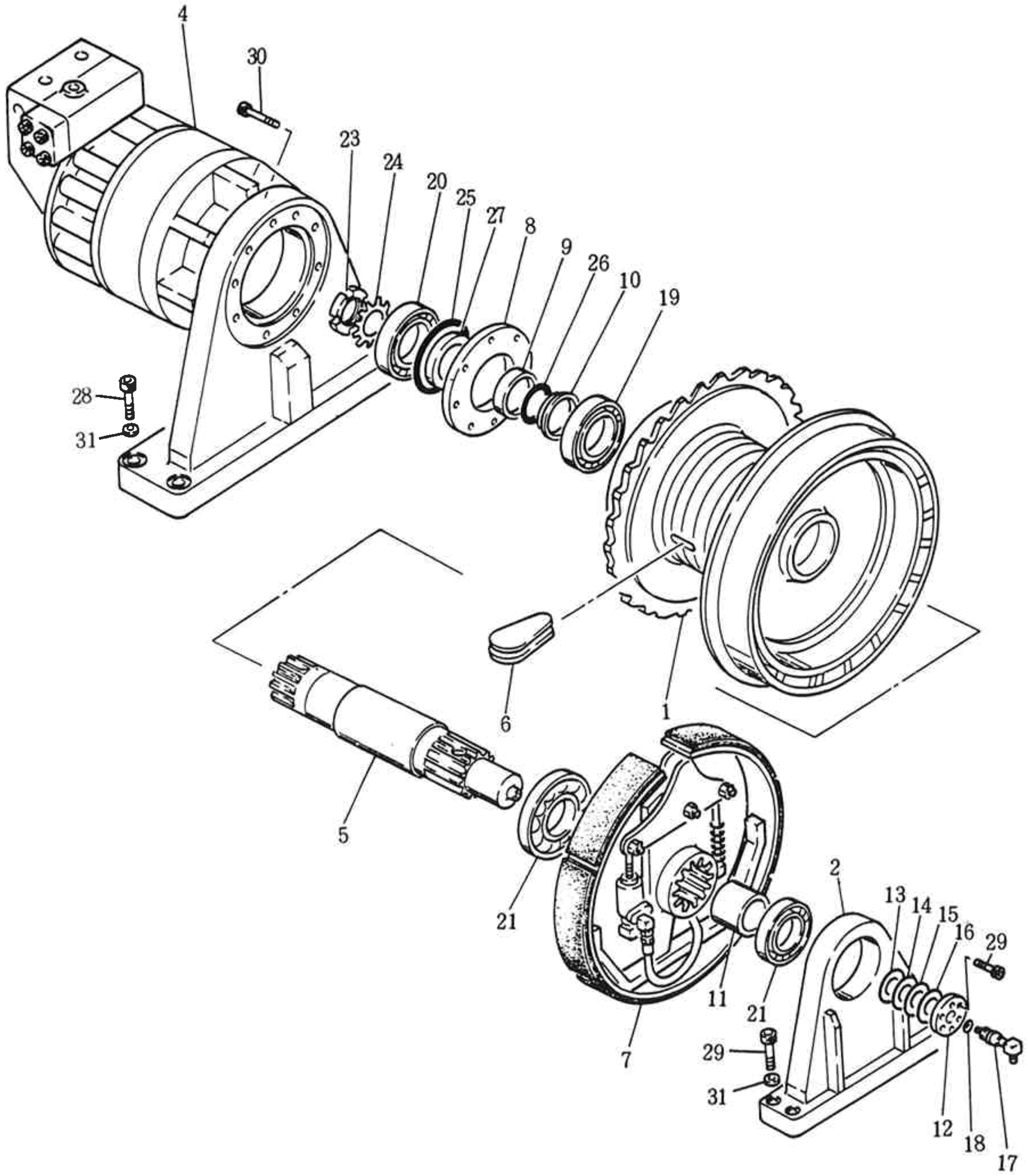


Fig. 5-1 Third Drum Assembly (1)



1. DRUM
2. STAND
4. REDUCER
5. DRUMSHAFT
6. WEDGE
7. CLUTCH ASSEMBLY
8. RETAINER
9. COLLAR
10. SPACER
11. SPACER
12. END PLATE
13. SHIM 0.1
14. SHIM 0.2
15. SHIM 0.5
16. SHIM 1.0
17. SWIVEL JOINT
18. PACKING
19. BEARING
20. BEARING
21. BEARING
22. BEARING
23. NUT
24. WASHER
25. O-RING
26. O-RING
27. OIL SEAL
28. CAPSCREW
29. CAPSCREW
30. CAPSCREW
31. WASHER

Fig. 5-2 Third Drum Assembly (2)

3.3.3 INSPECTION AND REPAIR

Before reassembling the third drumshaft, inspect all parts while observing the following instructions.

1) Replace all O-rings and oil seals with new ones.
2) Wash bearings in pure cleaning solvent. After drying them with compressed air, inspect for flaws and pitting.
   Apply a thin coat of lubricant to bearings, and inspect them for smooth rotation, excessive axial and circumferential clearance and play, signs of rolling slippage on the surfaces onto which the inner and outer races are inserted, etc. Replace faulty ones.
3) Inspect the splined portions of the shaft for cracking, excessive wear and dents. Repair or replace any faulty shaft.
4) Inspect the threads of capscrews and screw holes for burrs and deformations. Repair or replace any faulty part.
5) Inspect the clutch and brake linings. If necessary, replace.
6) Inspect the cooling fins on the drum ratchet and rim for cracks and damage. Replace any faulty parts.
7) Inspect the rim surfaces of the brake and clutch for cracks, scratches and deformation. Replace any faulty parts.

3.3.4 ASSEMBLY

To reassemble the third drumshaft, proceed as follows (Fig. 5).

1) Coat each capscrew with Loctite #242 or equivalent before tightening.
2) Coat the periphery of each oil seal with Loctite #515 or equivalent before assembly.
   Fill grease to about one third of the gap between the seal lip and dust lip of each oil seal.
3) Apply a thin coat of grease to each O-ring and its mating surface.
4) Heat bearing (21) in oil to about 120°C, and insert it until it fully contacts the step of shaft (5).
5) Place drum (1) on a block, its brake rim side facing up. Press shaft (5) into the drum until bearing (21) inserted onto the shaft comes into full contact with the shoulder of the inside diameter of the drum.
6) Reverse the drum, and press bearing (19) into the drum until its inside and outside diameters come into full contact with the step of the shaft and the shoulder of the drum respectively.
7) Insert spacer (10), O-ring (26) and collar (9) onto shaft (5), being careful that O-ring (26) is not damaged by the threaded portion of shaft (5).
8) Insert oil seal (27) into retainer (8). Do not insert the oil seal to its bottom, but leave a gap of 0.2~1.0 mm between retainer (8) and oil seal (27).
9) Apply a thin coat of grease to collar (9) and insert retainer (8) into it.
10) Heat bearing (24) in oil to about 120°C and insert it onto shaft (5).
11) Insert bearing lock washer (24) and tighten bearing lock nut (23).
12) Reverse the drumshaft, and place it on a block, the brake rim side facing up.
13) Install clutch assembly (7) on shaft (5), being careful to align the oil holes in shaft (5) and the clutch spider inside diameter.
14) Install spacer (11) and shaft (5).
15) Heat bearing (22) in oil to about 120°C and insert it onto shaft (5).
16) Press the inside diameter of stand (2) onto bearing (22), being careful that the chamfered face of the inside diameter is on the brake side.
17) Install shims (13,14,15,16) and tighten end plate (12) to the end face of shaft (5) with capscrew (29). The tightening torque should be 6.0~7.4 kgf·m. Adjust the thickness of shims (13,14,15,16) so that the clearance between the end face of bearing (22) and end plate (12) measures 0.05~0.1 mm.

3.3.5 INSTALLATION

To install the third drumshaft, proceed as follows (See Fig. 5 and 6).

1) Place the third drumshaft horizontally on a block.
2) Install O-ring (25) on the end face of the reducer. Using a lifting device of suitable capacity, insert reducer (4) with the third drum motor on it, onto drumshaft (5).
3) Install retainer (8) on reducer (4) with capscrew (30). The tightening torque of capscrew (30) should be 10.5~12.9 kgf·m.
4) Using a lifting device of suitable capacity, position the third winch assembly on the revolving frame so that the rear end faces of the right and left stands contact the machined step of the revolving frame (See Fig. 6).
5) Tighten capscrews (28), 4 each for the right and left stands, alternately to 85~105 kgf·m to secure the right and left stands to the revolving frame.
6) Feed extreme pressure oil #90 to the reducer until the oil appears at the level plug.
7) Install swivel joint (17) on shaft (5).
8) Referring to "5. Drum Brakes" install all the brake bands on the drum.
9) Connect all the hydraulic lines to the third winch assembly.
10) Install the guard, gantry compression member and A frame, which were removed prior to removal of the third drumshaft.

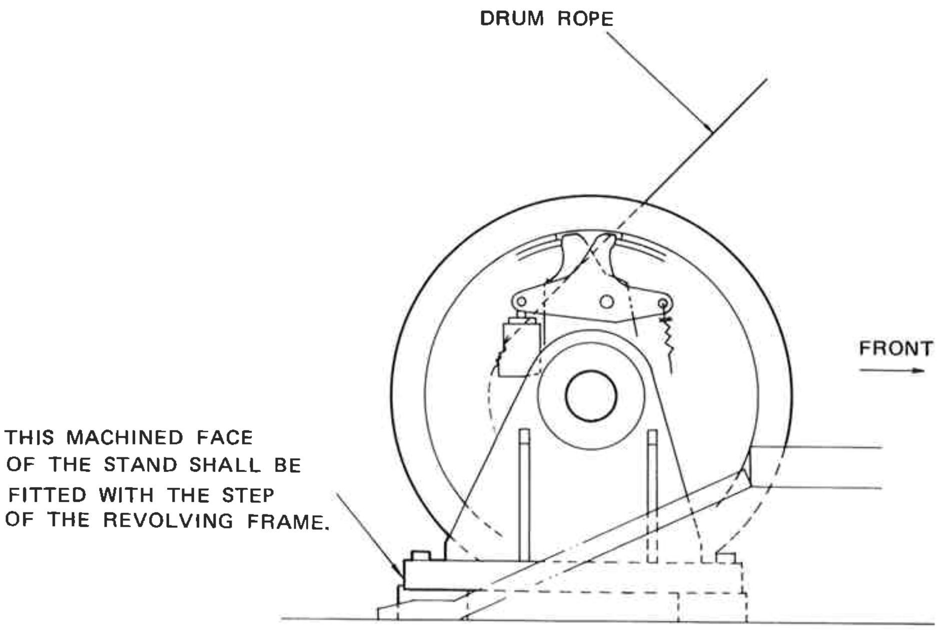


Fig. 6 Installation of the Clutch and Third Drum Assembly

4. REDUCERS

4.1 GENERAL

This section contains information necessary to remove, disassemble, inspect and repair, reassemble, and install the front, rear and third drum reducers.

4.2 FRONT AND REAR DRUM REDUCERS

4.2.1 DESCRIPTION

The front (rear) reducer is installed between the front (rear) drum motor and front (rear) drum shaft, and transmits the rotation of the front (rear) drum motor to the front (rear) drum.

The front (rear) reducer comprises the first and second stages of planetary gear mechanisms. The planetary gear mechanism depends on a sun gear, planetary pinions and an internal gear for speed reduction.

4.2.2 REMOVAL

To remove the front and rear drum reducers, refer to "2. Drum Motors". Each of the front and rear drum reducers weighs about 260 kgf·m.

4.2.3 DISASSEMBLY

To disassemble the front or rear drum reducer, proceed as follows (See Fig. 7).

NOTE

Before disassembly, thoroughly clean the reducer, and make a matchmark on the contact faces of cover, internal gear and stand.

1) Place the reducer, the motor mounting side facing up, and remove cover (3).
2) Remove spacer (19) and 1st-stage sun gear (7).
3) Remove the 1st stage spider (5) assembly.
4) If it is absolutely necessary to disassemble the spider (5) assembly, proceed as follows:
   a) Remove capscrew (18) and lock plate (14).
   b) Using a press, pull out shaft (11).
   c) Remove planetary pinion (9) and thrust washer (24).
   d) Likewise, remove the other two sets of shafts (11), planetary pinions (9) and thrust washers (24).
   e) Remove thrust plate (12).
5) Remove capscrews (16) to remove insternal gear (2).
6) Remove sun gear (6). Using a lifting device of suitable capacity, remove the 2nd stage spider (4) assembly.
7) If it is necessary to disassemble the 2nd stage spider assembly, follow the same procedure mentioned above for the 1st stage spider assembly.
8) Remove bearing (15).

4.2.4 INSPECTION AND REPAIR

Before reassembling the front or rear drum reducer, inspect all parts. Replace all suspicious parts to assure a long service life for the reassembled reducer and also to prevent the occurrence of trouble.

During inspection, observe the following instructions.

1) Clean all parts with pure cleaning solvent and dry them with compressed air.
2) Inspect the bearing balls and inner and outer races for pitting and flaws. If any such abnormality is located; replace the part.
3) Apply a thin coat of lubricant to bearings which are free of pitting and flaws and inspect for axial and circumferential clearance and play. If the clearance or play is excessive, replace the bearing.
4) Inspect the surfaces onto which the inner and outer races of the bearing are inserted. If there are any signs of rolling slippage, replace the bearing.
5) Inspect the tooth faces of pinion and gear for pitting, scoring (scratches), excessive wear, burrs and cracks. Replace any faulty parts.
   If a planetary pinion and shaft are to be replaced, replace all the pinions and shafts.
6) Inspect the splined portion of the shaft for cracks, excessive wear and dents. Repair or replace any faulty parts.
7) Inspect the thrust washer, thrust plate and plate for excessive wear, scratches and seizing. Repair or replace any faulty parts.
8) Inspect housing and cover for cracks, deformation and flaws. Replace any faulty parts.
9) Inspect the threads of capscrews and screw holes for burrs and deformation. Replace any faulty parts.

4.2.5 ASSEMBLY

To assemble the front or rear drum reducer, proceed as follows (See Fig. 7).

1) Coat each capscrew with Loctite #242 before tightening.
2) Apply a thin coat of grease to each O-ring and its

mating surface.

3) Place stand (1) on a block, its drum motor mounting surface facing up.
4) Apply Loctite #515 to the mating surfaces of stand (1) and internal gear (2), and temporarily tighten them together while aligning the matchmarks.
5) If the 2nd stage spider assembly was disassembled, reassemble by the following procedure:
a) Heat bearing (15) in oil to about 100°C, and insert it onto spider (4).
b) Place spider (4) on the press table, and insert spacer (12) into the spider.
c) Apply a thin coat of grease to thrust washer (25) and pinion (8), and insert them into spider (4).
d) Press shaft (10) into place. Check that the notch in lock plate (13) on the shaft is placed at the correct position.
e) Install lock plate (13) on spider (4) with capscrew (17). The tightening torque of the capscrew should be 6.0~7.4 kgf·m.
f) Likewise, press the other two shafts (10).
6) Lift the assembled 2nd stage spider (4) assembly with a lifting device of suitable capacity. Engage the teeth of pinion (8) and internal gear (4), and slowly insert spider (4) into internal gear (4). Insert the 2nd stage sun gear (6) as well.
7) If the 1st stage spider assembly was disassembled, reassemble by the same procedure as mentioned above for the 2nd stage spider assembly.
8) Lift the assembled 1st stage spider (5) assembly with a lifting device of suitable capacity. Engage the teeth of pinion (9) and internal gear (2), and slowly insert the spider (5) assembly into internal gear (2).
9) Engage 1st stage sun gear (7) with three planetary pinions (9), and insert it into them.
10) Apply Loctite #515 to the mating surfaces of internal gear (2) and cover (3), and install cover (3) on internal gear (2) while aligning the matchmarks.
11) Pass capscrew (16) through cover (3) and internal gear (2), and tighten it to stand (1) at 25.5~31.5 kgf·m.
12) Install O-ring (21).
Install spacer (19) on the motor output shaft before installing the drum motor.

4.2.6 INSTALLATION

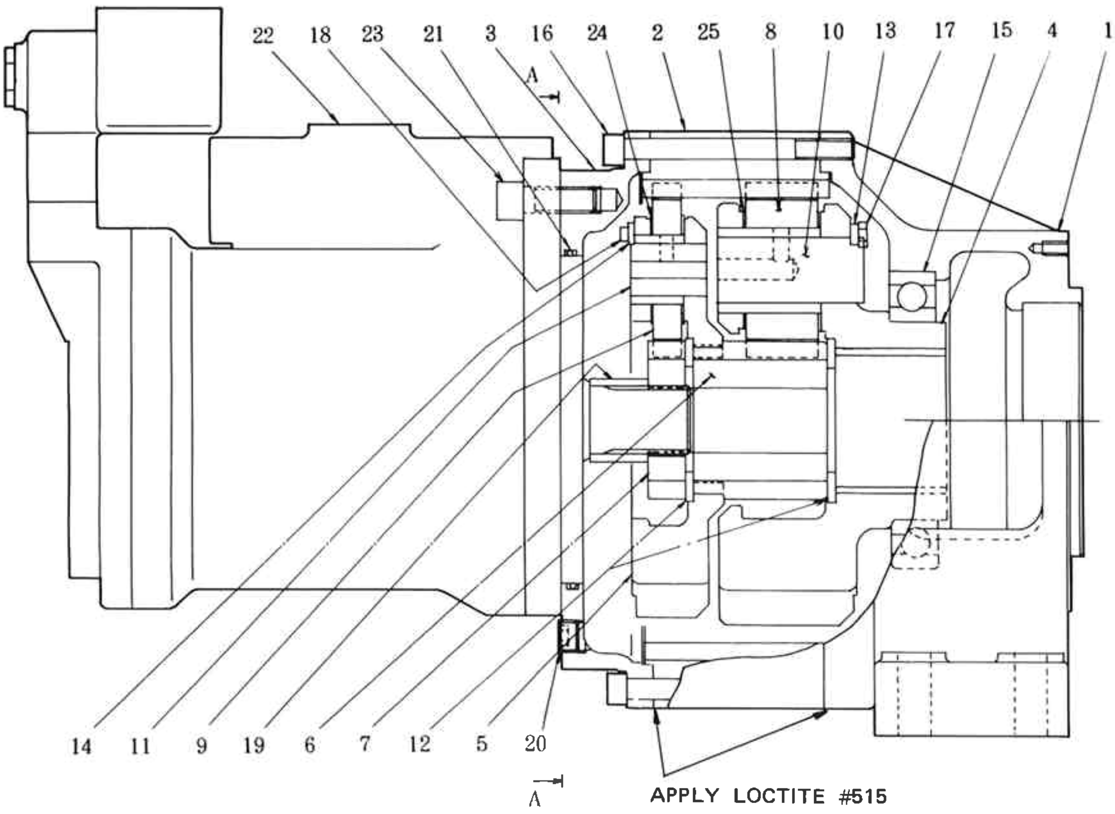
To install the front or rear drum reducer, refer to "2. Drum Motors" and "3. Drumshafts".

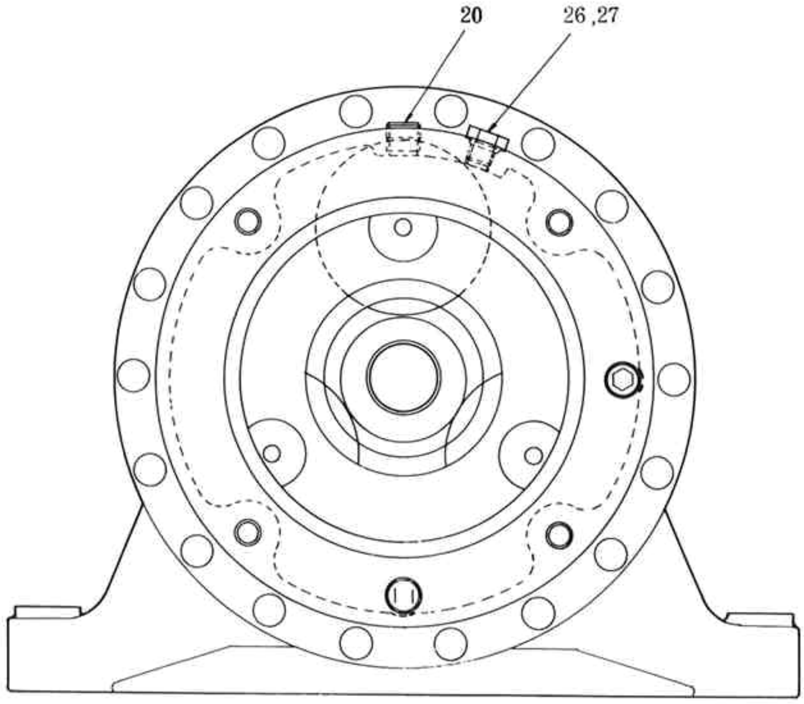
4.3 THIRD DRUM REDUCER

The construction of the third drum reducer (option) is shown in Fig. 8.

The shapes of its parts are slightly different from those of the front and rear drum reducers, but its construction and function are the same.

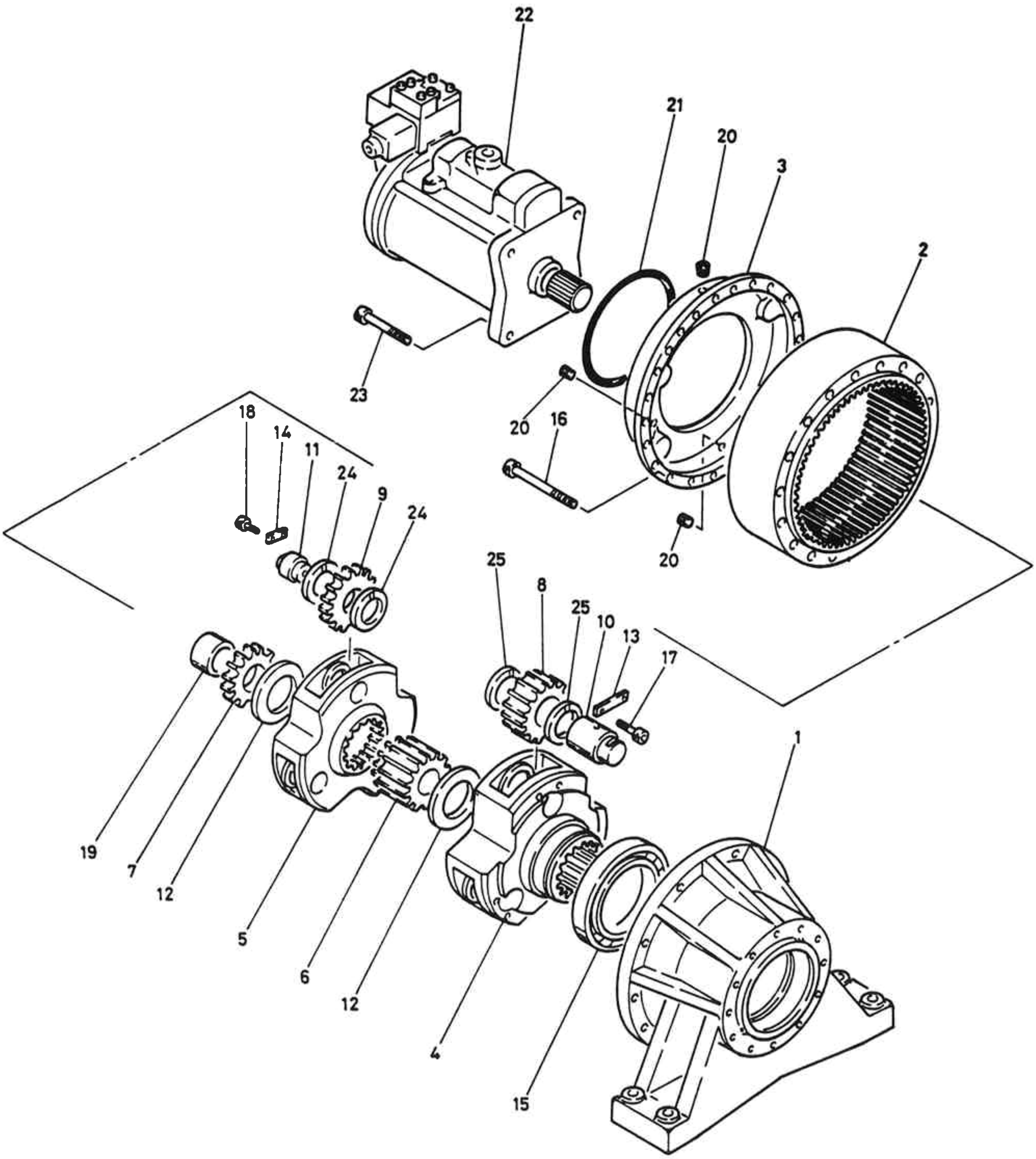
For the removal, disassembly, inspection and repair, assembly, and installation of the third drum reducer, see the sections above for the front and rear drum reducers.
assembly, and installation of the third drum reducer, see the sections above for the front and rear drum reducers.





VIEW A–A

Fig. 7-1 Front and Rear Drum Reducer (1)



1. STAND	11. SHAFT	21. O-RING
2. RING GEAR	12. SPACER	22. MOTOR
3. COVER	13. LOCK PLATE	23. CAPSCREW
4. SPIDER	14. PLATE	24. WASHER
5. SPIDER	15. BEARING	25. THRUST WASHER
6. SUNGEAR	16. CAPSCREW	
7. SUNGEAR	17. CAPSCREW	
8. PINION	18. CAPSCREW	
9. PINION	19. SPACER	
10. SHAFT	20. PLUG	

Fig. 7-2 Front and Rear Drum Reducer (2)

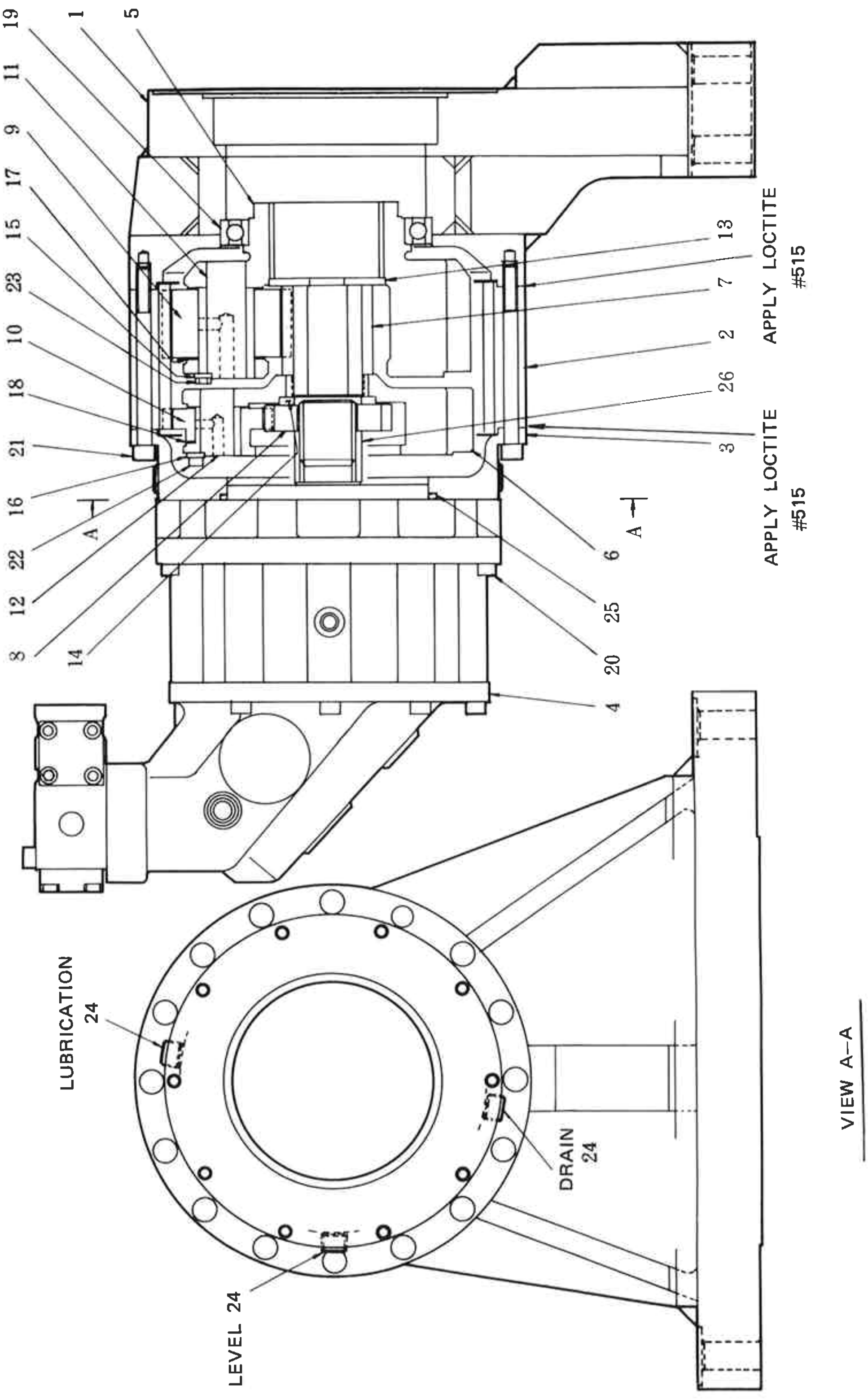
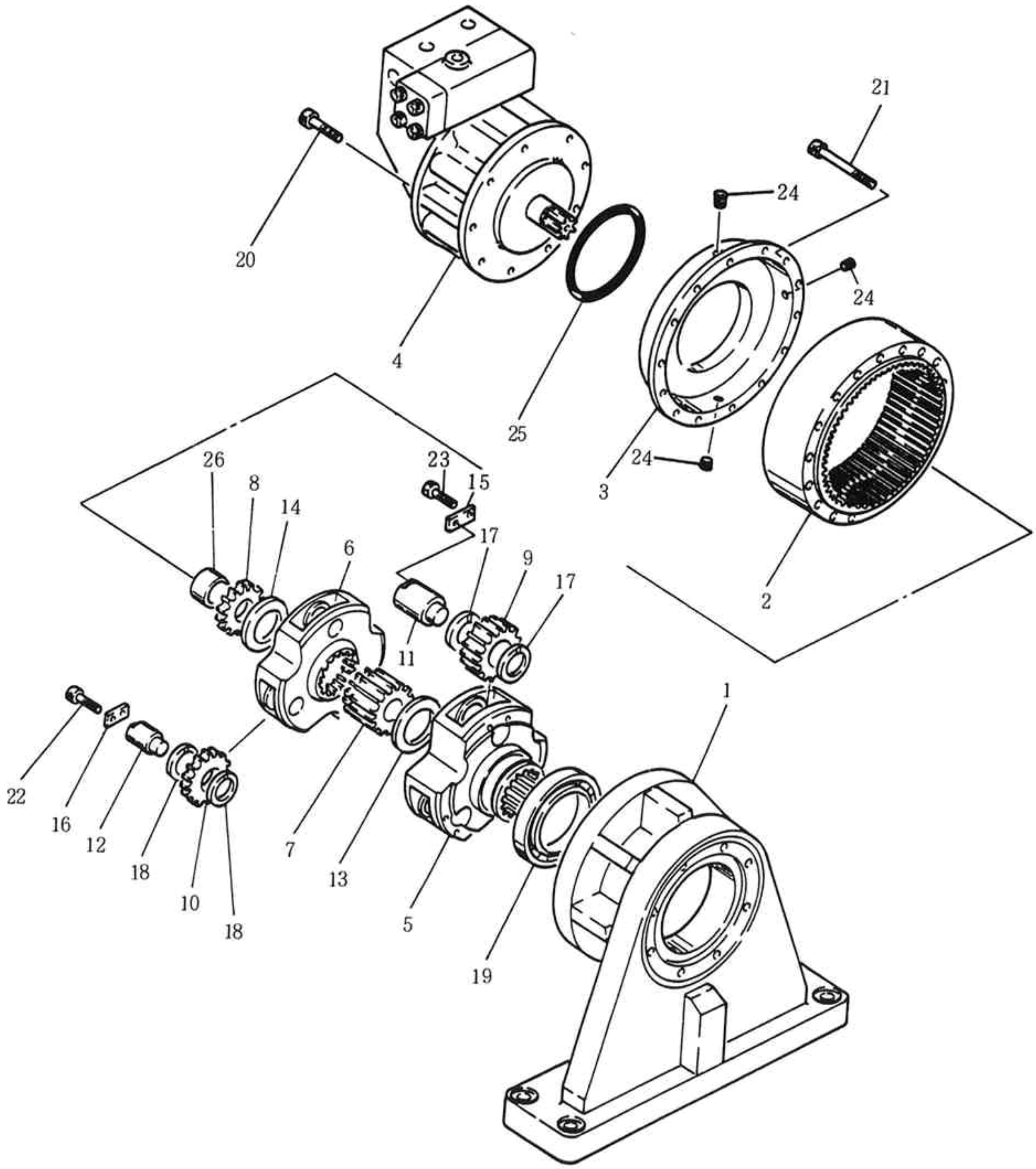


Fig. 8-1 Third Drum Reducer (1)



1. STAND	10. PINION	19. BEARING
2. RING GEAR	11. SHAFT	20. CAPSCREW
3. COVER	12. SHAFT	21. CAPSCREW
4. MOTOR	13. SPACER	22. CAPSCREW
5. SPIDER	14. THRUST WASHER	23. CAPSCREW
6. SPIDER	15. LOCK PLATE	24. PLUG
7. SUN GEAR	16. LOCK PLATE	25. O-RING
8. SUN GEAR	17. THRUST WASHER	26. SPACE
9. PINION	18. THRUST WASHER	

Fig. 8-2 Third Drum Reducer (2)

5. DRUM BRAKES

5.1 GENERAL

This subsection contains the information necessary to remove, repair, install and adjust the drum brakes of the front, rear and third drums.

Several terms are often misunderstood when used in reference to brake bands on this machine. The following definitions, as used in this manual, are as follows:

1) Brake Set. This means the brake band is tightened around a rotating member to stop or prevent the rotation of that member.
2) Live End. This is the end of the brake band to which force is applied.
3) Dead End. This is the anchor end of a brake band. Typically, most lining wear will occur at this end of the band.

5.2 FRONT AND REAR DRUM BRAKES

5.2.1 DESCRIPTION

The front and rear drum brakes control the rotation of the front and rear drums. Each brake band is connected to two hydraulic cylinders, a lock brake (B) and a foot brake (A).

When system pressure is not available or when the drum brake select switch is in the NEUTRAL brake position, and the drum control lever is in the neutral position, the lock brake (B) is set by the lock spring. When the operator moves the brake select switch to the FREE FALL position, hydraulic pressure is applied to the lock cylinder (B), extending the piston and compressing the lock spring. This releases the brake so that the drum must be controlled with the foot brake.

When the operator depresses the foot brake pedal (with the brake select switch in either NEUTRAL brake or FREE FALL), hydraulic pressure is applied to the brake cylinder, extending the piston and setting the brake. When the operator releases the brake pedal, hydraulic pressure is released from the brake cylinder (A), retracting the piston and releasing the brake. A return spring is used to assist in releasing the brake and retracting the piston.

As the brake linings wear, two measurements will increase. With the brake set, the length of the lock spring and the piston extension of the foot brake cylinder will increase. See the Operator's Manual for the method of adjusting the brakes for normal lining wear. The main brakes should be relined when brake lining thickness reaches 6.5 mm (1/4 inch) as measured at the dead end of the band.

5.2.2 REMOVAL

To remove the front and rear drum brake bands, proceed as follows (see Figure 9):

1) Remove the sheet metal from around the brake band to be worked on.
2) With the engine running, lower the attachment (hook block) to the ground and place the control levers and the brake select switches in the NEUTRAL position.
3) Engage all the manual drum pawls.
4) Move the control lever to release the lock brake and loosen brake band adjusting bolt (1-19, 49-19).
5) Return the control lever to neutral and shut down the machine.
6) Release the tension on all hanger springs (47) by loosening jam nuts (48). Remove the springs.
7) Remove the dead end link pin (23) by first removing capscrew (25) and lockwasher (43).
8) Remove capscrews (28) and lockwashers (31) from cylinder bracket (6) and brake band (1).
9) Pull the top end of bracket (6) away from the drum far enough to remove pin (21) from cylinder bracket (6) and brake band (1).
10) Remove lever (3) from brake band (1) by removing capscrew (25), lockwasher (43), and pin (19).
11) Remove brake band adjusting bolts (1-19, 49-19), jam nut (1-12, 49-12), spacers (1-12, 49-12 and 1-13, 49-13), and spring (1-14, 49-14). Brake band (1) can now be removed.
12) Remove pin (22) from lever (2).
13) Remove return spring adjusting nut (35). Remove link (4) together with guide (11), push rod (10) and spring (15).
14) Remove foot brake return spring (16) and eyebolt (12).
15) Remove the hydraulic hose assembly from cylinder (8). Remove capscrews (29,30) and remove cylinder (8).
16) Remove pin (20), and separate lever (2) from lever (3).
17) Disconnect the hydraulic hose from negative cylinder (7).
18) Remove capscrew (25), lock washer (43), pin (17),

and spacers (24,34), and remove cylinder support (5) from lever (3).

19) Remove capscrew (26) and lock washer (27). Compress springs (13,14) by tightening the M24 nut on the threads of push rod (9), and remove hydraulic cylinder (7).

20) Remove capscrew (25), lock washer (27) and pin (18), and remove lever (2), push rod (9) and springs (14,13).

5.2.3 INSPECTION AND REPAIR

Before reinstalling the band halves on the drum, inspect the following items:

1) Check all the springs for sufficient compression. Replace any weak springs.
2) Inspect all pins, bushings and operating rods for wear. Replace any worn parts. Also check that operating rods are not bent.
3) If the cylinders leak or have been performing erratically, remove and overhaul if necessary.
4) Check the brake bands for distortion.
5) Inspect the brake drum surfaces for cracks, scoring or other damage. If necessary, replace the drum.

5.2.4 INSTALLATION

After relining the brake bands, install the band halves as follows (see Figure 9):

1) Before screw in capscrews and bolts, apply Loctite #242 or equivalent on the threads.
2) Insert springs (13,14) onto push rod (9).
3) Install lever (2) and push rod (9) on support (5), and insert pin (18) into support (5). Pay particular attention to the direction in which to install push rod (9).
   Install lock washer (43) and tighten capscrew (25) to 2.2~2.6 kgf·m (unlubricated).
4) Compress springs (13,14) by tightening M24 nut on the threads of push rod (9), and install hydraulic cylinder (7) on support (5) with lock washer (27) and capscrew (26). The tightening torque for capscrew (26) should be 19~23 kgf·m.
   Apply extreme pressure grease to the faces of push rod (9) coming into contact with hydraulic cylinder (7) and spring (14).
   Pay special attention to the direction in which to install hydraulic cylinder (7).
5) Install support (5), lever (3) and spacers (24,23), and insert pin (17).
   Install lock washer (43) and tighten capscrew (25) to 2.2~2.6 kgf·m (unlubricated).
6) Connect lever (2) and lever (3) together with pin (20), lock washer (43) and capscrew (25).
7) Install hydraulic cylinder (8) on bracket (6) with lock washers (32,33) and capscrews (29,30). The tightening torque should be as follows:
   Capscrew (29) 1.28~1.56 kgf·m (unlubricated)
   Capscrew (30) 3.8 ~4.6 kgf·m (unlubricated)
8) Install guide (11) in the center hole of link (4), and install spring (15) and push rod (10) on link (4). Apply extreme pressure grease to the faces of push rod (10) coming into contact with spring (15) and hydraulic cylinder (8).
9) Install bracket (6) on link (4) with eyebolt (12) and spring (16).
10) Install brake bands (1,49) on the drums, and install brake band adjusting bolts (1-19,49-19), springs (1-14,49-14), spacers (1-12, 49-12,1-13,49-13), nuts (1-17,49-17). Do not tighten the adjusting bolts securely here.
11) Pull bracket (6) slightly from link (4), and connect bracket (6) to the live ends of brake bands (1,49) with pin (21).
12) Connect the dead ends of brake bands (1,49) to link (4) with spacer (44), lock washer (43) and capscrew (25).
13) Install bracket (5) on brake bands (1,49) with lock washer (31) and capscrew (28).
14) Insert pin (22) into aligned pin holes of lever (2), link (4) and bracket (6), and secure pin (22) with lock washer (43) and capscrew (25). The tightening torque for capscrew (25) should be 2.2~2.6 kgf·m.
15) Connect lever (3) and brake bands (1,49) together using pin (19), lock washer (43) and capscrew (25).
16) Install hanger springs (47), studs (45), trunnions (46), and jam nuts (48).
17) Bleed the hydraulic cylinders to remove any air trapped in the hydraulic lines.

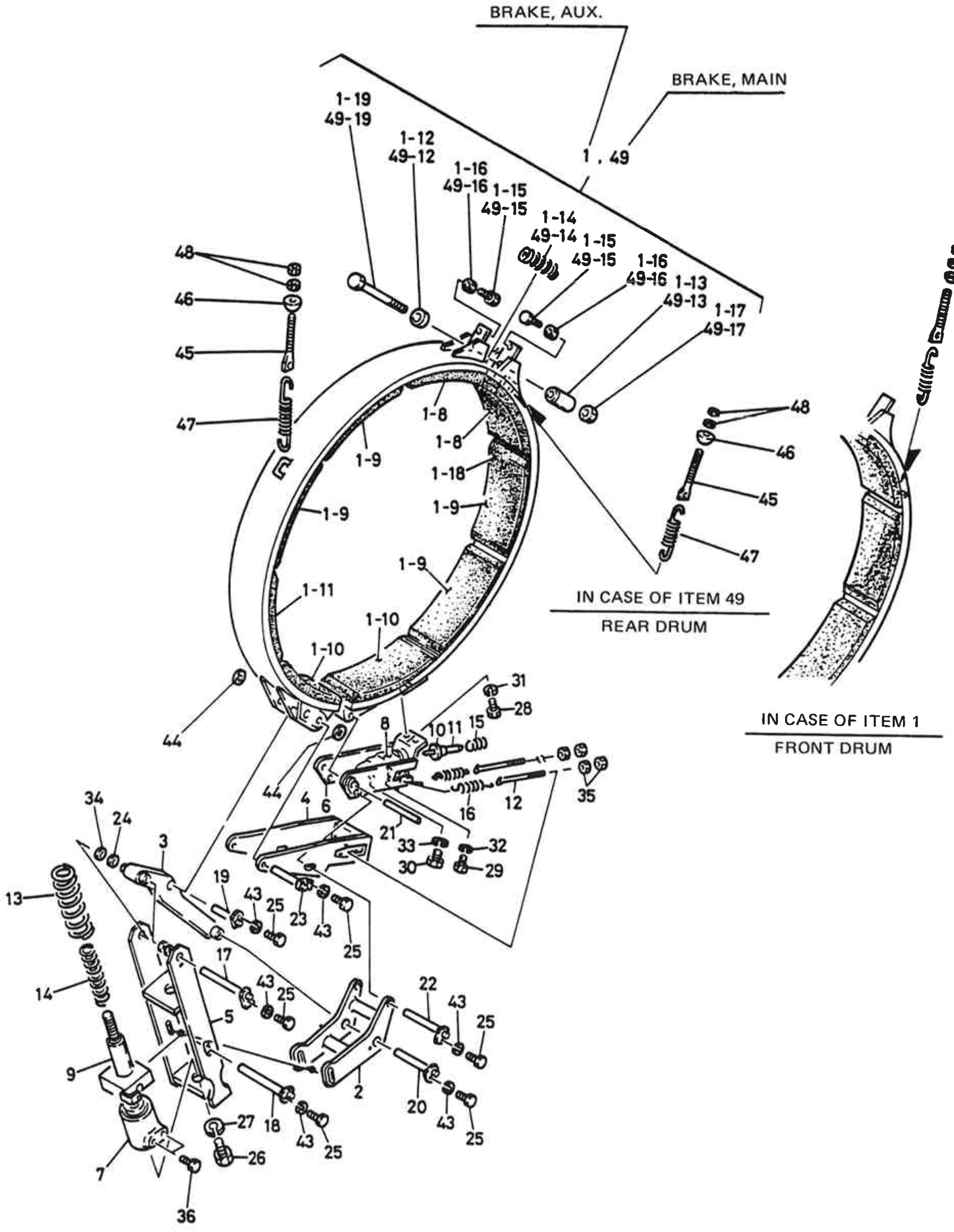


Fig. 9 Main (Front and Rear) Drum Brake

1.	BRAKE BAND ASSEMBLY	13.	SPRING	43.	LOCKWASHER
1-8.	LINING	14.	SPRING	44.	SPACER
1-9.	LINING	15.	SPRING	45.	STUD
1-10.	LINING	16.	SPRING	46.	TRUNNION
1-11.	LINING	17.	PIN	47.	SPRING
1-12.	SPACER	18.	PIN	48.	NUT
1-13.	SPACER	19.	PIN	49.	BRAKE BAND ASSEMBLY
1-14.	SPRING	20.	PIN	49-8.	LINING
1-15.	CAPSCREW	21.	PIN	49-9.	LINING
1-16.	NUT	22.	PIN	49-10.	LINING
1-17.	NUT	23.	PIN	49-11.	LINING
1-18.	RIVET	24.	SPACER	49-12.	SPACER
1-19.	BOLT	25.	CAPSCREW	49-13.	SPACER
2.	LEVER	26.	CAPSCREW	49-14.	SPRING
3.	LEVER	27.	CAPSCREW	49-15.	CAPSCREW
4.	LINK	28.	CAPSCREW	49-16.	NUT
5.	SUPPORT	29.	CAPSCREW	49-17.	NUT
6.	BRACKET	30.	CAPSCREW	49-18.	RIVET
7.	CYLINDER	31.	LOCKWASHER	49-19.	BOLT
8.	CYLINDER	32.	LOCKWASHER		
9.	PUSH ROD	33.	LOCKWASHER		
10.	PUSH ROD	34.	SPACER		
11.	GUIDE	35.	NUT		
12.	EYE BOLT	36.	PLUG		

5.2.5 ADJUSTMENT

To adjust the front or rear drum brake, proceed as follows (See Fig. 10).

1) With the hydraulic pressure in the hydraulic cylinder of the lock brake released, tighten the nut on the brake band adjusting bolt so that the length of springs (1,2) measure 148.5 mm each. The protruding length of the piston of cylinder (B) should be about 24.5 mm.
2) With the hydraulic pressure in hydraulic cylinder (A) of the foot brake released, adjust the length of spring (3) to 95 mm by means of nut (4).
3) Release the hydraulic pressure in hydraulic cylinder (B) of lock brake, and with the lock brake ON, bring the heads of bolts (5) at the brake band connection spot into slight contact, and tighten them a quarter of a turn each, and lock the lock nuts. Dimension D at the brake band connection spot should be about 68 mm (reference value) for a new machine.
4) Pressurize hydraulic cylinder (B), and with the brake band released, adjust the lengths of hanger spring stud (6) and lock brake link support spring (7) so that the clearance from the brake band becomes even and about 0.8 mm all through its circumference.
5) Operate the lock brake and foot brake and repeat the above steps until the brake operate properly.

NOTE

The first steps of this adjustment are intended to set up the brake operating mechanism. The next steps are physical tests to check the load handling capabilities of the brake.

WARNING

The final criterion for correct brake adjustment is safe load handling. Do not put the machine back into service until the brakes have been tested as described below. Failure to properly test the brakes could cause a load to drop causing serious injury or death.

6) Set the brake select switch in the NEUTRAL brake position, and disengage the drum lock pawl.
7) Lift a capacity load an inch or two off the ground, and apply the foot brake.
8) Release the foot brake pedal. The brake lock cylinder must hold the drum without drifting.
9) Reapply the foot brake.
10) Move the brake select switch to the FREE FALL position. The foot brake cylinder must hold the drum without drifting.
11) Lower the load to the ground.
12) If the load drifts during these tests, release the brakes and recheck thc brake adjusting procedures as necessary to achieve proper load handling.

NOTE

Do not tighten the brake band to the point where an empty hook block cannot be lowered.

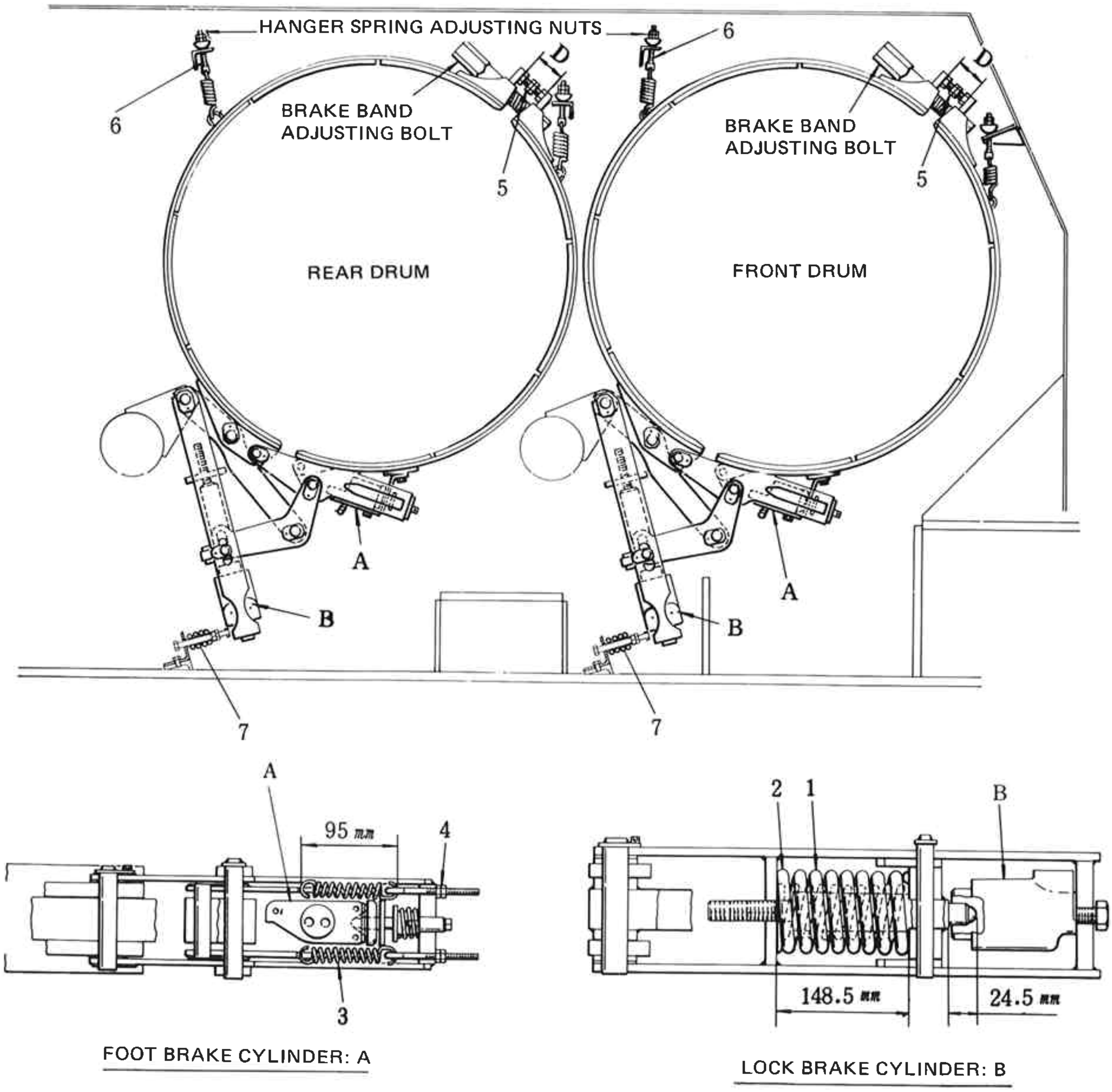


Fig. 10 Main (Front and Rear) Drum Brake Adjustment

5.3 THIRD DRUM BRAKE

5.3.1 DESCRIPTION

The third drum brakes control the rotation of the third drum. The brake band is connected to two hydraulic cylinders, a lock brake (A) and a foot brake (B) (see Figure 12).

When system pressure is not available or when the control lever is in the neutral position and drum brake switch is turned in "Neutral Brake" position, the lock brake is set by the lock spring.

When the operator places the drum brake select switch in FREE FALL, hydraulic pressure is applied to the hydraulic cylinder (B) of the lock brake, compressing the lock spring and releasing the lock brake. The drum must then be controlled by foot brake (B).

When the operator depresses the foot brake pedal, hydraulic pressure is applied to the brake cylinder (B), extending the piston and setting the brake. When the operator releases the brake pedal, hydraulic pressure is released from the brake cylinder, retracting the piston and releasing the brake. A return spring is used to assist in releasing the brake and retracting the piston.

As the brake linings wear, two measurements will increase. With the brakes set, the length of the lock spring will increase and the length of the piston extension of the foot brake cylinder will increase. See the Operator's Manual for the method of adjusting the brakes for normal lining wear.

The drum brakes should be relined when brake lining thickness reaches 6.5 mm (1/4 inch) as measured at the dead end of the band.

5.3.2 REMOVAL

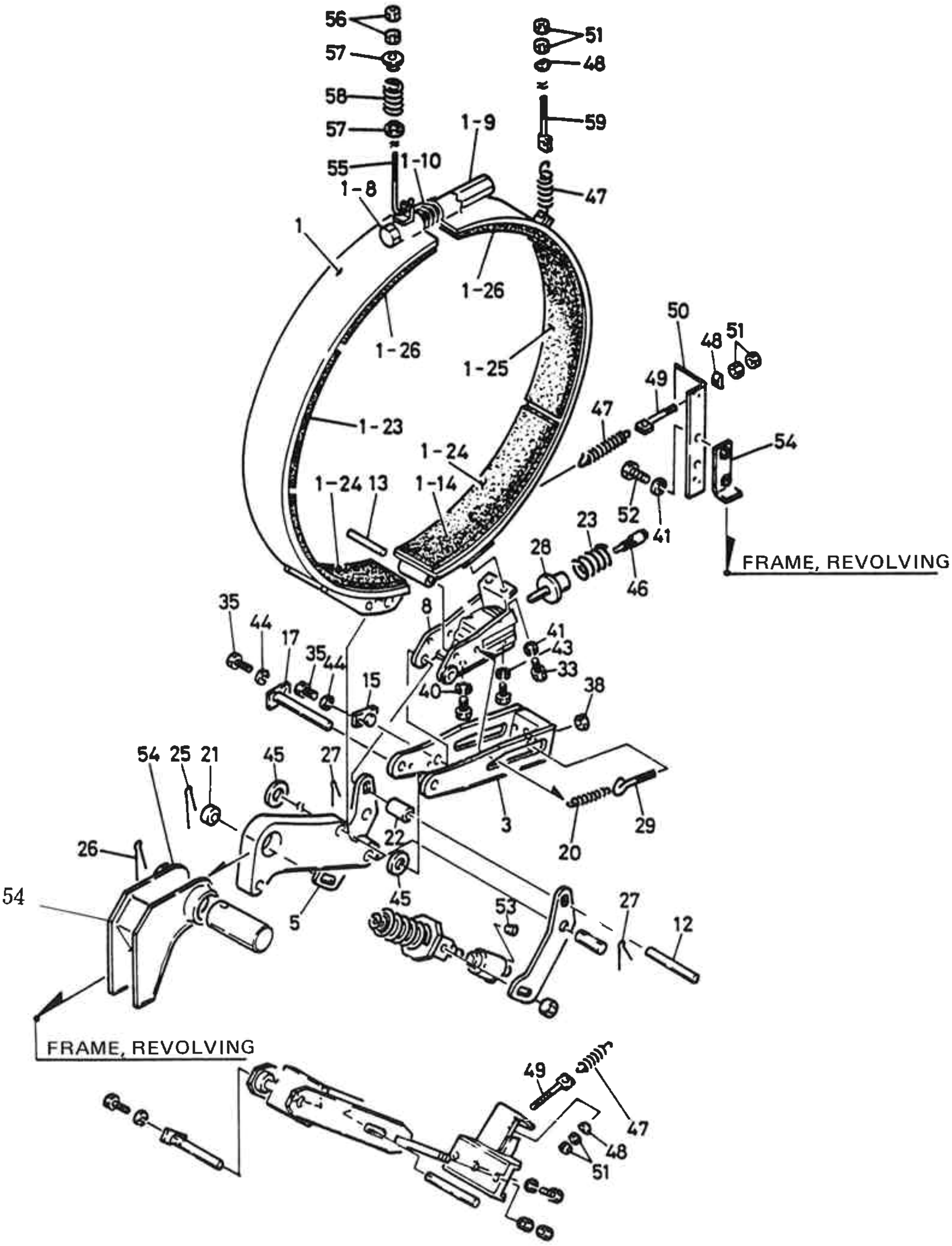
To remove the third drum brake band, proceed as follows (See Fig. 11).

1) Remove the guards around the brake band which must be removed in order to remove the brake bands.
2) Start the engine and lower the attachment to the ground. Place the control lever and brake select switch in the neutral position.
3) Engage the drum lock to prevent rotation of the drum.
4) Operate the control lever to release the lock brake, and remove brake band adjusting bolt (1-8).
5) Remove hanger spring nuts (51,56), and remove all hanger springs (47,58).
6) Remove capscrew (35), lock washer (44) and washer (45) first, then dead end link pin (17).
7) Remove capscrew (33) and lock washer (41) from cylinder bracket (8) and brake band (1).
8) Pull link (3), and pull out pin (13) from cylinder bracket (8) and brake band (1).
9) Remove brake band adjusting bolt (1-8), nut (1-9) and spring (1-10), and remove brake band assembly (1).
10) Disconnect hydraulic hoses from hydraulic cylinders (6,7).
11) Remove return spring adjusting nut (38), and remove eyebolt (29) and foot brake return spring (20) from link (3) and bracket (8).
12) Remove capscrew (35), lock washer (44) and pin (15) from link (3). Pull out pin (15), and remove lever (5) and pipe spacer (22).
13) Pull bracket (8) from link (3), and remove guide (46), push rod (28) and spring (23) from link (3).
14) Remove capscrews (30,31) and lock washers (40,43), and remove cylinder (7).
15) Remove pin (11), and separate link (4) and lever (5).
16) Pull out cotter pin (26) and pin (16), and remove link (4) from bracket mounting (54).
17) Remove capscrew (34), lock washer (42) and pin (14), and remove side plate (2) from link (4).
18) Remove nuts (36,37) from side plate (2), and remove hydraulic cylinder (6) and bracket (24) from push rod (9).
19) Remove capscrew (32) and lock washer (39), and remove hydraulic cylinder (6) from bracket (24).
20) Pull out cotter pin (25) from spacer (21). Remove pin (10) slowly, and remove spacer (21), one lever (5), push rod (9), the other lever (5) and spacer (21).
21) Pull springs (18,19) from push rod (9).

5.3.3 INSPECTION AND REPAIR

Before reinstalling the band halves on the drum, inspect the following items:

1) Check all the springs for sufficient compression. Replace any weak springs.
2) Inspect all pins, and bushings for wear. Replace any worn parts.
3) If the cylinders leak or have been performing erratically, remove and overhaul if necessary.
4) Check the brake bands for distortion.
5) Inspect the brake drum surfaces for cracks, scoring or other damage. If necessary, replace the drum.



1. BRAKE BAND ASSEMBLY
1-8. ADJUST BOLT
1-9. NUT
1-10. SPRING
1-14. RIVET
1-23. LINING
1-24. LINING
1-25. LINING
1-26. LINING
2. SIDE PLATE
3. LINK
4. LINK
5. LINK
6. CYLINDER
7. CYLINDER
8. BRACKET
9. PUSH ROD
10. PIN
11. PIN
12. PIN
13. PIN
14. PIN
15. PIN
16. PIN
17. PIN
18. SPRING
19. SPRING
20. SPRING
21. SPACER
22. SPACER
23. SPRING
24. BRACKET
25. COTTER PIN
26. COTTER PIN
27. COTTER PIN
28. PUSH ROD
29. EYE BOLT
30. CAPSCREW
31. CAPSCREW
32. CAPSCREW
33. CAPSCREW
34. CAPSCREW
35. CAPSCREW
36. NUT
37. NUT
38. NUT
39. LOCK WASHER
40. WASHER
41. LOCKWASHER
42. LOCKWASHER
43. LOCKWASHER
44. LOCKWASHER
45. WASHER
46. WASHER
46. GUIDE
47. SPRING
48. TRUNNION
49. STUD
50. BRACKET
51. NUT
52. CAPSCREW
53. PLUG
54. BRACKET
55. EYE BOLT
56. NUT
57. SPRING GUIDE
58. SPRING
59. STUD

Fig. 11 Third Drum Brake

5.3.4 INSTALLATION

After relining the brake bands, install the band halves as follows (see Figure 11):

1) Coat each capscrew and bolt with Loctite #242 or equivalent before tightening.
2) At reassembly, apply extreme pressure grease to the push rod of each cylinder and all spring guides.
3) Insert springs (18,19) onto push rod (9).
4) Install push rod (9), lever (5) and spacer (21) on side plate (2), and insert pin (10). Install cotter pin (25) on pin (10).
5) Install hydraulic cylinder (6) on bracket (24) with capscrew (32) and lock washer (39). The tightening torque for capscrew (32) should be 19~23 kgf·m (lubricated).
6) Insert bracket (24) into side plate (2) and tighten it with nuts (36,37).
7) Install link (4) on side plate (2) with pin (14), capscrew (34) and lock washer (42).
8) Install link (4) on bracket (54) with pin (16) and cotter pin (26).
9) Install pin (11) and cotter pin (27), and connect link (4) and lever (5) together.
10) Install cylinder (7) on cylinder bracket (8) with capscrews (30,31) and lock washers (40,43). Coat capscrews (30,31) with Loctite #242 or equivalent, and tighten them to the following torque:
    Capscrew (30) 1.28~1.56 kgf·m (lubricated)
    Capscrew (31) 3.8 ~4.6 kgf·m (lubricated)
11) Install guide (46), push rod (28), spring (23), eyebolt (29) and nut (38) on link (3). Coat the threads of guide (46) with Loctite #271 or Three Bond #1324.
12) Insert link (3) into bracket (8); assemble link (3), bracket (8), lever (5) and pipe spacer (22), then insert pin (12) into this assembly.
13) Install pin (15), capscrew (35) and lock washer (44) on link (3).
14) Install return spring (20) on eyebolt (29) and bracket (8).
15) Connect hydraulic hoses to hydraulic cylinders (6,7).
16) Place brake band assembly (1) on the drum, and temporarily tighten brake band adjusting bolt (1-8), nut (1-9) and spring (1-10).
17) Pull cylinder bracket slightly from link (3), and connect cylinder bracket (8) and live end of the brake band assembly together by pin (13).
18) Install pin (17), washer (45), capscrew (35) and lock washer (45), and connect links (3,4) to the dead ends of brake band assembly (1).
19) Install cylinder bracket (8) on brake band assembly (1) with capscrew (33) and lock washer (41).
20) Install hanger springs (47,48) on 4 spots.
21) Bleed the hydraulic cylinders to remove any air trapped in the hydraulic lines.
22) Install the guards around the brake band which were removed for the removal of the brake band.

5.3.5 ADJUSTMENT

To adjust the third drum brakes when the bands have been removed or the brake operating mechanism has been disturbed, proceed as follows (see Figure 12):

NOTE

The adjustment procedure given below is made with the spring set brake in the set position (hydraulic pressure released from the cylinders).

1) With the hydraulic pressure in hydraulic cylinder (A) of the lock brake released, adjust nut with code (4) so that the dimension shown in section A-A measures 452.5 mm.
2) Adjust the brake band adjusting nut so that the length of springs with code (1,2) measures 130.5 mm. The protruding length of the piston of cylinder (A) should be about 19.5 mm.
3) With the foot brake released, measure the length of the return spring (3) on the foot brake cylinder. The length of the spring should be 105 mm (4-1/8 inch). Adjustments can be made with the spring adjusting nuts (5).
4) After the brakes have been properly adjusted, release the brakes and check the alignment of the hanger springs and brake band guides. The linings should surround the drum uniformly 0.8 mm (1/32 inch).
5) Repeat the above steps until the brake is set up as explained.

NOTE

The first steps of this adjustment are intended to set up the brake operating mechanism. The next steps are physical tests to check the load handling capabilities of the brake.

WARNING

The final criterion for correct brake adjustment is safe load handling. Do not put the machine back into service until the brakes have been tested as described below. Failure to properly test the brakes could cause a load to drop causing serious injury or death.

6) Turn the drum brake switch to "Neutral Brake", and disengage the drum lock pawl.
7) Lift a capacity load 25~50 mm (an inch or two) off the ground, and apply the foot brake.
8) Release the foot brake pedal. The lock brake spring must hold the drum without drifting.
9) Reapply the foot brake and push the control lever forward. The foot brake cylinder must hold the drum without drifting.
10) Turn the drum brake switch to "Free Fall". The foot brake cylinder must hold the drum without drifting.
11) Lower the load to the ground.
12) If the load drifts during these tests, release the brake and recheck the brake adjusting procedures as necessary to achieve proper load handling.

NOTE

Do not tighten the brake band to the point where an empty hook block cannot be lowered.

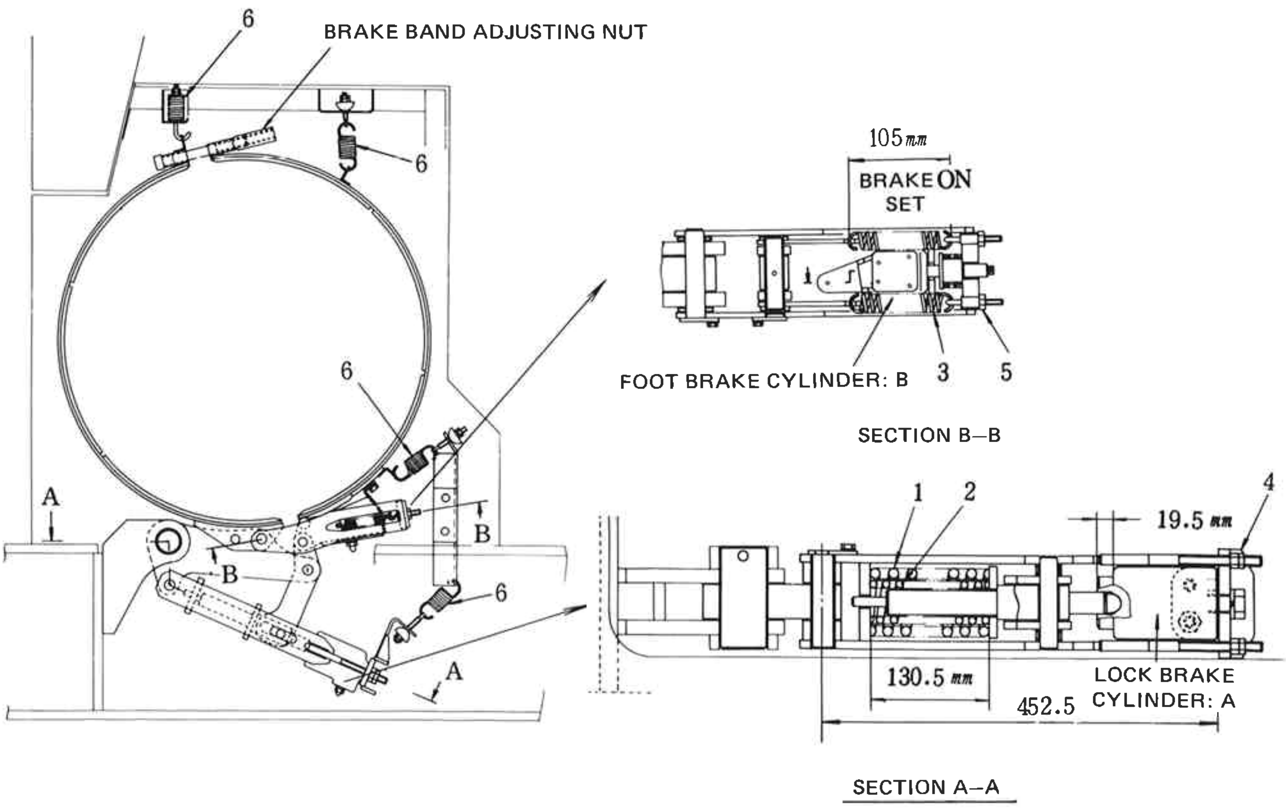


Fig. 12 Third Drum Brake Adjustment

6. CLUTCHES

6.1 GENERAL

This subsection contains the information necessary to remove, repair, install and adjust the front, rear, and third drum clutches.

6.2 FRONT AND REAR DRUM CLUTCHES

6.2.1 DESCRIPTION

The front and rear drum clutches are splined to the right hand ends of their respective drumshafts. These clutches are identical.

Both clutches are hydraulically applied, spring released. When there is no pressure to the clutch cylinder, the return spring applies force to the actuating levers to contract the band and release the clutch. When the operator moves a control lever to raise a load hydraulic fluid is forced into the clutch cylinder causing the piston to extend. As the piston extends it moves the push rod outward forcing the actuating lever up to expand the bands and apply the clutch.

Since wear will usually be greatest at the dead end of the clutch linings, the clutch bands may be interchanged when wear has reduced the thickness of the lining at the dead end to 6.5 mm (1/4 inch). When wear has reduced the thickness of the both lining ends to 6.5 mm (1/4 inch) the lining should be replaced. See the Operator's Manual to adjust the clutches for normal lining wear.

6.2.2 REMOVAL

To remove the clutch bands, proceed as follows (see Figure 13):

1) Lower the attachment (hook block) to the ground and place the control lever in the neutral position.
2) Engage the manual lock pawls.
3) Shut down the engine and operate a control lever until all hydraulic pressure is exhausted from the system. Confirm that the pilot pressure warning lamp lights up. Return all control levers to the neutral position.
4) Remove any material that may interfere with the removal of the clutch band.
5) Remove hydraulic hoses connected to the clutch swivel, cylinder (6) to drumshaft. Cap the hoses. Remove the swivel joint from the drumshaft.
6) Loosen nuts (43) and turn in capscrew (42,43) until there is adequate clearance for removal of clutch band (5).
7) Remove spring (25) from clutch band (5). The clutch band may now be removed and relined.
8) Remove cotter pins (20) and pin (21) from lever (3,4) and spring guide (22). Remove spring guide (22) and spring (24).
9) Remove cotter pin (19), nut (18), and bolt (17).
10) Remove trunion (13) and push rod (11) by removing cotter pin (16), nut (14), washer (15) and lever (3,4).
11) Remove cylinder (1) from spider (1) by removing the capscrew (7) and lockwasher (8).
12) Remove capscrew (28), lockwasher (37) and bracket (2).

6.2.3 INSPECTION AND REPAIR

Prior to reinstalling the clutch band on the drum, inspect the following items (see Figure 13):

1) Inspect and replace any weak return springs (25) and spring (24).
2) Inspect bushing (1-6) and bolt (17) and replace it if necessary.
3) If cylinder (6) leaks or has been performing erratically, remove and overhaul if necessary.
4) Check the clutch bands for distortion.
5) Check actuating lever (3,4) and spider (1) for wear. Replace if necessary.
6) Inspect the clutch drum to see that it is not cracked, scored or otherwise damaged.

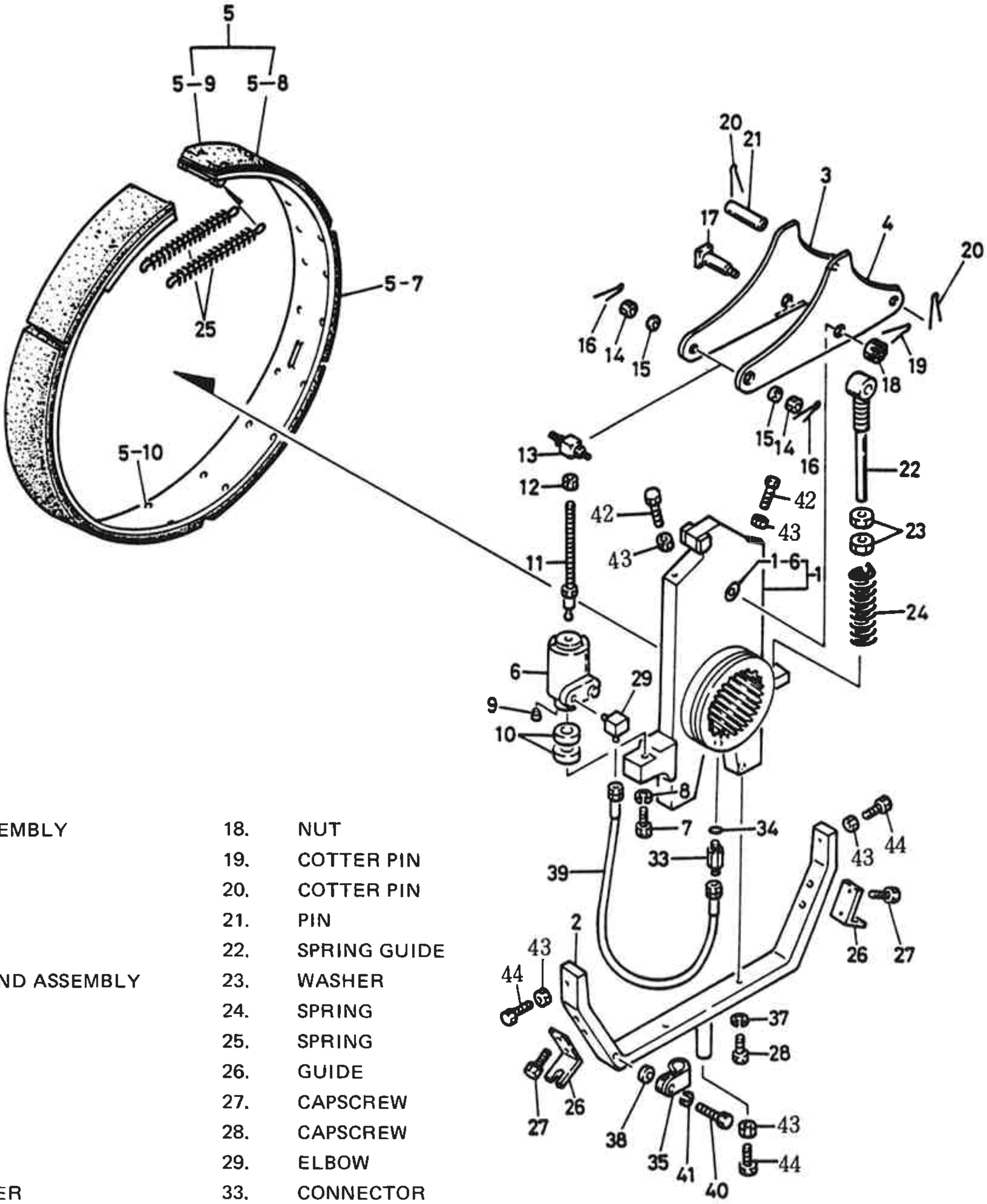
6.2.4 ASSEMBLY AND INSTALLATION

To assemble and install the clutch, proceed as follows (See Fig. 13).

NOTE

Be very careful not to contaminate the clutch lining with oil or dust. Degrease and clean spider (1), levers (3,4), etc. before assembly.

1) Install cylinder (6) and bracket (2) on spider (1). Apply Loctite #242 to capscrews (7,28) beforehand.
2) Install trunnion (13) and push rod (11) on levers (3,4) with nut (14), washer (15) and split pin (16). Apply extreme pressure grease (EPG No.2) to the bearing face of trunnion (13) and the tip of push rod (11) beforehand.



1.	SPIDER ASSEMBLY	18.	NUT
1-6.	BUSHING	19.	COTTER PIN
2.	BRACKET	20.	COTTER PIN
3.	LEVER	21.	PIN
4.	LEVER	22.	SPRING GUIDE
5.	CLUTCH BAND ASSEMBLY	23.	WASHER
5-7.	LINING	24.	SPRING
5-8.	LINING	25.	SPRING
5-9.	RIVET	26.	GUIDE
5-10.	RIVET	27.	CAPSCREW
6.	CYLINDER	28.	CAPSCREW
7.	CAPSCREW	29.	ELBOW
8.	LOCKWASHER	33.	CONNECTOR
9.	PLUG	34.	O-RING
10.	WASHER	35.	CLIP
11.	PUSH ROD	37.	LOCKWASHER
12.	NUT	38.	SPACER
13.	TRUNNION	39.	HOSE
14.	NUT	40.	CAPSCREW
15.	WASHER	41.	LOCKWASHER
16.	COTTER PIN	42.	CAPSCREW
17.	BOLT	43.	NUT
		44.	CAPSCREW

Fig. 13 Main (Front and Rear) Drum Clutch

3) Install levers (3,4) on spider (1) with bolt (17), nut (18) and cotter pin (19). Coat bolt (17) with extreme pressure grease (EPG No.2) beforehand.
5) Insert spring (24) onto spring guide (22), and install this assembly on spider (1). Install spring guide (22) on levers (3,4) with pin (21) and cotter pin (20). Coat pin (21) with extreme pressure grease (EPG No.2) beforehand.
6) Install clutch band (5) on clutch drum, and install spring (25) on clutch band (5).
7) Install the swivel joint on the clutch shaft, and connect two hydraulic hoses to swivel joint, cylinder (6) and drumshaft.
8) Bleed air from hydraulic cylinder (6).

6.2.5 ADJUSTMENT

To adjust the clutch, proceed as follows (See Fig. 14).

1) In the case of a new lining, with the clutch disengaged, adjust nut (23) so that the installation length of spring (24) measures 118 mm.
2) Adjust nut (11) so that the clutch works securely at a stroke of about 3.6 mm on the live end of the clutch band.
3) With the clutch disengaged, adjust capscrews (42,44) so that the clearance between clutch lining and drum measures as shown in the table below.

unit: mm

A	B	C	D	E
1.2	1.0	0.8	0.6	0.4

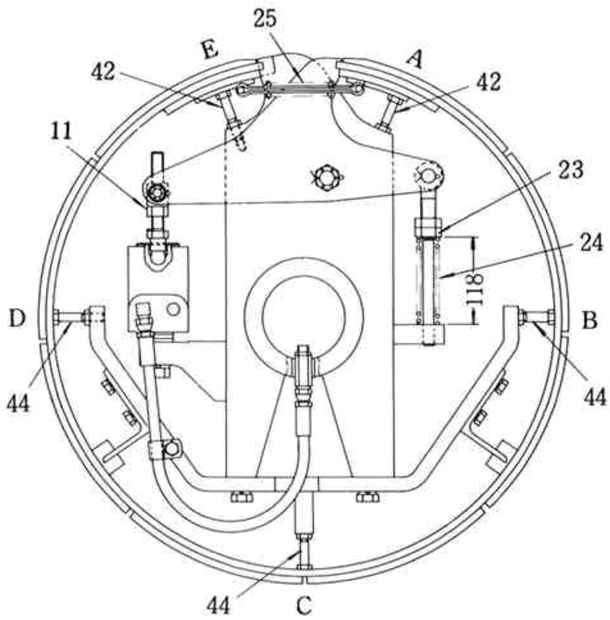


Fig. 14 Main (Front and Rear) Drum Clutch Adjustment

6.3 THIRD DRUM CLUTCH

6.3.1 DESCRIPTION

The clutch is hydraulically applied spring released. When pressure is not supplied to the clutch cylinder the return spring holds the clutch actuating lever which contracts the bands and releases the drum. When the operator pulls the third drum control lever to raise a load, hydraulic fluid is forced into the clutch cylinder causing the piston to extend. As the piston extends, it moves the push rod outward forcing the actuating lever up, to expand the bands and apply the clutch.

Since wear will usually be greatest at the dead end of the clutch lining. When wear has reduced the thickness of Since wear will usually be greatest at the dead end of the clutch lining. When wear has reduced the thickness of the lining at the dead end to 6.5 mm (1/4 inch), the lining should be replaced. See the Operators Manual to adjust the clutch for normal lining wear.

6.3.2 REMOVAL

To remove the clutch bands, proceed as follows (see Figure 15):

1) Lower the attachment (hook block) to the ground and place the control lever in the neutral position.
2) Engage the manual lock pawls.
3) Shut down the engine and operate a control lever until all hydraulic pressure is exhausted from the system. Confirm that the pilot pressure warning lamp lights up. Return all control levers to the neutral position.
4) Remove any material that may interfere with the removal of the clutch band.
5) Remove hydraulic hoses connected to the clutch swivel, cylinder (41) to drumshaft. Cap the hoses.
6) Loosen jam nuts (20) and turn in adjusting bolts (19 and 33) until there is adequate clearance for removal of clutch bands (5).
7) Remove spring (35) from clutch band (5). Before removal of spring (35), loosen nut (20) and turn plate (36) left to rotate link (32) with spanner wrench. (see Figure 16.)
8) Remove nut (5-11), lockwasher (5-12), spacer (5-7, 5-8 and 5-9), capscrew (5-10) and remove clutch band (5). The clutch band may now be removed and relined.
9) Remove nut (17), lockwasher (18), and washer (16) from rod (26) and lever (3,4). Remove the rod and spring (27).
10) Remove cotterpin (37), nut (12), bolt (13) and

spacer (14).

11) Remove nut (17), lockwasher (18), washer (16) and lever (3,4) and remove trunnion (11), push rod (9).
12) Remove capscrew (7), lockwasher (8) and remove cylinder (41) from spider (42).
13) Remove capscrew (24), lockwasher (25) and bracket (21).

6.3.3 INSPECTION AND REPAIR

Prior to installing the clutch inspect the following items (see Figure 15):

1) Inspect and replace any weak springs (27 and 35).
2) Inspect bushing (42-8) in spider (42), push rod (9), and bolt (13) and replace if worn.
3) If cylinder (41) leaks or has been performing erratically, remove and overhaul if necessary.
4) Check clutch bands (5) for distortion.
5) Check lever (3,4) and spider (42) for wear.
6) Inspect the clutch drum to see that it is not cracked, scored or otherwise damaged.

6.3.4 ASSEMBLY AND INSTALLATION

To assemble the drum clutch and install the clutch band halves, proceed as follows (see Figure 15):

1) Be very careful that the clutch lining is not contaminated with oil or dust. Degrease and clean spider (42) and levers (3,4) before assembly.
2) Install cylinder (41) and bracket (2) on spider (42). Coat capscrews (7,24) with Loctite #242.
3) Install trunnion (11) and push rod (9) on levers (3,8) with washer (16), nut (17) and lock washer (18). Apply extreme pressure grease (EPG No.2) to the bearing face of trunnion and the tip of push rod (9) beforehand.
4) Install levers (3,4) on spider (42) with bolt (13), nut (12) and cotter pin (37). Coat bolt (13) with extreme pressure grease (EPG No.2) beforehand.
5) Insert spring (27) onto rod (26) and install this assembly on spider (42). Install rod (26) on levers (3,4) with bolt (15), washer (16) and lock washer (18). Coat bolt (15) with extreme pressure grease (EPG No.2) beforehand.
6) Install the clutch band halves (5) on the drum and connect them together with capscrew (5-10), nut (5-11), lock washer (5-12) and spacers (5-7,5-8,5-9).
7) Install spring (35) on clutch band (5) and link (32) and secure link (32) with plate (36).
8) Install swivel on clutch shaft, and connect 2 hydraulic hoses to swivel, cylinder (41) and spider (42).
9) Bleed air from hydraulic cylinder (41).

6.3.5 ADJUSTMENT

To adjust the third drum clutch, proceed as follows (See Fig. 16).

1) For a new lining, with the clutch disengaged, adjust nut (21) so that the installation length of spring (27) measures 118 mm.
2) Adjust nut (10) for an initial setting so that the distance from the center of trunnion (11) to the cylinder mounting face of spider (42) measures 196 mm.
3) Re-adjust nut (10) so that the clutch works securely when the clutch lever is operated.
4) With the clutch disengaged, adjust capscrews (19,33) so that the clearance between clutch lining and drum measures as shown in the table below.

unit: mm

A	B	C	D	E
1.2	1.0	0.8	0.6	0.4

5) Tighten all the jam nuts after the adjustment has been completed.
6) Start the engine and check the clutch for proper operation.

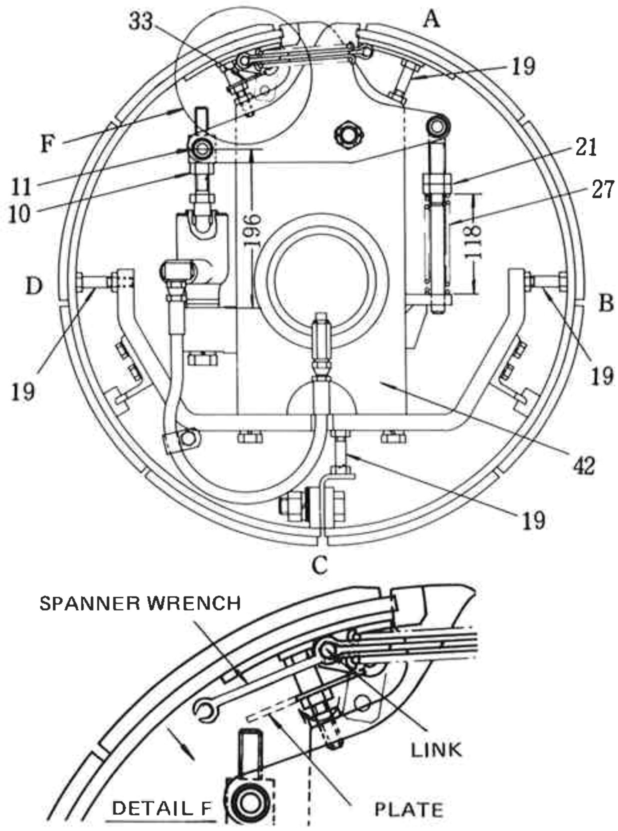


Fig. 16 Third Drum Clutch Adjustment

2. BRACKET
3. LEVER
4. LEVER
5. CLUTCH BAND ASSEMBLY
5-7. SPACER
5-8. SPACER
5-9. SPACER
5-10. CAPSCREW
5-11. NUT
5-12. LOCKWASHER
5-13. LINING
5-14. LINING
5-15. RIVET
5-16. RIVET
7. CAPSCREW
8. LOCKWASHER
9. PUSH ROD
10. NUT
11. TRUNNION
12. NUT
13. BOLT
14. SPACER
15. BOLT
16. WASHER
17. NUT
18. LOCKWASHER
19. CAPSCREW
20. NUT
22. GUIDE
23. SEMS-BOLT
25. LOCKWASHER
26. LOD
27. SPRING
28. ELBOW
29. HOSE
30. CONNECTOR
31. O-RING
32. LINK
33. CAPSCREW
34. SPACER
35. SPRING
36. PLATE
37. COTTER PIN
38. WASHER
39. CLIP
40. SEMS-BOLT
41. CYLINDER
42. SPIDER
42-8. BUSHING

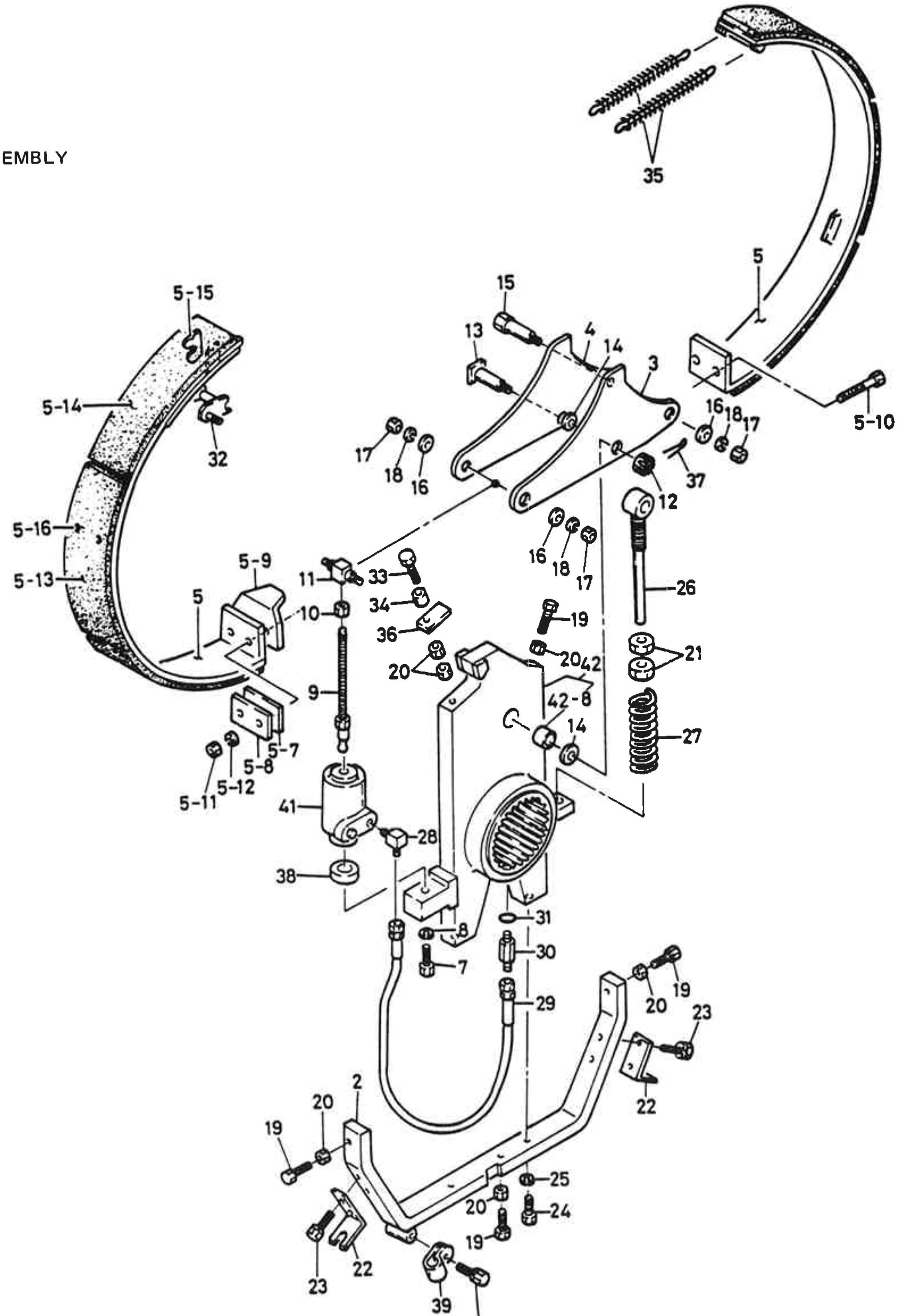


Fig. 15 Third Drum Clutch

7. DRUM PAWLS

7.1 GENERAL

This subsection covers the removal, instllation and adjustment of the front, rear and third drum pawls, and of the mechanism that operates them.

7.2 FRONT AND REAR DRUM PAWLS

7.2.1 DESCRIPTION

Both the front and rear drums are provided with identical drum pawls (see Figure 17). These pawls are mechanically engaged and disengaged by the operator from the cab. The pawls should be engaged whenever a load is suspended for an extended period of time, or whenever the machine is shutdown.

When the knob is pulled, the control cable pulls the pawl and the pawl engages in the teeth of the drum ratchet. When the knob is pushed in, the pawl releases by gravity and spring assistance.

7.2.2 REMOVAL AND INSTALLATION

If upon inspection, it is revealed the pawl is damaged in any way, the pawl must be replaced. Also, if the mechanism does not function as described above, it must be adjusted. To remove and install a pawl, proceed as follows (see Figure 16):

1) Start the engine and lower the attachment (hook block), to the ground.
2) Shut down the engine and operate a control lever to remove any remaining pressure in the hydraulic lines.
3) Disengage the pawl.
4) Remove nuts (10), washer (11) and spring (8).
5) Remove tube (13), and connector (12).
6) Remove capscrew (5), and lockwasher (6).
7) Remove pin (2) that holds pawl (1) in place from bracket (14).
8) Remove spring (9) from pin (7).
9) Inspect the pawl, springs and other parts for damage. Replace if necessary.
10) Install spring (4) onto pin (7).
11) Set the new pawl into bracket (14) and secure the pawl with pin (2).
12) Apply Loctite #242 to capscrew (5) and tighten it to 0.88~0.96 kgf-m.
13) Install connector (12) and the tube assembly to the pin.
14) Install spring (8), washer (11) and nuts (10) onto pin (7).
15) Lubricate the pawl with multipurpose grease. See the Operator's Manual.

7.2.3 ADJUSTMENT

To adjust the pawl mechanism after replacement, proceed as follows (see Figure 18):

1) Measure the length of the pawl engage springs and adjust them until they measure 43 mm (1-11/16 inches).
2) Measure the length of the pawl disengage springs and adjust them until they measure 35 mm (1-3/8 inches).
3) Pull the drum lock knob up to check proper engagement.
4) Check the OFF position of the pawls; the pawls should be disengaged from the drum teeth by approximately 25 to 35 mm. If not, repeat steps 1 through 3.

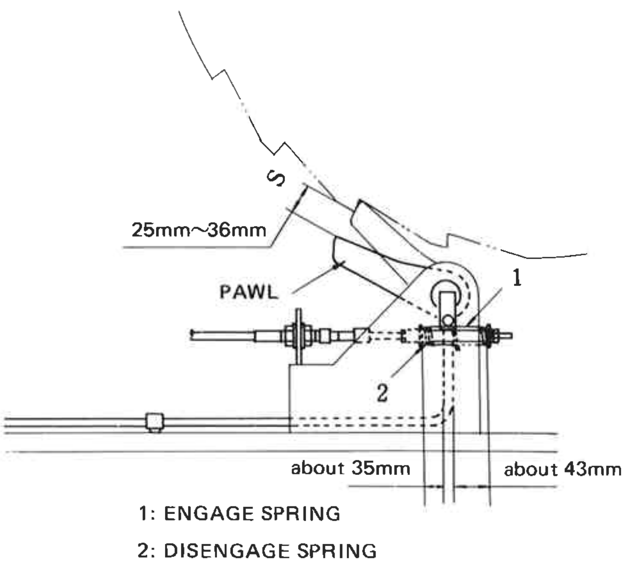


Fig. 18 Front and Rear Drum Adjustment

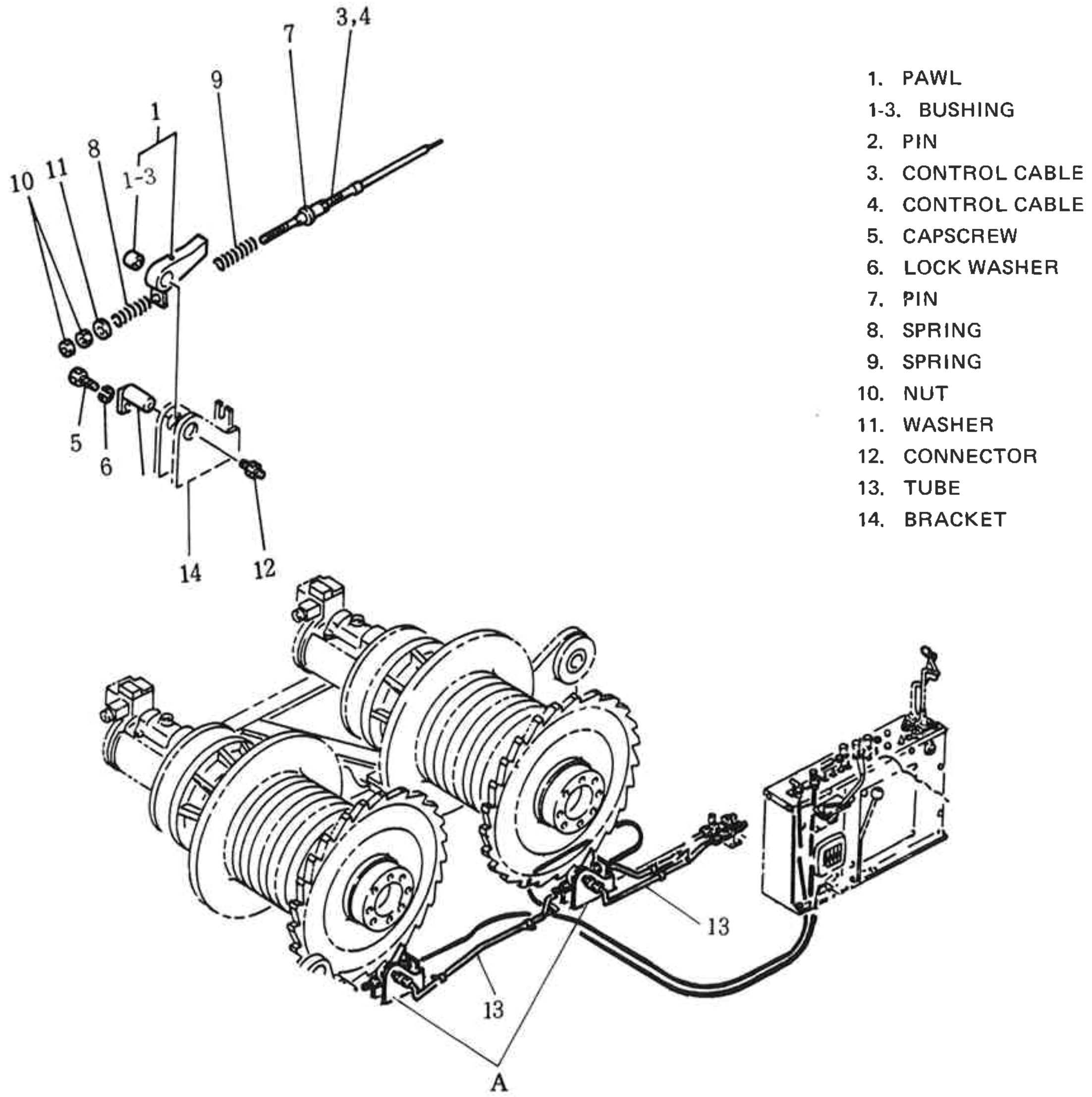


Fig. 17 Front and Rear Drum Pawls

7.3 THIRD DRUM PAWL

7.3.1 DESCRIPTION

The third drum pawl is more similar to the boom hoist manual pawl than the front and rear drum pawls (see Figure 19). Like the other manual pawls, the third drum pawl is mechanically engaged and disengaged by the operator from the cab. The pawl should be engaged whenever a load is suspended for an extended period of time, or whenever the machine is shutdown.

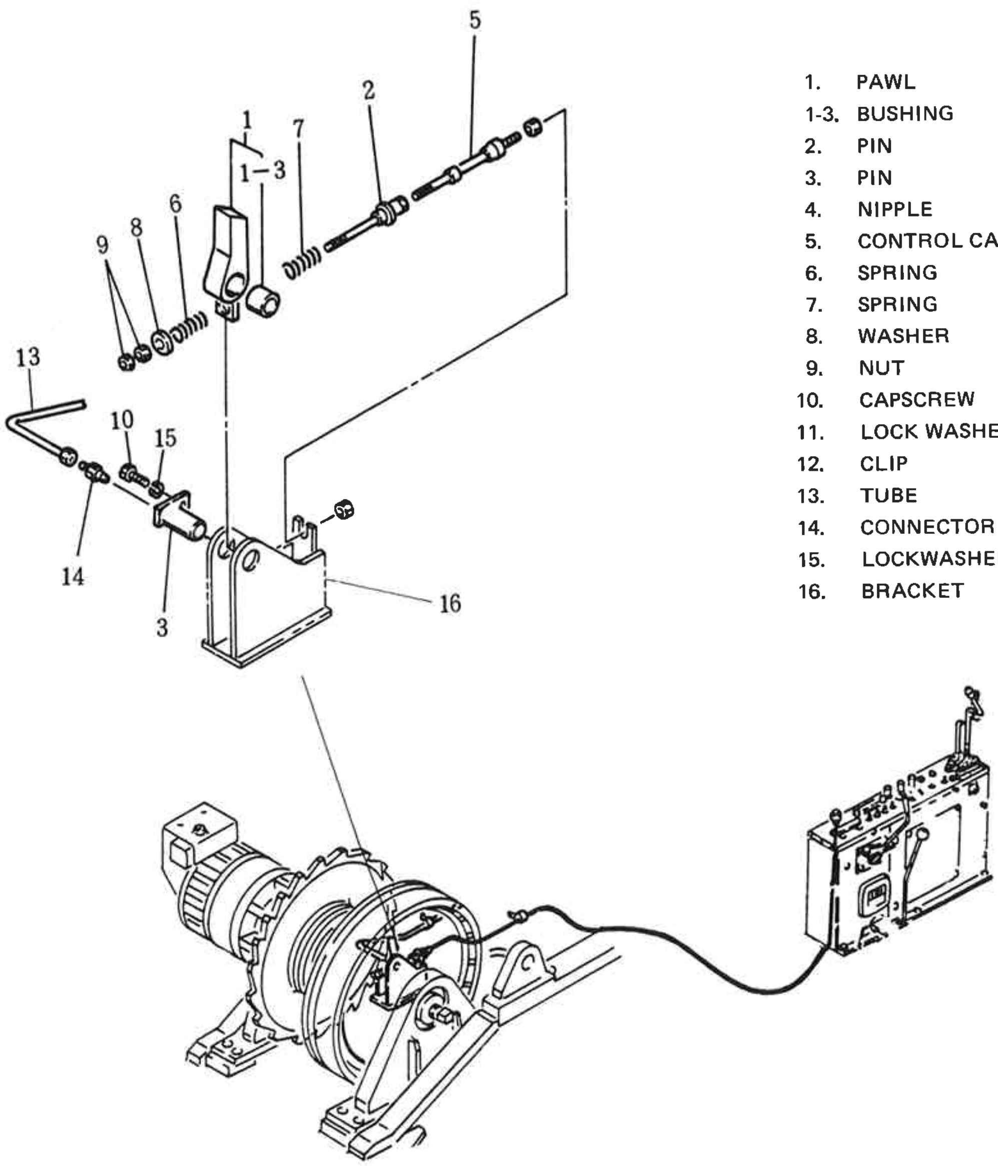
When the knob is pulled, the control cable pulls the pawl and the pawl engages the drum teeth. When the knob is pushed in, the pawl releases by gravity and spring assistance.

7.3.2 REMOVAL AND INSTALLATION

If upon inspection, it is revealed the pawl is damaged in any way, the pawl must be replaced. Also, if the mechanism does not function as described above, it must be adjusted. To remove and install a pawl, proceed as follows (see Figure 19):

1) Start the engine and lower the attachment (hook block), to the ground.
2) Shut down the engine and operate a control lever to remove any remaining pressure in the hydraulic lines.
3) Disengage the third drum pawl.
4) Remove jam nuts (9), washer (8), and spring (6).
5) Remove tube (13), and connector (14) from pin (3).

6) Remove capscrew (10), and lockwasher (15). Remove pawl (1) by removing pin (09) from bracket (16).
7) Slide disengage spring (7) off pin (2).
8) Inspect the pawl, springs and other parts for damage. Replace if necessary.
9) Install spring (7) onto pin (2).
10) Set the new pawl into bracket (16) and hold the pawl with pin (2).
11) Apply Loctite #242 to capscrew (10) and tighten it to 0.88~0.96 kgf-m.
12) Install connector (14), and tube (13).
13) Slide spring (6) and washer (8) on pin (2) and install jam nuts (9).
14) Lubricate the pawl with multipurpose grease. See the Operator's Manual.



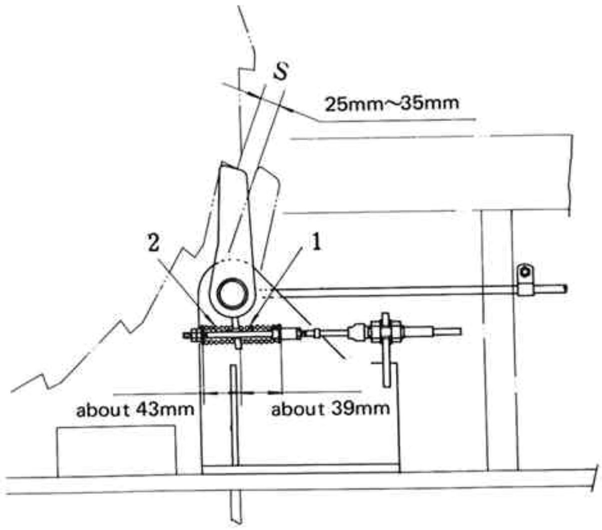
1. PAWL
1-3. BUSHING
2. PIN
3. PIN
4. NIPPLE
5. CONTROL CABLE
6. SPRING
7. SPRING
8. WASHER
9. NUT
10. CAPSCREW
11. LOCK WASHER
12. CLIP
13. TUBE
14. CONNECTOR
15. LOCKWASHER
16. BRACKET

Fig. 19 Third Drum Pawl

7.3.3 ADJUSTMENT

To adjust the pawl mechanism after replacement, proceed as follows (see Figure 20):

1) Check the OFF position of the pawl; it should be disengaged from the drum teeth by approximately 25 to 35 mm.
2) Measure the length of the pawl engage spring and adjust until it measures 43 mm (1-11/16 inches).
3) Measure the length of the pawl disengage spring and adjust it until it measures 35 mm (1-3/8 inches).
4) Operate the pawl and check for performance.



1: ENGAGE SPRING

2: DISENGAGE SPRING

Fig. 20 Third Drum Pawl Adjustment

1. LOCATION OF COMPONENTS

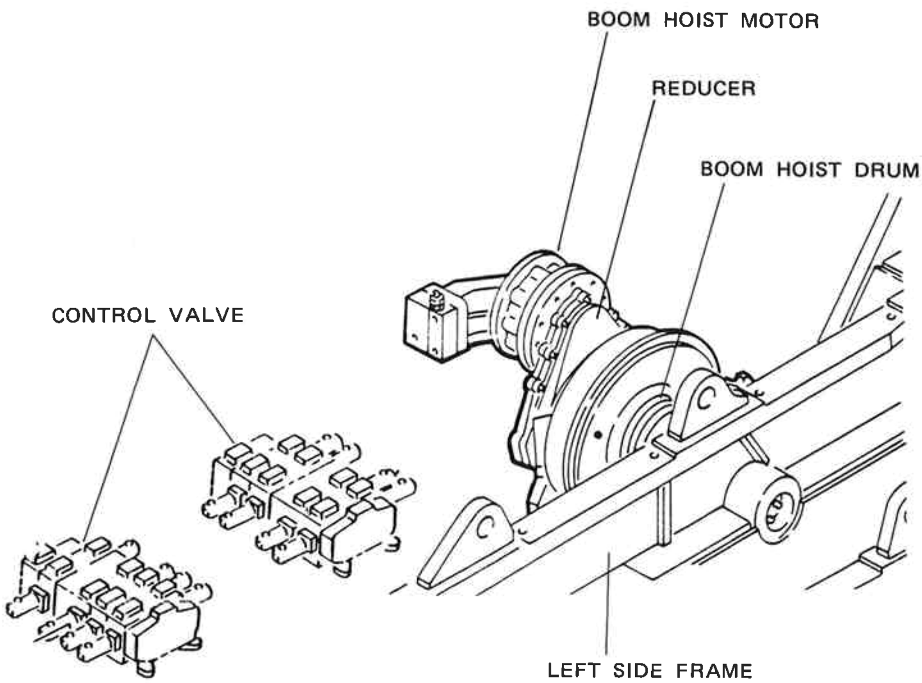


Fig. 1 Boom Hoist System

2. BOOM HOIST MOTOR

2.1 GENERAL

In this section the removal and installation of the boom hoist motor is outlined. For more details about the boom hoist motor, please refer to the components section in the separate shop manual volume.

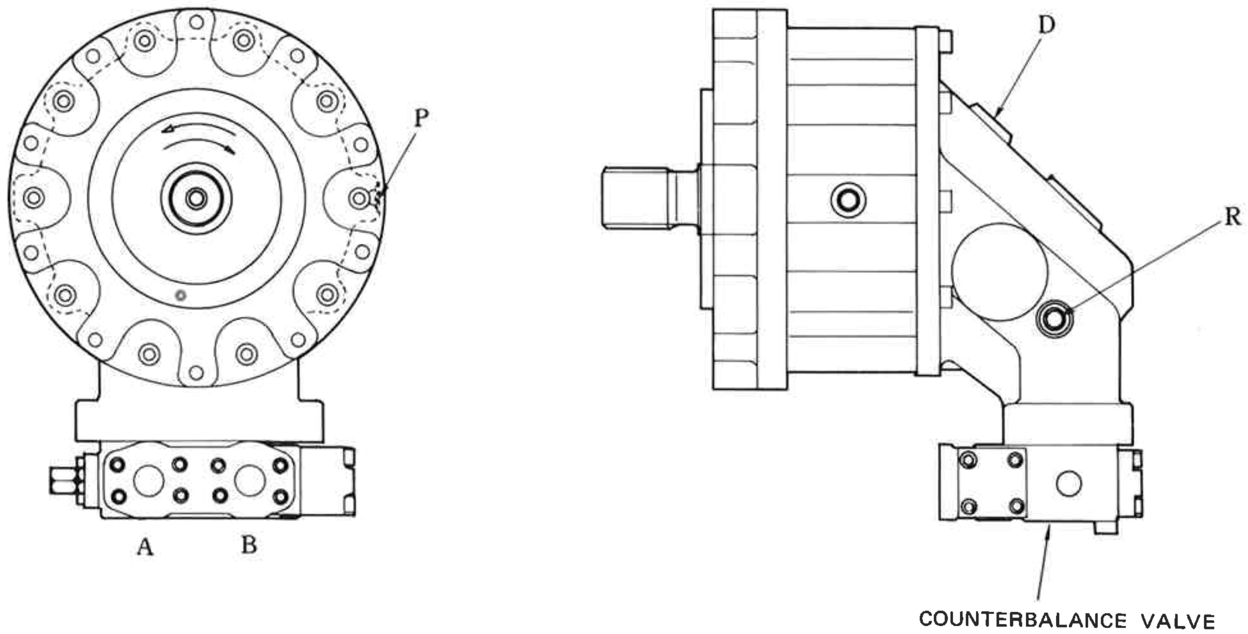
2.2 DESCRIPTION

Figure 2 is an external view of the boom hoist motor. This motor is a fixed-capacity axial piston motor equipped with a multi-plate disk brake and counter-balance valve.

2.3 REMOVAL

The removal of the boom hoist motor should be carried out using the following procedure. (See Fig. 2 and 3)

1) Bring the boom down to ground level and support it with a suitable block.
2) Remove the guards and panels that need to be taken off for the removal of the boom hoist motor.
3) Remove the reduction unit's drain plug and discharge the oil into a suitable container.
4) Before removing the boom hoist motor, clean off all the hydraulic piping and the boom hoist motor.
5) Remove the boom hoist motor's pressure piping, brake piping and drain piping and attach name tags to them. In order to prevent foreign matter from entering the hydraulic system, place caps on all the pipes and plugs in all the ports.
6) Attach a lifting device with suitable capacity to the motor, remove the 10 capscrews holding the motor and remove the motor from the reduction unit.



A, B : HIGH PRESSURE PORTS
P : BRAKE PORT
D : DRAIN PORT
R : AIR BLEED PORT

Fig. 2 Boom Hoist Motor

2.4 INSTALLATION

When installing a new motor or re-installing a motor that has been repaired, be sure to align the shaft so as to prevent excessive wear.

The installation of the motor should be carried out using the following procedure. (See Fig. 2 and 3)

1) In order to assemble the motor and the reduction unit properly, inspect the motor output shaft for faults such as cracks and burrs.
2) Lightly grease the spline of the output shaft.
3) Lightly grease the O-ring (27) and install it in the O-ring groove on the reduction unit side.
4) Insert the motor output shaft (with the motor suspended with a lifting device) into the reduction unit.
5) Apply Loctite #242 to the 10 capscrews and tighten them alternately to 6~7 kgf·m tightening torque.
6) Install the pressure piping, brake piping and the drain piping.
7) Fill the reduction unit as well as the motor casing with extremely pressure gear oil SAE 90.
8) Install the guards and panel taken off during removal.
9) Turn on the engine and with it running at a low speed, check as to whether the motor is leaking oil, whether it is rotating in the right direction, whether there is too much vibration when it turns or during operation of the control valve, and to see if there is any abnormal rise in the temperature of the oil during a short period of running operation.

3. BOOM HOIST WINCH

3.1 GENERAL

This section outlines the removal, disassembly, inspection and repair, assembly and installation of the boom hoist winch.

3.2 DESCRIPTION

The boom hoist winch is composed of a reducer and a drum. The reducer consists of two stages: flat gear reduction and planetary gear reduction, by which the boom hoist motor rotation is converted to low-speed and high-torque before being transmitted to the boom hoist drum. The planetary gear reduction is performed by means of a sun gear, planetary pinion and internal gears.

3.3 REMOVAL

The removal of the boom hoist winch should be carried out using the following procedure. (See Fig. 3)

1) Bring down the boom and support it on a suitable block and remove the boom hoist wire rope from the boom hoist winch drum.
2) Remove the guards that must be removed in order to remove the boom hoist winch.
3) Remove all hydraulic piping connected to the boom hoist winch. Place caps on all the piping and plugs in all the ports and in related parts that have been removed.
   In addition, remove all of the parts apparently necessary for the removal of the boom hoist winch.
4) Remove the reduction unit's drain plug and after having disposed of the oil in a suitable container, screw the drain plug back in.
5) Using the screw hole for lifting on top of the reduction unit, attach a lifting device with suitable capacity to the boom hoist winch.
6) Remove the four capscrews (42) and slowly move the boom hoist winch horizontally and take out the spring pin (41) and bearing (21) which are fitted together. Remove the boom hoist winch from the machine and put it on a block with the side on which the drum is positioned facing the ground. The weight of the boom hoist winch assembly is approximately 340 kg.
7) Referring to the second section that outlines the boom hoist motor, remove the boom hoist motor (44) and the O-ring (27).

3.4 DISASSEMBLY

Disassembly of the boom hoist winch should be carried out using the following procedure. (See Fig. 3)

1) Place the boom hoist winch on a block with the drum facing the ground and remove the snap ring (24).
2) Match mark the pin (12) and the housing (3). Remove the capscrew (34) which holds the pin (12) and screw the capscrew into the pin's removal screw hole and remove the pin (12).
3) Remove the capscrews (34) holding housing (3) to housing (47) and by using a lifting device of suitable capacity, remove housing (3).
4) From housing (47), remove gear (15), pinion (16) and bearing (22). And from gear (15), remove snap ring (25) and bearing (23). Pull out the inner race of bearing (22) from pinion (16).
5) Remove the outer race bearing (22) from housings (3,47).
6) Pull out the sun gear (18) and spider (7) assembly and spacer (10) from housing (47). Do NOT remove ring gear (14) unless absolutely necessary.
7) If it is necessary to disassemble the second-stage planetary reducer, use the following procedure.
   a. Remove capscrew (38) and remove lock plate (13).
   b. Pull out the three shafts (19) using a press.
   c. Remove pinion (17) and thrust washer (43).
   d. Remove spacer (9).
8) Turn the drum in the opposite direction and place it on a block with housing (47) facing the ground. Remove capscrew (37), end plate (33) and the shims (29,30,31,32).
9) Pull out bearing (21) with a bearing puller.
10) Pull out drum (46) from shaft (4).
11) Remove capscrew (37) and remove retainer (8) and sleeve (11). Then remove oil seal (26) from retainer (8) and remove O-ring (28) from sleeve (11).
12) Pull out shaft (4) from housing (47) and remove bearing (20) and spacer (10).

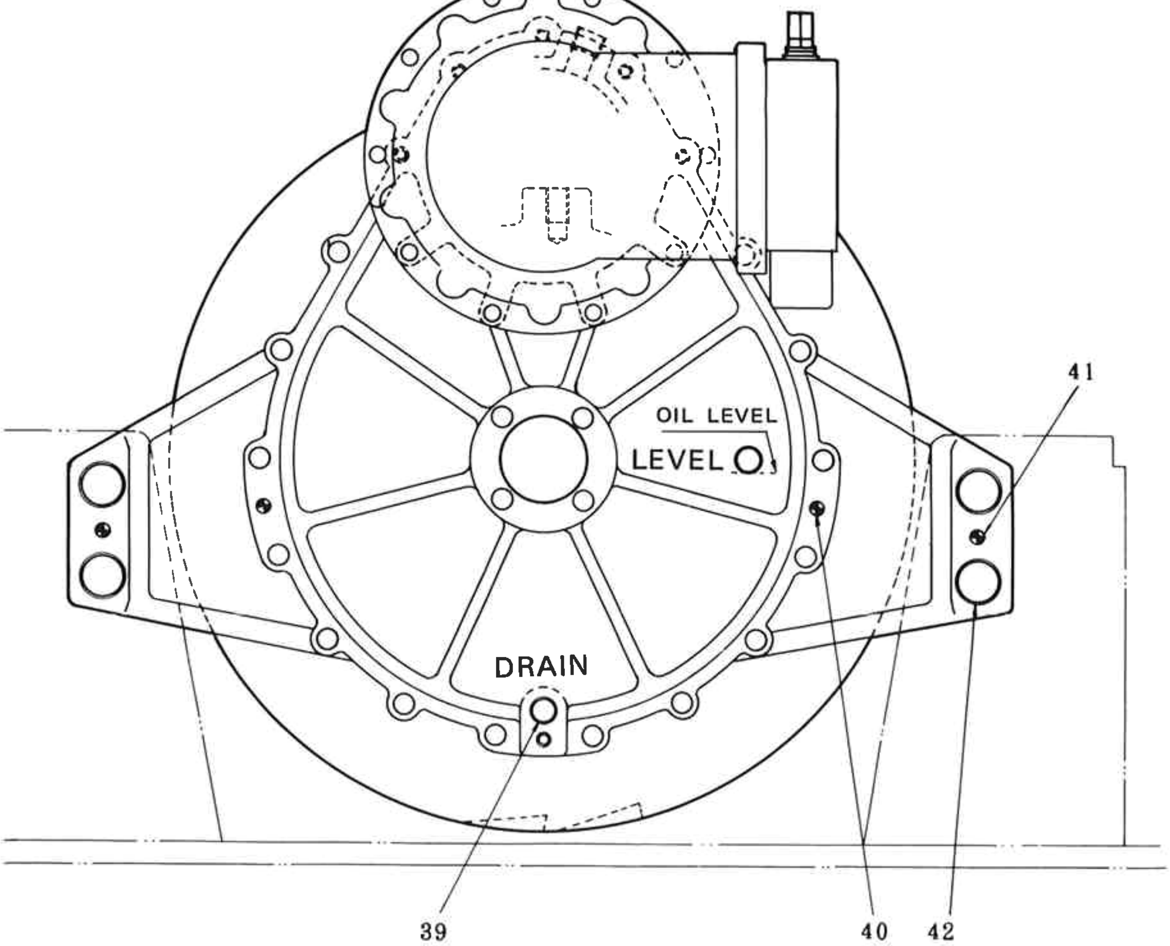
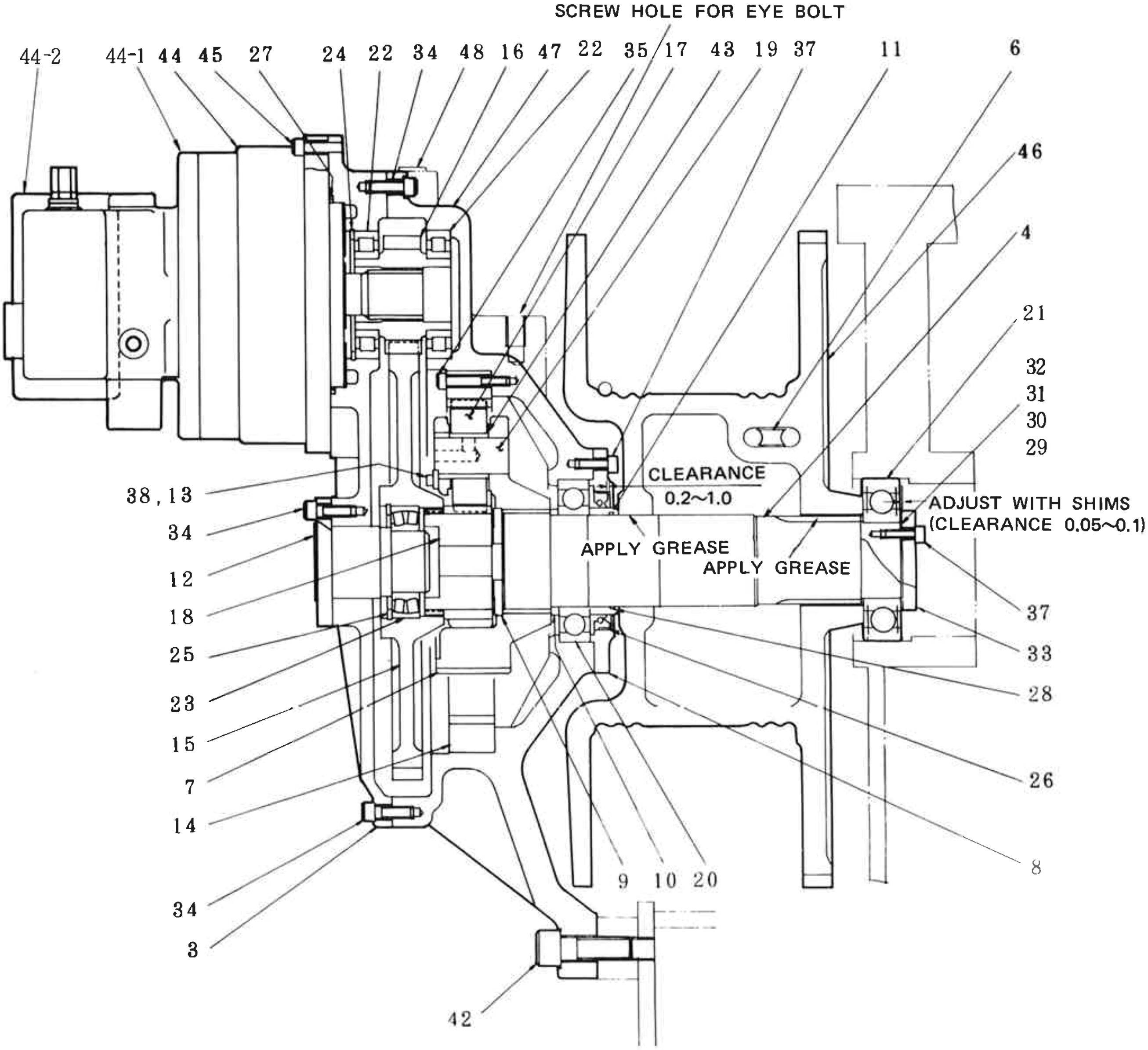
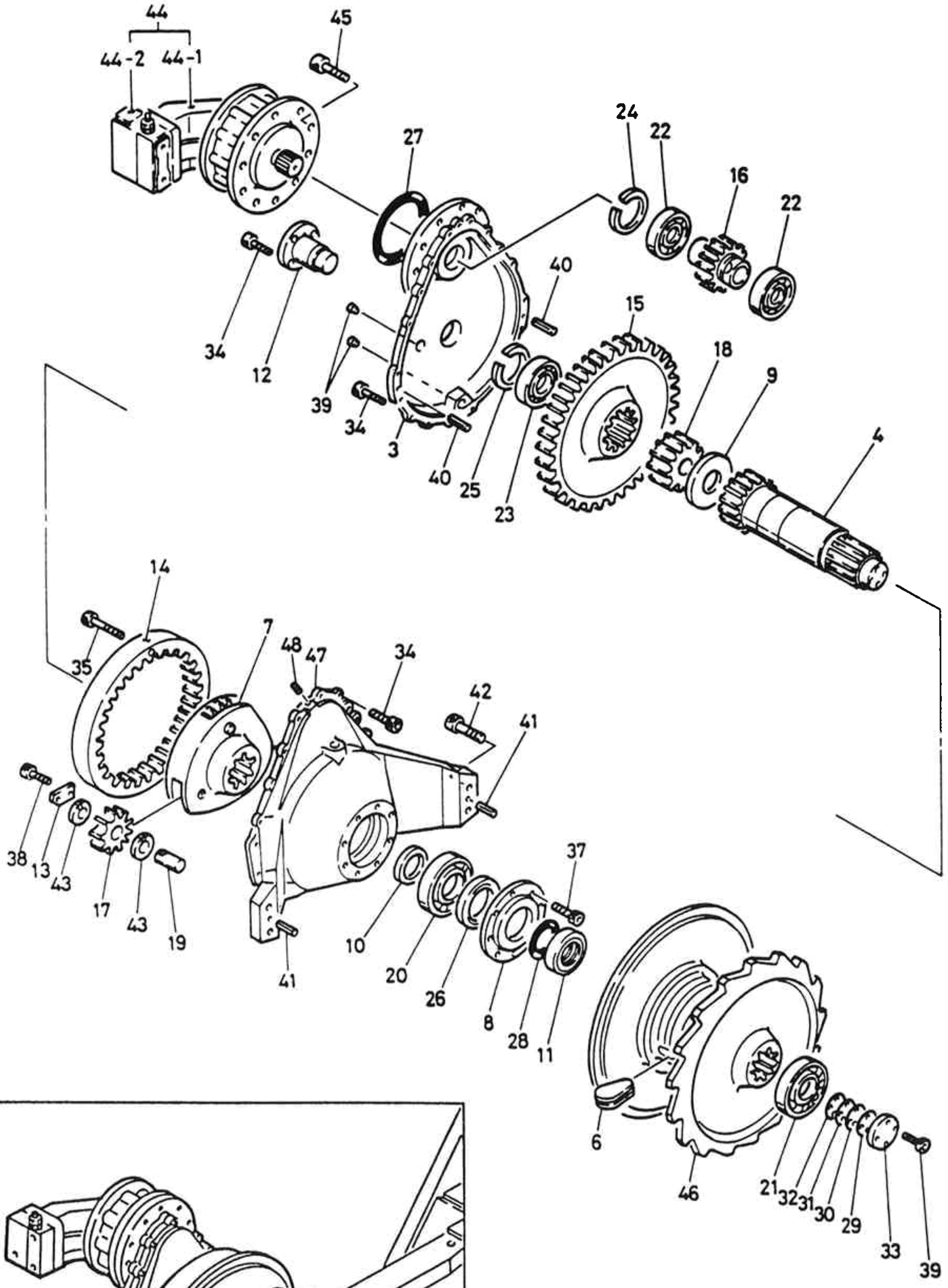


Fig. 3-1 Boom Hoist Winch (1)



3. HOUSING
4. SHAFT
6. COTTER
7. SPIDER
8. RETAINER
9. SPACER
10. SPACER
11. SLEEVE
12. PIN
13. LOCK PLATE
14. RING GEAR
15. GEAR
16. PINION
17. PINION
18. SUN GEAR
19. SHAFT
20. BEARING
21. BEARING
22. BEARING
23. BEARING
24. SNAP RING
25. SNAP RING
26. OIL SEAL
27. O-RING
28. O-RING
29. SHIM 1.0
30. SHIM 0.5
31. SHIM 0.2
32. SHIM 0.1
33. END PLATE
34. CAPSCREW
35. CAPSCREW
37. CAPSCREW
38. CAPSCREW
39. PLUG
40. SPRING PIN
41. SPRING PIN
42. CAPSCREW
43. WASHER
44. MOTOR ASSEMBLY
44-1. MOTOR
44-2. COUNTERBALANCE VALVE
45. CAPSCREW
46. DRUM
47. HOUSING
48. PLUG

Fig. 3-2 Boom Hoist Winch (2)



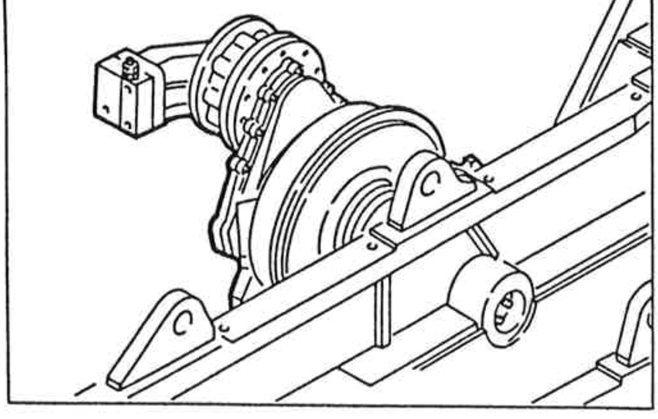


Fig. 3-3 Boom Hoist Winch (3)

3.5 INSPECTION

Inspect all of the parts before reassembling the boom hoist winch. Replace all suspect parts in order to preserve the long life of the boom hoist winch and to prevent the occurrence of breakdowns in advance.

Carry out the inspection in accordance with the outline listed below.

1) Clean all the parts with pure cleaning oil and dry them with compressed air.
2) On having inspected all of the bearing balls, rollers, inner and outer races for pitting and flaws, replace all those where such faults have been found.
3) For those bearings with no pitting or flaws, wipe them lightly with lubricating oil and confirm that there is no gap or rattling in the axial or circumferential direction.
4) Inspect the outer and inner races on the sides where the bearings fit in. Replace those which show traces of sliding.
5) Inspect the surfaces of the pinion and the gears. Replace those which exhibit pitting, scoring, wear, burrs and cracks.
6) Inspect the bushings of the planetary pinion shaft and replace those which show signs of wear, scratches or seizing and the like. If the planetary pinion shaft must be replaced, replace all of the outer shafts at the same time.
7) Inspect the spline of the drum, spiders and shafts for cracks, wear or for parts that have been strongly hit. Repair or replace any faulty parts.
8) Inspect the thrust washer, the thrust plate and the spacers for signs of wear, scratches, seizing and the like. Repair or replace any faulty parts.
9) Inspect the housing and the cover for cracks, deformation, flaws and the like. Repair or replace any faulty parts.
10) Replace all O-rings and oil seals with new parts.
11) Inspect the screw parts of the capscrews, screw holes, bolts and nuts. Repair or replace any part that is deformed or worn out.

3.6 ASSEMBLY

The assembly of the boom hoist winch should be carried out using the following procedure. (See Fig. 3)

1) Tighten the capscrews after having put a suitable amount of Loctite #242 on each.
2) Put spacer (10) and bearing (20) on shaft (4).
3) With housing (47) placed on a block with the drum side facing upwards, insert bearing (20) that is attached to shaft (4) inside housing (4).
4) Insert O-ring (28) that has been lightly greased into spacer (11). Put spacer (11) on to shaft (4).
5) Apply Loctite #515 or equivalent to the outer edge of the oil seal (26). Apply grease to about one third of the empty space between the seal lip and dust lip. Press oil seal (26) into retainer (8). At this time, press oil seal (26) into retainer (8) in such a way that the clearance between the inner side of retainer (8) and the exterior of the oil seal is 0.2~1.0 mm. (See Fig. 3.)
6) Apply Loctite #515 where retainer (8) and housing (47) meet and install retainer (8) into housing (47) with capscrews (37). The tightening torque for capscrews (37) is 6.0~7.4 kgf·m.
7) Apply grease to the bore and the spline part of drum (46) and put the drum on to shaft (4).
8) Warm bearing (21) in oil to 100°C and put it on to shaft (4).
9) Put shims (29,30,31,32) on the tip of shaft (4) and attach end plate (33) with capscrews (39).
   At this time, adjust the thicknesses of shims (29, 30, 31, 32) so that the clearance between bearing (21) and end plate (33) is 0.05~0.1 mm.
   The tightening torque for capscrews (39) is 6.0~7.4 kgf·m.
10) Turn drum (46) in the opposite direction so that housing (47) is facing upwards and place it on the block.
11) If the second-stage planetary reducer was disassembled, assembly should be carried out using the following procedure.
   a. Place spider (7) on a press stand and insert spacer (9) into spider (7).
   b. Lightly grease thrust washer (43) and pinion (17) and insert them into spider (7).
   c. Push in shaft (19) with a press. At this time, make sure that the notch of lock plate (13) on top of the shaft is correctly positioned.
   d. Attach the lock plate (17) to the spider (7) with the capscrew (38). The tightening torque for the cap screw (38) is 1.25~1.55 kgf·m.

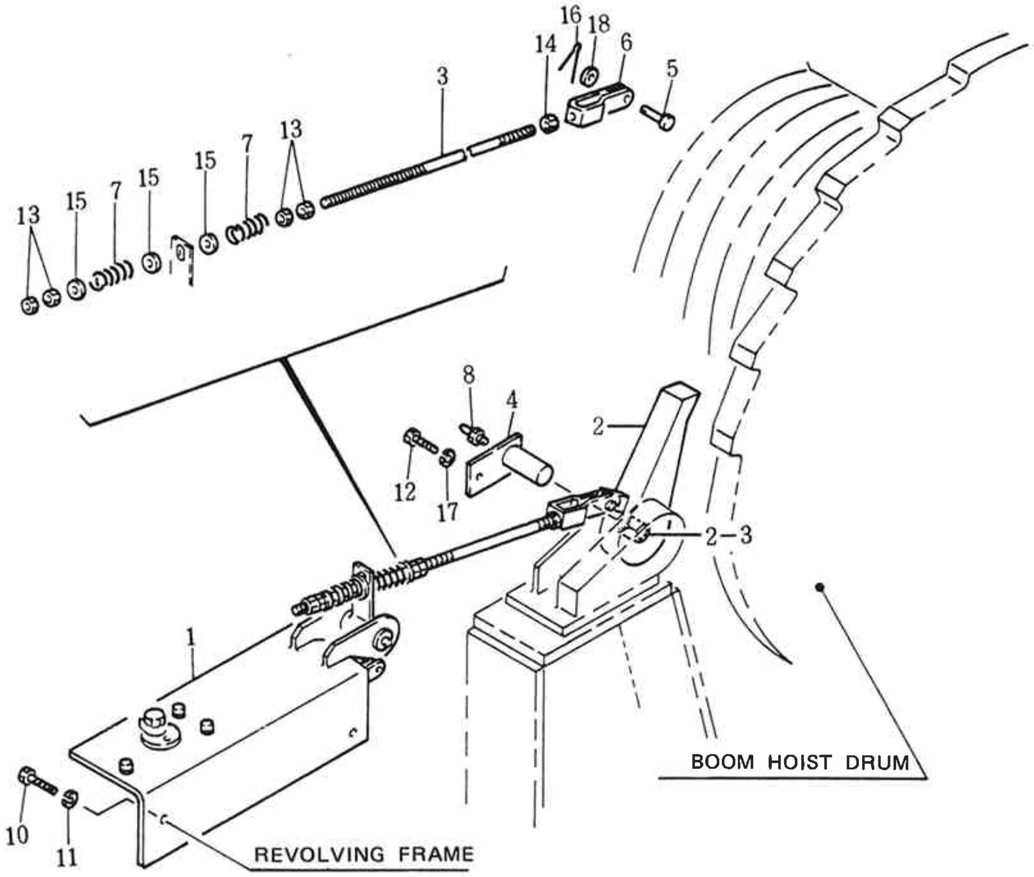
12) Hoist the second-stage planetary spider, previously assembled, with a lifting device of suitable capacity and while slowly making the pinion (17) and the ring gear (14) fit together, insert the shaft into the spline.
13) Insert and fit the sun gears (18) into the three planetary pinions (17).
14) Insert the outer race of the lower bearing (22) into the housing (47) using dry ice or a suitable jig. Insert the inner race of the bearings (22) on both sides of the pinion (16) using a suitable jig.
15) Insert the pinion (16) assembly into the outer race of bearing (22) positioned on the lower side.
16) Put the bearings (23) into the gear (15) using dry ice or a suitable jig and attach snap ring (25).
17) Cool pin (12) with dry ice.
    Cover the mating surfaces of pin (12) and housing (3) with Loctite #515 and insert pin (12) into housing (3), while lining up the matchmarks. Check to make sure that the capscrew holes of pin (12) and housing (3) are properly lined up at this time.
18) With capscrew (34), tighten pin (12) to housing (3). The tightening torque for capscrew (34) is 10.5~12.9 kgf·m.
19) Place gear (15) horizontally on a press stand supporting the boss part with a suitable block. Lift up housing (3) with a lifting device of suitable capacity and press pin (12) into bearing (23).
20) Check to make sure that spring pin (40) is attached to housing (47).
21) Cover the mating surfaces of housing (3) and (47) with Loctite #515.
    Hoist the assembly of housing (3) with a lifting device of suitable capacity and while aligning gear (15) and pinion (16), slowly lower the housing assembly on top of housing (47).
    At this time, pay attention to the fitting and alignment of spring pin (40).
22) Tighten capscrews (34) with a torque 10.5~12.9 kgf·m.
23) Attach the outer race of bearing (22) and snap ring (24).

3.7 INSTALLATION

Installation of the boom hoist winch should be carried out using the following procedure. (See Fig. 3.)

1) Having greased the O-ring lightly, attach it to the O-ring groove in housing (3).
2) Using a lifting device of suitable capacity, lift the boom hoist motor (44) and insert the output shaft into the spline hole of pinion (16).
   Tighten capscrew (45) using a 6.0~7.4 kgf·m torque.
3) Using the screw holes provided for lifting bolts on top of the reduction unit, lift the boom hoist winch assembly and insert bearing (20) into the hole in the left side of the side frame with a horizontal movement, inserting it in alignment with spring pin (41) in the spring pin hole of housing (47).
4) Alternately tighten the four capscrews diagonally using a 85.5~104.5 kgf·m torque.
5) Attach all the hydraulic piping originally attached to the boom hoist winch.
6) Install the guards and all the other parts which were removed during removal of the boom hoist winch.
7) Supply extreme pressure gear oil #90 to the reduction unit until it reaches the proper oil level.
8) Attach the boom hoist wire rope to the drum.
9) Start up the engine, and with the boom hoist winch operating slowly, inspect the winch to confirm that it is working correctly and that there are no oil leaks.

4. BOOM HOIST PAWL



1.	BRAKE CYLINDER ASSEMBLY	6.	YOKE	13.	NUT
2.	PAWL	7.	SPRING	14.	NUT
2-3.	BUSHING	8.	GREASE FITTING	15.	WASHER
3.	ROD	10.	LOCKWASHER	16.	COTTER PIN
4.	PIN	11.	CAPSCREW	17.	LOCK WASHER
5.	PIN	12.	CAPSCREW	18.	WASHER

Fig. 4 Boom Hoist Pawl

4.1 GENERAL

This section involves the removal, inspection, repair, installation and adjustment of the boom hoist pawl.

4.2 DESCRIPTION

The boom hoist pawl is attached to the revolving frame behind the boom hoist drum.

The boom hoist pawl is released automatically when the boom is hoisted or lowered.

When the boom hoist lever is in neutral, no hydraulic pressure occurs in the drum lock brake cylinder and the drum pawl is aligned with the drum ratchet by the force of springs.

When the boom hoist lever is operated to lift or lower the boom, the hydraulic oil in the control circuit passes through the solenoid valve that prevents the lifting or lowering of the boom and enters the drum lock brake cylinder, releasing the drum pawl. (See Fig. 4.)

4.3 REMOVAL

If the pawl shows any signs of wear, cracks or damage when inspected, the pawl must be replaced.

The removal of the boom hoist drum pawl should be carried out using the following procedure. (See Fig. 4.)

1) Lower the boom to the ground and support it with a block. Loosen the tension of the boom hoist rope.
2) Stop the engine and relieve the hydraulic circuit of any remaining pressure by operating the control lever.
3) Remove cotter pin (16), lock washer (17) and pin (5).
4) Remove capscrew (12), lock washer (17) and pin (4) and then remove pawl (2).

4.4 INSPECTION AND REPAIR

Before installing the boom hoist drum pawl, please check the following items.

1) Check the pawl. Replace if there is any sign of wear, cracks, or damage.
2) Check the brake cylinder. Repair or replace if there are any operational malfunctions or leaks.
3) Inspect the spring and replace if necessary.
4) Inspect the ratchet of the boom hoist drum; repair or replace if there is any sign of wear, cracks or other damage.

4.5 INSTALLATION

Installation of the boom hoist drum pawl should be carried out using the following procedure. (See Fig. 4.)

1) Grease pin (4) and attach pawl (2) to the bracket with pin (4).
2) Grease the threads of capscrew (12) with Loctite #242 and attach pin (4) to the bracket with an (oil lubricated) 0.83~1.01 kgf·m tightening torque.
3) Attach yoke (6) to pawl (2), joining them with pin (5), washer (18) and cotter pin (16). Please grease pin (5) during this operation.

4.6 ADJUSTMENT

Adjustment of the boom hoist drum lock pawl should be carried out using the following procedure. (See Fig. 5)
Adjust spring (1) and (2) such that the dimension of S becomes 15mm~20mm when the pawl has been released. At that time, the set length of spring (1) becomes approx. 41mm and the set length of spring (2) becomes approx. 38mm.

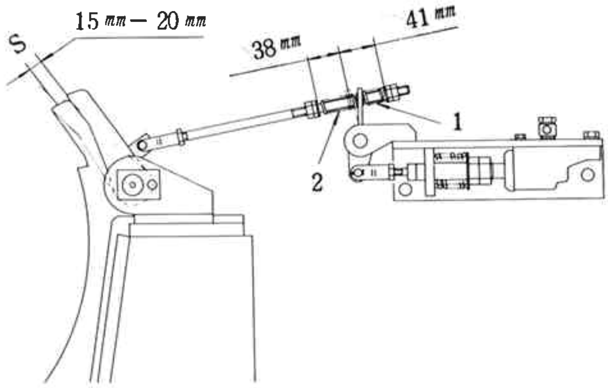


Fig. 5 Boom Hoist Pawl Adjustment

1. LOCATION OF COMPONENTS

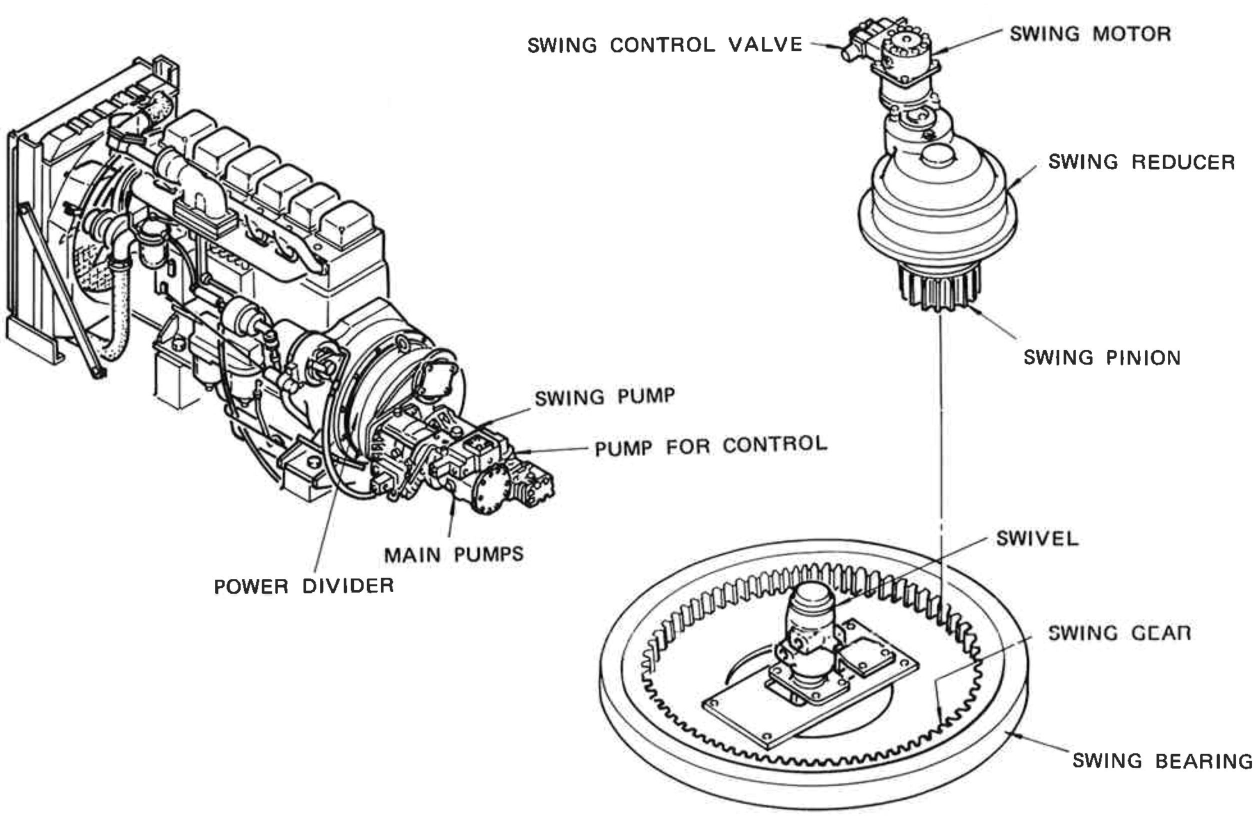


Fig. 1 Swing System

2. SWING MOTOR

2.1 GENERAL

This chapter explains the removal and installation of the swing motor.

For the disassembly and reassembly of the swing motor, refer to the separately available shop manual "Component Section".

2.2 DESCRIPTION

The swing motor is located on the front of the revolving frame, mounted directly on top of the swing reducer. The swing motor of this machine is a fixed displacement type swash plate axial piston motor with a built-in brake. The swing brake is a spring set, hydraulic release, wet-type multi-plate disk brake. (Fig. 2)

2.3 REMOVAL

Proceed as follows to remove the swing motor. (Fig. 2)

1) Place the machine on flat and rigid ground, and set the swing lock.
2) Stop the engine and move the swing lever back and forth several times to purge residual pressure from the hydraulic circuit.
3) Before removing the swing motor, clean the swing motor and the hydraulic pipes.
4) Remove all hydraulic pipes; plug the ports and cap the hydraulic pipes to prevent the entry of foreign matter.
5) Remove the four capscrews holding the motor and remove the swing motor from the reduction unit

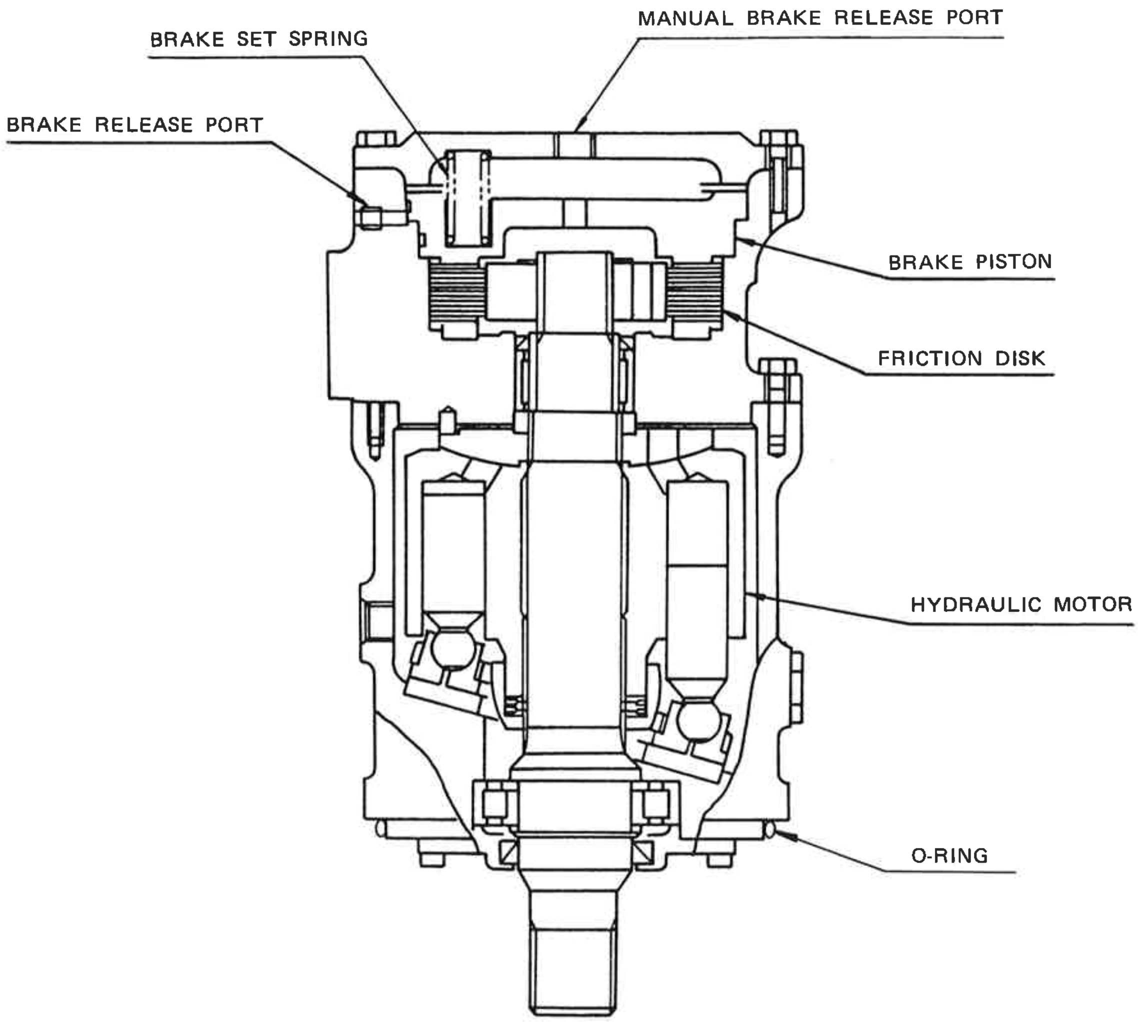


Fig. 2 Swing Motor

using a lifting device of suitable capacity.
Swing motor weight: about 80 kg

2.4 INSTALLATION

Proceed as follows to install the swing motor. (Figs. 2 & 3)

1) Put a lightly greased O-ring on the spigot joint of the swing motor fitting part.
2) Set the swing motor on the reduction unit using a lifting device of suitable capacity, and tighten the four capscrews.
   At this time, apply Loctite #242 or equivalent to the threads of the capscrews and tighten to 24 kg-m.
3) Attach all motor piping.
4) Fill the casing with hydraulic oil through the manual brake release port/motor drain port.
5) Start the engine and perform left and right swing operations with the swing brake and lock activated to relieve air.
6) Swing at low speed, and confirm that there is no abnormal noise or oil leakage.

3. SWING REDUCER

3.1 GENERAL

This chapter explains the removal, disassembly, inspection, repair, assembly and installation of the swing reducer.

3.2 DESCRIPTION

The swing reducer converts the swing motor rotation to low-speed and high-torque and transmitting it to the swing pinion. The swing reducer consists of two stages: flat gear reduction and planetary gear reduction. The planetary gear reduction in the second stage is performed by means of the planetary pinion and ring gear.

3.3 REMOVAL

Proceed as follows to remove the swing reducer. (Fig. 3)

1) Place the machine on flat and rigid ground, and set the swing lock.
2) Move the swing lever back and forth several times to purge residual pressure from the hydraulic circuit.
3) Before removing the swing motor, clean the swing motor and the hydraulic pipes.
4) Remove the drain plug from the reducer and drain all the oil into a suitable container; screw the plug back in.
5) Put match marks on the reducer casing and swing frame.
6) Remove all hydraulic pipes; plug the ports and cap the hydraulic pipes to prevent the entry of foreign matter.
7) Remove the 19 capscrews mounting the reducer and detach the reducer assembly from the machine using a lifting device of suitable capacity.
   Reducer assembly weight: about 390 kg.
8) Remove the swing motor.

3.4 DISASSEMBLY

Proceed as follows to disassemble the swing reducer. (Fig. 4)

1) Place the swing reducer with the swing pinion side facing upwards; enter match marks on the mating surfaces of the rear casing (104), ring gear (202), front casing (102), etc.
2) Remove the capscrew (604), end plate (252) and shim (962), and take out spacer ring (253) and swing pinion (251).
3) Remove the capscrew (601) and take off the front cover (101).
   Then, remove the oil seal (801) from the front cover (101).
4) Reverse the swing reducer and place it on a block so that the motor side faces upwards.
5) Remove the capscrew (703) and take off the rear casing (104) using the jack bolt hole.
6) Remove the No. 1 gear (208) and bearing (404) from the rear casing (104).
7) Remove the No.1 pinion (209) and ball bearing (405) using a puller.
8) Remove the sun gear (204).
9) Remove the capscrew (701); reverse the gear reducer and place the whole assembly on a block with the output shaft facing upwards.
10) Remove the capscrew (603); set an eye bolt in the screw hole at the end of the output shaft (201) and slowly lift it perpendicularly in order to separate the ring gear (202) from the middle casing (103).
11) Remove the ring gear (202).
12) Place on a press table with the output shaft at the bottom; press ,down the front casing (102) and remove the second-stage planetary assembly from the front casing (102).
13) If it is necessary to disassemble the second-stage planetary assembly, proceed as follows. (Fig. 3)
    a) Remove the bearings (401,402) with a bearing puller.
    b) Take out the spring pin (932).
    c) Take out the pin (262) using a press.
    d) Remove the planetary gear (203) and thrust washer (281).
    e) Remove the other two pairs of pins (262), planetary gears (203) and thrust washers (281) in the same way.
    f) Remove the thrust button (282).

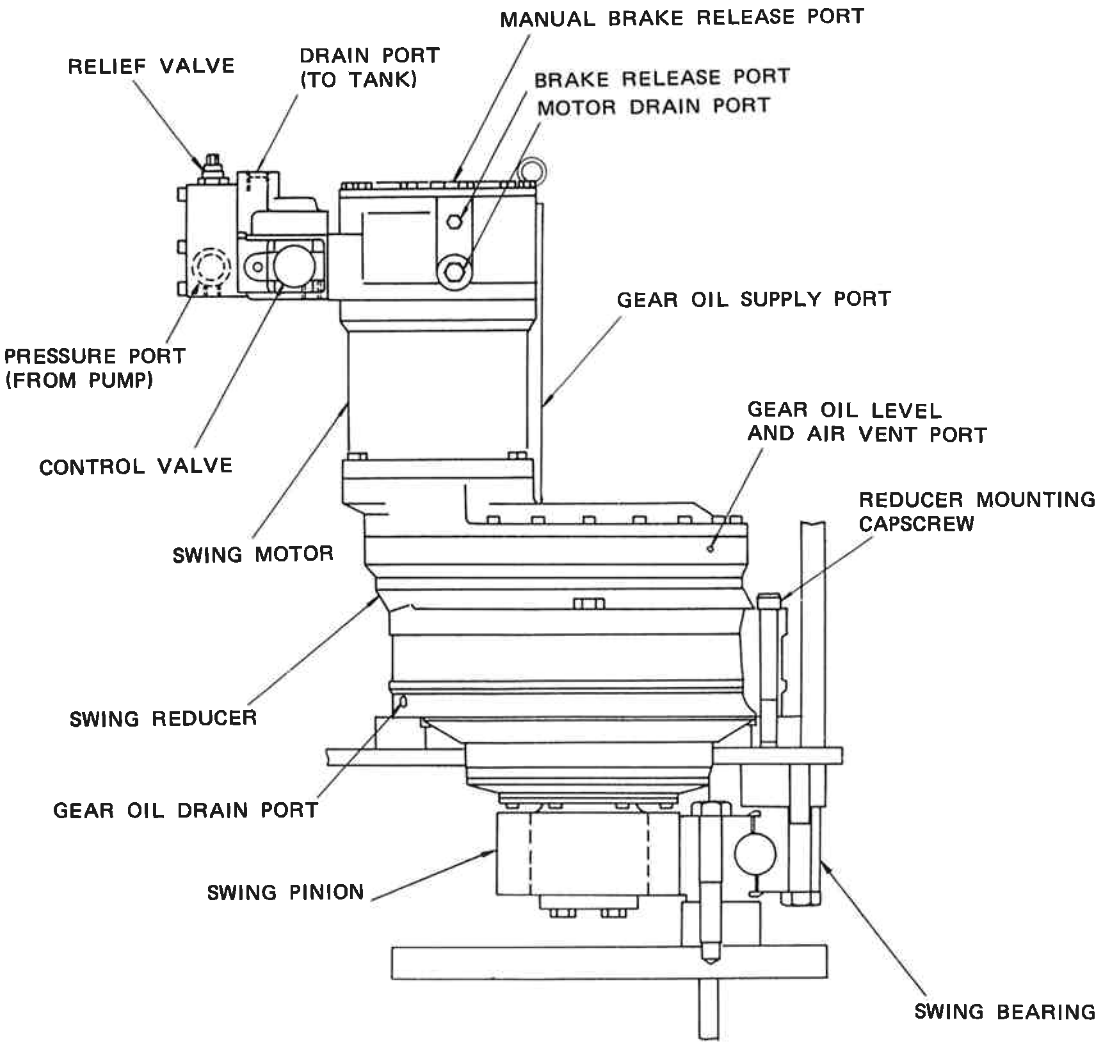


Fig. 3 Swing Motor and Reducer

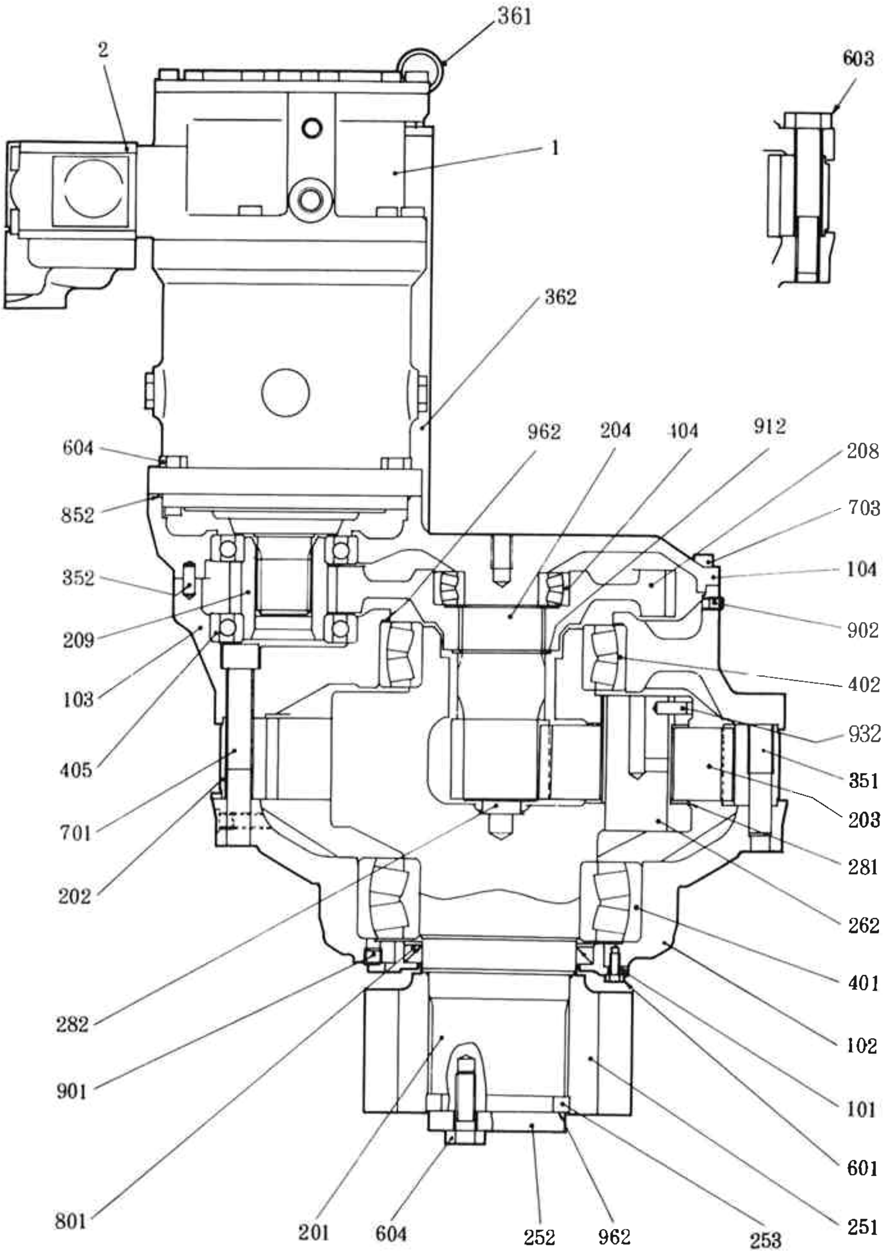


Fig. 4 Swing Reducer

1. MOTOR
2. CONTROL VALVE
101. FRONT COVER
102. FRONT CASING
103. MIDDLE CASING
104. REAR CASING
201. OUTPUT SHAFT
202. RING GEAR
203. PLANETARY GEAR
204. SUN GEAR
208. GEAR NO.1
209. PINION No.1
251. SWING PINION
252. END PLATE
253. SPACER RING
262. PIN
281. THRUST WASHER
282. THRUST BUTTON
351. KNOCK PIN
352. PIN 10 x 25
361. LEVEL BAR
362. PIPE
401. BEARING
402. BEARING
404. BEARING
405. BALL BEARING
601. CAPSCREW
603. CAPSCREW
604. CAPSCREW
701. CAPSCREW
703. CAPSCREW
801. OIL SEAL
852. O-RING
901. PLUG
902. PLUG
903. PLUG
912. SNAP RING
932. SNAP RING
961. SHIM
962. SHIM

3.5 INSPECTION AND REPAIR

Check all components before putting the swing reducer back together. Replace all suspicious parts in order to prevent any accidents beforehand and to extend the service life of the reducer. Proceed as follows for inspection.

1) Clean all parts with pure cleaning oil and dry with compressed air.
2) Check bearing balls, rollers, inner races and outter races for flaws and pitting; replace all faulty parts.
3) Apply a light coat of lubricant to those bearings showing no pitting or flaws; check for gaps or rattling in the axial and circumferential directions. Replace any part that has a large gap or rattles.
4) Check engaging surface of outer race and inner race to which bearings are fitted in. Replace any part showing traces of wear on rotating surface.
5) Check the pinion and gear tooth surfaces; replace any part showing pitting, scoring, wear, bend, crack. When replacing the planetary pinion and shaft, replace all planetary and shaft units.
6) Check the spline; repair or replace any part showing crack, wear, strong local impact, etc.
7) Check the thrust washer, thrust plate and thrust button; repair or replace any part showing wear, scoring, seizure, etc.
8) Check the housing and cover; repair or replace any part showing wear, deformation, scratch, etc.
9) Check the capscrew and screw holes; repair or replace any parts showing burrs, wear, etc.

3.6 ASSEMBLY

Proceed as follows to assemble the reducer unit. (Fig. 4)

1) Apply Loctite #242 or equivalent to capscrews before tightening.
2) If the second-stage planetary gear was disassembled, proceed as follows to assemble it. (Fig. 4)
   a) Put the thrust button (282) on the driving shaft (201).
   b) Place the driving shaft (201) on the press table; after applying a light coat of grease, insert the thrust washer (281) and planetary gear (203) into the driving shaft (201).
   c) Press set the pin (262) with the press; at this time, confirm that the spring pin (932) holes are in the right position.
   d) Set the spring pin (932).
   e) Warm the bearings (401,402) in oil to about 120°C, and put them on the driving shaft (201).
3) Support the front casing (102) on a block; press set the secondary-stage planetary reducer bearing (401) assembled in the preceding item into the front casing (102).
4) Apply Loctite #515 to the mating surfaces of the front casing (102) and ring gear (202), and enter match marks; set the ring gear (202) to the front casing (102). Pay attention to the engagement of the knock pin (351).
5) Apply Loctite #515 to the mating surfaces of the ring gear (202) and middle casing (103), and press set the middle casing into the secondary-stage planetary reduction bearing (402) by observing the match marks.
6) Evenly tighten opposite capscrews (603,701).
7) Set the snap ring (912) to the sun gear (204); then put it, engaged with the planetary gear (203), on to the driving shaft (201).
8) Warm the two bearings (405) to about 120°C in oil and put one of each side of the No.1 pinion (209).
9) Press set the No.1 pinion assembly bearing (405) assembled in the preceding item into the middle casing (103).
10) Press set the bearing (404) into the No.1 gear (208).
11) Press set the bearing (404) of the No.1 gear (208) assembled in the preceding item into the boss part of the rear casing (104).
12) Apply Loctite #515 to the mating surfaces of the middle casing (103) and rear casing (104), and line up the match marks; then set the rear casing (104) assembly to the middle casing (103) by matching

the spline part of the bearing and No.1 gear (208). Pay attention to the engagement of the knock pin (352).

13) Evenly tighten opposite capscrews (703).
14) Insert the oil seal (801) into the front cover (101); apply a light coat of grease to the lip of the oil seal (801).
15) Invert the reducer assembly, and place it on a block with the output shaft side facing upwards.
16) Apply Loctite #515 to the mating surfaces of the front cover (101) and front casing (102), and line up the match marks; then put the front cover (101) on the front casing (102) while lining up the match marks. Tighten the capscrews (601) evenly.
17) Put the swing pinion (251) and spacer ring (252) on to the driving shaft (201).
18) Insert the shims (962) and tighten the end plate (252) with the capscrew (604).
    At this time, adjust shim thickness so that the gap between the spacer ring (253) and the end plate (252) is 0.05~0.15 mm.

3.7 INSTALLATION

Proceed as follows to install the reducer.

1) Apply a light coat of grease to O-ring (852) and put it on the output shaft of the swing motor.
2) Put the swing motor on the rear casing (104) of the reducer and evenly tighten opposite capscrews (604).
3) Suspend the swing reducer assembly with a lifting device of suitable capacity; slowly lower it perpendicularly while engaging the swing pinion and the ring gear; enter match marks.
4) Evenly tighten opposite capscrews to 51~63 kg-m.
5) Fit all swing motor hydraulic piping.
6) Add specified gear oil through the oil port of the reducer up to the level plug.
7) Turn at low speed, and check that there is no abnormal noise or oil leaks.

4. SWING LOCK

Fig. 5 is a diagram of the swing lock. The swing lock is engaged and released manually. The lever movement is transmitted to the pin by means of the link mechanism. When the lever is pushed down the pin is engaged in the pin hole of the lower frame, serving as the swing lock. When the lever is lifted up the pin moves upward, releasing the swing lock.

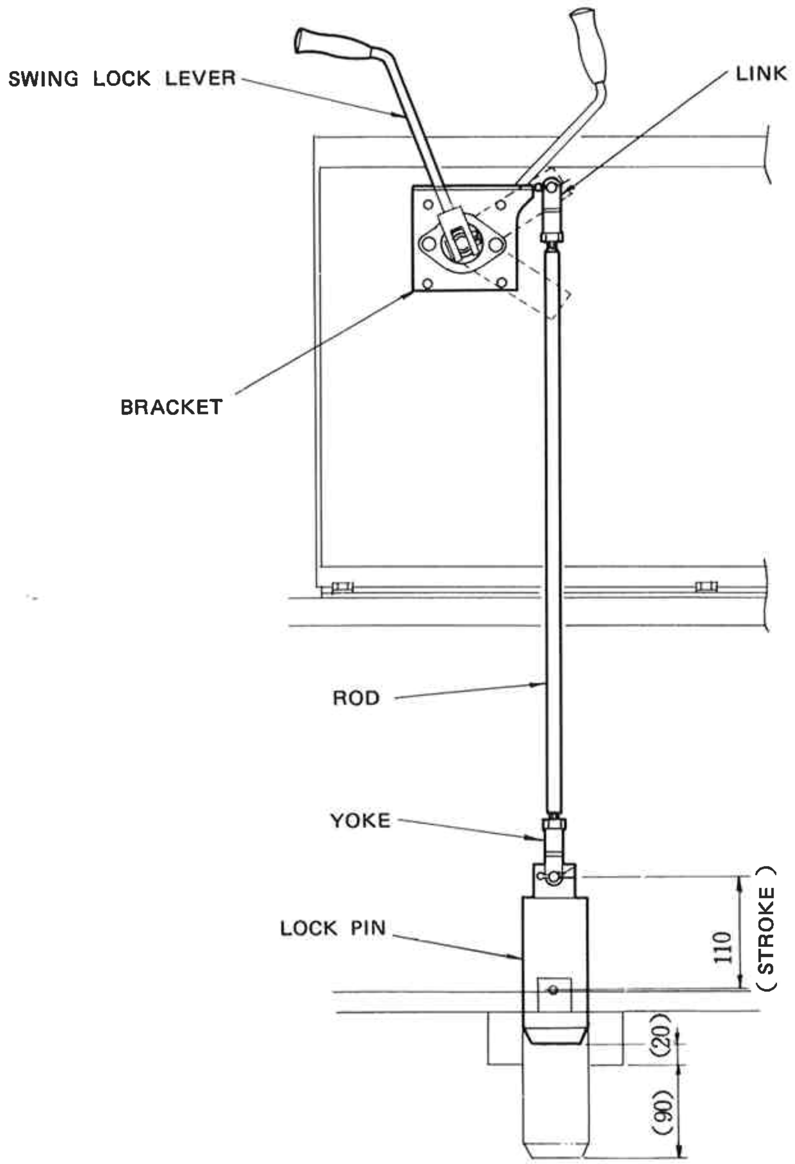


Fig. 5 Swing Lock

5. SWING BEARING

5.1 GENERAL

This chapter explains the removal and installation of the swing bearing.

NOTE

Replacing the swing bearing is a dangerous task requiring precision. If you want to replace the swing bearing within the warranty period, be certain to contact our service staff. Bear in mind that we will not be responsible for the removal of a swing bearing performed without contacting our service staff.

The work procedures described in this section are designed to be of assistance in the removal and installation of the swing bearing after the warranty period is over. However, we recommend that you still contact our service staff even should you intend to work by following these steps.

5.2 DESCRIPTION

The swing bearing, as shown in Figures 6 and 7, is made up of an inner race, outer race and balls; the inner race (swing gear) is bolted to the lower frame turret and the outer race is bolted to the revolving frame.

The swing reducer's pinion, engaged with the swing gear of the inner race, rotates the upper part of the machine a full 360°.

5.3 REMOVAL

Proceed as follows to remove the swing bearing. (Figs. 9 and 10)

WARNING

Before removing the swing bearing, the entire upper structure of the machine must be removed, which requires utmost care.

Pay maximum attention to preventing the upper part of the machine from tilting or falling over when lifting or removing it from the car body. Lack of attention could lead to a serious accident, possibly fatal.

1) Place the machine on flat and rigid ground so that it cannot move when removing the upper part; use blocks to fix the crawler.
2) Remove the boom.
3) Remove the hydraulic pipes fitted to the swivel joint. At this time, attach name tags to pipes in order to facilitate reassembly. Cap all ports of the pipes and swivel joint to prevent the entry of foreign matter.
4) Support the upper part with a crane of suitable capacity. Confirm that the upper part is firmly supported.
   Remove the capscrews fixing the upper part to the swing bearing.
5) Loosen from below the 36 oapscrews fixing the outer race of the swing bearing to the upper part and let them drop on to the car body.
6) Slowly lift the upper part until the lower edge of the swing frame is higher than the hydraulic swivel; swing the crane and lower the upper part on to support blocks.
7) Remove the 40 capscrews fixing the inner race of the swing bearing to the car body.
8) Screw suitable eyebolts in at opposite positions on the swing bearing,
   Swing bearing weight: 7055 – about 670 kg
   7065 – about 840 kg

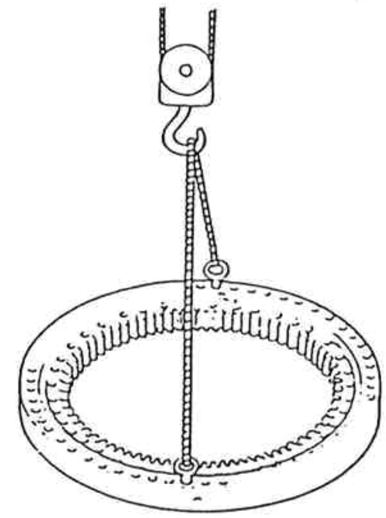


Fig. 8 Removal of Swing Bearing

NOTE

The swing bearing cannot be repaired. If the swing bearing becomes unusable, replace with a new one.

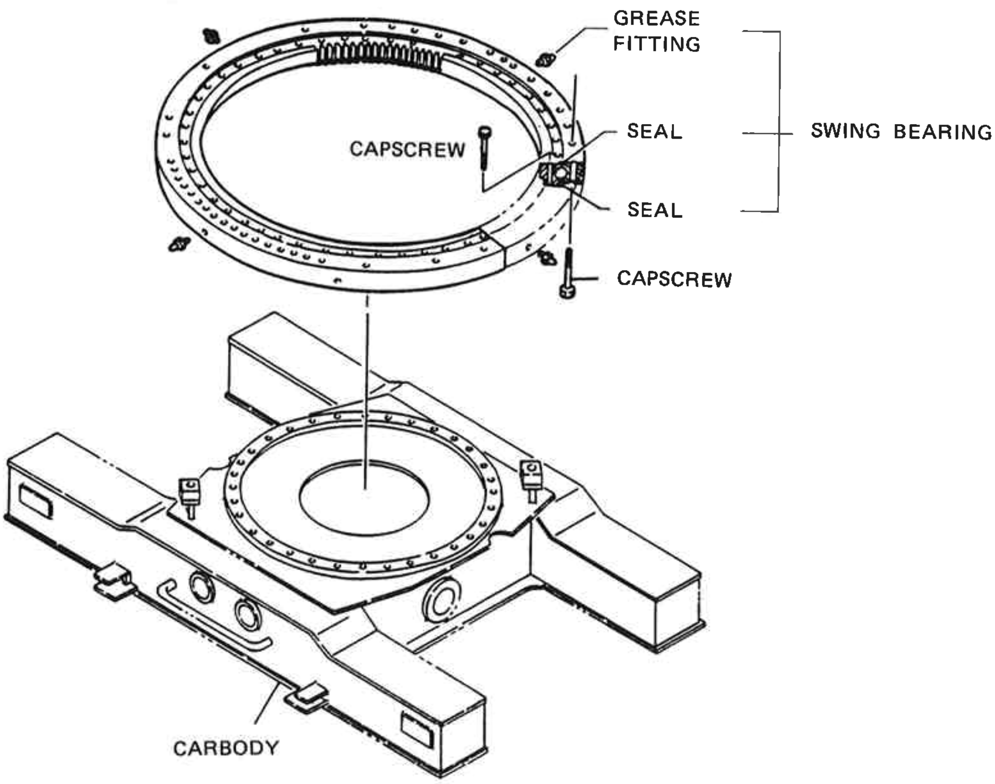


Fig. 6 Swing Bearing (7055)

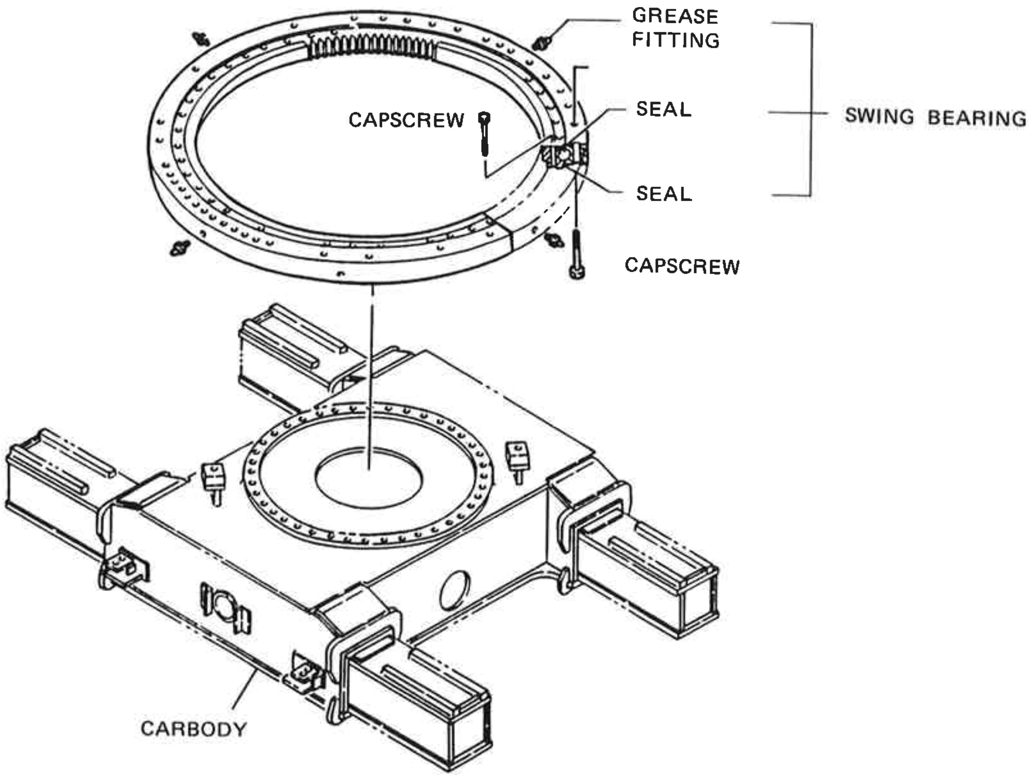


Fig. 7 Swing Bearing (7065)

5.4 INSTALLATION

Proceed as follows to install the swing bearing. (Figs. 9 and 10)

1) Thoroughly clean the fitting seat of the swing frame, lower frame and bearing before installation, completely clean off all dirt and oil.
2) Screw two eyebolts into the new swing bearing; hoist the swing bearing, and place it on the car body. At this time, pay attention in placing the inner race on the car body so that the S mark engraved on the inner race is at the right or left side of the crawler and that fitting holes perfectly match.
3) Apply Loctite #242 or equivalent to the 40 capscrews fixing the inner bearing.
4) Tighten two capscrews located 180° apart at 15 kgf·m.
5) Tighten two capscrews located 90° from those in 4) above at 15 kgf·m.
6) Tighten all opposite capscrews at 15 kgf·m.
7) Repeating this procedure tighten all capscrews at 130~150 kgf·m.
8) Apply grease containing molybdenum disulfide to the gear surface after tightening the swing bearing to the lower frame.
9) Place the upper part on the swing bearing so that the S mark engraved on the outer race of the swing bearing is to the right or left side of the swing frame.
10) Apply Loctite #242 or equivalent to the threads of the 36 capscrews for fixing the outer race to the swing frame.
11) Fit the outer race to the frame in the same way as fitting the inner race to the car body, tighten at the same final torque of 130~150 kgf·m.
12) Install all hydraulic pipes removed before taking off the swing bearing.
13) Check the tightening torque of the capscrews of the swing bearing after 200 hours of operation.

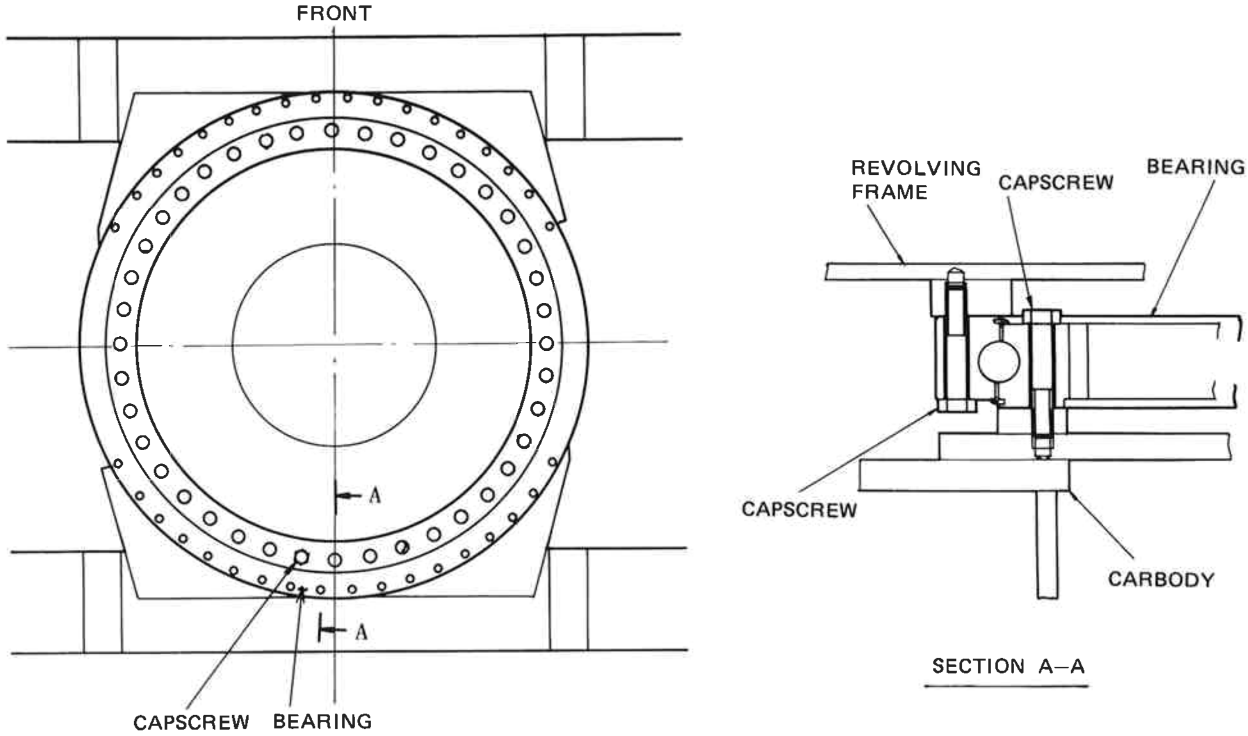


Fig. 9 Swing Bearing Installation (7055)

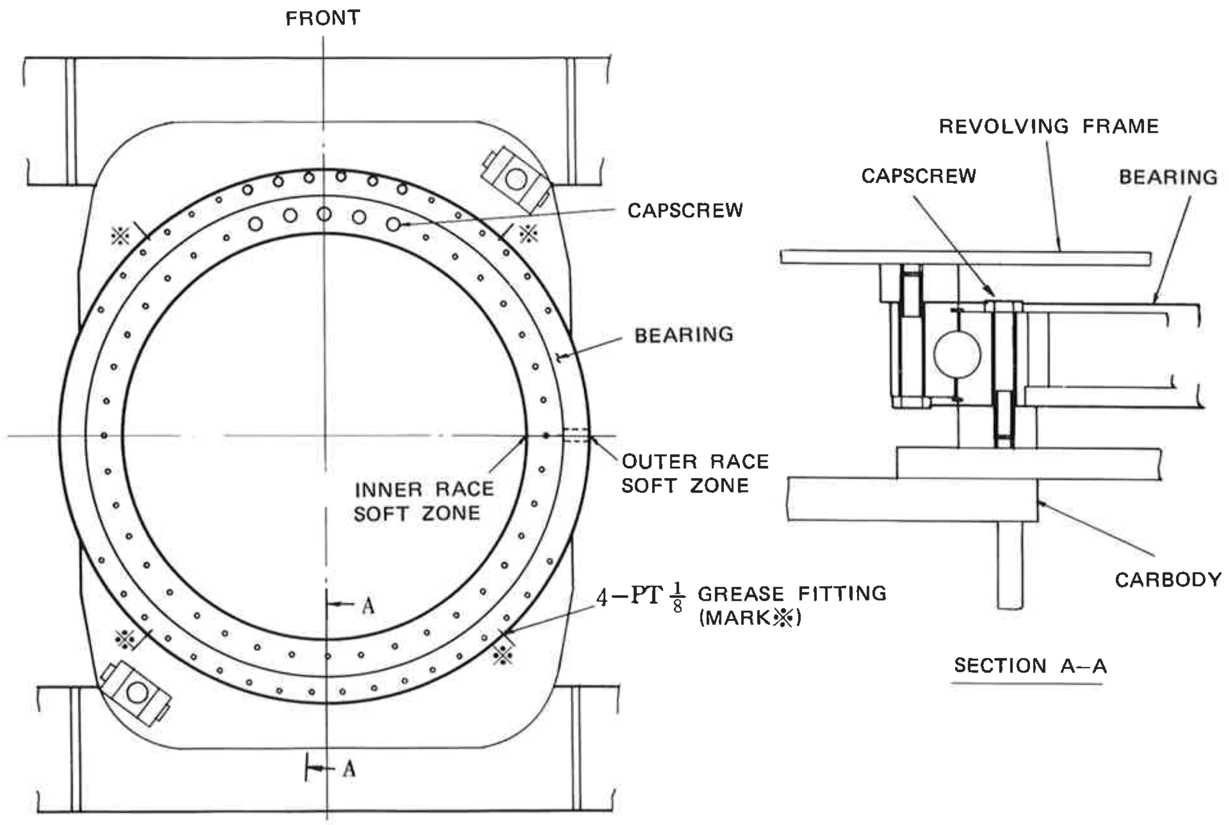
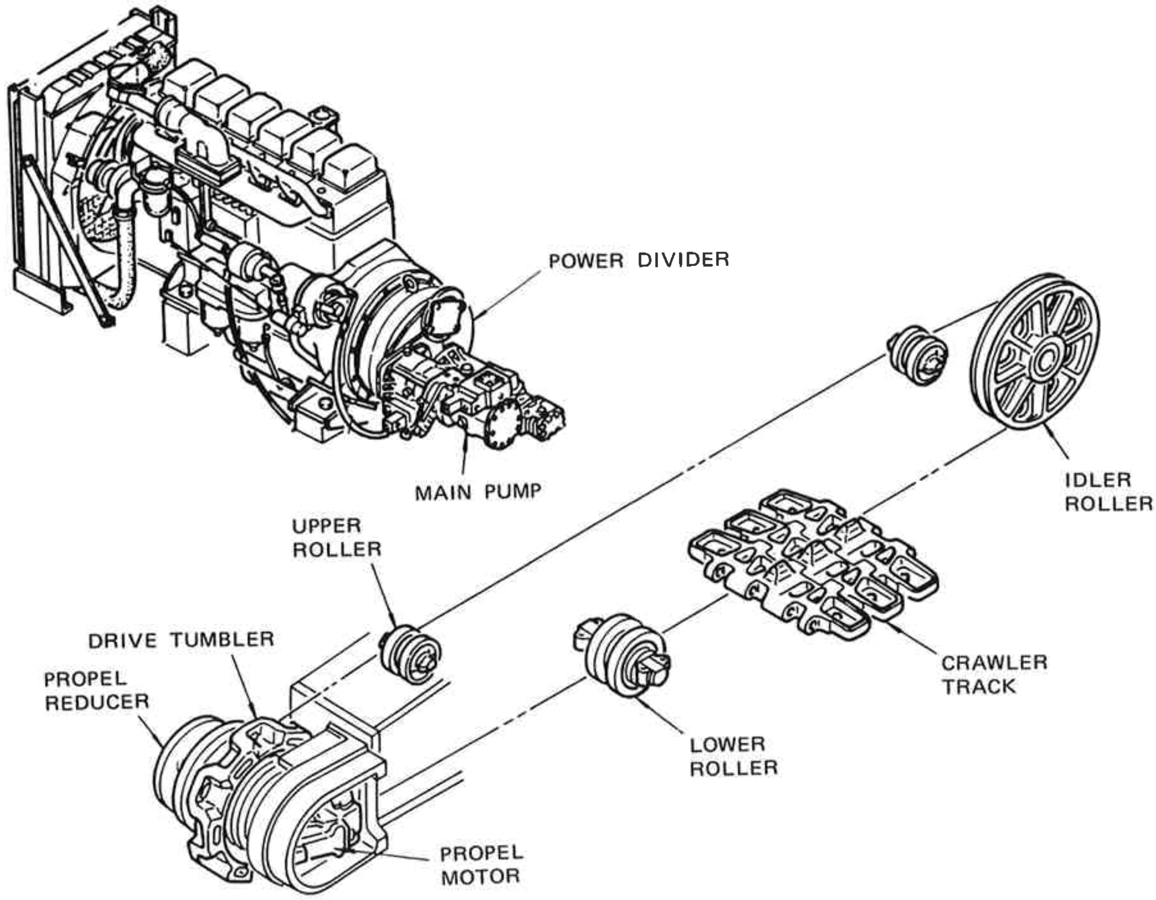


Fig. 10 Swing Bearing Installation (7065)

1. LOCATION OF COMPONENTS



2. PROPEL MOTOR AND BRAKE

2.1 GENERAL

This chapter deals with the removal and installation of the propel motor and propel brake.
For details of the propel motor and propel brake, please refer to the "Components Section" in the separate shop manual.

2.2 DESCRIPTION

This hydraulic motor is a variable displacement type axial piston motor. One of these hydraulic motors is attached to both the left and right crawler frames.
Pressurized oil from the hydraulic pump passes through the control valve and swivel joint, and enters the hydraulic motor, causing the hydraulic motor's output shaft to rotate.
The rotation of the output shaft is slowed down by the propel reducer, and by running the drive sprocket the machine is propelled. The direction of propulsion is determined by the position of the control valve spool. The speed of propulsion can be switched to low or high speed by means of the propel speed shift switch on the instrument panel.
The propel brake is built into the propel motor, and is composed of two types of disc, one a steel plate with cogs on the outside, and the other a brake plate with cogs on the inside.
The disc with cogs on the inside is engaged with the spline of the gear which stopped onto the output shaft of the motor. The disc with cogs on the outside engages with the spline on the inner side of the brake housing.

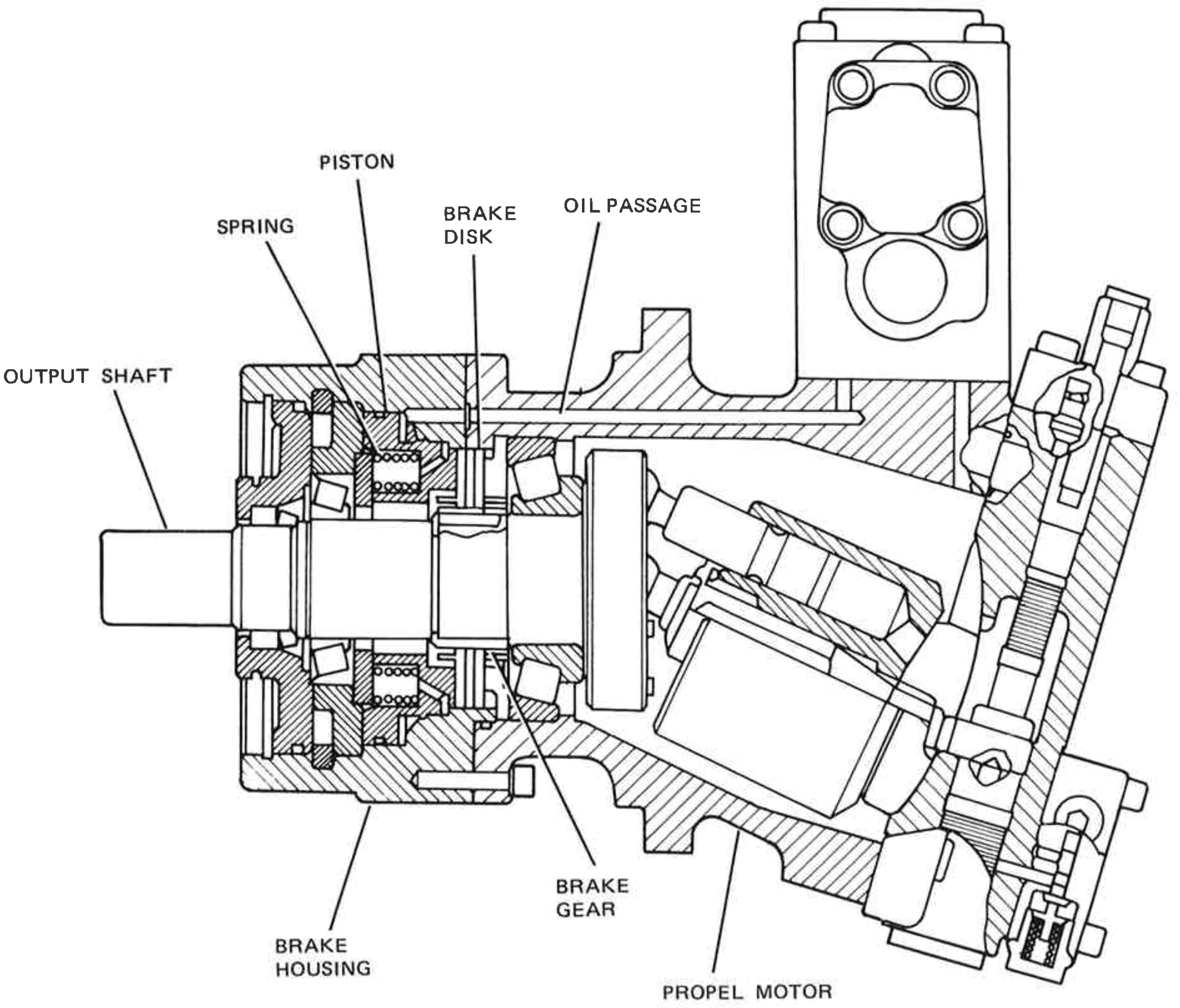


Fig. 2 Propel Brake

When the propel lever is in neutral, the spring causes friction on the discs by pushing the piston.

As a result, the two discs come together, and the disc stopped by the spline on the inner side of the brake housing stops the rotation of the motor's output shaft. The drive tumbler is connected to the motor's output shaft, an if that is fixed the machine stops.

In order to run the propel motor, if pressurized oil is sent along to the propel motor, the oil pressure in that section operates the back of the piston.

This oil pressure compresses the spring which holds the two types of disc together, and they separate.

After the above, the motor's output shaft can rotate freely. (Fig. 4)

2.3 REMOVAL

To remove the propel motor, proceed as follows. (Fig. 3)

1) Stop the machine with the propel reducer drain plug facing straight down. (Fig. 4)
2) Stop the engine and drain the oil from inside the reducer into a suitable container.
   Remove the propel motor cover.
3) Remove all of the hydraulic piping and put identification tags on each one.
   Attach caps and plugs to prevent foreign matter from entering the hydraulic piping and the hydraulic motor.
4) Support the propel motor with a lifting device.
5) Remove the capscrews holding the propel motor to the reducer, and remove the propel motor by means of screw hole M16.
   The propel motor weighs approximately 87 kg (including the counterbalance valve).
6) Remove the O-ring.

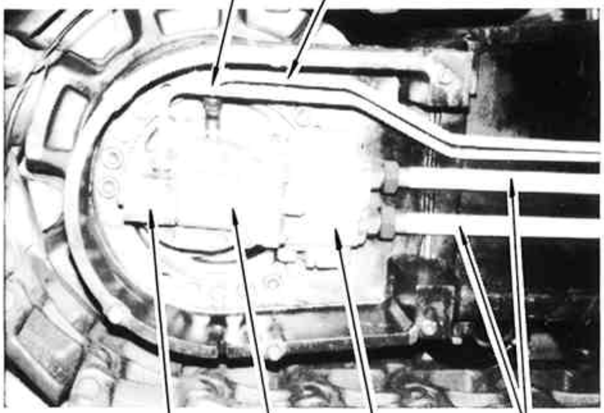


Fig. 3 Propel Motor Installation

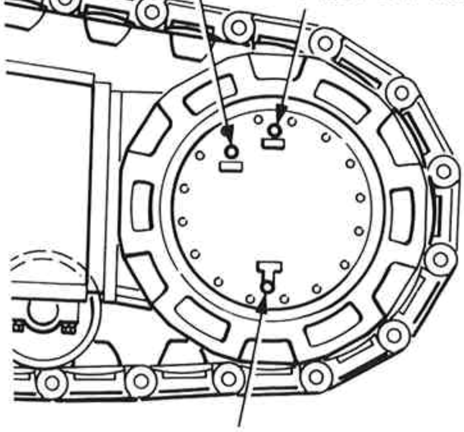


Fig. 4 Plugs of Reducer

2.4 INSTALLATION

To install a new or overhauled propel motor, proceed as follows. (Fig. 2)

When installing the propel motor, be sure that the shaft is properly aligned. Faulty shaft alignment can cause excessive wear of the propel motor.

1) Check that there are no burrs or any other flaws on the mating surfaces of the reducer and the propel motor, inner diameter of the reducer spindle, spline coupling to be fitted to the reducer input shaft, and spline of the propel motor output shaft, in order to guarantee correct fitting of the propel motor to the propel reducer spindle.
2) Apply a thin coating of grease to the reducer spindle gauge and the spline of the propel motor output shaft. Apply Loctite #515 or equivalent to the mating surfaces of the reducer spindle and propel motor flange.
3) Apply a thin coat of grease to the O-ring, and insert it into the reducer spindle.
   Attach the propel motor to the reducer spindle.
   Apply Loctite #242 or equivalent to the threads of the capscrews, and tighten at 25.5~31.5 kgf·m.
4) If the counterbalance valve has been removed, attach it to the propel motor.
5) Attach all of the hydraulic piping.
6) Attach the motor cover to the crawler frame. Apply Loctite #242 or equivalent to the threads of the capscrews, and tighten at 26~31 kgf·m.
7) From the FILL port in the propel reducer, pour in gear oil SAE #90 up to the LEVEL port.
8) Start the engine, and check for strange noises, oil leaks, operative problems etc.

3. PROPEL REDUCER

3.1 GENERAL

This chapter deals with the removal and installation of the propel reducer.

For details of the propel reducer, please refer to the "Components Section" in the separate shop manual.

3.2 DESCRIPTION

The propel reducer is attached to the rear part of the crawler frame to the left and right.

The spindle, which is the fixed part of the propel reducer, is attached to the rear section of the crawler frame on the outside. The drive tumbler is attached to the propel reducer's output hub. The propel reducer slows the rotation of the propel motor and increases torque by means of a 3-stage planetary reduction units. The planetary structure is composed of a planetary pinion, a sun gear, spider and ring gear.

The planetary pinion rotates freely, supported by the spider. The rotation of the sun gear, supported by the planetary pinion, slowly rotates the ring gear, gaining a large reduction ratio. (Fig. 5)

3.3 REMOVAL

To remove the propel reducer, proceed as follows. (Fig. 5)

1) Place the machine on level and stable ground and stop the engine with the propel reducer DRAIN port setting lowest position.
2) Drain the oil from inside the reducer into a suitable container.
3) Remove residual pressure from the system by operating the propel lever back and forth several times.
4) Referring to Chapter 4, remove the crawler track.
5) Place a jack under the corner of the car body nearest to the reducer. Use a suitable block underneath the jack which can support the machine's weight.
6) Jack up the machine so that there is no weight on the drive tumbler.
7) Remove the propel motor cover.
8) Clean the motor section and the pipe coupling section, and remove the motor piping, the brake

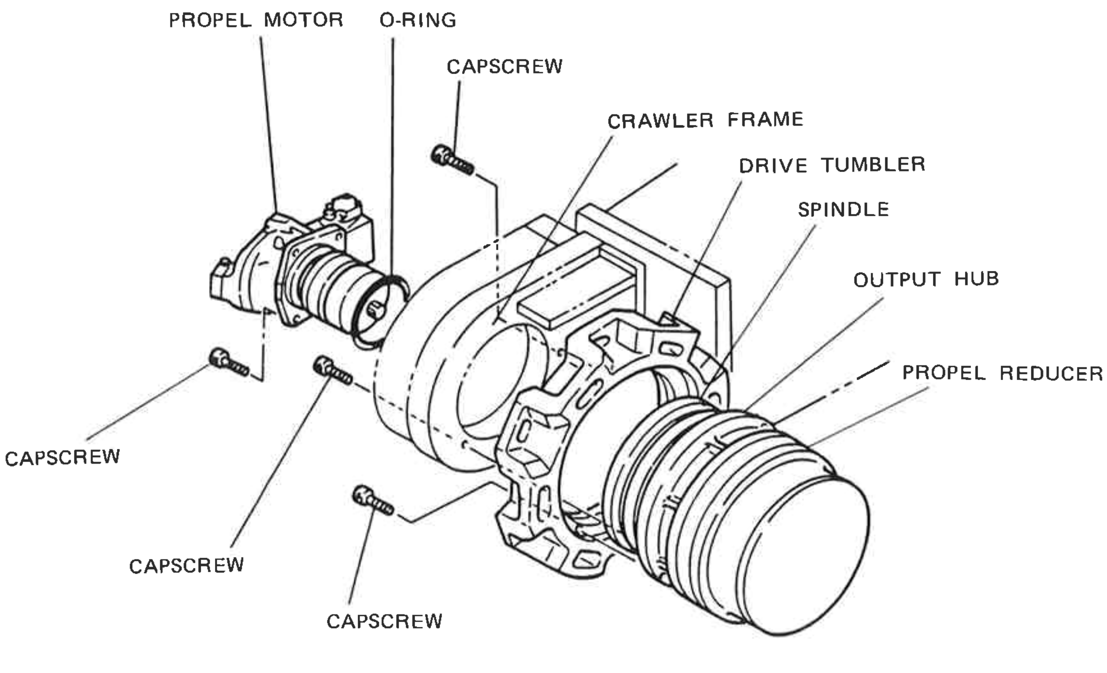


Fig. 5 Propel Reducer Installation

piping and the motor drain piping.

After removing the piping, attach plugs and caps to all of the motor ports and the hydraulic piping to prevent the entry of foreign matter.

9) Remove the counterbalance valve from the hydraulic motor.

10) Put matchmarks on the reducer between the crawler frame and the spindle which is attached to it.

11) Suspending the reducer assembly with a lifting device of suitable capacity, remove the capscrews holding the propel reducer to the crawler frame, and remove the reducer assembly from the crawler frame using the screw holes in three places of the reducer.

Including the drive tumbler, the reducer weighs:

7055 approx. 550 kg

7065 approx. 635 kg

12) Remove the capscrews holding the drive tumbler to the reducer and detach the drive tumbler from the reducer by means of the jack screw holes in three places.

13) Remove the propel motor.

3.4 INSTALLATION

To install the propel reducer, proceed as follows. (Fig. 5)

1) Apply Loctite #242 or equivalent to the threads of the capscrews, and attach the drive tumbler to the reducer output hub, tightening at 51~63 kgf·m.

2) Clean the joining surfaces of the crawler frame and the propel reducer.

3) Attach a lifting device of suitable capacity to the propel reducer, and, lining up the matchmarks, attach the reducer to the crawler frame. Apply Loctite #242 or equivalent to the threads of the capscrews, and tighten at 83~106 kgf·m.

4) Apply a thin coat of grease to the O-ring, and attach it to the propel motor.

5) Attach the coupling to the propel reducer's sun gear shaft.

6) Put the propel motor's output shaft onto the coupling. It may be necessary to rotate the coupling in order to match the motor's output shaft with the coupling spline.

Apply Loctite #242 or equivalent to the threads of the capscrews and tighten the propel motor at 25.5~31.5 kgf·m.

7) Remove the jack and block supporting the car body, and attach the crawler track to the crawler frame.

8) From the FILL port in the reducer, pour in high pressure gear oil SAE #90 up to the LEVEL port.

9) Start the engine, and check for strange noises and oil leaks while it is running at low speed.

4. CRAWLER COMPONENTS

4.1 GENERAL

This subsection covers the maintenance and repair of the crawler components.

4.2 MAINTENANCE

Crawler component wear cannot be prevented completely, but the rate of wear can be held to a minimum by performing the following preventive maintenance procedures:

1) Check the propel drive components and the crawler rollers and idler often. Lubricate them in accordance with the lubrication charts.
2) Keep crawler parts tight. Check the torque of the components in Table 1, and maintain the torque specifications.
3) Maintain proper track adjustment (see Crawler Adjustment in this subsection).
4) Check the crawler components daily for leaks. Repair or replace parts as required.
5) Clean mud and debris from the crawler components daily.

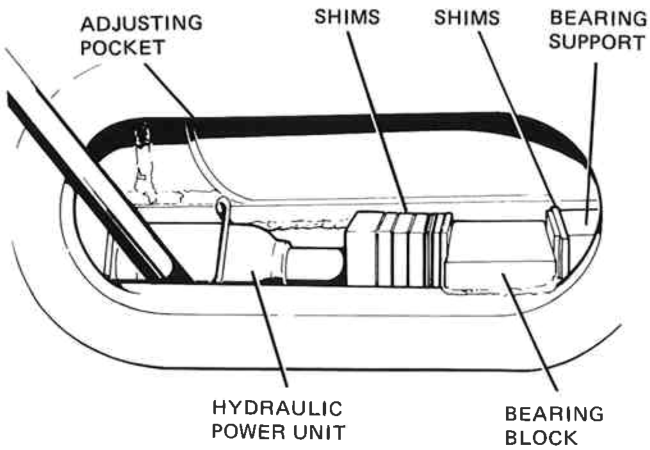
4.3 CRAWLER TRACK TENSION ADJUSTMENT

Adjust crawler track tension, as follows (see Figure 1):

1) Propel the machine so that any sag will appear at the front of the track (the end where the adjustment is made). Remove the capscrews that secure the cover on the track adjusting pocket.
2) Remove the shims found in front of the bearing blocks.
3) Place a hydraulic power unit between the side frame bracket and the bearing block. Jack the idler sprocket forward to remove the slack from the track.
4) Place the shims behind the bearing block, in the slot opening, to take up the space.
5) Repeat steps 1 through 4 on the other side.

NOTE

The amount of sag in the right side crawler track must equal the amount of sag in the left side crawler track. This is necessary to maintain parallel alignment of the propel motion.



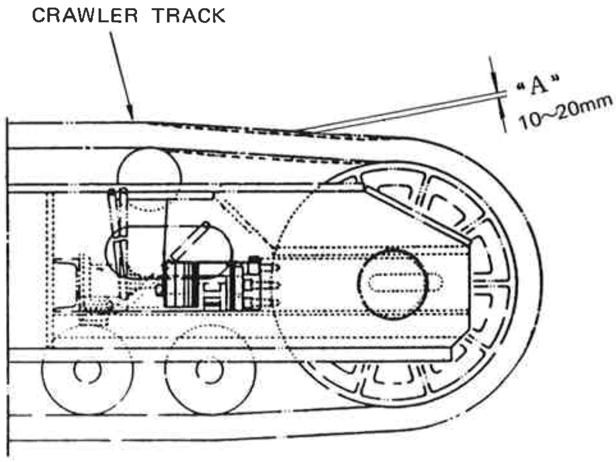


Fig. 6 Crawler Track Adjustment

6) Place the remainder of the shims in the slot in front of the bearing block to hold it firmly in place.
7) When the track has been properly adjusted, install the adjusting pocket cover.
8) After an extended period of operation, crawler track wear will reach the point where all the shims are on the inside of the bearing block. When this point is reached, remove all shims and break the crawler track. Remove one crawler shoe. Reconnect the track and obtain the desired track tension by placing shims behind the bearing block until the desired track tension is achieved.

Table 1. Bolt Torque Table

BOLT LOCATION	BOLT TORQUE kgf-m	BOLT TORQUE Ft - Lb
Motor Mounting Bolts	25.5 ~ 31.5	184 ~ 228
Propel Reducer Retaining Bolts	86 ~ 106	62 ~ 766
Drive Tumbler Bearing Retainer Bolts	51 ~ 63	369 ~ 455
Upper Roller Retaining Bolts	16.5 ~ 20.5	119 ~ 148
Crawler Roller Retaining Bolts	51 ~ 63	369 ~ 455
Upper Rail Retaining Bolts	48 ~ 53	347 ~ 383

4.4 CRAWLER TRACK REMOVAL AND INSTALLATION

4.4.1 REMOVAL

To remove the track, proceed as follows (see Figure 7):

1) Loosen the track tension by removing the shims behind the bearing block of the idler shaft.
2) Remove the track pin hardware.
3) Drive out the track pin that is positioned above the vertical centerline of the idler shaft.
4) Propel the machine to the rear until the track is laid out flat. Do not propel the machine forward, because the crawler track will bunch up and may cause damage to the machine. Propel backward until the track is free of the crawler tumbler on the rear.
5) Jack up the carbody and pull the track out from under the crawler side frame.

4.4.2 TRACK REPAIRS

Repairs are limited to the replacement of individual parts. If the crawler has been adjusted to the point where no more slack can be taken up, a crawler shoe will have to be removed. If this is the case, it is important that this is done to both crawlers or there will be uneven propel motion.

4.4.3 INSTALLATION

To install the track, proceed as follows (see Figure 7):

1) Place the track under the crawler side frame and lower the machine onto the track. Insert a bar

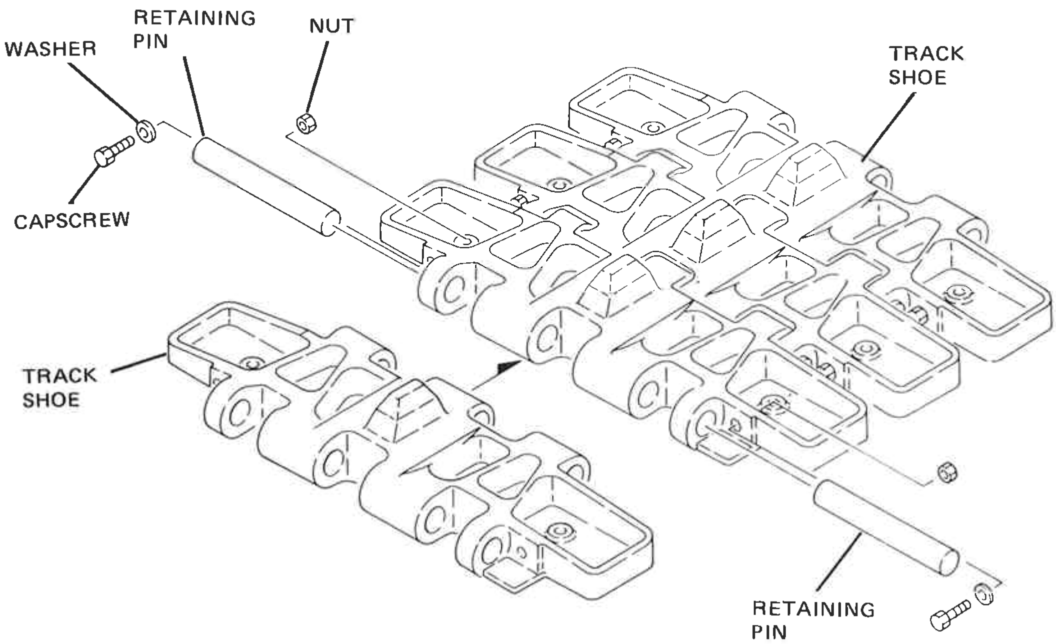


Fig. 7 Crawler Track

through the holes in the shoe and attach a cable to each end of the bar. Run the cable over the top of the crawler side frame and attach it to a pulling device. Propel the machine forward while keeping the cable taut. Make sure the shoe engages the rollers.
2) Continue this operation until the shoe is over the top of the idler shaft. Remove the bar and cables.
3) Using a suitable lifting device, lift the lower shoe portion and align the holes in the two shoes.
4) Drive the track pin into the two shoes until the pin is centered. Install the retaining pin hardware.
5) Adjust the track tension.

4.5 IDLER ROLLER ASSEMBLY

4.5.1 REMOVAL AND DISASSEMBLY

If it is necessary to remove the idler roller assembly, proceed as follows (see Figure 8):

1) Remove the crawler track as explained earlier in this subsection.
2) Place a jack beneath the corner of the carbody nearest the idler shaft to be removed. Use suitable blocking beneath the jack to support the weight of the machine on the jack.
3) Remove cover (10) and shims (11).
4) Support sprocket (9) with a suitable lifting device [the sprocket weights approximately 200 kg (440 lbs)] and remove capscrews (2) and lockwashers (12). Slide the assembly forward to remove it. Set it aside for further disassembly.
5) Remove bolts (3) and snap rings (4).
6) Separate guide blocks (5) and O-rings (6). Remove pin (7) and floating seals (8).

4.5.2 CLEANING AND INSPECTION

Clean and inspect all components as follows:

1) Clean all parts in solvent and dry with compressed air.
2) Inspect the bushings and pin. These parts should be replaced if worn excessively or deeply scratched.
3) Check all parts for cracks, breaks or unusual wear.
4) Replace both floating seals (8) and both O-rings (6).
5) Check the oil groove inside the pin. The groove must be open to allow the free flow of oil to the bushing.

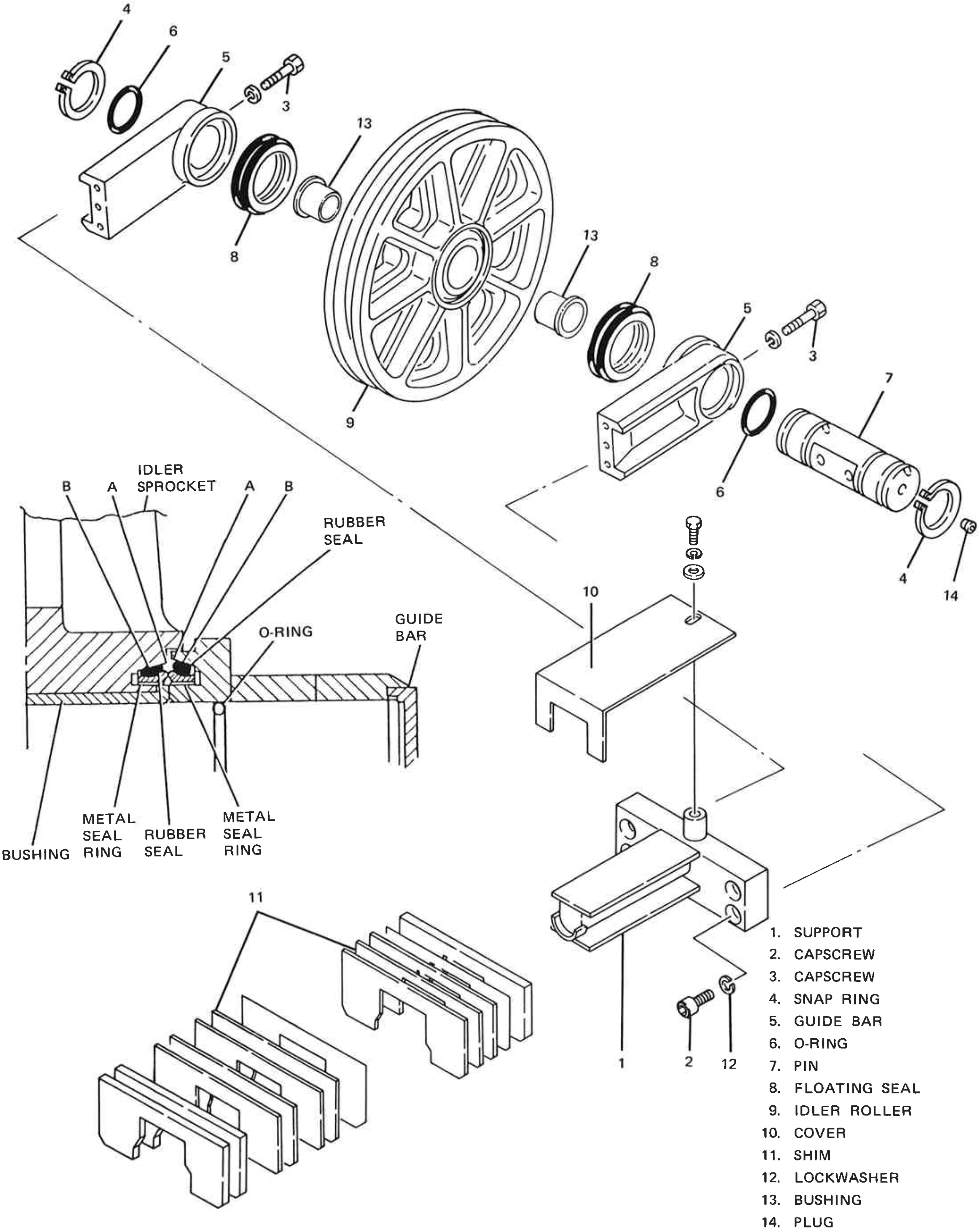
4.5.3 ASSEMBLY AND INSTALLATION

To assemble and install the crawler idler shaft, proceed as follows:

1) Install bushings (13) into idler sprocket (9).
2) Install an O-ring (6) into each inner groove on shaft (7).
3) Install shaft (7) into idler sprocket (9).
4) Remove all oil and any protective coating from the metal seal rings and from seal seat B on the idler roller (9), and from seal seat B on guide block (5). Use cleaning solvent and make sure that all surfaces are clean.
5) Check retaining lips A and seal seats B for any deep scratches or nicks. Smooth any nicks and reclean the seal seat to remove any abrasive dust. Also make sure that the sealing face of the metal seal rings is free of nicks.
6) Wipe all seal faces to remove any foreign material. Place a few drops of clean gear oil on a cleaning tissue and completely coat the sealing faces of the seals to ensure corrosion protection and initial lubrication. Install a rubber seal on each metal seal ring. Be certain that the rubber seals seat uniformly on the seal rings. Check to be sure that the rubber seals are not twisted and are resting uniformly against the lip that prevents them from falling off of the metal seal rings.
7) Install one half of a floating seal (8) into each guide block (5). Install the other half of each floating seal into idler sprocket (9). Press each rubber seal into its seal seat, making sure that it is straight in the bore and inside retaining lips A. Do not use a screw-driver or any sharp instrument to seat the rubber rings.
8) Install a guide block (5) onto each end of shaft (7).
9) Thread a bolt (3) through each guide block (5) and into shaft (7). Tighten blots (3) securely.
10) Use a snap ring pliers to install a snap ring (4) into the outer end of each guide block (5). The snap rings will hold shaft (7) in place. Loosely install the lubrication plug into the end of the shaft.
11) Attach the idler sprocket (9) to a suitable lifting device.

NOTE

The idler sprocket weights approximately 200 kg (400 lbs.).



1. SUPPORT
2. CAPSCREW
3. CAPSCREW
4. SNAP RING
5. GUIDE BAR
6. O-RING
7. PIN
8. FLOATING SEAL
9. IDLER ROLLER
10. COVER
11. SHIM
12. LOCKWASHER
13. BUSHING
14. PLUG

Fig. 8 Idler Sprocket Assembly

12) Lift the idler sprocket and lower it into position on the sideframe.
13) Slide the idler sprocket back until the guide blocks (5) contact the support (1).
14) Secure the guide blocks (5) to the support (1) with capscrews (2) and lockwashers (12).
15) Place cover (10) over the shims (11).
16) Remove lubrication plug (14) from shaft (7) and fill the hub of the idler sprocket with gear lube.
17) Attach the crawler track as indicated earlier in this subsection.
18) Adjust the crawler track as indicated at the beginning of this subsection.

4.6 DRIVE TUMBLER ASSEMBLY

4.6.1 REMOVAL AND DISASSEMBLY

To remove and disassemble the drive sprocket assembly, proceed as follows (see Figure 9):

1) Remove the track as described earlier in the subsection
2) Jack the machine at the corner of the carbody nearest the drive tumbler to be removed. Use suitable blocking beneath the jacks to support the weight of the machine on the jack.
3) Remove the propel reducer. See Subsection 3.
4) Remove the twenty one capscrews which secure the drive tumbler to the reducer.
5) Remove the drive tumbler from the reducer. The drive tumbler weights about 110 kg (240 lbs).

4.6.2 ASSEMBLY AND INSTALLATION

To install the drive tumbler, reverse the above procedure and adjust the crawler track as explained earlier.

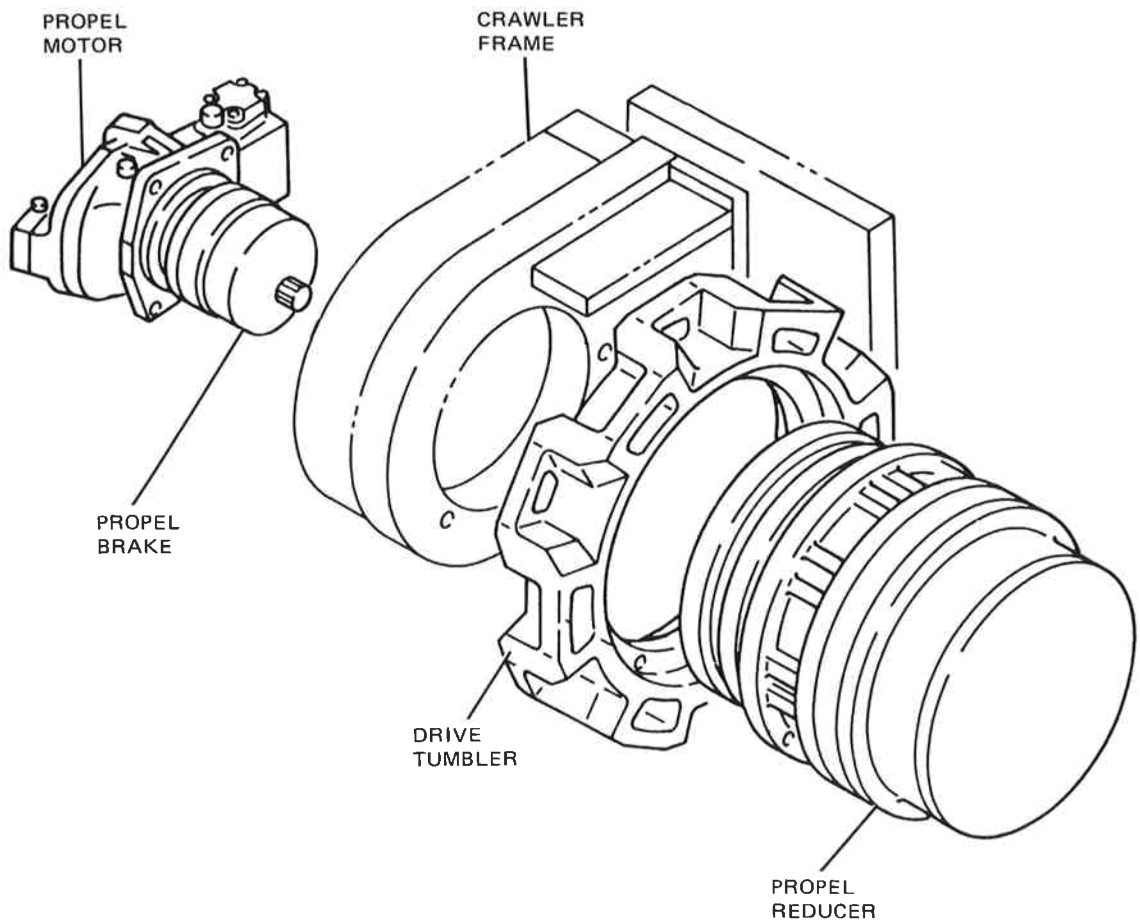


Fig. 9 Drive Tumbler Installation and Removal

4.7 CRAWLER ROLLER

4.7.1 DESCRIPTION

The crawler rollers guide the crawler track in a straight line as it rotates around the crawler side frame. Wear of the rollers is a result of contact between the crawler track and the outside surfaces of the rollers (see Figure 7 and Figure 10). These surfaces, called rolling diameters, can be expected to decrease as the machine is propelled. As the outside diameter of the rollers becomes smaller, the hubs of the rollers will come closer to the point of the drive teeth on the crawler track. The hub of the rollers must never be allowed to contact the drive teeth. The crawler rollers must be replaced before they wear to this extent.

4.7.2 REMOVAL

To remove a crawler roller, proceed as follows:

1) Jack up the carbody enough to allow the roller to drop out of the crawler frame. Fully support the side frame at the carbody. Remove all tension from the crawler track by removing the shims at the idler sprocket as previously described in this subsection.

NOTE

The crawler rollers can be removed without disconnecting the crawler track. However, the nearer the roller is to the end of the crawler, the less clearance there will be between the roller and crawler. It will be necessary to start in the middle and remove each roller until the faulty roller can be removed.

2) The crawler roller weighs approximately 60 kg (132 lbs). Support the roller so that it will not fall, and remove the capscrews which secure the roller collars (3) to the crawler side frame (see Figure 10). Remove the roller from the side frame.

4.7.3 DISASSEMBLY AND REPAIR

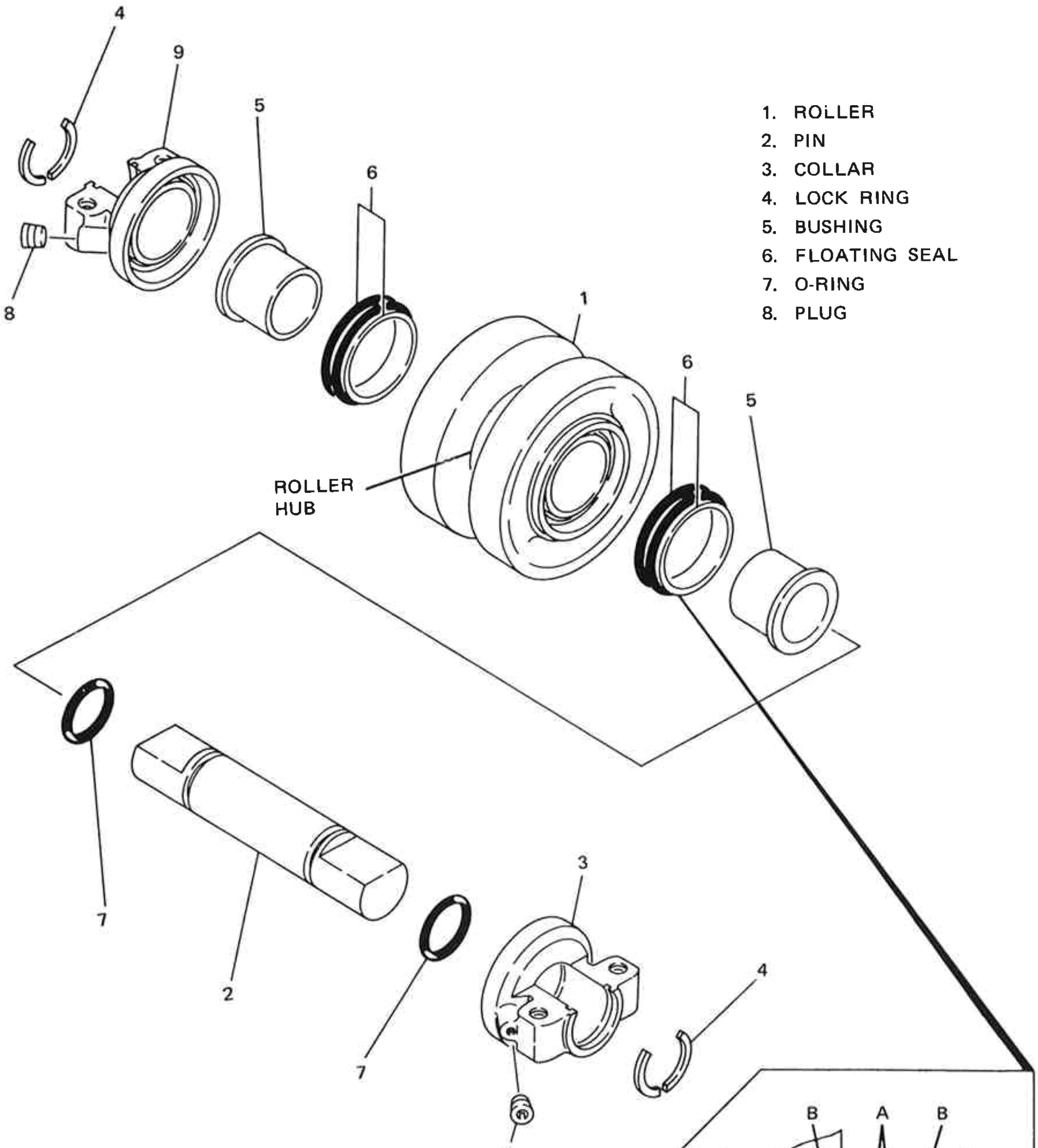
It is recommended that all floating seals and O-rings be replaced whenever a roller is disassembled. To repair a crawler roller, proceed as follows (see Figure 10):

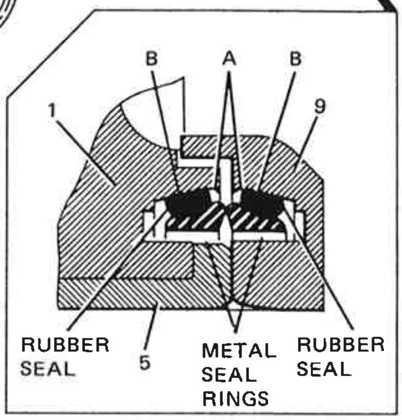
1) Remove plug (8) from the collar and drain the oil from the roller.
2) Remove lock rings (4) from each end of pin (2).
3) Pull collars (3) off of each end of pin (2).
4) Remove O-ring (7) from each side of pin (2).
5) Press pin (2) out of roller (1). Then remove bushings (5) by pressing them out of roller (1).
6) Remove one half of floating seal (6) from each collar (3) and the other half of floating seal (6) from each end of roller (1).
7) Thoroughly wash all parts in solvent and dry. Inspect all metal parts for excessive wear, cracks or distortion. Replace parts as required.

4.7.4 ASSEMBLY

To assemble the crawler roller, proceed as follows (see Figure 10):

1) Install bushings (5) into each side of roller (1).
2) Insert pin (2) into the roller.
3) Install floating seals (6) as follows:
   a) Remove all oil and any protective coating from the metal seal rings and seal seat B on the roller and collar. Use a cleaning solvent and make sure all surfaces are dry.
   b) Check retaining lips A and seal seats B for rough tool marks or nicks. Smooth any nicks and reclean. Also make sure that the sealing face of the metal seal rings is free of nicks.
   c) Wipe all seal faces to remove any foreign material. Place a few drops of clean gear oil (see Section III) on a cleaning tissue and completely coat the sealing faces of the seals to assure corrosion protection and initial lubrication. Install a rubber seal on each metal seal ring so they seat uniformly on the metal rings. Be sure the rubber seals are not twisted and are resting uniformly against the lip that prevents them from falling off the metal seal rings.
   d) Install one half of a floating seal in each collar (3) and in each end of roller (1). Press the rubber seal into the seal seat making sure that it is straight in the bore and inside retaining lips A. DO NOT use a screwdriver or any sharp instrument to seat the rubber rings.
4) Install a new O-ring (7) in the groove on each side of pin (2). Install collars (3) on the end of pin (2).
5) Align the mounting holes and install lock rings (4).
6) Fill the crawler roller with gear oil through the hole in collar (3) and install plugs (8).





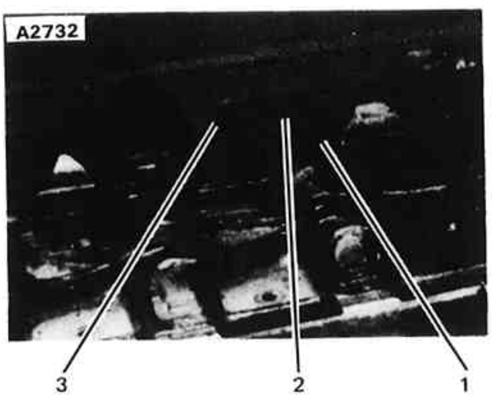


Fig. 10 Crawler Roller

4.7.5 INSTALLATION

To install a new or repaired crawler roller, proceed as follows:

1) Position the roller below the crawler side frame and align the mounting holes. Block the roller in position.
2) Apply Loctite #242 on the threads of the mounting screws. Install the screws with flat washers. Torque the screws to 51 to 63 kgf-m (370 to 455 ft-lbs).
3) Install all other crawler rollers that were removed.
4) Remove the blocking from the rollers and adjust track tension.
5) Raise the crawler with the jack and remove the blocking from the carbody. Lower the crawler onto the ground.

1. INTRODUCTION

1-1 ARRANGEMENT OF COMPONENTS

(1) LIFTCRANE

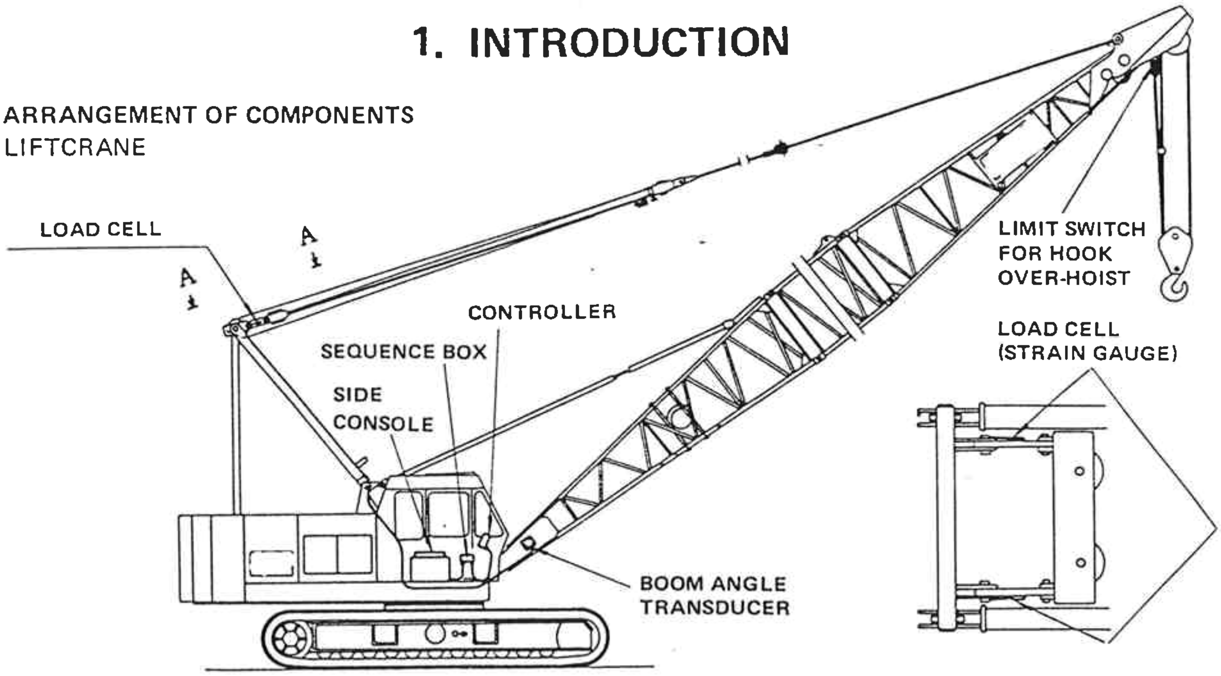
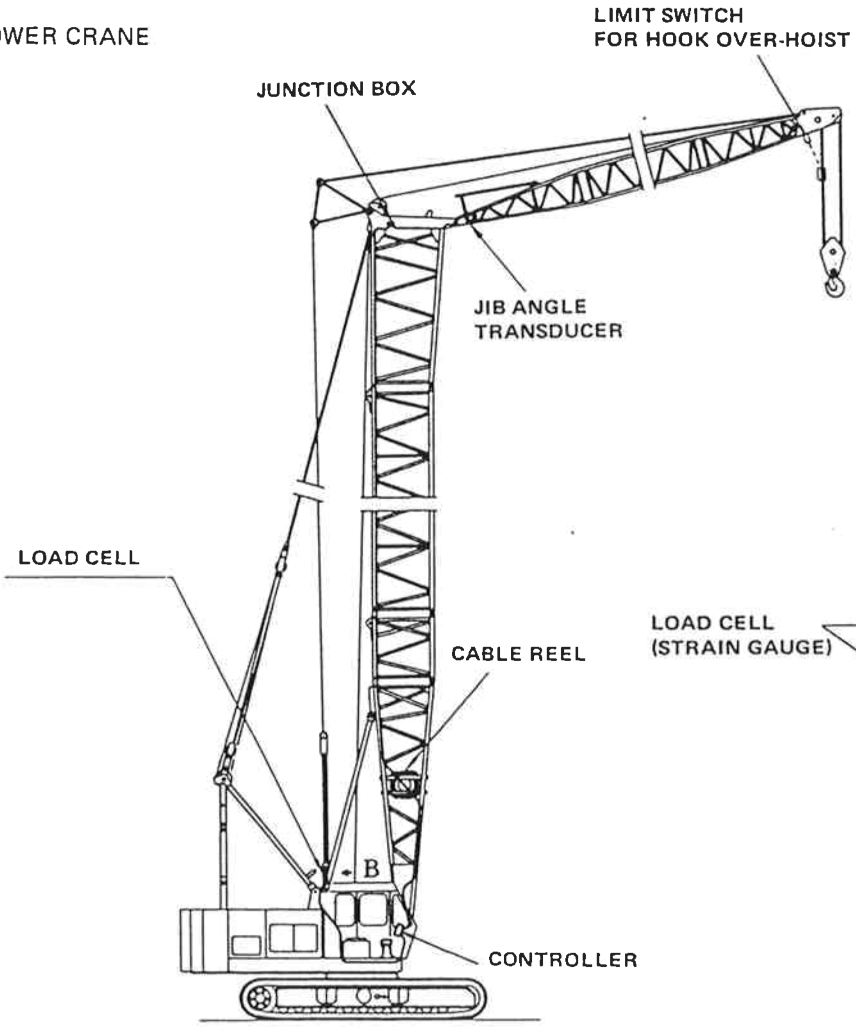
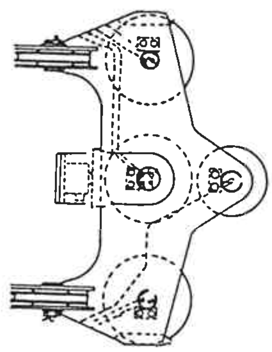


Figure 1. Arrangement of Components (Liftcrane)

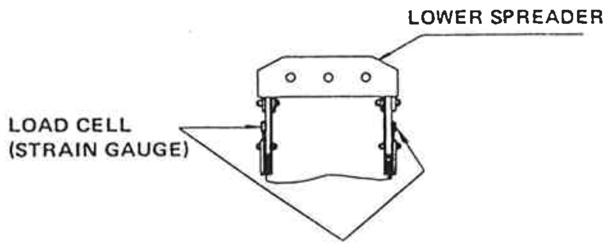
VIEW FROM "A–A" (200B · 200B-1)

(2) TOWER CRANE





VIEW FROM "A–A" (500B · 500B-1)



VIEW FROM "B"
(200B · 200B-1)

Figure 2. Arrangement of Components (Tower Crane)

1-2 BLOCK DIAGRAM

The block diagrams of the load safety devices for liftcrane and tower crane are shown in Figures 3 and 4.

NOTE

The different load cell and angle transducer are used individually for liftcrane and tower crane. Therefore, the cables should be also changed.

(1) LIFTCRANE

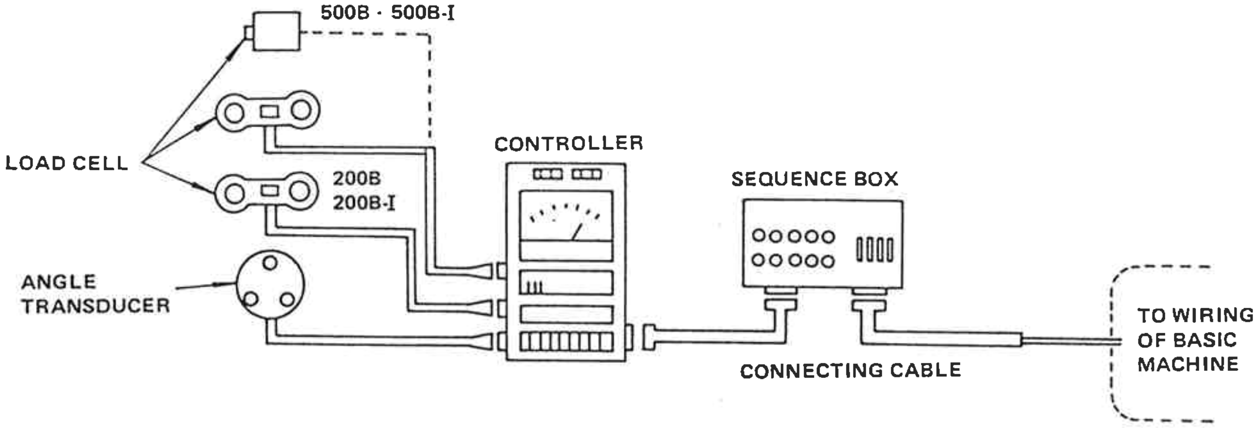


Figure 3. Block Diagram of Load Safety Device (Liftcrane)

(2) TOWER CRANE

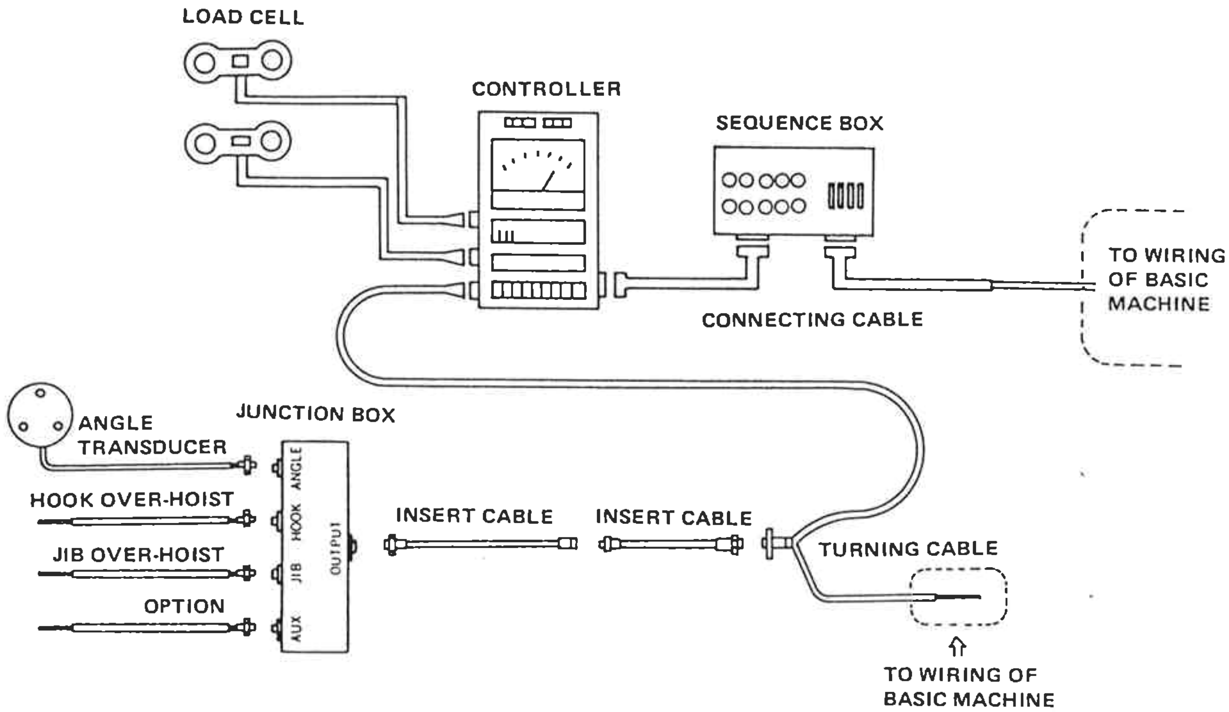
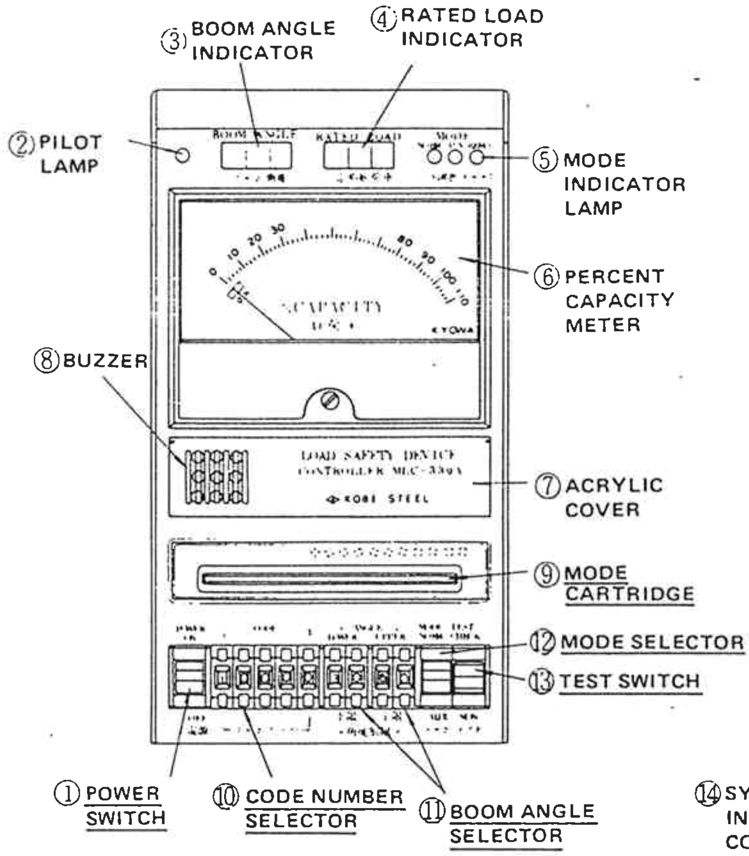
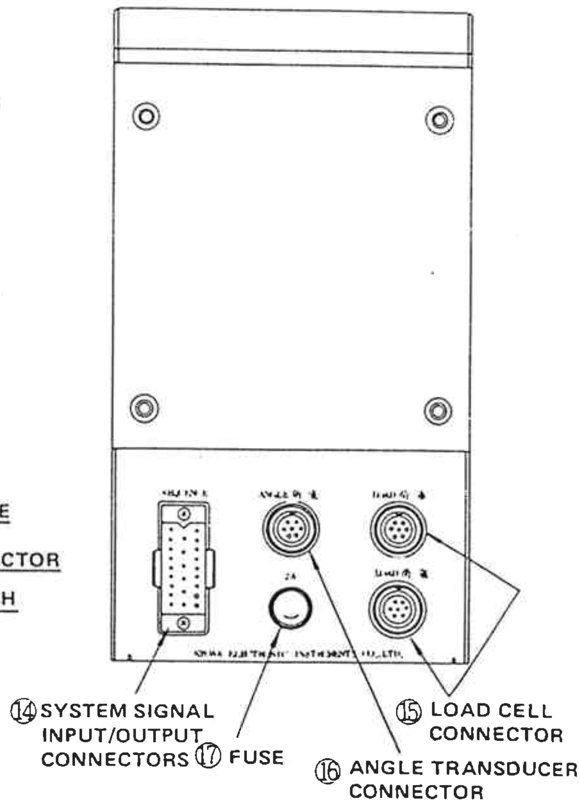


Figure 4. Block Diagram of Load Safety Device (Tower Crane)

1-3 IDENTIFICATION OF COMPONENTS

(1) CONTROLLER

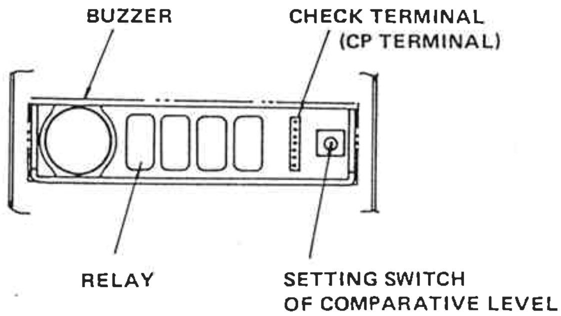




NOTE: Parts to be operated are shown with underlines.

Figure 5. Front Panel of Controller

Figure 6. Back Panel of Controller



VIEW WHEN ACRYLIC COVER (7) IS OPENED.

(2) LOAD CELL

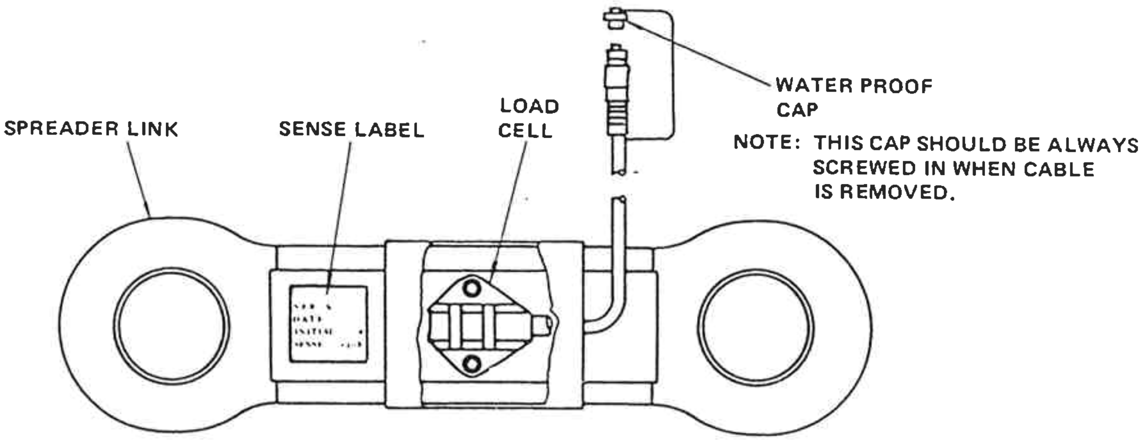


Figure 7. Load Cell (For 200B · 200B-I)

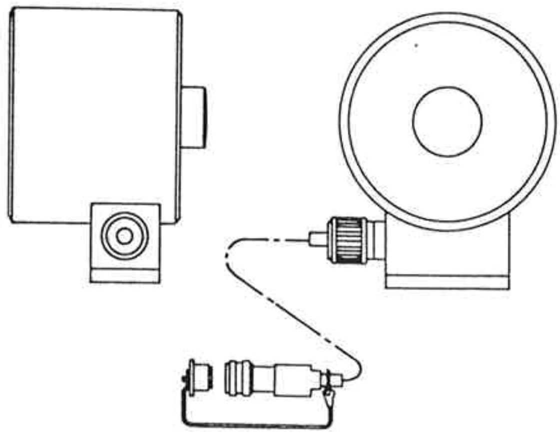


Figure 7A. Load Cell (For 500B · 500B-I)

(3) ANGLE TRANSDUCER

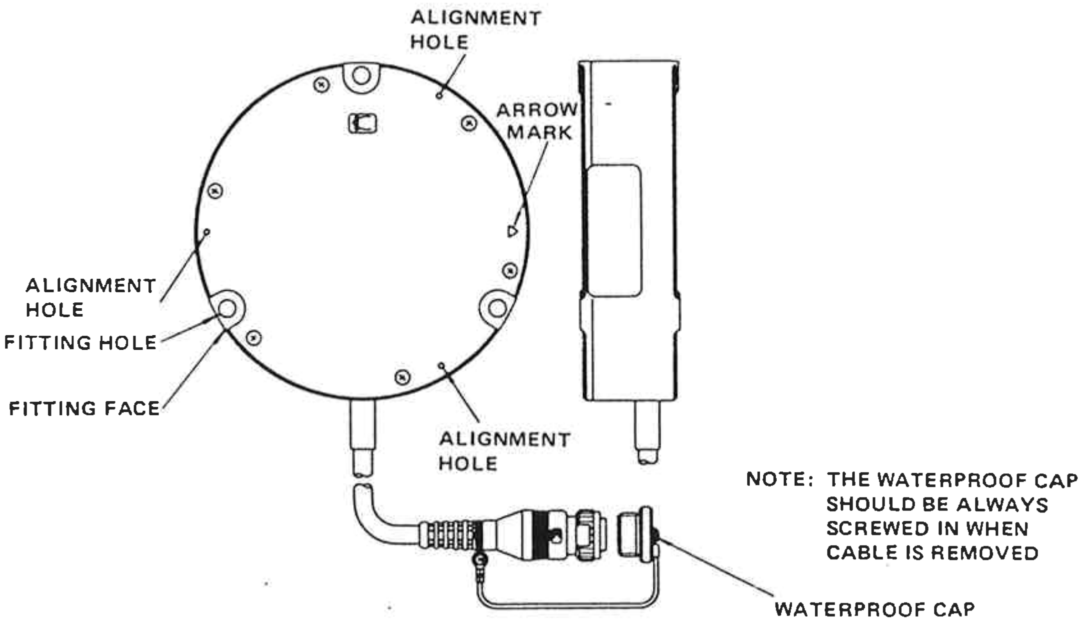


Figure 8. Angle Transducer

(4) JUNCTION BOX

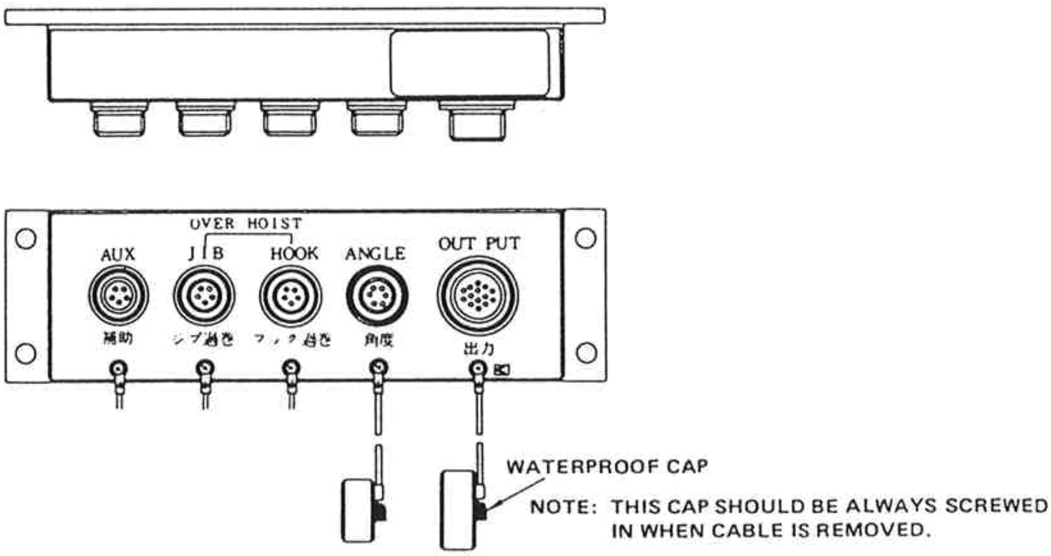


Figure 9. Junction Box

(5) CARTRIDGE

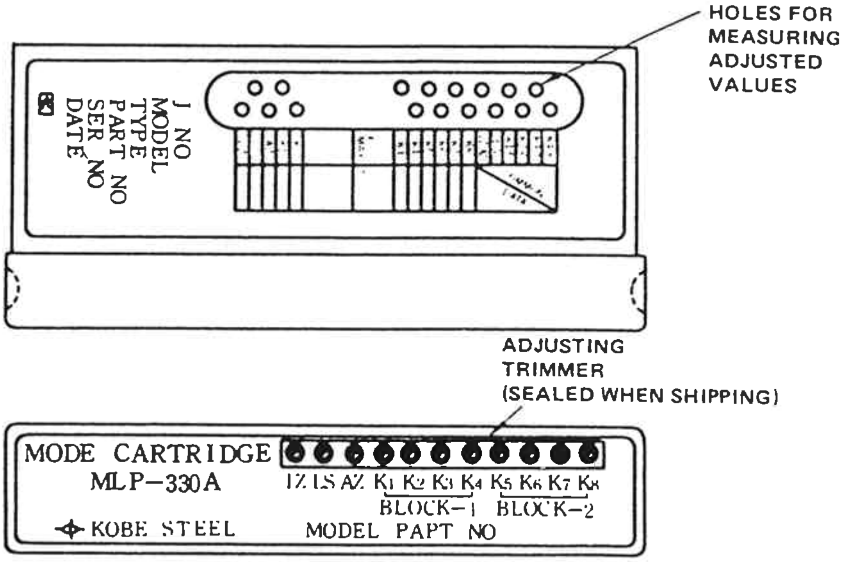


Figure 10. Cartridge

(6) SEQUENCE BOX (FOR ALARM AND STOP TYPE)

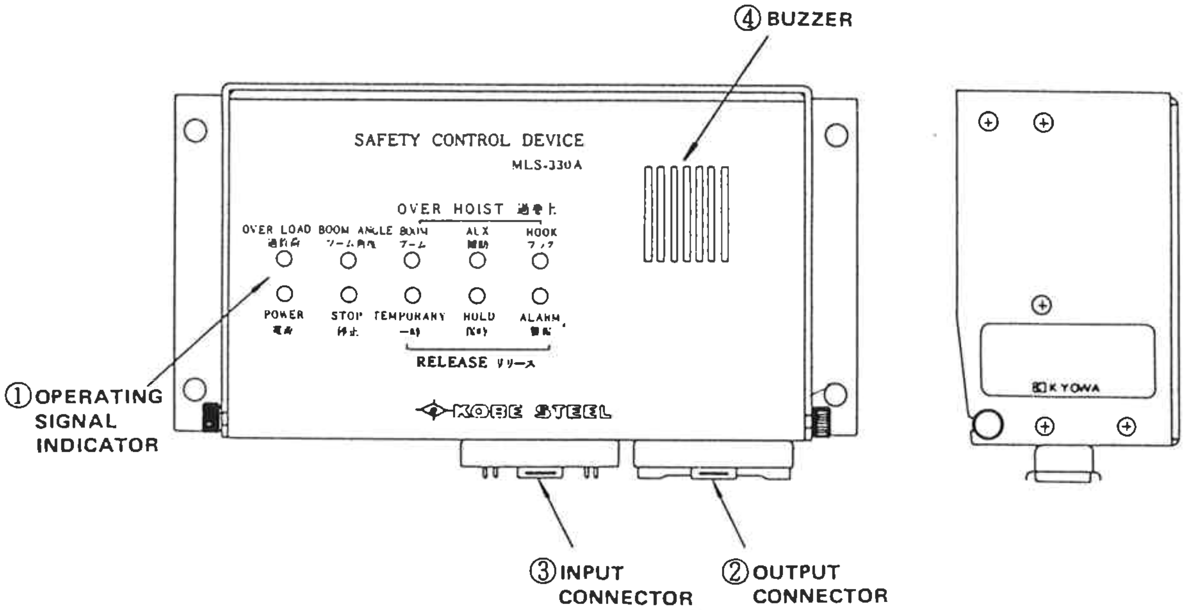


Figure 11. Sequence Box

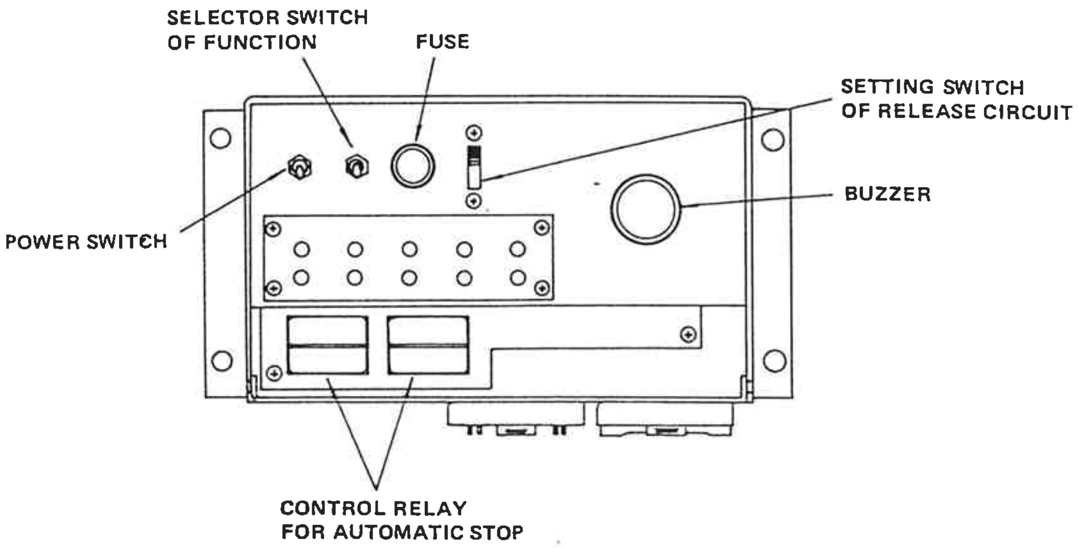


Figure 11A. Sequence Box View when Front Cover is Opened.

(7) OVERHOIST ALARM (SEQUENCE BOX)
(ALARM TYPE)

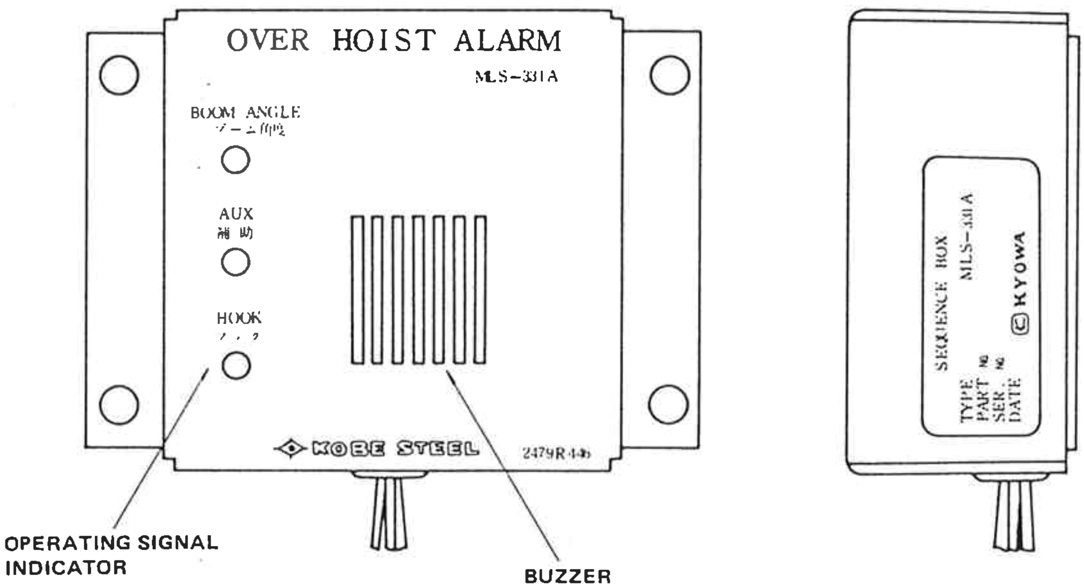


Figure 11B. Overhoist Alarm

2. TYPES OF DEVICES AND APPLICATION

Types of device and their application are as follows:

LSD-200B-I (Alarm Type):
  Crawler crane . . . 320H, 325, 335AS, 440AS, 60P, 75P, 85P and 100P, 5035, 5045
  Truck crane . . . . 330TC, and 435ATC
LSD-200B (Stop Type):
  Crawler crane . . . 540S, 550AS, 7055, 7080, 5100 and 7150
  Truck crane . . . . 9170TC and 9200TC
LSD-500B-I (Alarm Type):
  Crawler crane . . . 5300
  Truck crane 6350TC
  Floating crane . . FD1200, FD1500A, F&G1000 and F&G1500

Models	Controller	Sequence Box			Load Cell				
		Alarm Type	Alarm-stop Type: Alarm	Alarm-stop Type: Stop	15 tons	25 tons	25 tons	45 tons	50 tons
320H	○	○			○				
325	○	○			○				
335AS	○	○			○				
440AS	○	○			○				
60P	○	○			○				
75P	○	○			○				
85P	○	○			○				
100P	○	○			○				
330TC	○	○			○				
435ATC	○	○			○				
5035	○	○			○				
5045	○	○			○				
540S	○			○	○				
550AS	○			○	○				
7055	○			○	○				
7080	○			○	Δ	○			
5100	○			○	Δ	○			
7150	○			○		Δ	○		
9170TC	○			○		Δ	○		
9200	○			○				○	
5300	○		○						○
6350TC	○		○						○
FD-1200	○		○						○
FD-1500A	○		○						○
F&G1000	○	○							○
F&G1500	○	○							○

NOTE 1: Mark Δ shows tower crane.

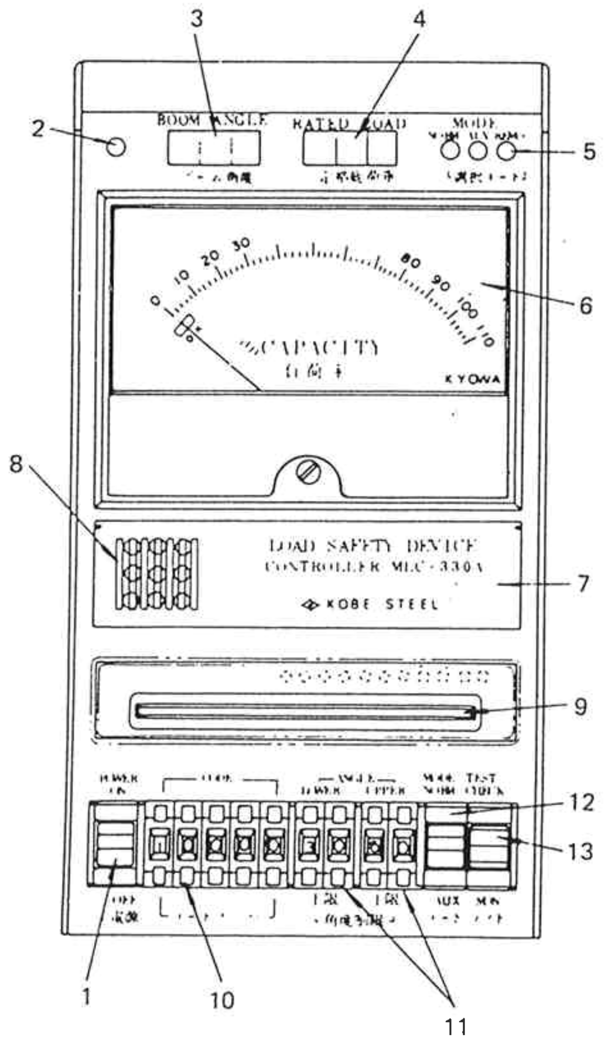
3. OPERATION

3-1 OPERATION

(1) INSERTING THE MODE CARTRIDGE

To insert the mode cartridge, proceed as follows (see Figure 12):

1. Select the mode cartridge according to the operating condition of the crane (refer to the cartridge table in the basic machine manual).



1. POWER SWITCH
2. PILOT LAMP
3. BOOM ANGLE INDICATOR
4. RATED LOAD INDICATOR
5. MODE INDICATOR LAMP
6. PERCENT CAPACITY METER
7. ACRYLIC COVER
8. BUZZER
9. MODE CARTRIDGE
10. CODE NUMBER SELECTOR
11. BOOM ANGLE SELECTOR
12. MODE SELECTOR
13. TEST SWITCH

Figure 12. Controller

2. Place the power switch (1) in OFF.

CAUTION

Inserting or taking off the mode cartridge with the power switch in ON results in troubles.

3. Insert the mode cartridge to the controller as follows:

A. Grasping the lower both ends of the acrylic cover so as to push it into inside by one hand, then pull it up to get the cartridge inlet. After inserted, return the cover by the reverse procedures.

B. Insert the cartridge to the bottom securely. It may be too tight while it is new, but it will be proper by repeating inserting and taking off.

C. Do not leave the charging inlet opened. Be sure that the inlet is always charged with a cartridge.

4. Place the power switch in ON.

(2) SETTING THE CRANE OPERATING CONDITION

To set the crane operating condition as follows (see Figure 12):

1. Set the code number selector (10) according to the crane operating conditions (boom length, and etc.) as follows (refer to the code number table in the basic machine manual):

A. The code number selector is of five figures. Each figure identifies as topic Code Number Selector in paragraph 2-2.

B. To operate the switch, pull up the top or bottom nail of the number indicator and push it. Push the (+) nail to increase the number, and push (–) nail to decrease the number.

C. If the cartridge is not inserted, or the cartridge is not memorized with the data which corresponds to the set value, abnormal number will be indicated.

2. Set the mode selector (12) in NORM or AUX according to the operating condition (main boom or jib, and etc.). If the machine is equipped with remote mode selector (optional), setting will be operated with it.

NOTE

A. The mode selector is a snap switch of two positions (NORM and AUX), and is used to select the operating condition anytime during crane operation (main boom ⇄ jib or over side ⇄ over rear.).

B. The remote mode selector is three position switch (NORM, N and AUX). When this selector is in N, the setting is operated with the selector provided in the controller. When this selector is in NORM or AUX, this remote mode selector takes precedence over the selector of the controller.

The condition selected is indicated in the mode indicator lamp (5). (See paragraph 3-2).

3. Set the upper boom angle or lower boom angle with the boom angle selector (11) as required.

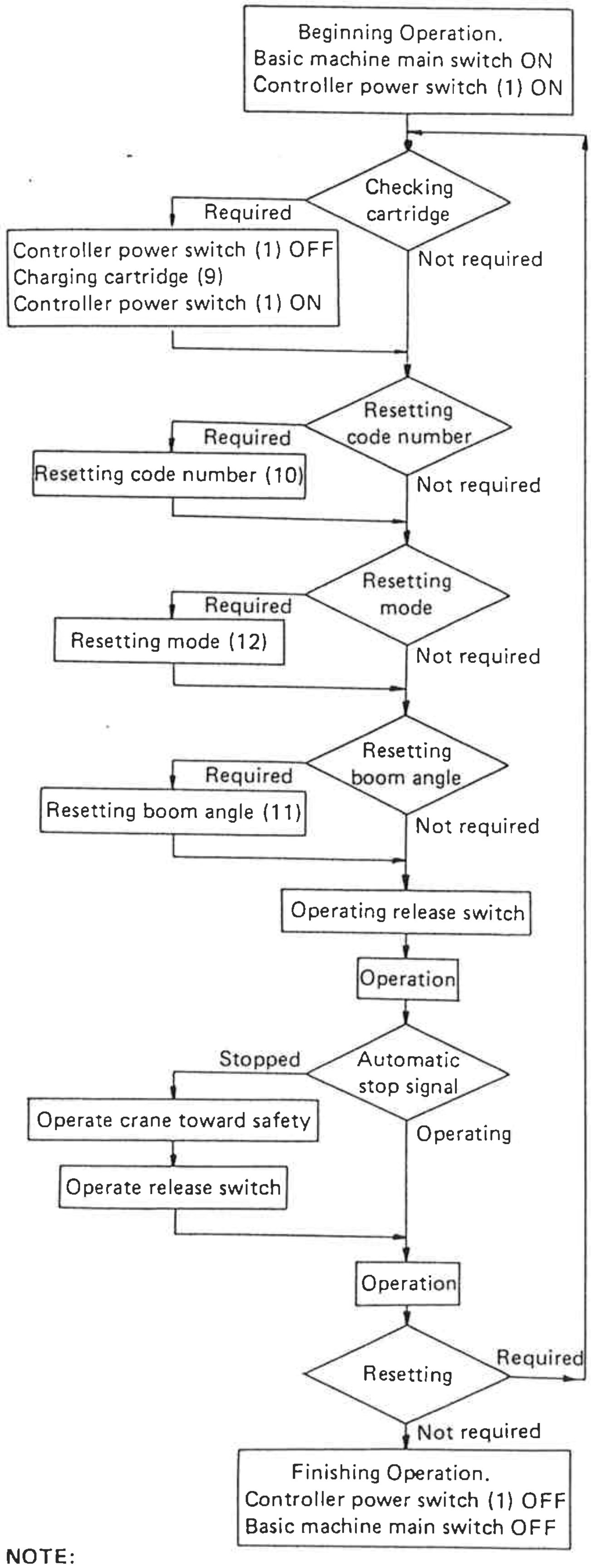
NOTE

A. The boom angle selector is two figure (pitch 1°) switch in UPPER and LOWER respectively. The procedure is same as that of the code number selector (10).

B. The setting is generally 79° for UPPER and 30° for LOWER.

C. Concerning the function when the boom angle or tower jib exceeds the upper or lower the setting limit, refer to paragraph 4-2.

(3) SUM UP OF PROCEDURES



NOTE:

◇ : Check items ▭ : Operation items

CAUTION

A. Do not put on nor put off the basic machine main switch with the power switch of the controller in ON. This results in troubles.

B. Place the power switch of the sequence box always in ON.

C. After the power switch of the controller is placed in ON, wait several minutes before beginning operation.

D. When the crane becomes overload or overhoist condition, immediately lower the load or operate the boom (or tower jib) toward the safe side.

E. After the power switch of the controller is placed in ON, when the automatic stopping device actuates, the device can not be released without operating the release switch provided on the control panel of crane to temporary or holding release, even if the crane is placed in safe side.

3-2 FUNCTIONS OF CONTROLLER

The instruments and controls in the controller are shown in Figure 12. The numbers on this illustration correspond to the numbers in the following, which identifies the controls and describes their function.

1. POWER SWITCH. Push the upper of this switch (ON) to energize the controller.

2. PILOT LAMP. This lamp illuminates when the power switch (1) is in ON. If the controller is abnormal, this lamp illuminates intermittently.

3. BOOM ANGLE INDICATOR. This indicates the boom angle by three figure degital of 0.1° unit. When the boom angle exceeds the setting value, this indicates slowly intermittently for forecast and promptly intermittently for automatic stopping against upper limit. Zero (0) degree is indicated with 0.0, and below zero and abnormality are shown with .0.

4. RATED LOAD INDICATOR. This indicates the rated load by three figure digital of 0.1 ton unit for below 50 tons and of 1 ton unit for 50 tons and above. When the actual load being lifted exceeds 90% of rated load, it indicates slowly intermittently, and when the actual load exceeds 100% rated load, it indicates promptly intermittently. Place the test switch (13) in MONI to indicate the actual load being lifted as reference. The actual load is less than the rated load, the difference will be larger.
This also indicates abnormal numbers (900 to 944) for abnormality.

5. MODE INDICATOR LAMP. The lamp of mode NORM or AUX selected by mode selector (12) illuminates.
Lamp REMO illuminates when set by the remote mode selector, regardless of the selected position of mode selector (12) on the controller.

6. PERCENT CAPACITY METER. This meter indicates the percentage (0 to 110%) of the actual load being lifted to the rated load. When the test switch (13) is placed in CHECK, if this meter indicates OK zone in the neighbourhood of 0%, the calculation of controller is correct.

7. ACRYLIC COVER. Pull this with fingers on its top to open. Open this only for checking the monitor output voltage and replacing the relay, and close during operation.

8. BUZZER. This rings intermittently when the load being lifted exceeds 90% of rated load, and continuously when exceeds 100%.

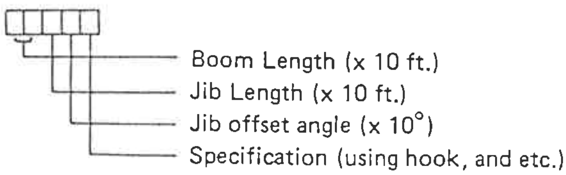
9. MODE CARTRIDGE. Insert the proper mode cartridge so that its label correctly.

NOTE

The mode cartridge should be always inserted to prevent dust.

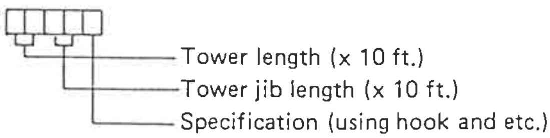
10. CODE NUMBER SELECTOR. This selector is of five figure degital. Pull up the top or bottom nail of the number indicator and push it. Push the (+) nail to increase the number, and push (—) nail to decrease the number. Concerning the code number, refer to the code number table in the basic machine manual. Each figure of the code number is fixed by the following rule.

A. Liftcrane:



NOTE: If the crane is not attached with jib, the 3rd and fourth figures are 00.

B. Tower Crane:



CAUTION

A. Do not put on nor put off the basic machine main switch with the power switch of the controller in ON. This results in troubles.

B. Place the power switch of the sequence box always in ON.

C. After the power switch of the controller is placed in ON, wait several minutes before beginning operation.

D. When the crane becomes overload or overhoist condition, immediately lower the load or operate the boom (or tower jib) toward the safe side.

E. After the power switch of the controller is placed in ON, when the automatic stopping device actuates, the device can not be released without operating the release switch provided on the control panel of crane to temporary or holding release, even if the crane is placed in safe side.

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4. RATED LOAD INDICATOR. This indicates the rated load by three figure digital of 0.1 ton unit for below 50 tons and of 1 ton unit for 50 tons and above. When the actual load being lifted exceeds 90% of rated load, it indicates slowly intermittently, and when the actual load exceeds 100% rated load, it indicates promptly intermittently. Place the test switch (13) in MONI to indicate the actual load being lifted as reference. The actual load is less than the rated load, the difference will be larger.

This also indicates abnormal numbers (900 to 944) for abnormality.

5. MODE INDICATOR LAMP. The lamp of mode NORM or AUX selected by mode selector (12) illuminates. Lamp REMO illuminates when set by the remote mode selector, regardless of the selected position of mode selector (12) on the controller.

6. PERCENT CAPACITY METER. This meter indicates the percentage (0 to 110%) of the actual load being lifted to the rated load. When the test switch (13) is placed in CHECK, if this meter indicates OK zone in the neighbourhood of 0%, the calculation of controller is correct.

7. ACRYLIC COVER. Pull this with fingers on its top to open. Open this only for checking the monitor output voltage and replacing the relay, and close during operation.

8. BUZZER. This rings intermittently when the load being lifted exceeds 90% of rated load, and continuously when exceeds 100%.

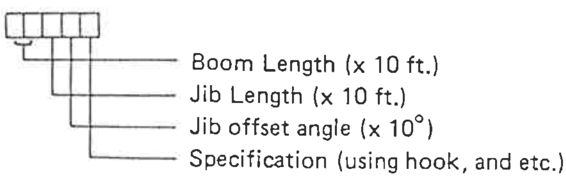
9. MODE CARTRIDGE. Insert the proper mode cartridge so that its label correctly.

NOTE

The mode cartridge should be always inserted to prevent dust.

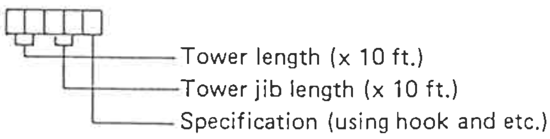
10. CODE NUMBER SELECTOR. This selector is of five figure degital. Pull up the top or bottom nail of the number indicator and push it. Push the (+) nail to increase the number, and push (−) nail to decrease the number. Concerning the code number, refer to the code number table in the basic machine manual. Each figure of the code number is fixed by the following rule.

A. Liftcrane:



NOTE: If the crane is not attached with jib, the 3rd and fourth figures are 00.

B. Tower Crane:



11. BOOM ANGLE SELECTOR. The upper limit and lower limit of boom angle can be set with two figure degitals of one degree (°) unit by this selector. The operating procedure of this selector is same as that of code number selector (10).

12. MODE SELECTOR. Place this selector in NORM when the lifting loads on main hoist line, and in AUX when on the jib hoist line. This selector is used sometime to select the standard crane specification and special specification. If the crane is equipped with the optional remote mode selector, remote control is available. The remote mode selector is of three position selector (NORM, N and AUX).

A. When the remote mode selector is placed in N, the mode is set with the selector of the controller.

B. When the remote mode selector is placed in NORM or AUX, this remote selector takes precedure over the selector of the controller.

The mode set with the controller mode selector or the remote mode selector can be confirmed with the mode indicator lamp (5) as the below table.

Selector setting		Mode indicator lamp		
Controller selector	Remote selector	NORM	AUX	REMO
NORM	N	O	X	X
AUX	N	X	O	X
—	NORM	O	X	O
—	AUX	X	O	O

NOTE: N ..... Remote mode selector in neutral.
O ..... Lamp illuminates
X ..... Lamp does not illuminates.

13. TEST SWITCH. This is of three position switch for check or monitor indication, and returns to neutral if this switch is released. Push the top "TEST" to check the function of the controller calculation and to indicate on the percent capacity meter (6). Push the bottom "MONI" to indicate the value of actual load being lifted on the rated load indicator (4) and the value of load cell on the percent capacity meter (6).

NOTE

For illustration of the following four items, refer to Figure 6.

14. SYSTEM SIGNAL INPUT/OUTPUT CONNECTOR. The power source, output signal and exterior operating signal circuits are to be connected to this connectors.

15. LOAD CELL CONNECTORS. Either of the left and the right load cells may be connected to these two connectors.

16. ANGLE TRANSDUCER CONNECTOR. The angle transducer circuit is to be connected to this connector.

17. FUSE. 2 ampere fuse. To remove it, remove the cap screwed in.

3-3 FUNCTIONS OF SEQUENCE BOX
(Alarm and Stop type)

(1) The sequence box gives out the signals of overhoist alarms and signal of automatic stop of crane, receiving the signals of limit switches and release signal. These selection can be obtained with the following switchs.

A. Selector switch for alarm and stop.
B. Release switch for selecting release.
- HOOK . . . Release of stop for hook overhoist.
- OFF . . . Stop for hook overhoist and overload.
- LOAD . . . Release of stop for overload.

(2) The input signals are indicated with lamps as follows (see Figure 11).

OVERHOIST:
HOOK . . . .Signal of limit switch for hook over hoist.
AUX . . . . .Signal of limit switch for boom over hoist and of limit switch for tower jib over hoists.
BOOM . . . .Signal within allowable minimum operating radius memorized by cartridge.

BOOM ANGLE:
Signal of forecast for upper limit and lower limit of boom angle set with controller.

OVER LOAD:
Signal when the actual load exceeds the point of automatic stop for over load.

RELEASE:
ALARM . . . . .Signal when alarm release switch is operated (holding release condition is indicated).
HOLD . . . . . .Signal when holding release switch is operated (holding release conditions is indicated).
TEMPORARY .Signal when temporary release switch is operated.

STOP:
Signal when stopping circuit for over load or hook over hoist operates.

11. BOOM ANGLE SELECTOR. The upper limit and lower limit of boom angle can be set with two figure degitals of one degree (°) unit by this selector. The operating procedure of this selector is same as that of code number selector (10).

12. MODE SELECTOR. Place this selector in NORM when the lifting loads on main hoist line, and in AUX when on the jib hoist line. This selector is used sometime to select the standard crane specification and special specification. If the crane is equipped with the optional remote mode selector, remote control is available. The remote mode selector is of three position selector (NORM, N and AUX).

A. When the remote mode selector is placed in N, the mode is set with the selector of the controller.

B. When the remote mode selector is placed in NORM or AUX, this remote selector takes precedure over the selector of the controller.

The mode set with the controller mode selector or the remote mode selector can be confirmed with the mode indicator lamp (5) as the below table.

Selector setting		Mode indicator lamp		
Controller selector	Remote selector	NORM	AUX	REMO
NORM	N	O	X	X
AUX	N	X	O	X
–	NORM	O	X	O
–	AUX	X	O	O

NOTE: N ..... Remote mode selector in neutral.
O ..... Lamp illuminates
X ..... Lamp does not illuminates.

13. TEST SWITCH. This is of three position switch for check or monitor indication, and returns to neutral if this switch is released. Push the top "TEST" to check the function of the controller calculation and to indicate on the percent capacity meter (6). Push the bottom "MONI" to indicate the value of actual load being lifted on the rated load indicator (4) and the value of load cell on the percent capacity meter (6).

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(Alarm and Stop type)

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- LOAD . . . Release of stop for overload.

(2) The input signals are indicated with lamps as follows (see Figure 11).

OVERHOIST:
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AUX . . . . .Signal of limit switch for boom over hoist and of limit switch for tower jib over hoists.
BOOM . . . .Signal within allowable minimum operating radius memorized by cartridge.

BOOM ANGLE:
Signal of forecast for upper limit and lower limit of boom angle set with controller.

OVER LOAD:
Signal when the actual load exceeds the point of automatic stop for over load.

RELEASE:
ALARM . . . . .Signal when alarm release switch is operated (holding release condition is indicated).
HOLD . . . . . .Signal when holding release switch is operated (holding release conditions is indicated).
TEMPORARY .Signal when temporary release switch is operated.

STOP:
Signal when stopping circuit for over load or hook over hoist operates.

POWER:

Signal when power source is ON (energized).

3-4 FUNCTIONS OF OVERHOIST ALARM
(Alarm Type)

(1) Receiving the signals of controller and limit switches, the overhoist alarm gives out the overhoist alarm of continuous sound of the buzzer.

(2) The input signals are indicated with lamps as follows:

When the crane operating condition can not be judged with the alarm, perform the appropriate check with the following lamp indications.

HOOK . . . . .Signal of the hook overhoist limit switch.

AUX . . . . .Signal of the boom overhoist limit switch and signal of the tower jib overhoist limit switch.

BOOM ANGLE . . .Signal of the forecast for the boom angle upper limit and lower limit which are set with controller, and signal to be issued when the operating radius exceeds the allowable minimum radius which is memorized by cartridge.

POWER:

Signal when power source is ON (energized).

3-4 FUNCTIONS OF OVERHOIST ALARM
(Alarm Type)

(1) Receiving the signals of controller and limit switches, the overhoist alarm gives out the overhoist alarm of continuous sound of the buzzer.

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When the crane operating condition can not be judged with the alarm, perform the appropriate check with the following lamp indications.

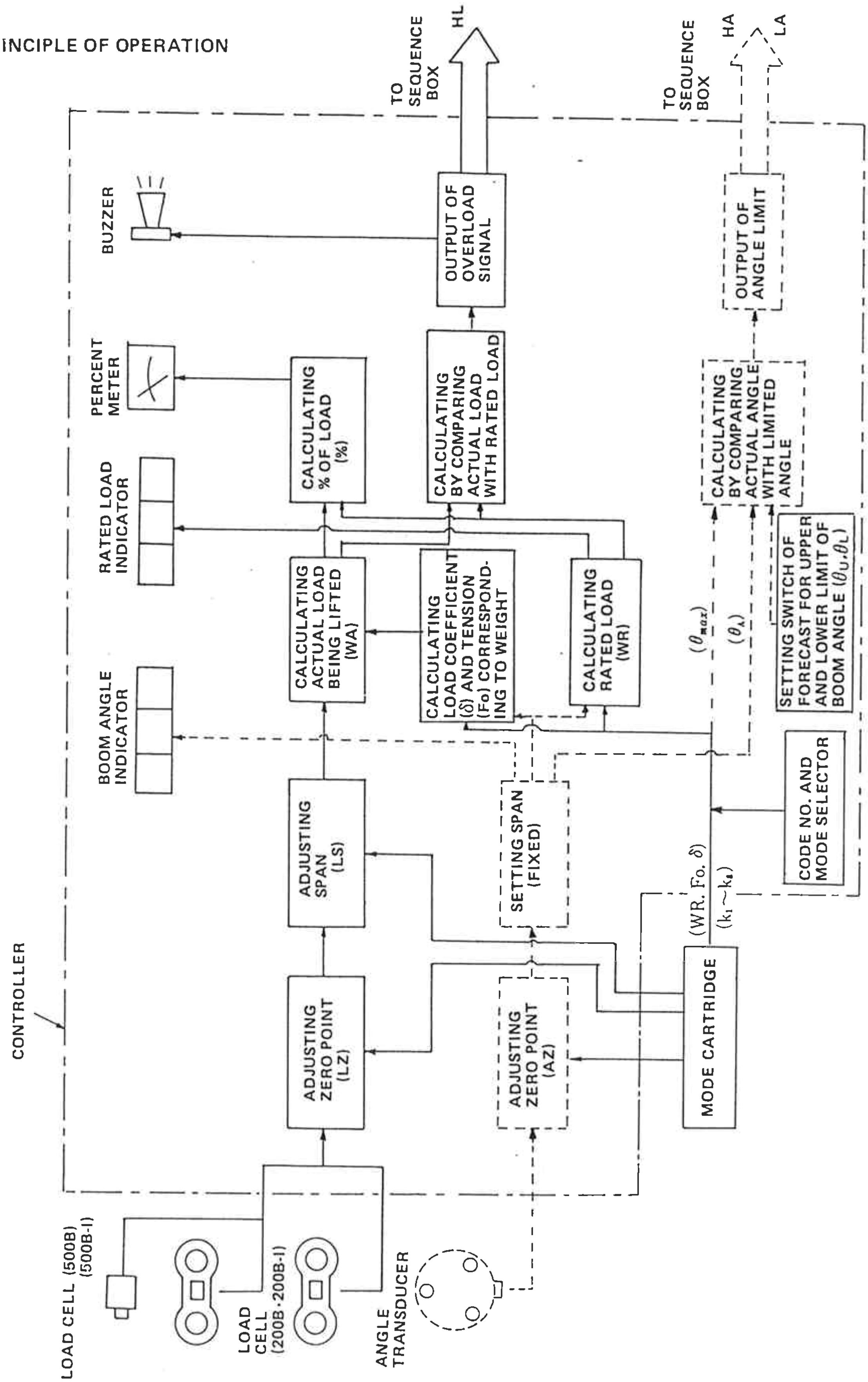
HOOK ....Signal of the hook overhoist limit switch.

AUX ....Signal of the boom overhoist limit switch and signal of the tower jib overhoist limit switch.

BOOM ANGLE . .Signal of the forecast for the boom angle upper limit and lower limit which are set with controller, and signal to be issued when the operating radius exceeds the allowable minimum radius which is memorized by cartridge.

4. PERFORMANCE

4-1 PRINCIPLE OF OPERATION



Principle of Operation

HL: Overload signal

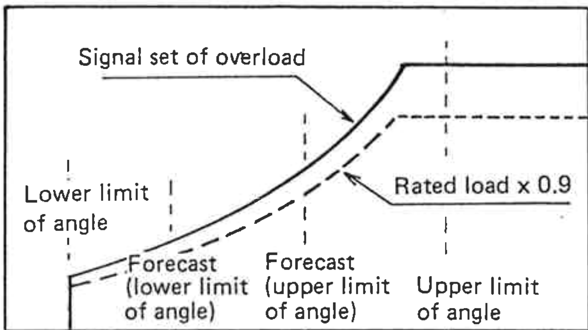
HA: Signal when angle exceeds upper limit set in cartridge.

LA: Signal forecast for upper and lower limit of boom angle.

4-2 PERFORMANCE OF CONTROLLER
(Alarm and Stop Type)

Conditions of crane / Indication	Only power switch of controller in OFF.	All power switches of devices in ON: Safe range	Load: Forecast 90%	Load: Alarm Over load	Angle: Alarm Lower limit	Angle: Forecast Lower limit	Angle: Forecast Upper limit	Angle: Alarm Upper limit	Signal for abnormality
Rated load indication	None	Illuminates continuously	Slowly intermittently	Promptly intermittently					Abnormal number
Angle indication	None	Illuminates continuously			Slowly intermittently			Promptly intermittently	0°
% indication	0%	Below 90%	Over 90%	Over load					100%
Status lamp	None	Illuminates continuously							Promptly intermittently.
Buzzer for over load	None	None	Rings intermittently	Rings continuously.					Rings continuously.

(1) CONDITION OF OUTPUT



Buzzer	Indicates rated load	Contact of forecast signal for overload (LL)	Contact of signal for overload (HL)
Rings continuously	Promptly intermittently	Opened	Opened
Rings intermittently	Slowly intermittently	Opened	Close
Does not ring	Illuminates continuously	Close	Close

Indicates angle	Illuminates slowly intermittently.	Illuminates continuously	Illuminates slowly intermittently	Illuminates promptly intermittently
Contact of forecast signal for angle (LA)	Open	Close	Open	Open
Contact of signal for upper limit of angle (HA)	Close	Close	Close	Open

Load system
Angle system

NOTE: Function of controller when release switch is operated:

1. Temporary Release.
   Alarm bell (continuous and intermittent) stops while this switch is operated.
   Self-holding function of alarm release is released.
2. Holding Release.
   Function is not affected.
3. Release of Alarm.
   Buzzer (continuous and intermittent) stops to sound when this switch is operated.
   When the switch is released, it will return to original position, but electrical release condition continues.
   The release condition returns for the following conditions.
   - When load signals (HL and LL) is changed.
   - When temporary release switch is operated.

WARNING

A. When the crane gets into a condition of overload or overhoist, immediately lower the load being lifted, or return the boom (or tower jib) to range of safety.

B. When the operating radius exceeds the allowable radius shown in the rating plate, the crane gets into a condition of overload and the rated load indicator shows 0.0 ton, even if the crane does not lift any load.

C. Always consult the rating plate for reeving on the hoist line required for a particular load to be lifted, and never exceed the allowable load per one hoist wire rope. If the load line reeving is less than the reeving shown in the rating plate, the alarms and lamps will not warn even when the actual load on the hoist line exceed the allowable load per one wire rope. Be careful of the reeving.

D. If the offset angle of jib is not set properly, the calculation can not be performed correctly. This is very dangerous. Referring to the basic machine manual, set the jib guy lines properly.

(2) FUNCTION OF RELEASE SWITCH

The release switch is provided on the operating panel of the crane operator's room, and used for the following purposes.

1. Reset before operating.
2. Placing the boom in the storage position.
3. Lowering the boom to replace the wire rope or to change the boom arrangement.
4. Reset after the crane is returned to the range of safety from the condition of automatic stop.

<table>
<tr><th>Func-tion</th><th colspan="2">Operation or indication / Release switch</th><th>Temporary release</th><th>Holding release</th><th>Alarm release</th></tr>
<tr><td rowspan="4">Release of auto. stop</td><td colspan="2">Automatic stop for overload</td><td>Effective</td><td>Effective</td><td>Invalid</td></tr>
<tr><td colspan="2">Stop fo main hook over hoist</td><td>Effective</td><td>Effective</td><td>Invalid</td></tr>
<tr><td colspan="2">Stop for jib hook over hoist</td><td>Effective</td><td>Effective</td><td>Invalid</td></tr>
<tr><td colspan="2">Stop for boom over hoist</td><td>Effective</td><td>Invalid</td><td>Invalid</td></tr>
<tr><td rowspan="3">Buzzer</td><td rowspan="2">Alarm for overload
Buzzer (controller)</td><td>Intermittent</td><td>Stop</td><td>Invalid</td><td>Stop</td></tr>
<tr><td>Continuous</td><td>Stop</td><td>Invalid</td><td>Stop</td></tr>
<tr><td colspan="2">Alarm for over hoist (sequence box)</td><td>Stop</td><td>Invalid</td><td>Stop</td></tr>
<tr><td rowspan="4">Lamp</td><td rowspan="4">Sequence box</td><td>Automatic stop</td><td>Light out</td><td>Light out</td><td></td></tr>
<tr><td>Temporary release</td><td>Light</td><td></td><td></td></tr>
<tr><td>Holding release</td><td>Light out</td><td>Ligh</td><td></td></tr>
<tr><td>Alarm release</td><td>Light out</td><td></td><td>Light</td></tr>
</table>

(3) INVALIDITY AND RETURN OF RELEASE SWITCH

1. Invalidity of Holding Release:

A. It is invalid when overload is reduplicate with hook overhoist.

B. It is invalid for boom overhoist.

2. Invalidity of Alarm Release:

(Release of overload alarm is effective.)

A. It is invalid when hook overhoist is reduplicate with boom angle forecast.

B. It is invalid for upper limit alarm of boom angle (within allowable minimum operating radius).

C. It is invalid for upper limit alarm of tower jib angle (within allowable minimum operating radius).

3. Operation of Release Switch Circuit:

The release switch will return to original position when released. However, the releases of holding release and alarm release are kept electrically even if the release switch returned to original position.

4. Conditions of Automatic Return of Release Function:

A. When the crane is in range of safety.

B. When the condition corresponds to item 1 or 2.

C. When temporary release is operated.

4-3 FUNCTION OF SEQUENCE BOX
(Alarm and Stop Type)

Output		Input	Power Switch in OFF	Power Switch in ON							
				Output of Controller Contact			Signal of Limit Switch		Signal of Release		
				HL (OFF)	LA (OFF)	HA (OFF)	K (OFF)	KS (ON)	RS (ON)	RH (ON)	AR (ON)
Operating Signal Indicator		POWER	Light out	Light	Light	Light	Light	Light	Light	Light	Light
		LOVER LOAD		Light	—	—	—	—	—	—	—
		BOOM ANGLE		—	Light	—	—	—	—	—	—
	OVER HOIST	BOOM		—	—	Light	—	—	—	—	—
		AUX		—	—	—	—	Light	—	—	—
		HOOK		—	—	—	Light	—	—	—	—
		STOP		Light	—	—	Light	—	Light out	Light out	—
	RELEASE	TEMPORARY		—	—	—	—	—	Light	—	—
		HOLD		—	—	—	—	—	Light out	Light	—
		ALARM		—	—	—	—	—	—	—	Light
Contact Output		BUZZER	—	—	Conti-nuously	Conti-nuously	Conti-nuously	Conti-nuously	None	—	None
		MAIN HOIST	Open	Open	—	—	Open	—	Close	Close	—
		AUX. HOIST	Open	Open	—	—	Open	—	Close	Close	—
		BOOM LOWER	Open	Open	—	—	Open	—	Close	Close	—
		BOOM RAISE	Open	—	—	Open	—	—	Close	—	—

4-4 FUNCTION OF OVERHOIST ALARM

Device: Conditions of crane / Performance of indication		Only power switch of controller in OFF	All power switches of devices in ON: Safe range	Load: Forecast 90%	Load: Alarm Over load	Angle Forecast: Lower limit	Angle Forecast: Upper limit	Signal for abnormality	Over hoist signal (limit switch): Main hook	Jib hook	Boom (tower)	Tower Jib
Overhoist Alarm: Lamp indications	BOOM ANGLE	Lights	Light out		Lights up							
	AUX		Light out								Lights up	
	HOOK		Light out						Lights up			
Buzzer for overhoist		Conti-nuously	Doesn't ring		Rings continuously							

WARNING

A. When the crane gets into a condition of overload or overhoist, immediately lower the load being lifted, or return the boom (or tower jib) to range of safety.

B. When the operating radius exceeds the allowable radius shown in the rating plate, the crane gets into a condition of overload and the rated load indicator shows 0.0 ton, even if the crane does not lift any load.

C. Always consult the rating plate for reeving on the hoist line required for a particular load to be lifted, and never exceed the allowable load per one hoist wire rope. If the load line reeving is less than the reeving shown in the rating plate, the crane will not stop automatically even when the actual load on the hoist line exceeds the allowable load per one wire rope. Be careful of the reeving.

D. If the offset angle if jib is not set properly, the calculation can not be performed correctly. This is very dangerous. Referring to the basic machine manual, set the jib guy lines properly.

(1) FUNCTION OF RELEASE SWITCH

The release switch is provided on the operating panel of the crane operator's room, and used for the following purposes.

1. Placing the boom in the storage position.

2. Lowering the boom to replace the wire rope or to change the boom arrangement.

Func-tion	Operation or indication / Release switch		Temporary release	Holding release	Alarm release
Buzzer	Alarm for overload	Intermittent	Stop	Invalid	Stop
	Buzzer (controller)	Continuous	Stop	Invalid	Stop
	Buzzer for over hoist		Stop	Invalid	Stop

(2) INVALIDITY AND RETURN OF RELEASE SWITCH

1. Invalidity of Release:
(Release of overload alarm is effective.)

A. It is invalid when hook overhoist is reduplicate with boom angle forecast.

B. It is invalid for upper limit alarm of boom angle (within allowable minimum operating radius).

C. It is invalid for upper limit alarm of tower jib angle (within allowable minimum operating radius).

2. Operation of Release Switch Circuit:

The release switch will return to original position when released. However, the release of holding release is kept electrically even if the release switch returned to original position.

3. Conditions of Automatic Return of Release Function:
A. When the crane is in range of safety.
B. When the condition corresponds to item 1.
C. When temporary release is operated.

4-5 OPERATIONS OF BASIC MACHINE

Operation \ Contact of Sequence Box		Main Hoist		Auxiliary Hoist		Boom Raise		Boom Lower	
		OFF	ON	OFF	ON	OFF	ON	OFF	ON
Main Hoist	Raise	Stop	Possible						
	Lower	Possible	Possible						
Auxiliary Hoist	Raise			Stop	Possible				
	Lower			Possible	Possible				
Boom	Raise					Possible	Possible	Stop	Possible
	Lower					Stop	Possible	Possible	Possible

(1) TERMINALS CORRESPONDING TO SEQUENCE BOX CONTACTS

Contacts \ Check Terminals	Number of connector pin	Color connecting cable
Main Hoist	2–10	Red–Yellow
Auxiliary Hoist	4–11	White/Green–Brown
Boom Lowering	6–12	Pink–Black
Boom Raising	8–13	Orange–White

NOTE

The relay contacts on the sequence box are provided between the terminals shown in the table.

For checking, it is required to put the selector switch of function on the sequence box to "Stop" side.

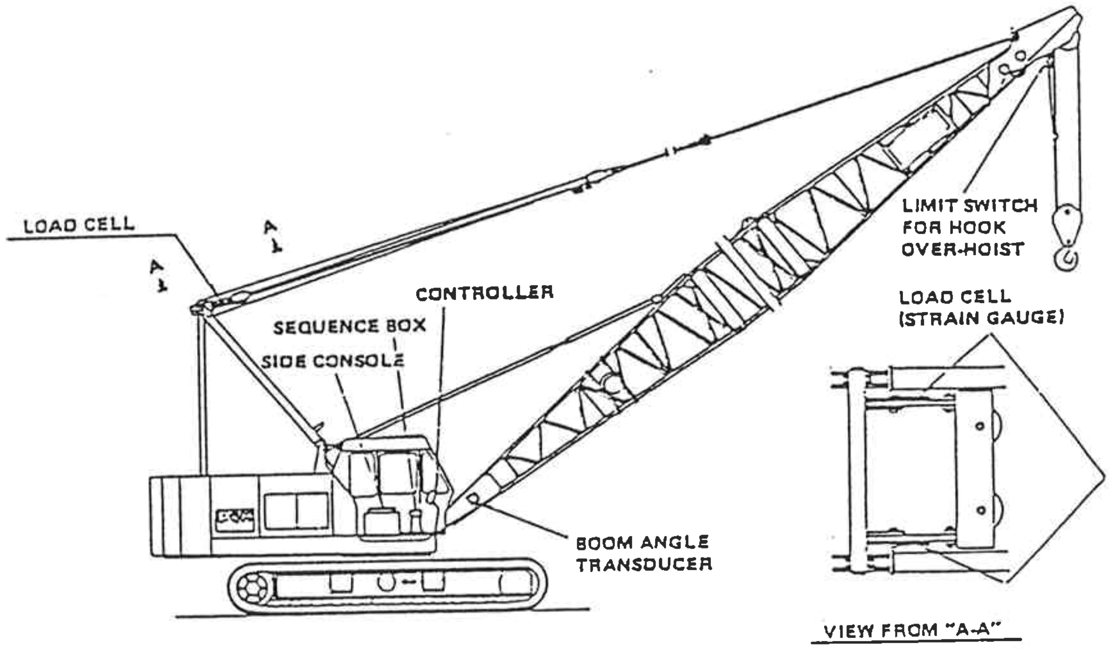
5. ADJUSTMENT

LOAD SAFETY DEVICE ADJUSTMENT PROCEDURE
(LSD-200B)

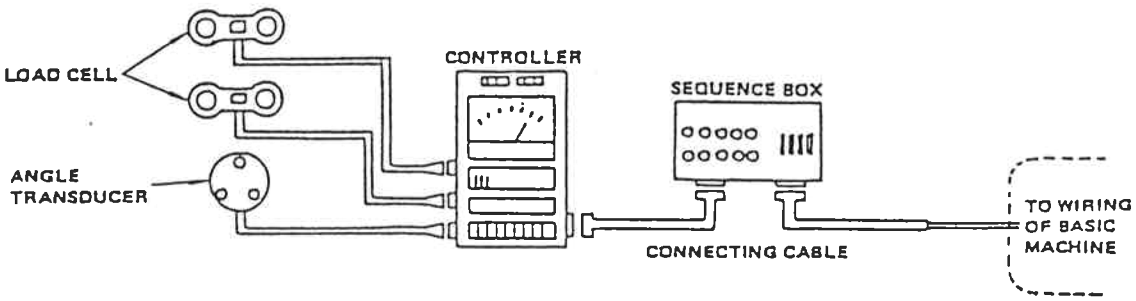
This manual provides the various adjustment procedure which is required when changing each component of the load safety device due to damages, malfunction, etc.

LIFT CRANE

Location of main components

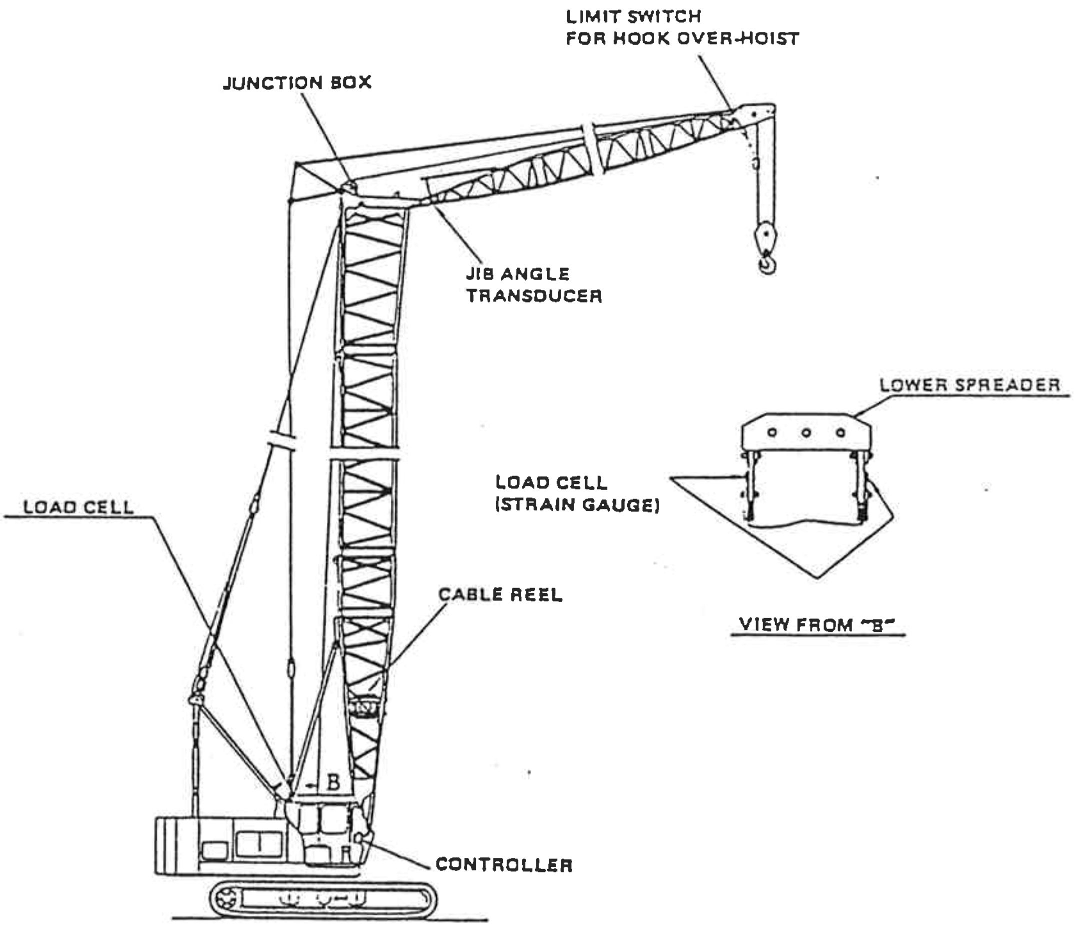


Block diagram

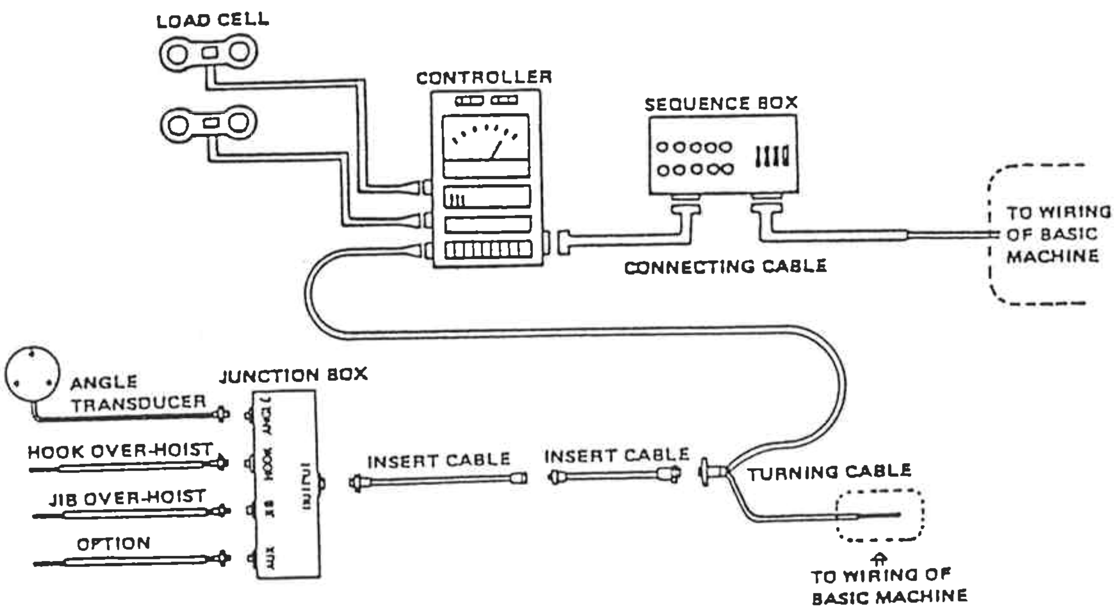


TOWER CRANE

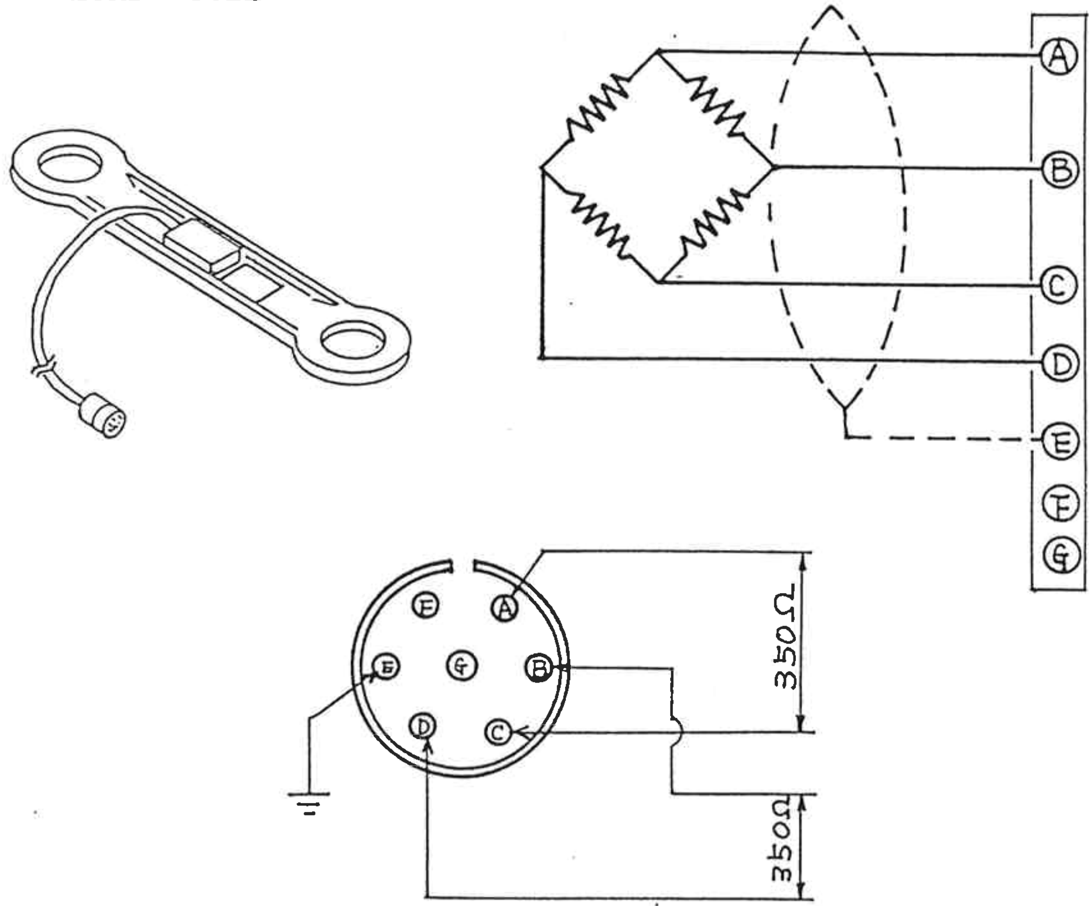
Location of main components



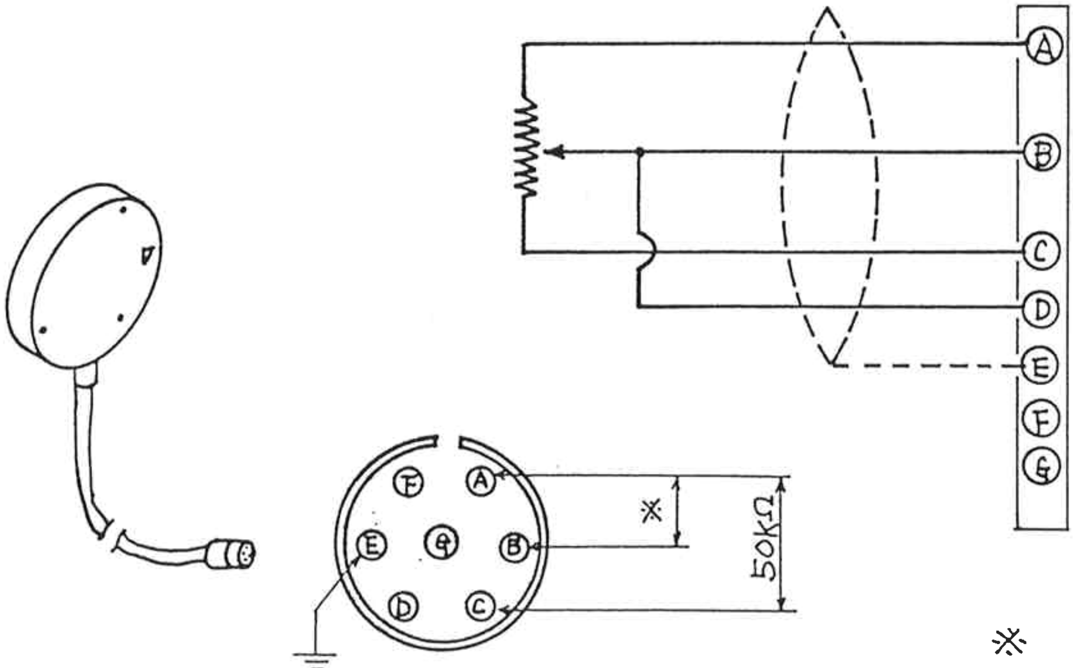
Block diagram



LOAD CELL



BOOM ANGLE TRANSDUCER



	※
0°	25.0KΩ
30°	29.2KΩ
60°	33.5KΩ
80°	36.3KΩ

5-1 INITIAL ADJUSTMENT

1. REPLACEMENT OF CONTROLLER AND SEQUENCE BOX

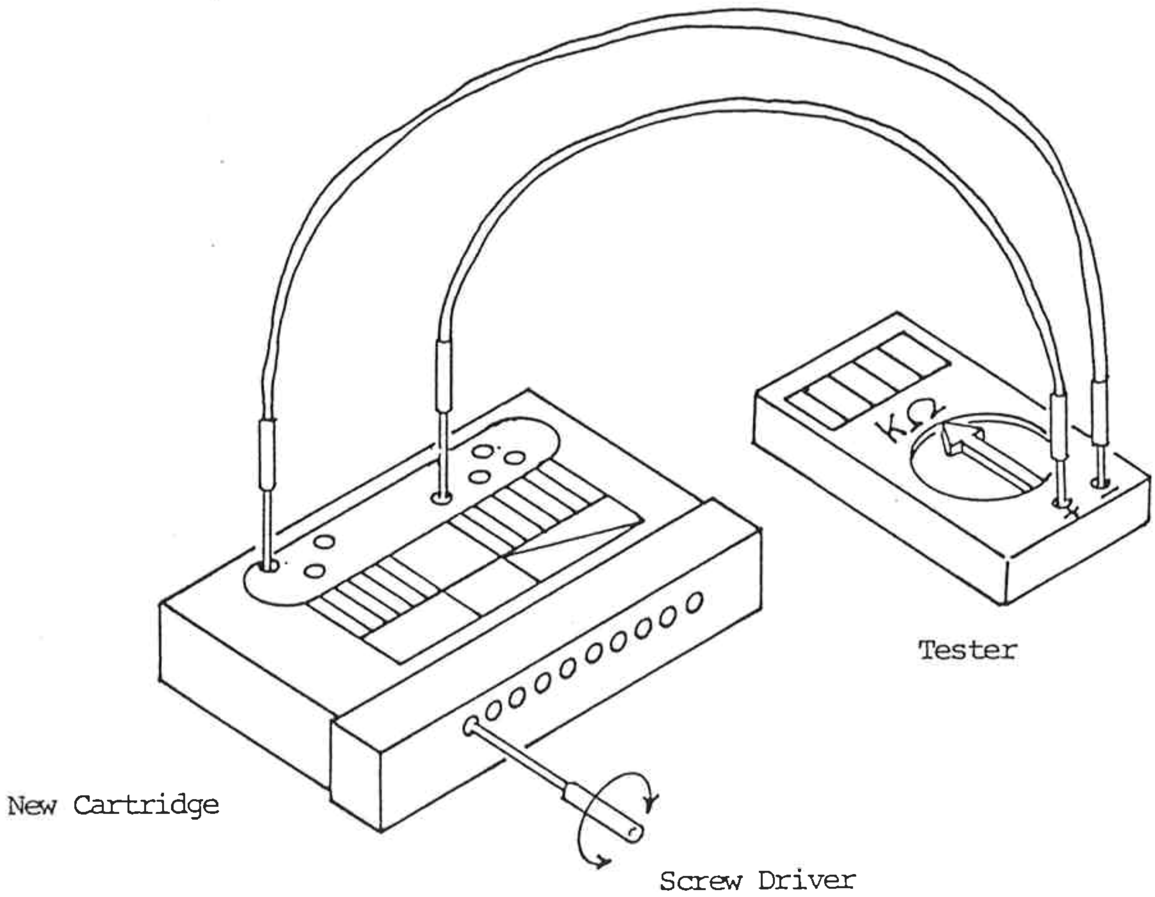
No adjustment is required.

2. REPLACEMENT OF MODE CARTRIDGE

Each trimmer (LZ to K8) of the new cartridge must be adjusted, proceed as follows.

By using the tester, input all resistance data,corrected from the old cartridge, into the new cartridge.

Should a resistance figure on the label of the old cartride wear away off, check the old cartridge for the original resistance figure with a tester.

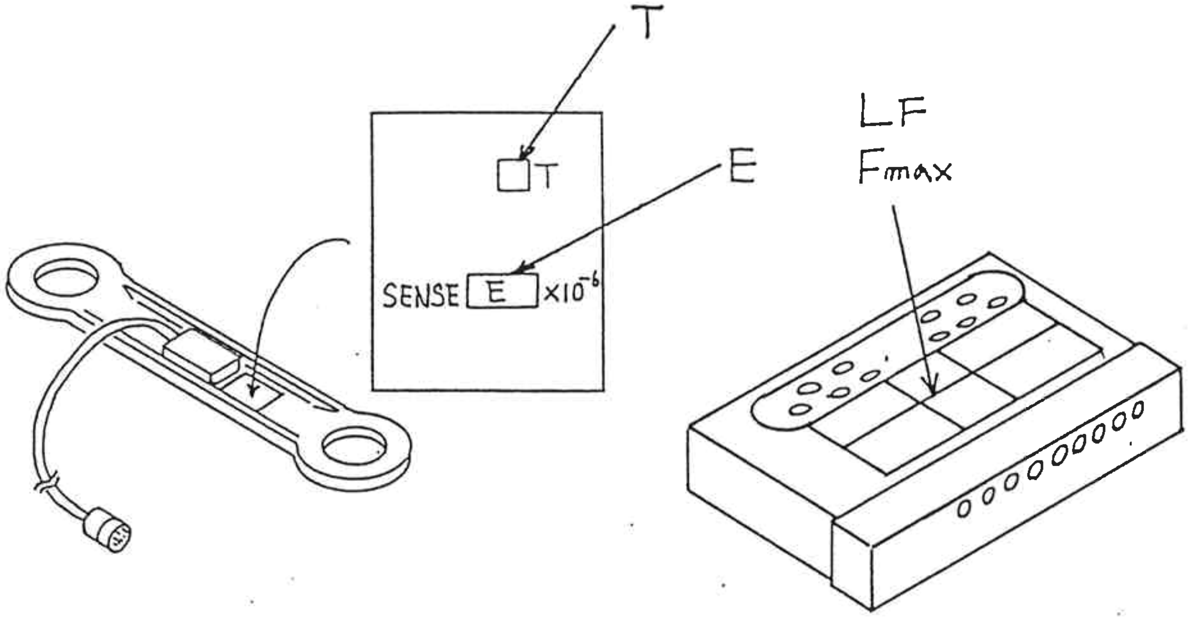


3. REPLACEMENT OF LOAD CELL

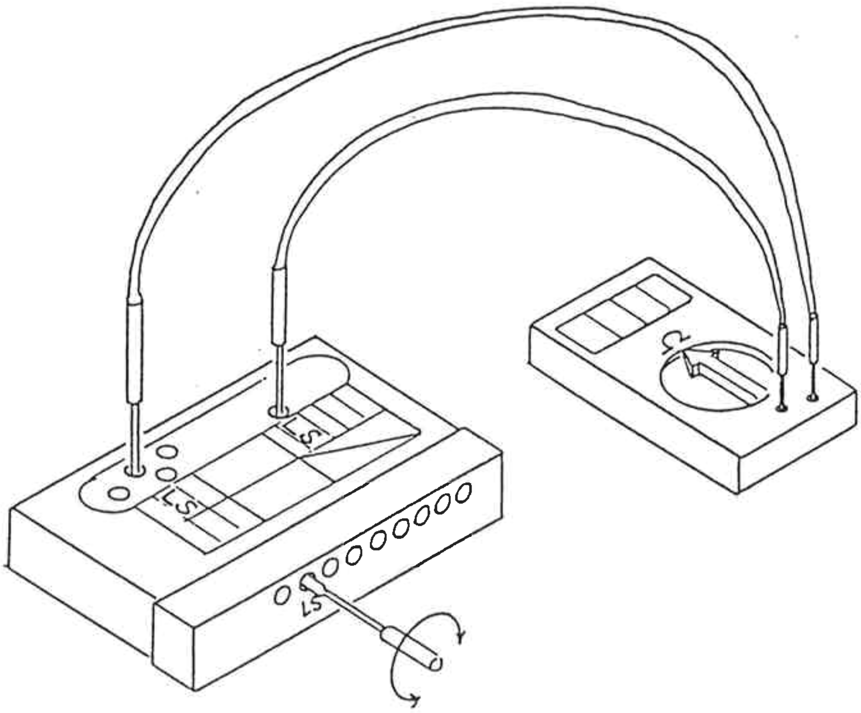
3-1 Calculate " LS " by using the following equation.

NOTE : Each cartridge has been provided with different " SENSE " and " Fmax " figures. Please calculate them one by one.

$$LS = \frac{5}{\dfrac{15910 \cdot T}{(E_1 + E_2) \cdot F_{max} \cdot LF} - 1} - 0.5 = K\Omega$$



3-2 Adjust " LS " trimmer on the front of the cartridge until the correct figure appears on the tester.



3-3 Adjustment of " LZ ", proceeds as follows:

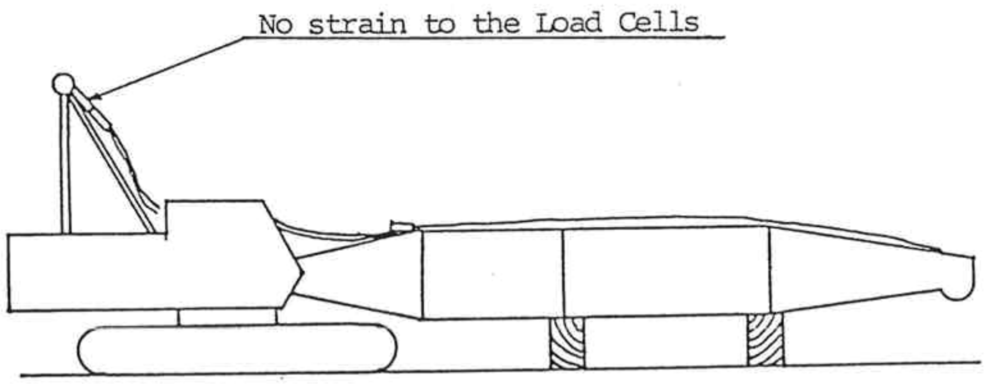
(a) Connect all necessary cables to the controller.

(b) Place the boom or jib as shown below so that no strain is applied to the load cells.

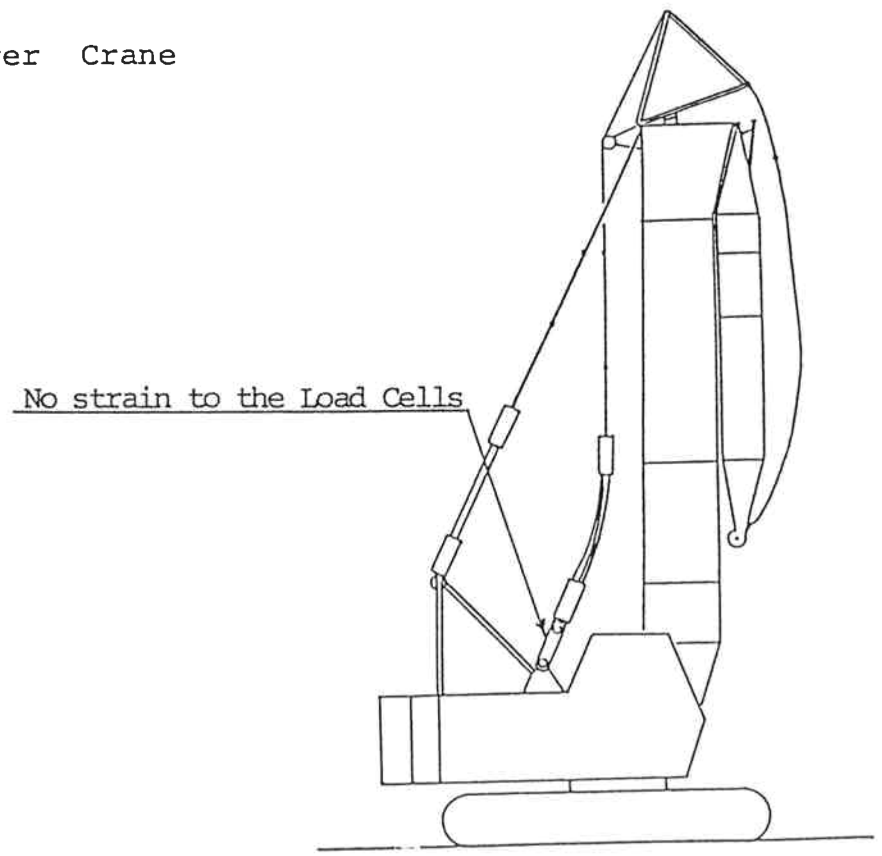
(c) Install the cartridge adjusted by the new " LS " figure into the controller, and punch the " BASIC CODE " for that cartridge into the CODE NUMBER SELECTOR BOARD at the base of the controller.

(d) Making sure that the MODE SELECTOR SWITCH is in the " NORM " position.

Lift Crane



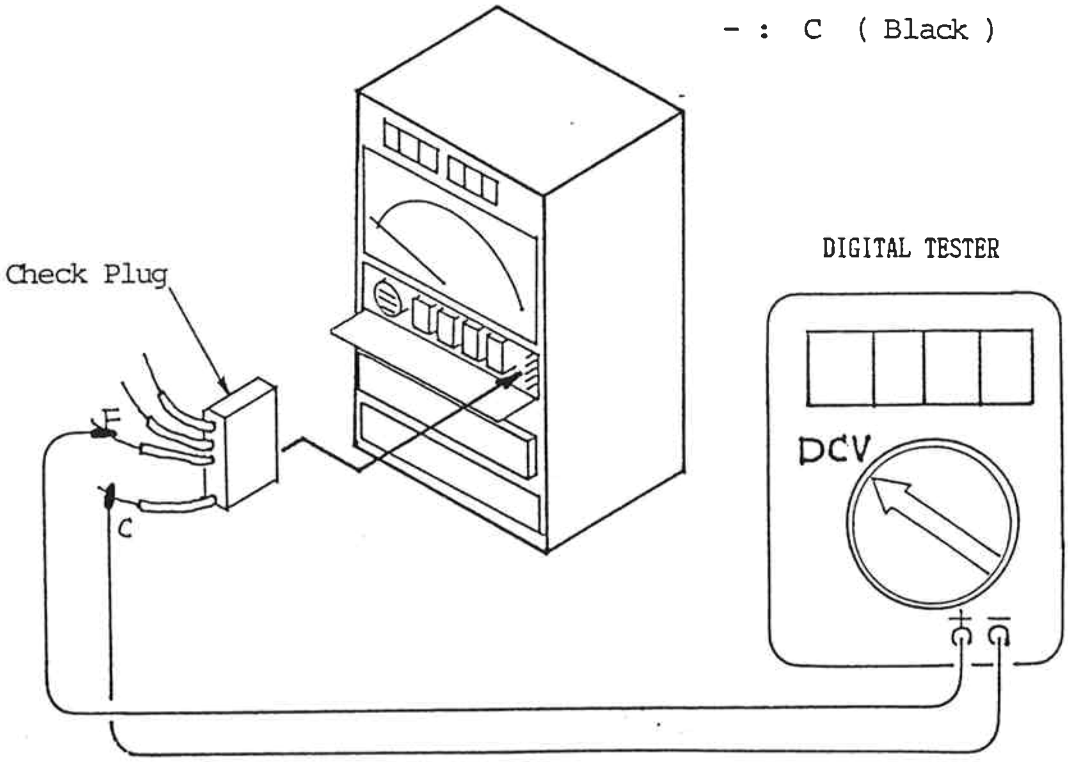
Tower Crane



(e) Install the CHECK PLUG to the CP SOCKET BOARD , and connect the tester to the CHECK PLUG as shown below.

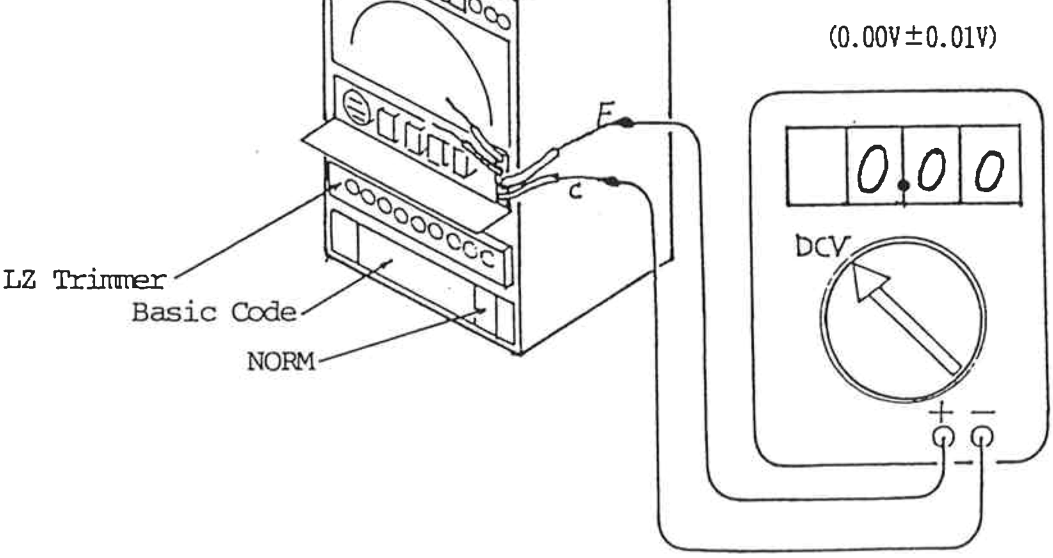
+ : F (Yellow)

- : C (Black)



(f) The main switch is ON , adjust the " LZ " trimmer with a screw driver until the reading of 0.00 V appears on the tester.

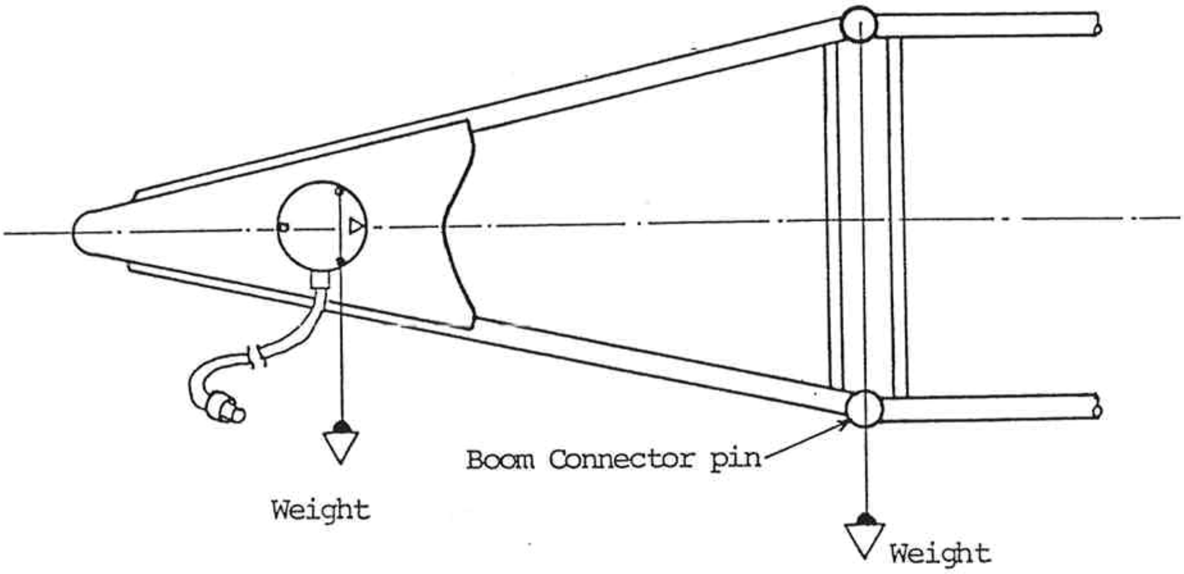
F (Yellow) — C (Black)



4. REPLACEMENT OF BOOM ANGLE TRANSDUCER

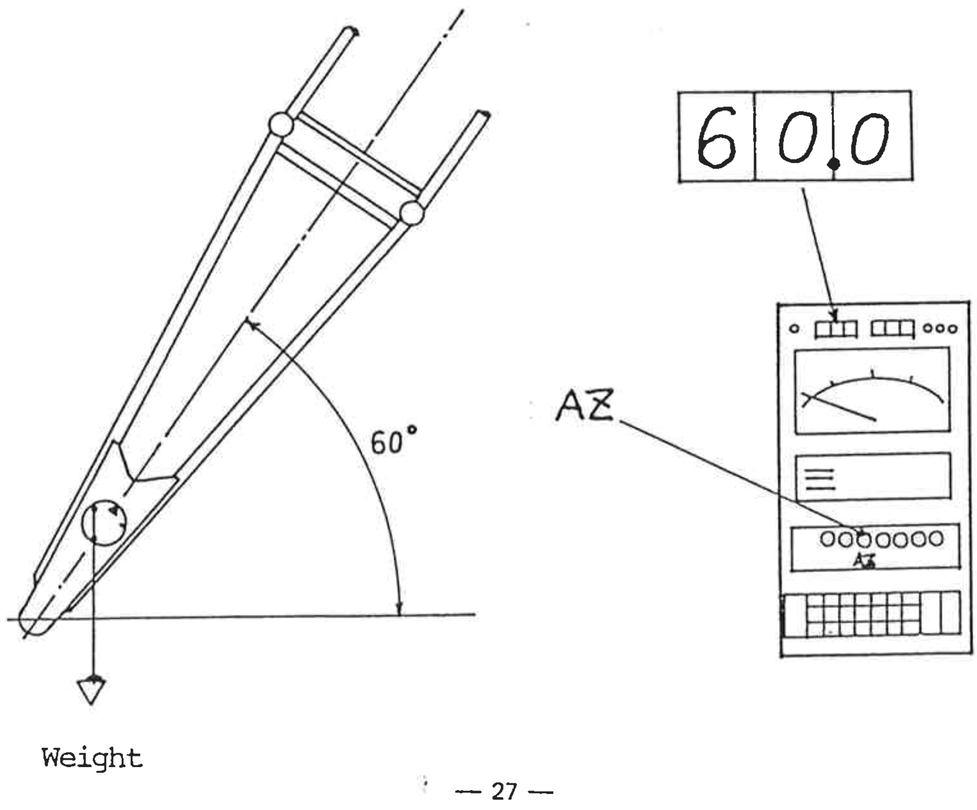
4-1 making sure that the BOOM ANGLE TRANSDUCER is correctly mounted on the boom, this is, the " ▶ " mark is pointing toward the boom tip and the electrical cable connects into the bottom of the BOOM ANGLE TRANSDUCER.

4-2 Set the boom to a perfectly horizontal position (0°), check this condition by hanging a weight from the center of the upper boom connector pin and then note when this line intersects with the center in the lower pin as shown below.



4-3 Hold a weight line on the upper alignment hole on the angle transducer cover and check if this line intersects the lower alignment hole, if it does not, loosen the transducer mounting bolts, shift it enough to bring the lower hole into alignment with the hanging line, then retighten the bolts.

4-4 Raise the boom to 60°. This can be checked by a hanging weight line as shown below, and adjust the " AZ " trimmer until a reading of " 60.0 " appears on the boom angle indicator.



NOTE

IT IS RECOMMENDED NOT TO ADJUSTING THE LOAD SAFETY DEVICE ON WINDY DAYS.

(AVERAGE WIND SPEED EXCEEDING 5m/sec)

5－2 SUPPLEMENTARY ADJUSTMENT

5. REPLACEMENT OF ATTACHMENT (FOR MAIN BOOM ONLY)

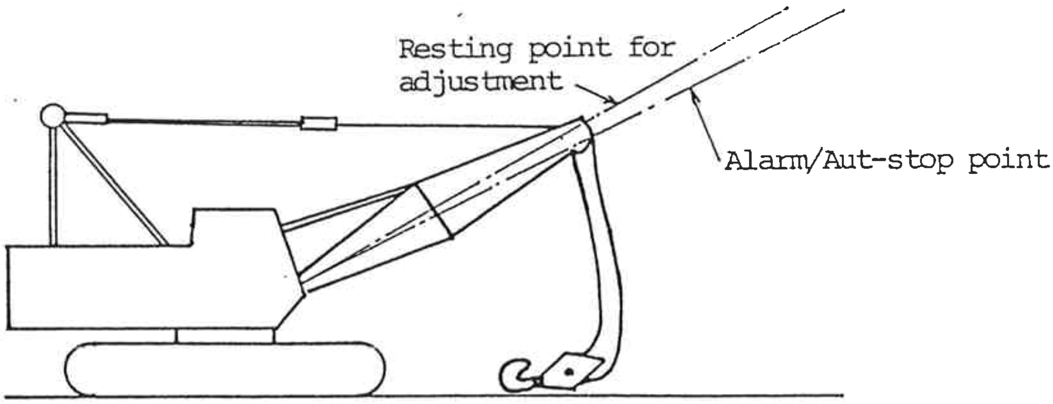
5-1 ADJUSTMENT OF " K1 "

(a) Assemble the booms according to the "BASIC CODE" of that cartridge (normally it is the basic boom length).

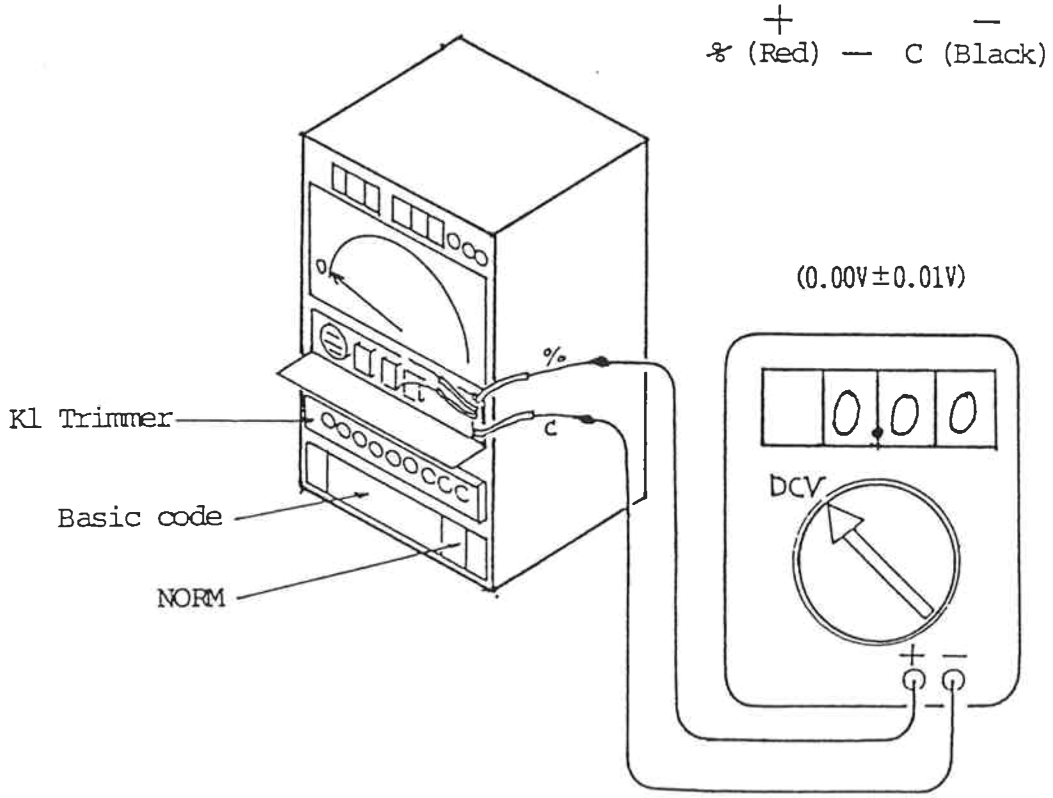
(b) Punch the " BASIC CODE " into the CODE NUMBER SELECTOR BOARD.

(c) Place the main hook block on the ground.

(d) Raise the boom until just (about 3°) past the point where the ALARM / AUTO-STOP stops, and then lower the boom 1° or 2° again.



(e) Install the CHECK PLUG to the controller and adjust the " K1 " trimmer on the cartridge to get a reading of 0.00 V as shown below.



5-2 ADJUSTMENT OF " K3 "

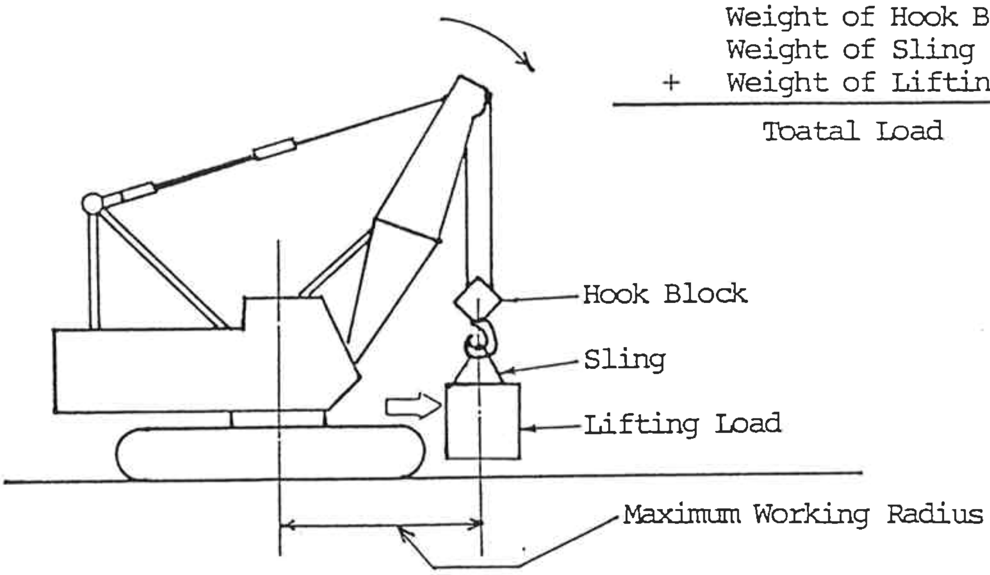
(a) Use the same boom configuration as mentioned in item 5-1.

(b) Calculate the total load which always includes the lifting weight (known weight) plus the hook block and the sling being used, and check the rating chart for the maximum working radius of that total load.

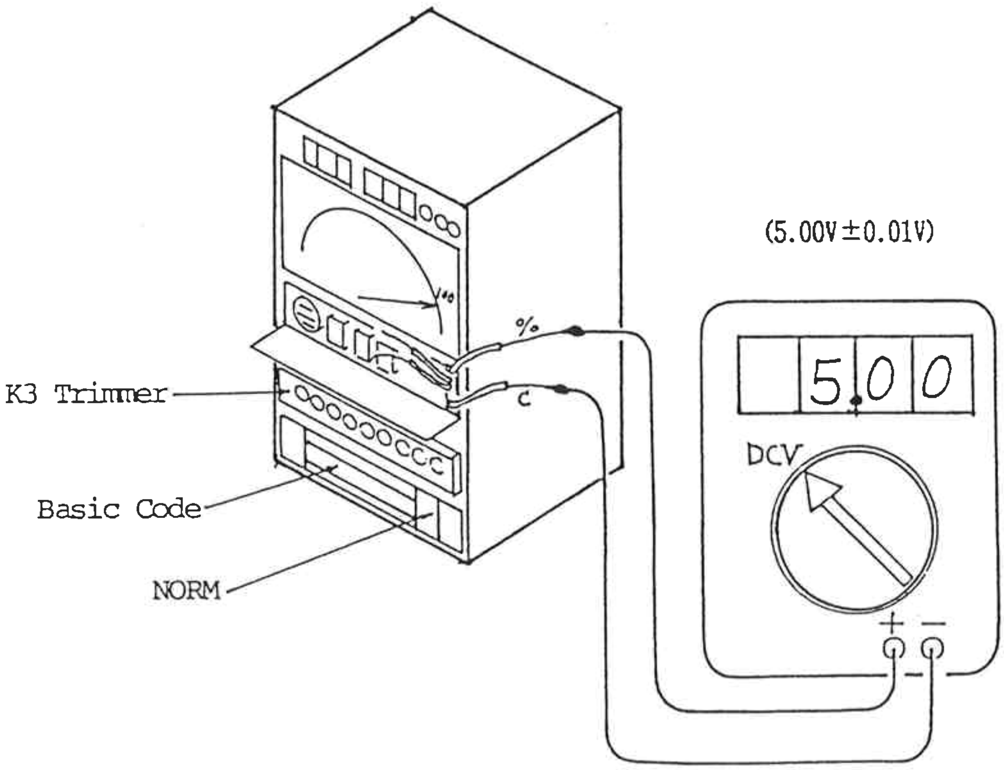
(c) Lift the load keeping a safe working radius, then lower the boom slowly to the maximum working radius for the load.
Adjusting use test weight of 60 to 80% from Max.Rated load.

Weight of Hook Block
Weight of Sling
\+ Weight of Lifting load

Toatal Load



(d) Adjust " K3 " trimmer to get a reading of 5.00 V as shown below.
After adjusting one or two times correct function check.



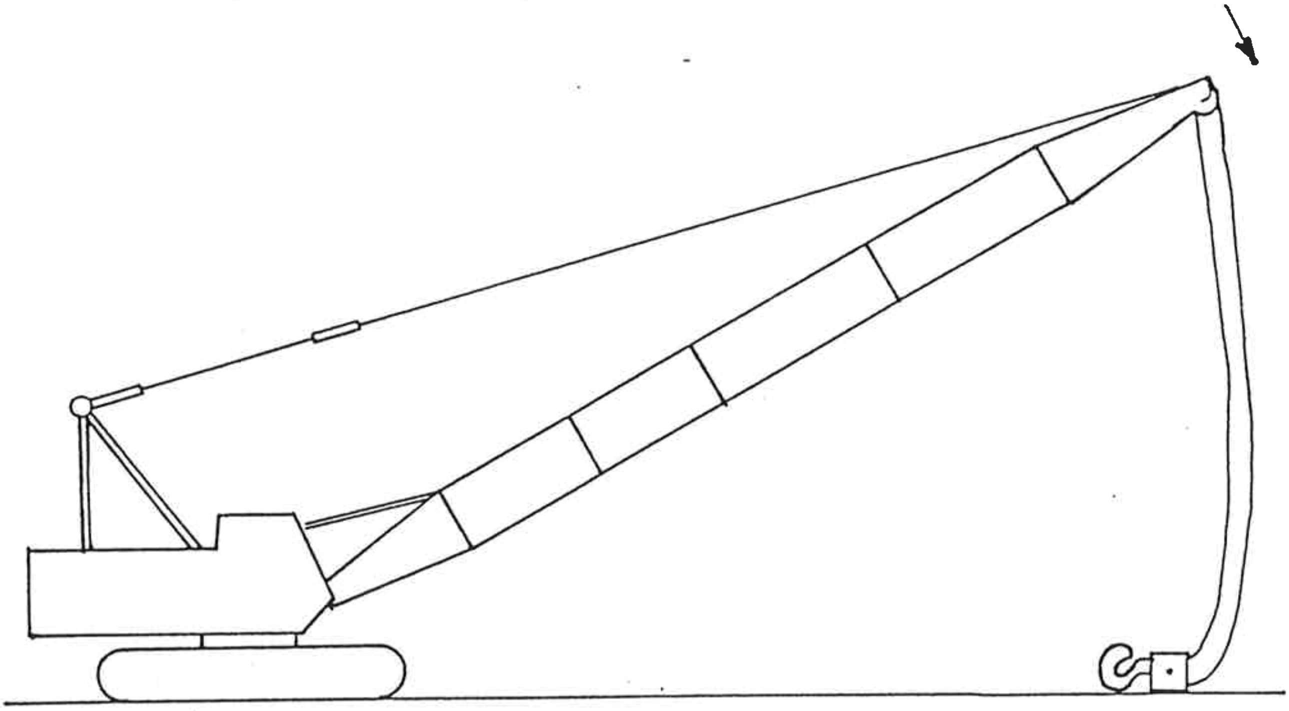
5-3 ADJUSTMENT OF " K2 "

(a) Assemble the booms to the maximum length .

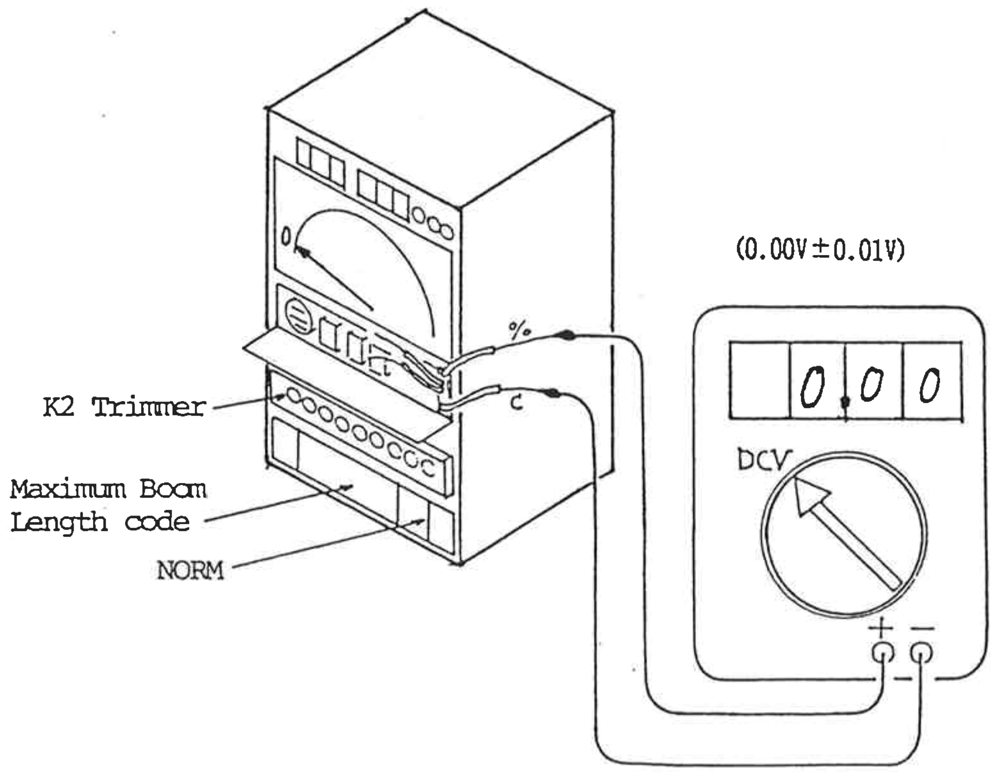
(b) Punch the MAXIMUM BOOM LENGTH CODE into the controller.

(c) Place the main hook block on the ground.

(d) Raise the boom until just (about 3°) past the point where the ALARM / AUTO — STOP stops, and then lower the boom 1° or 2° again.



(e) Adjust " K2 " trimmer to get a reading of 0.00 V.

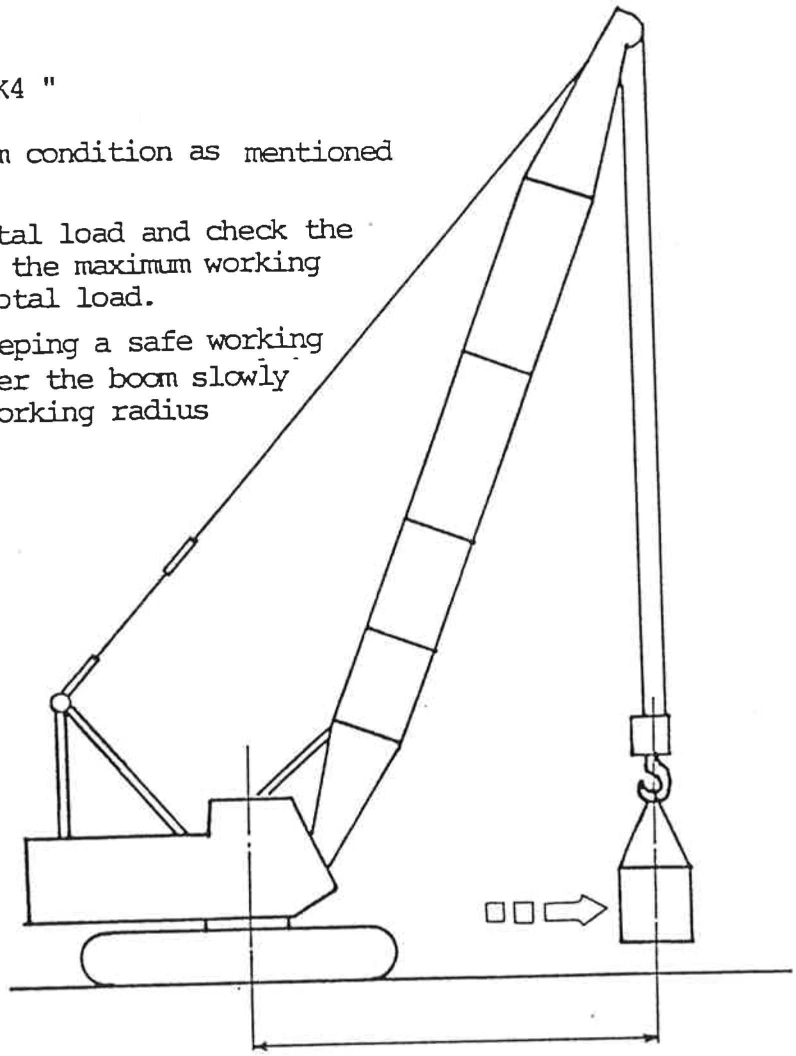


5-4 ADJUSTMENT OF " K4 "

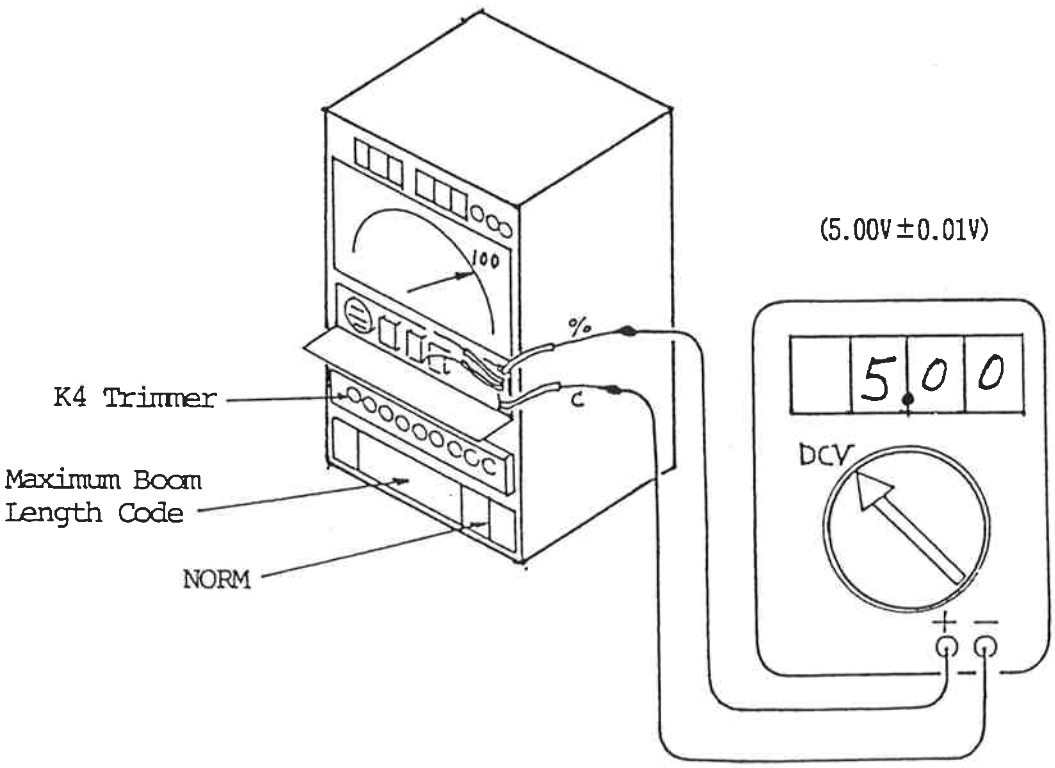
(a) Use the same boom condition as mentioned in item 5-3.

(b) Calculate the total load and check the rating chart for the maximum working radius of that total load.

(c) Lift the load keeping a safe working radius, then lower the boom slowly to the maximum working radius for the load.



(d) Adjust " K4 " trimmer to get a reading of 5.00 V.



6. REPLACEMENT OF ATTACHMENT (FOR MAIN BOOM + JIB BOOM)

6-1 ADJUSTMENT OF " K1 "

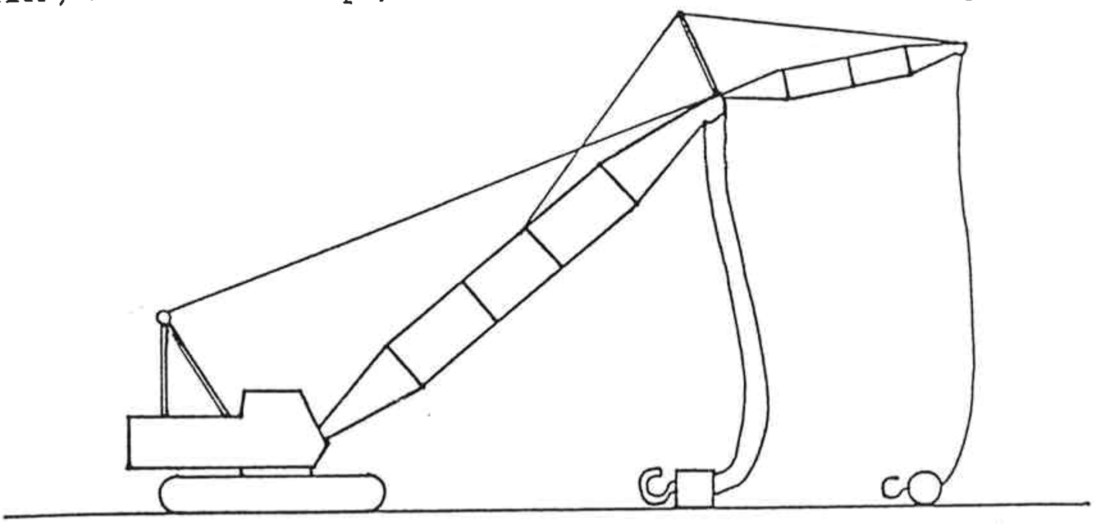
(a) Assemble the booms according to the " BASIC CODE " of that cartridge

(b) Punch the " BASIC CODE " into the CODE NUMBER SELECTOR BOARD.

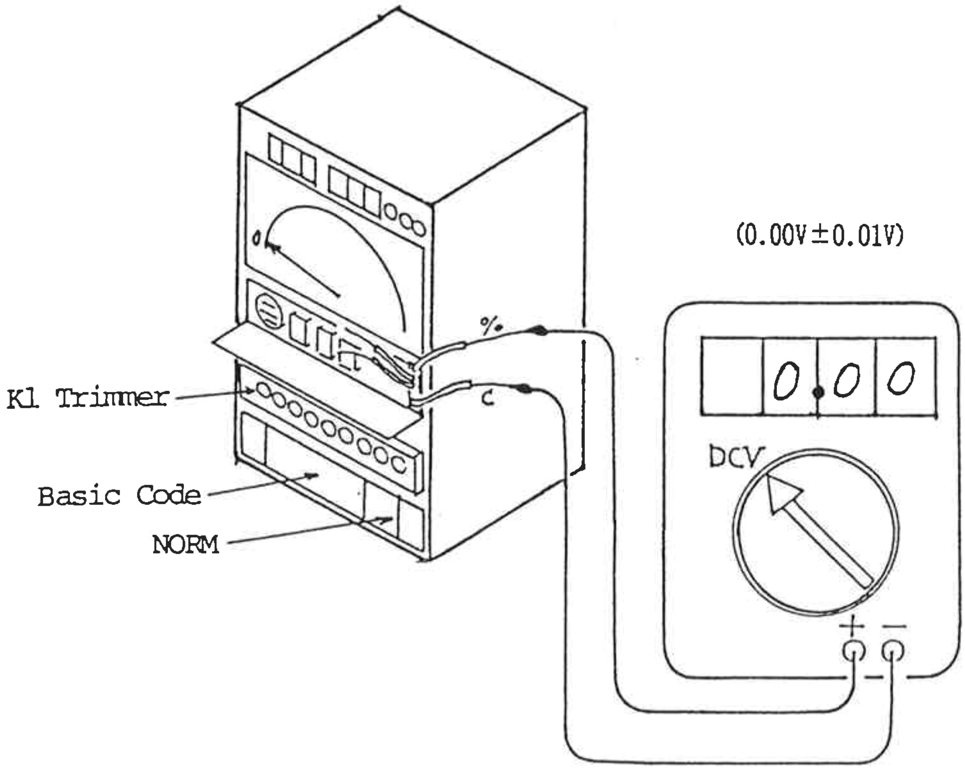
(c) Shift the MODE SELECTOR SWITCH to the " NORM " position.

(d) Place both main and auxiliary hook blocks on the ground

(e) Raise the boom until just (about 3°) past the point where the ALARM / AUTO — STOP stops, and then lower the boom 1° or 2° again.



(f) Adjust " K1 " trimmer to get a reading of 0.00 V.



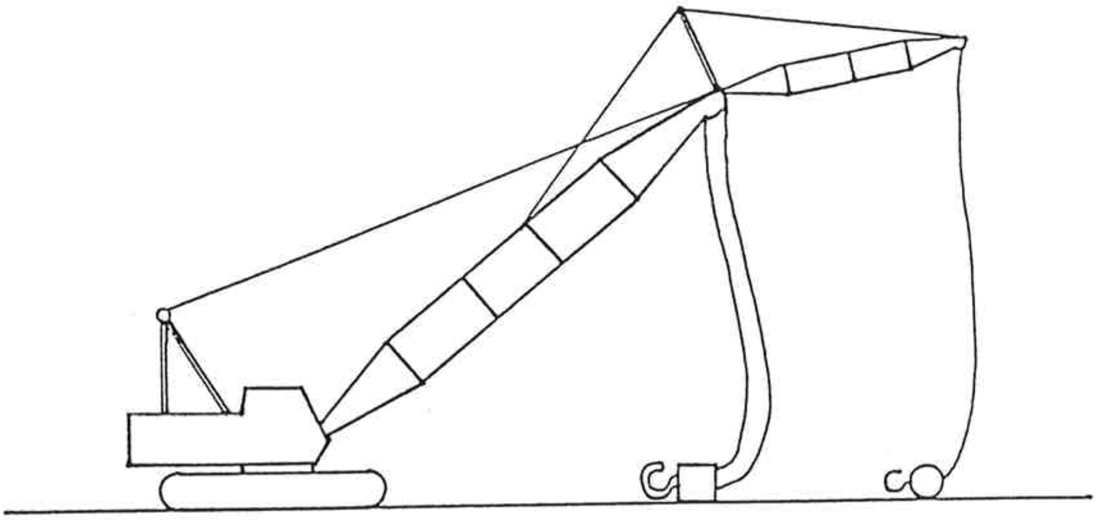
6-2 ADJUSTMENT OF " K5 "

(a) Use the same boom condition as mentioned in item 6-1.

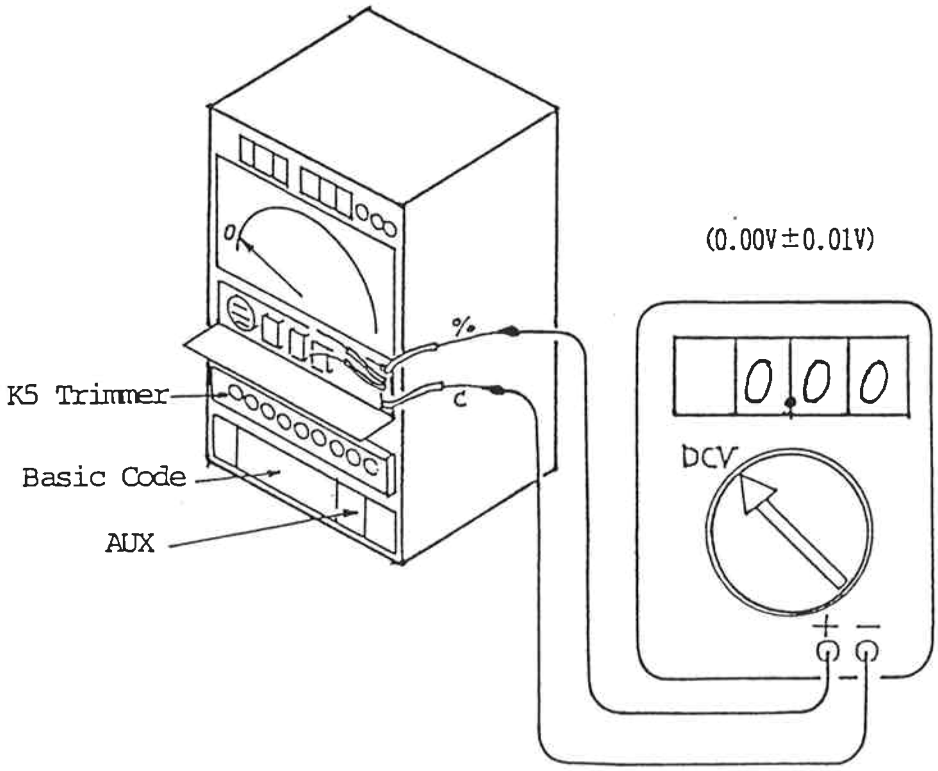
(b) Shift the MODE SELECTOR SWITCH to the " AUX " position.

(c) Place the both main and auxiliary hook blocks on the ground.

(d) Raise the boom until just (about 3°) past the point where the ALARM / AUTO-STOP stops, and then lower the boom 1° or 2° again.



(e) Adjust " K5 " trimmer to get a reading of 0.00 V.



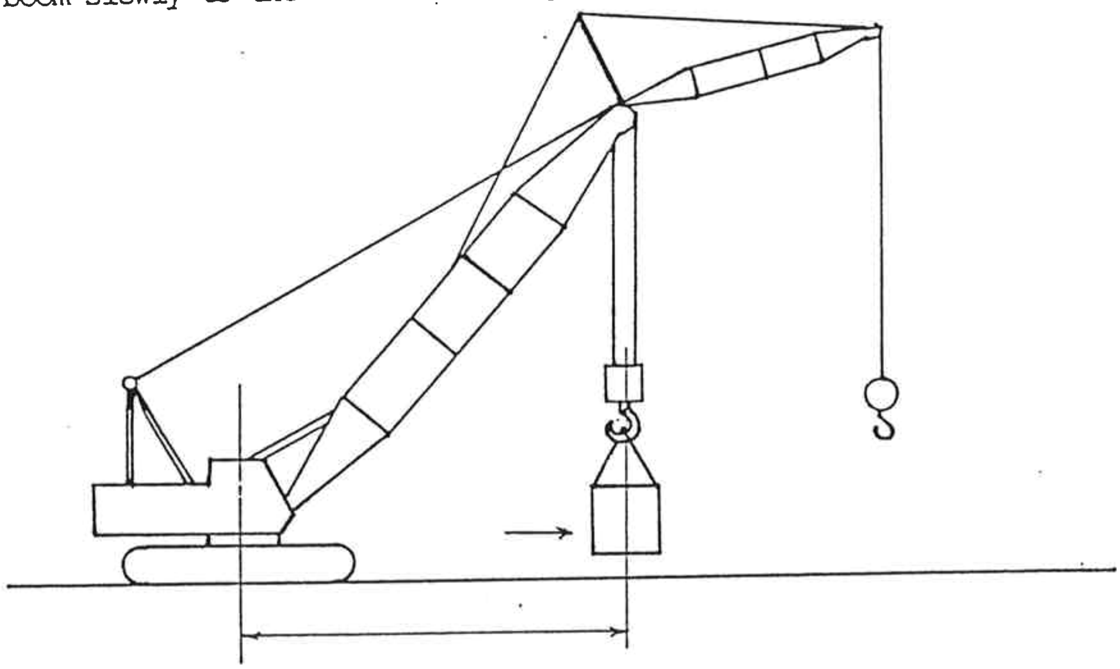
6-3 ADJUSTMENT OF " K3 "

(a) Use the same boom condition as mentioned in item 6-1.

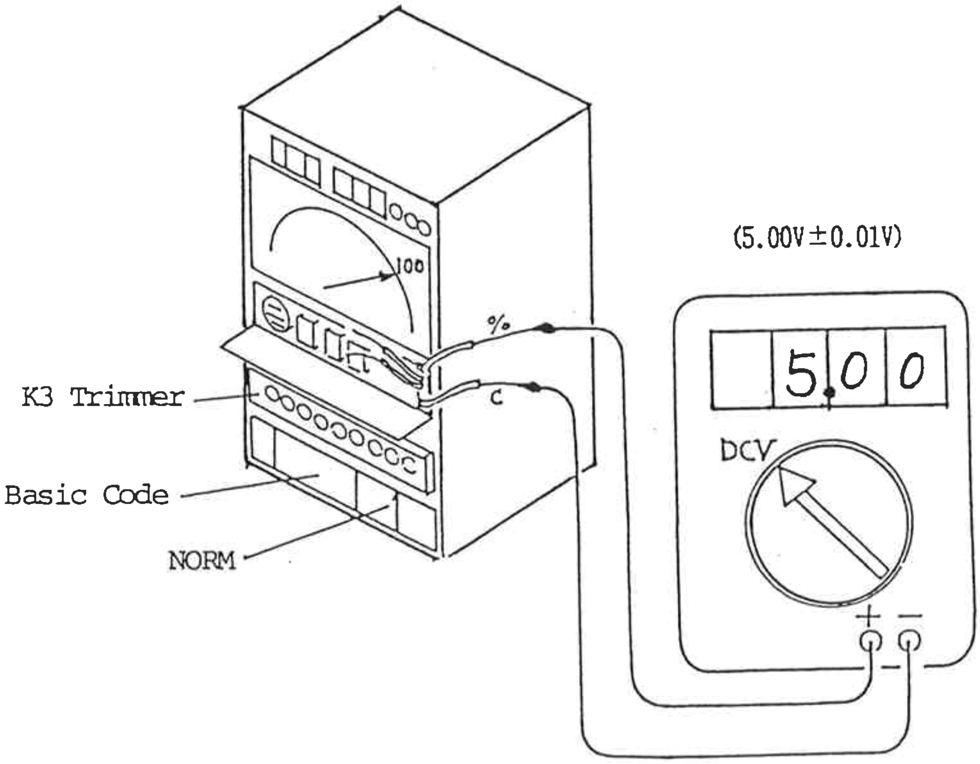
(b) Shift the MODE SELECTOR SWITCH to the " NORM " position.

(c) Calculate the total load for the main boom which consists of lifting the load (known load) plus the main and auxiliary hook blocks and the sling being used, and check the rating chart for the maximum working radius of that total load.

(d) Lift the load keeping a safe working radius, then lower the boom slowly to the maximum working radius for the load.



(e) Adjust " K3 " trimmer to get a reading of 5.00 V.



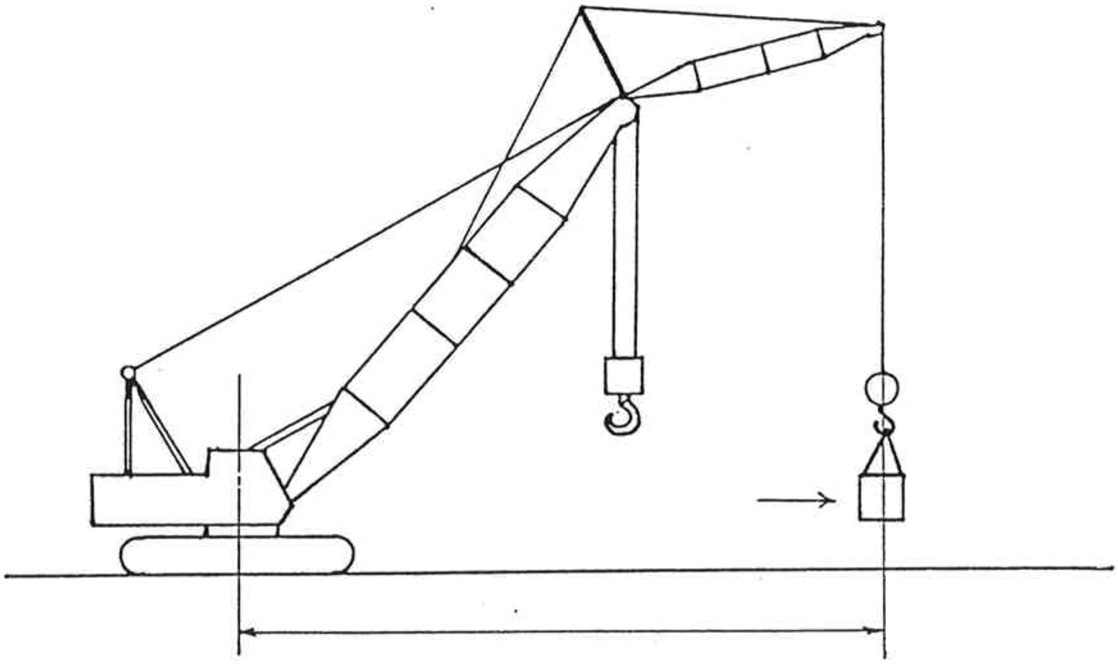
6-4 ADJUSTMENT OF " K7 "

(a) Use the same boom condition as mentioned in item 6-1.

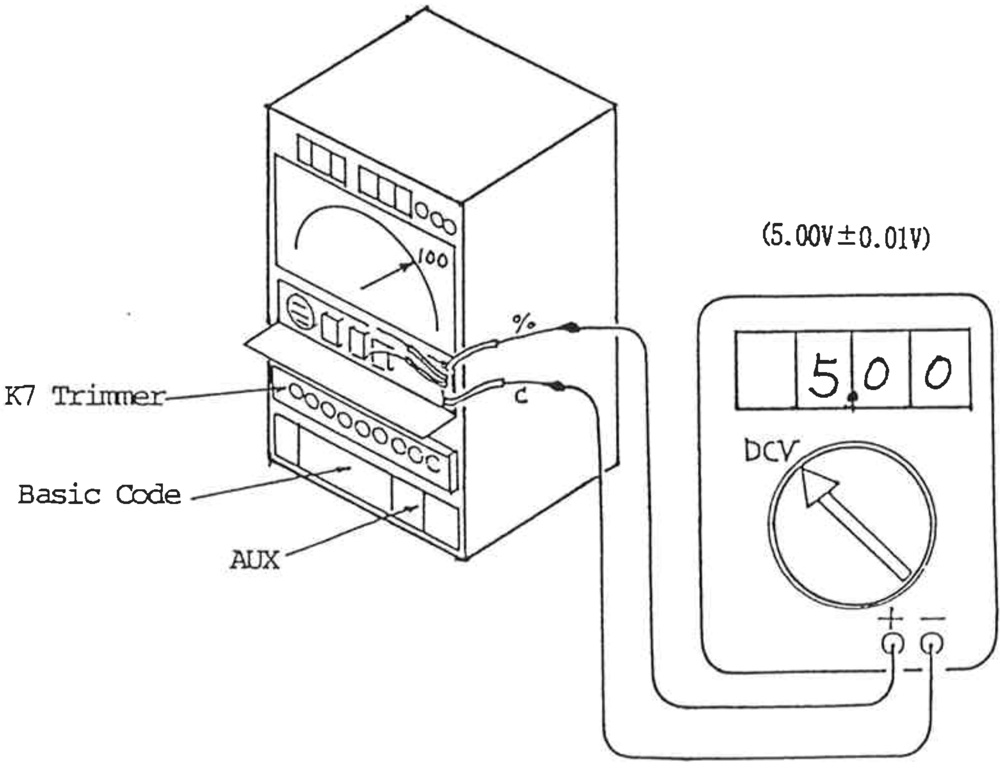
(b) Shift the MODE SELECTOR SWITCH to the " AUX " position.

(c) Calculate the total load for the jib boom, and check the rating chart for the maximum working radius of that total load.

(d) Lift the load Keeping asafe working radius, then lower the boom slowly to the maximum working radius for the load.



(e) Adjust " K7 " trimmer to get a reading of 5.00 V.



6-5 ADJUSTMENT OF " K2 "

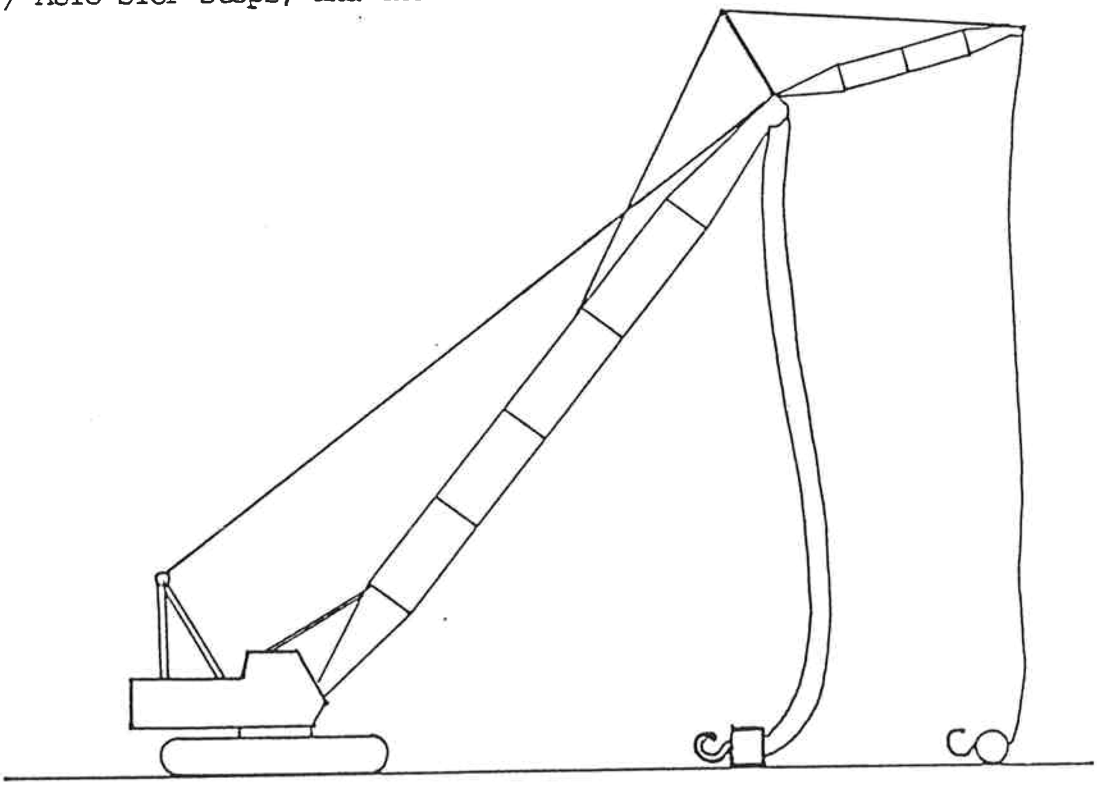
(a) Assemble the booms to the maximum main boom length with the jib boom according to the " MAXIMUM BOOM LENGTH CODE ".

(b) Punch the MAXIMUM BOOM LENGTH CODE to the controller.

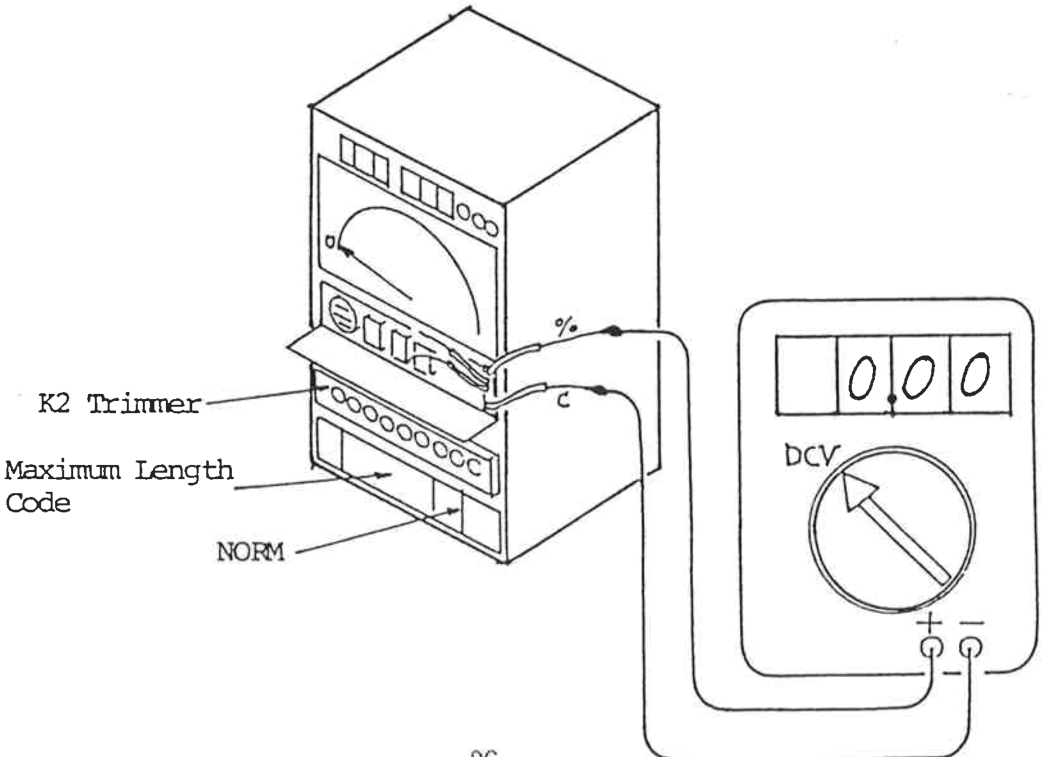
(c) Shift the MODE SELECTOR SWITCH to the " NORM " position.

(d) Place the main and auxiliary hook blocks on the ground.

(e) Raise the boom until just (about 3°) past the point where the ALARM / AUTO-STOP stops, and then lower the boom 1° or 2° again.



(f) Adjust " K2 " trimmer to get a reading of 0.00 V



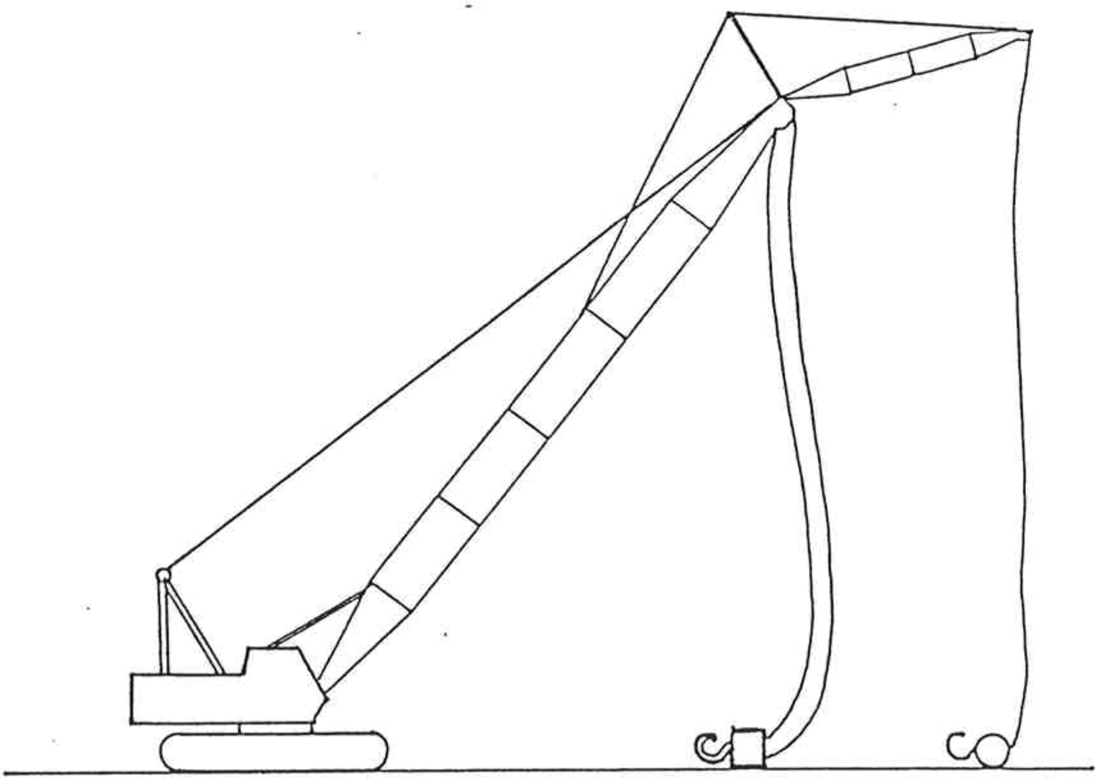
6-6 ADJUSTMENT OF " K6 "

(a) Use the same boom condition as mentioned in item 6-5.

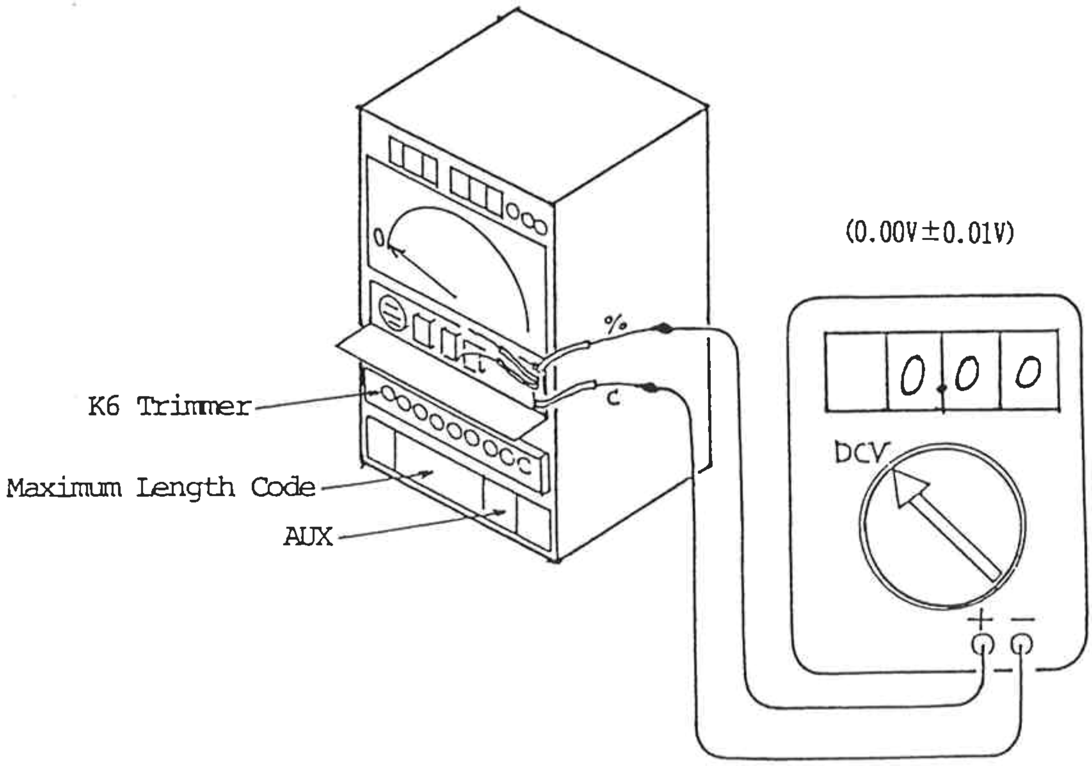
(b) Shift the MODE SELECTOR SWITCH to the " AUX " position.

(c) place both the main and auxiliary hook blocks on the ground.

(d) Raise the boom until just (about 3°) past the point where the ALARM / AUTO-STOP stops, and then lower the boom 1° or 2° again.



(e) Adjust " K6 " trimmer to get a reading of 0.00 V.



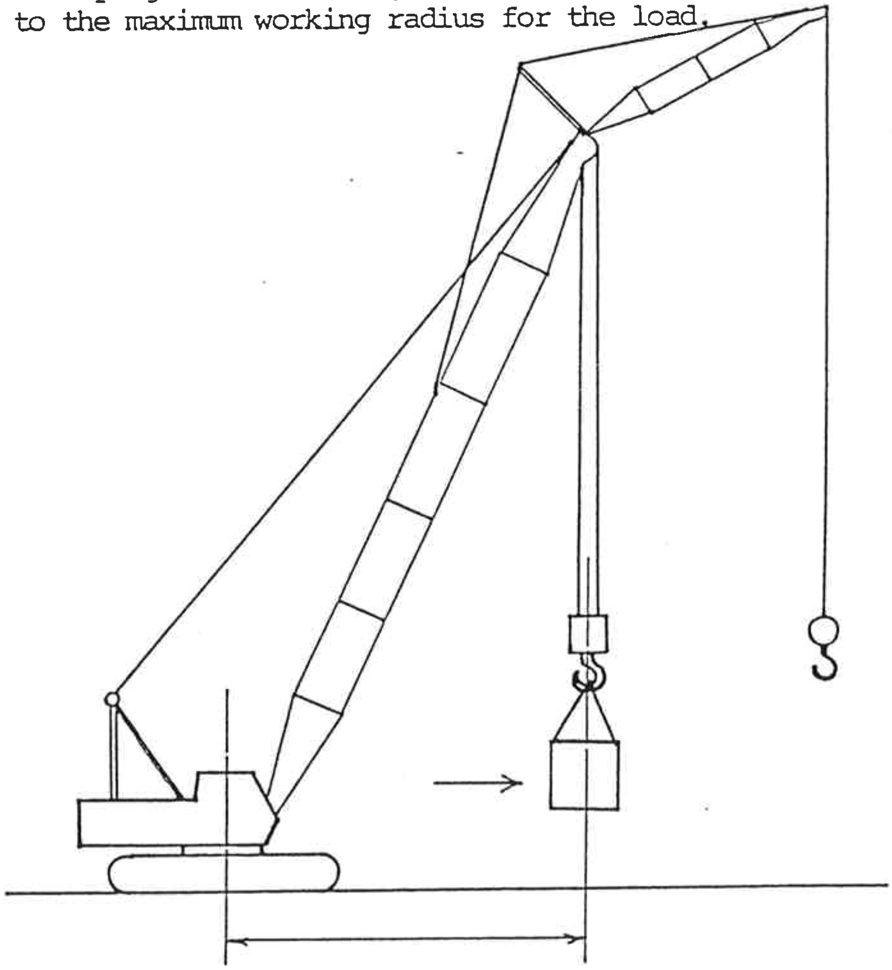
6-7 ADJUSTMENT OF " K4 "

(a) Use the same boom condition as mentioned in item 6-5.

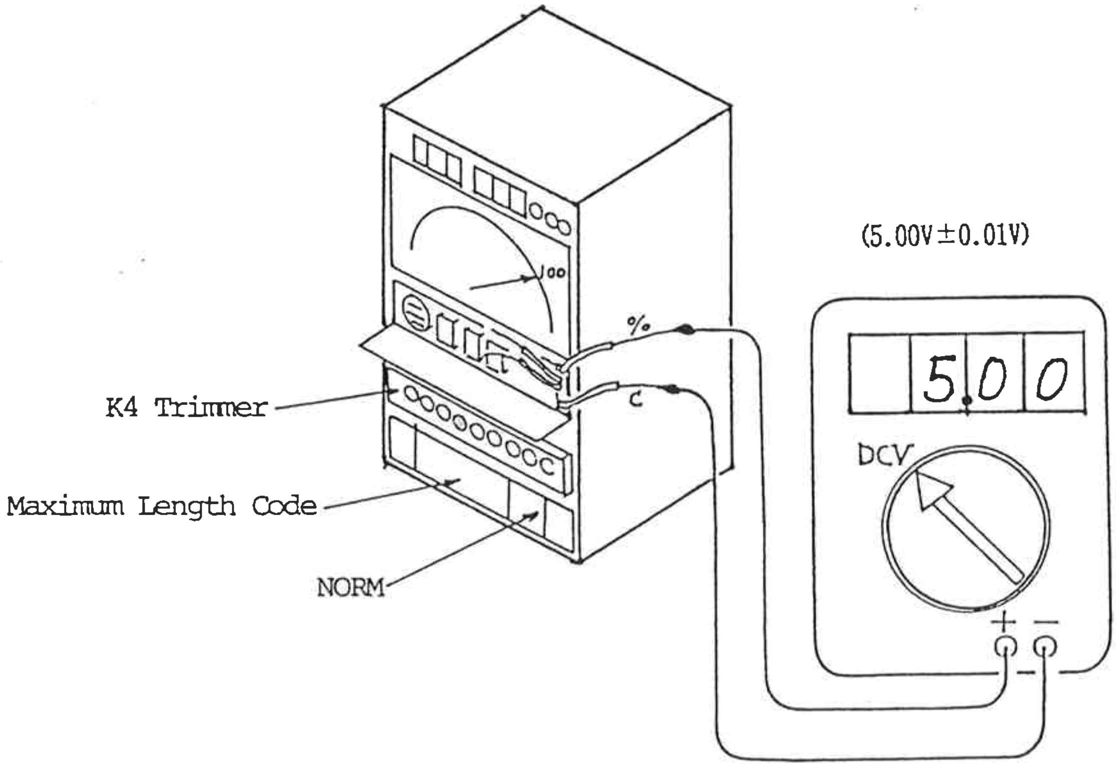
(b) Shift the MODE SELECTOR SWITCH to the " NORM " position.

(c) Calculate the total load for the main boom, and check the rating chart for the maximum working radius of that total load.

(d) Lift the load keeping a safe working radius, then lower the boom slowly to the maximum working radius for the load.



(e) Adjust " K4 " trimmer to get a reading of 5.00 V.



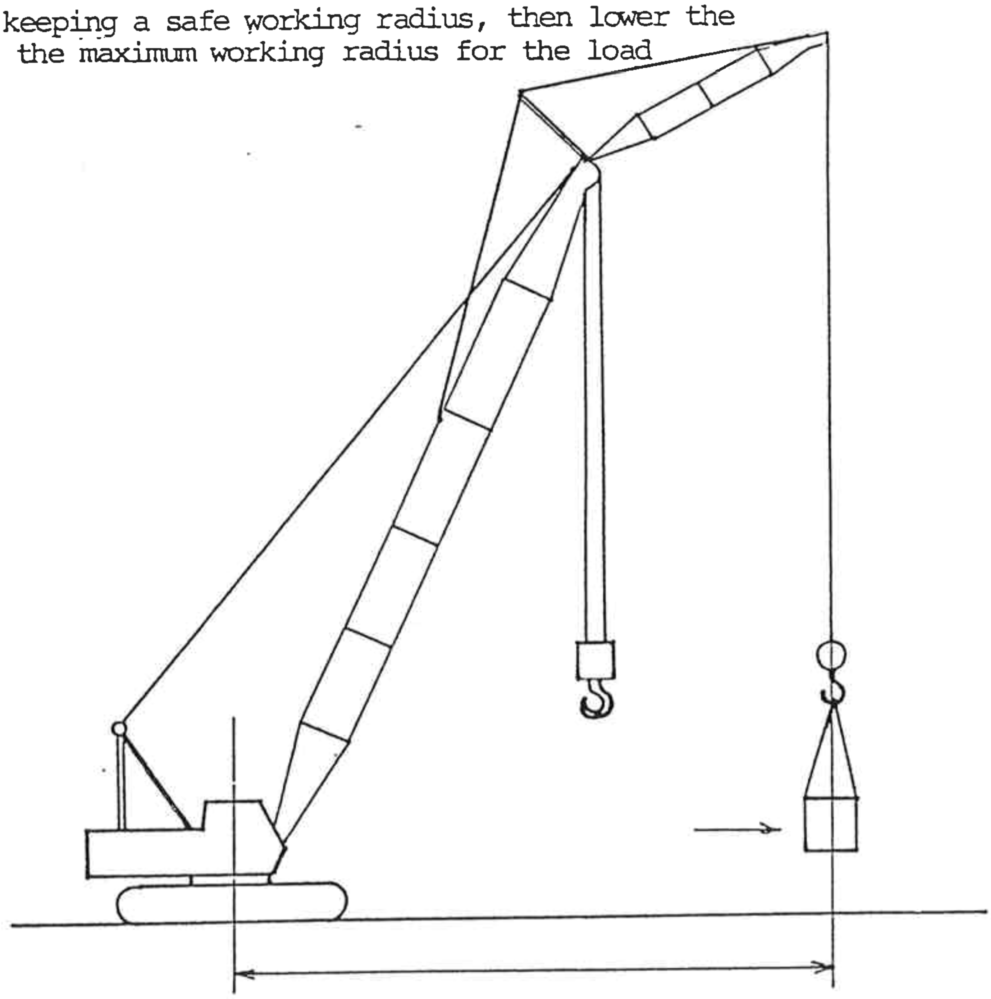
6-8 ADJUSTMENT OF " K8 "

(a) Use the same boom condition as mentioned in item 6-5.

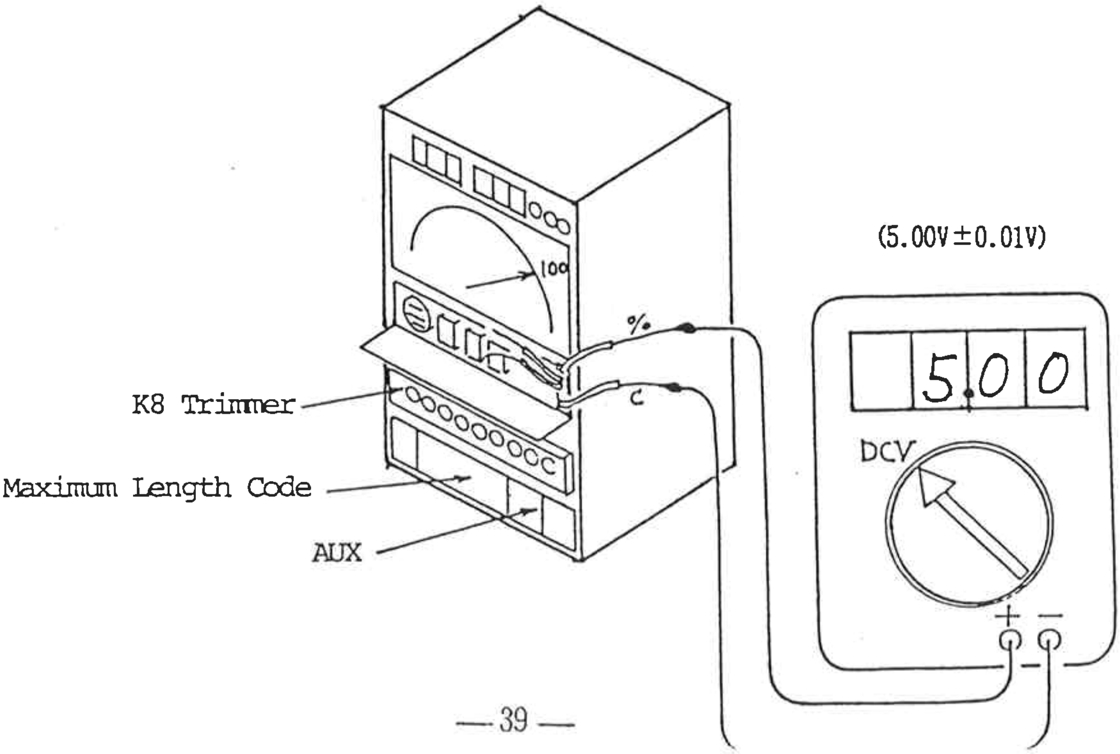
(b) Shift the MODE SELECTOR SWITCH to the " AUX " position.

(c) Calculate the total load for the jib boom, and check the rating chart for the maximum working radius of that total load.

(d) Lift the load keeping a safe working radius, then lower the boom slowly to the maximum working radius for the load

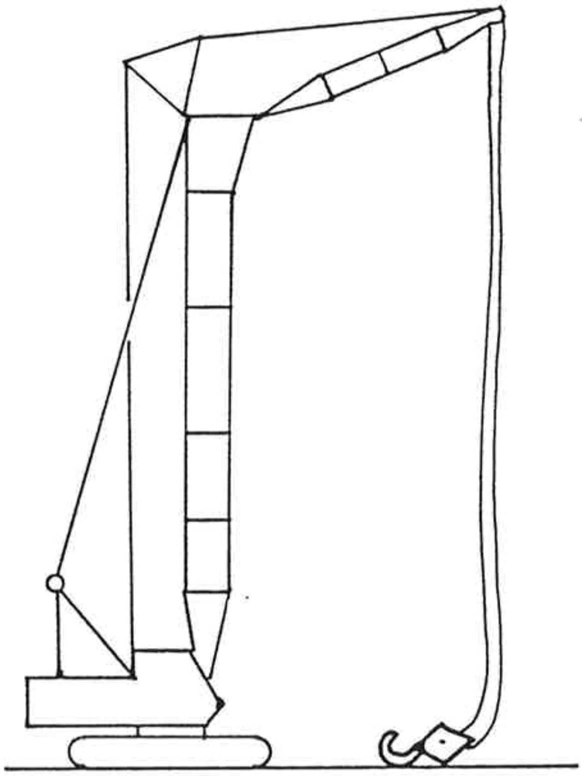


(e) Adjust " K8 " trimmer to get a reading of 5.00 V.

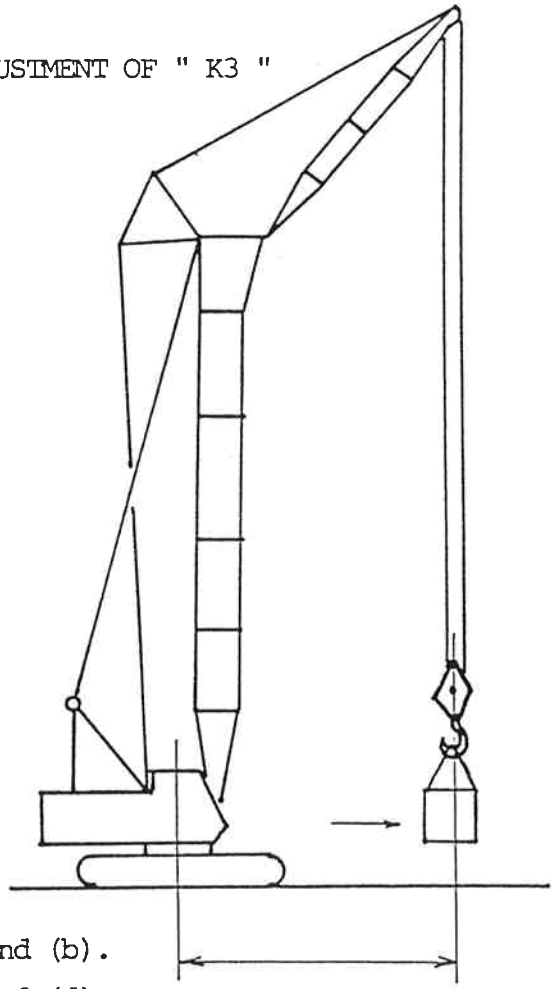


7. REPLACEMENT OF ATTACHMENT (FOR TOWER CRANE)
(Refer to item 5)

(a) ADJUSTMENT OF " K1 "

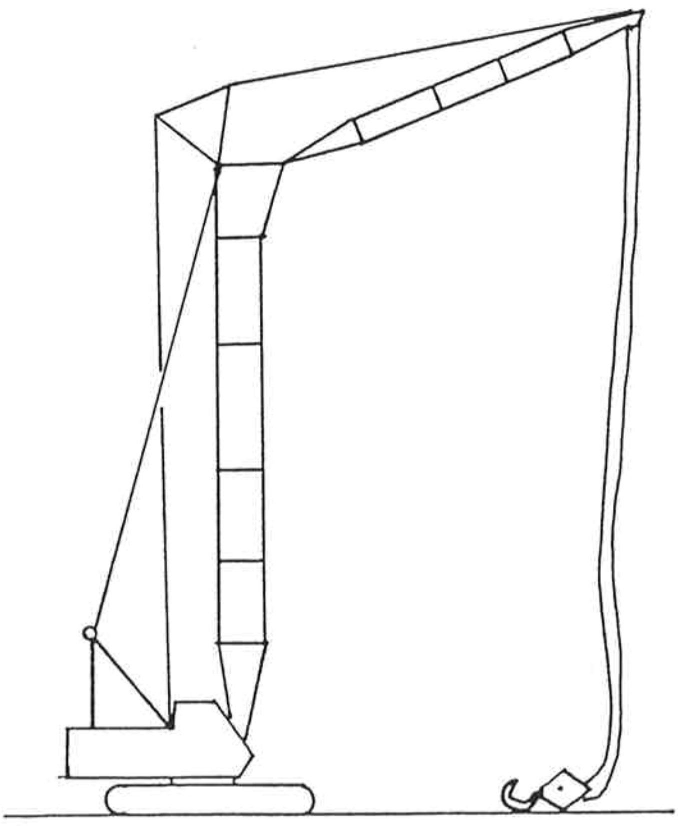


(b) ADJUSTMENT OF " K3 "

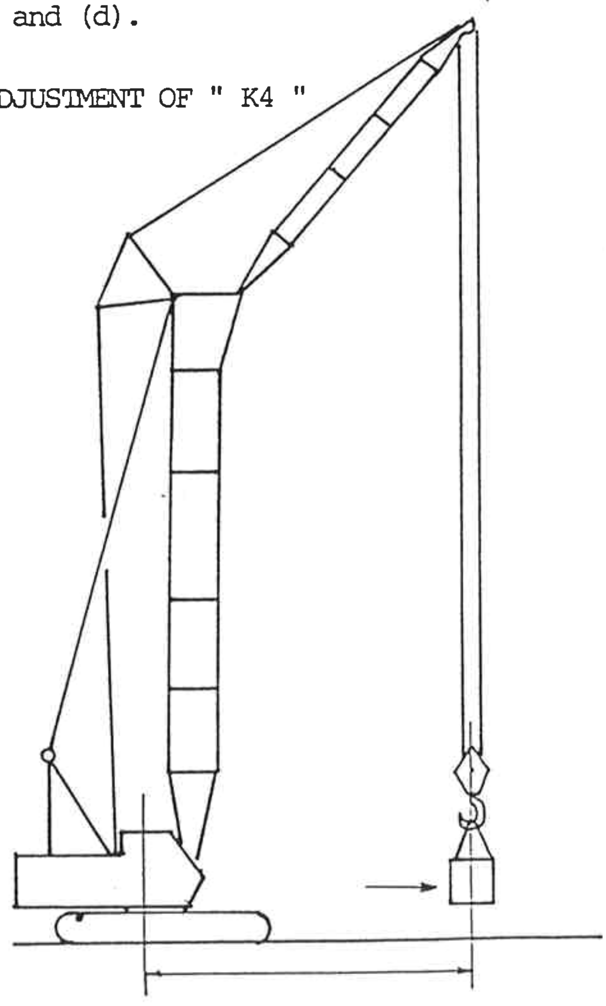


Note : Minimum jib boom length for (a) and (b).
Maximum jib boom length for (c) and (d).

(c) ADJUSTMENT OF " K2 "



(d) ADJUSTMENT OF " K4 "



Code Number Table(with Crane Boom)

(Lift Crane)

Boom Length (m)	Main Boom only			with Auxiliary Sheave			with Jib (Block Classification N 1 A 2)																Bucket Operation (Clamshell)	Boom Length (ft)
	Block Classification N 1			Block Classification N 1 A 2			6.09m (20')				9.14m (30')				12.19m (40')				15.24m (50')					
							Offset 10°		Offset 30°		Offset 10°		Offset 30°		Offset 10°		Offset 30°		Offset 10°		Offset 30°			
	Applicable Hook (t)			Applicable Hook (main/Auxiliary)			Applicable Hook (main/Auxiliary)																	
	55	32	19	55/B	32/B	19/B	32/B	19/B	32/B	19/B	32/B	19/B	32/B	19/B	32/B	19/B	32/B	19/B	32/B	19/B	32/B	19/B		
12.19	(04000)	04001	04002	(04100)	(04101)																		04003	40
15.24	05000	05001	05002	05100	05101																		05003	50
18.29	06000	06001	06002	06100	06101	06102																	06003	60
21.34	07000	07001	07002	07100	07101	07102																		70
24.38	08000	08000	08002	08100	08101	08102																		80
27.43	09000	09000	09002	09100	09101	09102																		90
30.48	10000	10000	10002	10100	10101	10102	(10211)	10212	(10231)	10232	10311	10312	10331	10332	(10411)	10412	(10431)	10432	10511	10512	10531	10532		100
33.53	11000	11000	11002	11100	11101	11102	11211	11212	11231	11232	11311	11312	11331	11332	11411	11412	11431	11432	11511	11512	11531	11532		110
36.58	12000	12000	12000	12100	12101	12101	12211	12212	12231	12232	12311	12312	12331	12332	12411	12412	12431	12432	12511	12512	12531	12532		120
39.62	13000	13000	13000	13100	13101	13101	13211	13212	13231	13232	13311	13312	13331	13332	13411	13412	13431	13432	13511	13512	13531	13532		130
42.67	14000	14000	14000	14100	14101	14101	14211	14212	14231	14232	14311	14312	14331	14332	14411	14412	14431	14432	14511	14512	14531	14532		140
45.72	15000	15000	15000	15100	15101	15101																		150
48.77	16000	16000	16000	16100	16101	16101																		160
51.82	17000	17000	17000	—	—	—																		170
Cartridge P/N	2480Q549D3			2480Q 551D3	2480Q 552D3		2480Q 554D3		2480Q 555D3		2480Q 554D3		2480Q 555D3		2480Q 556D3		2480Q 646D3		2480Q 556D3		2480Q 646D1		2480Q 549D3	Cartridge P/N

NOTES: 1. "B" : Ball hook
2. NORM=N BLOC1=1 N1=NORM BLOC1=Main hook
AUX =A BLOC2=2 A2=AUX BLOC2=Jib hook
3. Code number in ( ) : Basic code No.

(Tower Crane)

Tower Length \ Jib Length	16.76m (55')	19.81 (65')	22.86 (75')	25.91 (85')	28.96 (95')
20.42m (67')	07060	07070	–	–	–
23.47 (77')	08060	08070	08080	–	–
26.52 (87')	09060	09070	09080	09090	–
29.57 (97')	10060	10070	10080	10090	10100
32.61 (107')	11060	11070	11080	11090	11100
35.66 (117')	12060	12070	12080	12090	12100
38.71 (127')	13060	13070	13080	13090	13100
41.76 (137')	–	14070	14080	14090	–
PART №	2480Q561D2 (Fmax 23.0t If =0.9167)				

WARNING

There is no combination of such a length of tower with jib.

Code Number Table(with Crane Boom)

(Lift Crane)

Boom Length (m)	Main Boom only			with Auxiliary Sheave			with Jib																Bucket Operation	Boom Length (ft)
							Block Classification N 1 A 2: 6.09m (20')				9.14m (30')				12.19m (40')				15.24m (50')					
	Block Classification N 1			Block Classification N 1 A 2			Offset 10°		Offset 30°		Offset 10°		Offset 30°		Offset 10°		Offset 30°		Offset 10°		Offset 30°		(Clamshell)	
	Applicable Hook (t)			Applicable Hook (main/Auxiliary)			Applicable Hook (main/Auxiliary)																	
	55	32	19	55/B	32/B	19/B	32/B	19/B	32/B	19/B	32/B	19/B	32/B	19/B	32/B	19/B	32/B	19/B	32/B	19/B	32/B	19/B		
12.19	(04000)	04001	04002	(04100)	(04101)																		04003	40
15.24	05000	05001	05002	05100	05101																		05003	50
18.29	06000	06001	06002	06100	06101	06102																	06003	60
21.34	07000	07001	07002	07100	07101	07102																		70
24.38	08000	08000	08002	08100	08101	08102																		80
27.43	09000	09000	09002	09100	09101	09102																		90
30.48	10000	10000	10002	10100	10101	10102	(10211)	10212	(10231)	10232	10311	10312	10331	10332	(10411)	10412	(10431)	10432	10511	10512	10531	10532		100
33.53	11000	11000	11002	11100	11101	11102	11211	11212	11231	11232	11311	11312	11331	11332	11411	11412	11431	11432	11511	11512	11531	11532		110
36.58	12000	12000	12000	12100	12101	12101	12211	12212	12231	12232	12311	12312	12331	12332	12411	12412	12431	12432	12511	12512	12531	12532		120
39.62	13000	13000	13000	13100	13101	13101	13211	13212	13231	13232	13311	13312	13331	13332	13411	13412	13431	13432	13511	13512	13531	13532		130
42.67	14000	14000	14000	14100	14101	14101	14211	14212	14231	14232	14311	14312	14331	14332	14411	14412	14431	14432	14511	14512	14531	14532		140
45.72	15000	15000	15000	15100	15101	15101																		150
48.77	16000	16000	16000	16100	16101	16101																		160
51.82	17000	17000	17000	—	—	—																		170
Cartridge P/N	2480Q549D3			2480Q 551D3	2480Q 552D3		2480Q 554D3		2480Q 555D3		2480Q 554D3		2480Q 555D3		2480Q 556D3		2480Q 646D3		2480Q 556D3		2480Q 646D1		2480Q 549D3	Cartridge P/N

NOTES: 1. "B" : Ball hook
2. NORM=N BLOC1=1 N1=NORM BLOC1=Main hook
AUX =A BLOC2=2 A2=AUX BLOC2=Jib hook
3. Code number in ( ) : Basic code No.

(Tower Crane)

Tower Length \ Jib Length	16.76m (55')	19.81 (65')	22.86 (75')	25.91 (85')	28.96 (95')
20.42m(67')	07060	07070	—	—	—
23.47 (77')	08060	08070	08080	—	—
26.52 (87')	09060	09070	09080	09090	—
29.57 (97')	10060	10070	10080	10090	10100
32.61 (107')	11060	11070	11080	11090	11100
35.66 (117')	12060	12070	12080	12090	12100
38.71 (127')	13060	13070	13080	13090	13100
41.76 (137')	—	14070	14080	14090	—
PART №	2480Q1082D1 (Fmax20.0t f=0.8889)				

WARNING

There is no combination of such a length of tower with jib.

Code Number Table(Tower Boom)

Boom Length (m)	Main Boom only			with Aux. Sheave			With Jib																Bucket Operation (Clamshell)	Boom Length (ft)
	Block Classification N 1			Block Classification N 1 A 2			Block Classification N 1 A 2 — 6.09m (20')				9.14m (30')				12.19m (40')				15.24m (50')					
							Offset 10°		Offset 30°		Offset 10°		Offset 30°		Offset 10°		Offset 30°		Offset 10°		Offset 30°			
	Applicable Block (t)			Applicable Hook (Main/Aux.)			Applicable Hook (Main/Aux.)																	
	55	32	19	55/B	32/B	19/B	32/B	19/B	32/B	19/B	32/B	19/B	32/B	19/B	32/B	19/B	32/B	19/B	32/B	19/B	32/B	19/B		
12.19	(04000)	04001	04002	(04100)	(04101)	04102																	04003	40
15.24	05000	05001	05002	05100	05101	05102																	05003	50
18.29	06000	06001	06002	06100	06101	06102																	06003	60
21.34	07000	07001	07002	07100	07101	07102																		70
24.38	08000	08000	08002	08100	08101	08102																		80
27.43	09000	09000	09002	09100	09101	09102																		90
30.48	10000	10000	10002	10100	10101	10102	(10211)	10212	(10231)	10232	10311	10312	10331	10332	(10411)	10412	(10431)	10432	10511	10512	10531	10532		100
33.53	11000	11000	11002	11100	11101	11102	11211	11212	11231	11232	11311	11312	11331	11332	11411	11412	11431	11432	11511	11512	11531	11532		110
36.58	12000	12000	12000	12100	12101	12101	12211	12212	12231	12232	12311	12312	12331	12332	12411	12412	12431	12432	12511	12512	12531	12532		120
39.62	13000	13000	13000	13100	13101	13101	13211	13212	13231	13232	13311	13312	13331	13332	13411	13412	13431	13432	13511	13512	13531	13532		130
42.67	14000	14000	14000	14100	14101	14101	14211	14212	14231	14232	14311	14312	14331	14332	14411	14412	14431	14432	14511	14512	14531	14532		140
45.72	15000	15000	15000	15100	15101	15101																		150
48.77	16000	16000	16000	16100	16101	16101																		160
51.82	17000	17000	17000	—	—	—																		170
Cartridge P/N	2480Q742D1			2480Q 743D1	2480Q 744D1		2480Q 745D1		2480Q 746D1		2480Q 745D1		2480Q 746D1		2480Q 747D1		2480Q 748D1		2480Q 747D1		2480Q 748D1		2480Q 742D1	Cartridge P/N

NOTES: 1. "B" : Ball Hook
2. NORM=N BLOC1=1 N1=NORM BLOC1=Main Hook
AUX =A BLOC2=2 A2=AUX BLOC2=Aux. Hook
3. Code Number in ( ) : Basic Code Number

Code Number Table(Tower Boom)

Boom Length (m)	Main Boom only, Block Classification N 1, Applicable Block (t): 55	32	19	with Aux. Sheave, Block Classification N 1 A 2, Applicable Hook (Main/Aux.): 55/B	32/B	19/B	Bucket Operation (Clamshell)	Boom Length (ft)
12.19	(04000)	04001	04002	(04100)	(04101)	04102	04003	40
15.24	05000	05001	05002	05100	05101	05102	05003	50
18.29	06000	06001	06002	06100	06101	06102	06003	60
21.34	07000	07001	07002	07100	07101	07102		70
24.38	08000	08000	08002	08100	08101	08102		80
27.43	09000	09000	09002	09100	09101	09102		90
30.48	10000	10000	10002	10100	10101	10102		100
33.53	11000	11000	11002	11100	11101	11102		110
36.58	12000	12000	12000	12100	12101	12101		120
39.62	13000	13000	13000	13100	13101	13101		130
42.67	14000	14000	14000	14100	14101	14101		140
45.72	15000	15000	15000	15100	15101	15101		150
48.77	16000	16000	16000	16100	16101	16101		160
51.82	17000	17000	17000	—	—	—		170
Cartridge P/N	2480Q1073D1			2480Q 1074D1	2480Q 1075D1		2480Q 1073D1	Cartridge P/N

With Jib — Block Classification N 1 A 2 — Applicable Hook (Main/Aux.)

Boom Length (m)	6.09m (20') Offset 10° 32/B	6.09m (20') Offset 10° 19/B	6.09m (20') Offset 30° 32/B	6.09m (20') Offset 30° 19/B	9.14m (30') Offset 10° 32/B	9.14m (30') Offset 10° 19/B	9.14m (30') Offset 30° 32/B	9.14m (30') Offset 30° 19/B	12.19m (40') Offset 10° 32/B	12.19m (40') Offset 10° 19/B	12.19m (40') Offset 30° 32/B	12.19m (40') Offset 30° 19/B	15.24m (50') Offset 10° 32/B	15.24m (50') Offset 10° 19/B	15.24m (50') Offset 30° 32/B	15.24m (50') Offset 30° 19/B
12.19																
15.24																
18.29																
21.34																
24.38																
27.43																
30.48	(10211)	10212	(10231)	10232	10311	10312	10331	10332	(10411)	10412	(10431)	10432	10511	10512	10531	10532
33.53	11211	11212	11231	11232	11311	11312	11331	11332	11411	11412	11431	11432	11511	11512	11531	11532
36.58	12211	12212	12231	12232	12311	12312	12331	12332	12411	12412	12431	12432	12511	12512	12531	12532
39.62	13211	13212	13231	13232	13311	13312	13331	13332	13411	13412	13431	13432	13511	13512	13531	13532
42.67	14211	14212	14231	14232	14311	14312	14331	14332	14411	14412	14431	14432	14511	14512	14531	14532
45.72																
48.77																
51.82																
Cartridge P/N	2480Q 1076D1		2480Q 1077D1		2480Q 1076D1		2480Q 1077D1		2480Q 1078D1		2480Q 1079D1		2480Q 1078D1		2480Q 1079D1	

NOTES: 1. "B" : Ball Hook

2. NORM=N AUX =A BLOC1=1 BLOC2=2 N1=NORM A2=AUX BLOC1=Main Hook BLOC2=Aux. Hook

3. Code Number in ( ) : Basic Code Number

Code Number Table(with Crane Boom)

(Lift Crane)

Boom Length (m)	Main Boom only, Block Classification N1, Applicable Hook (t): 65	Main Boom only: 32	Main Boom only: 19	With Aux. Sheave, Block Classification N1 A2, Applicable Hook (t): 65/B	With Aux. Sheave: 32/B	With Aux. Sheave: 19/B	With Jib (Block Classification N1 A2), Applicable Hook (main/Auxiliary): 6.09m (20') Offset 10° 32/B	6.09m (20') Offset 10° 19/B	6.09m (20') Offset 30° 32/B	6.09m (20') Offset 30° 19/B	9.14m (30') Offset 10° 32/B	9.14m (30') Offset 10° 19/B	9.14m (30') Offset 30° 32/B	9.14m (30') Offset 30° 19/B	12.19m (40') Offset 10° 32/B	12.19m (40') Offset 10° 19/B	12.19m (40') Offset 30° 32/B	12.19m (40') Offset 30° 19/B	15.24m (50') Offset 10° 32/B	15.24m (50') Offset 10° 19/B	15.24m (50') Offset 30° 32/B	15.24m (50') Offset 30° 19/B	Bucket Operation (Clamshell)	Boom Length (ft)
12.19	(04000)	04002	04003	(04100)	(04102)																		04004	40
15.24	05000	05002	05003	05100	05102																		05004	50
18.29	06000	06002	06003	06100	06102	06103																	06004	60
21.34	07000	07002	07003	07100	07102	07103																		70
24.38	08000	08002	08003	08100	08102	08103																		80
27.43	09000	09002	09003	09100	09102	09103																		90
30.48	10000	10000	10003	10100	10102	10103	(10212)	10213	(10232)	10233	10312	10313	10332	10333	(10412)	10413	(10432)	10433	10512	10513	10532	10533		100
33.53	11000	11000	11003	11100	11102	11103	11212	11213	11232	11233	11312	11313	11332	11333	11412	11413	11432	11433	11512	11513	11532	11533		110
36.58	12000	12000	12003	12100	12102	12103	12212	12213	12232	12233	12312	12313	12332	12333	12412	12413	12432	12433	12512	12513	12532	12533		120
39.62	13000	13000	13000	13100	13102	13102	13212	13213	13232	13233	13312	13313	13332	13333	13412	13413	13432	13433	13512	13513	13532	13533		130
42.67	14000	14000	14000	14100	14102	14102		14213		14233		14313		14333		14413		14433		14513		14533		140
45.72	15000	15000	15000	15100	15102	15102		15213		15233		15313		15333		15413		15433		15513		15533		150
48.77	16000	16000	16000	16100	16102	16102																		160
51.82	17000	17000	17000	17100	17102	17102																		170
54.86	18000	18000	18000																					180
Cartridge P/N	2480Q563D3			2480Q 564D2	2480Q 565D2		2480Q 572D2		2480Q 573D2		2480Q 572D2		2480Q 573D2		2480Q 574D2		2480Q 633D1		2480Q 574D2		2480Q 633D1		2480Q 563D3	Cartridge P/N

NOTES: 1. "B" : Ball Hook
2. NORM=N AUX =A BLOC1=1 BLOC2=2 N1=NORM A2=AUX BLOC1=Main Hook BLOC2=Jib Hook
3. Code Number in ( ) : Basic Code Number

(Tower Crane)

Tower Length \ Jib Length	18.29m (60')	21.34 (70')	24.38 (80')	27.43 (90')	30.48 (100')
21.34m(70')	07060	–	–	–	–
24.38 (80')	08060	08070	–	–	–
27.43 (90')	09060	09070	09080	–	–
30.48 (100')	10060	10070	10080	10090	–
33.53 (110')	11060	11070	11080	11090	11100
36.58 (120')	12060	12070	12080	12090	12100
39.62 (130')	13060	13070	13080	13090	13100
42.67 (140')	–	14070	14080	14090	–
PART №	2480Q562D2(Fmax 24.0t 1f = 0.9167)				

WARNING

There is no combination of such a length of tower with jib in columns shown with – (bar).

Code Number Table(Tower Boom)

Boom Length (m)	Main boom only			With Aux. Sheave			With Jib																Bucket Operation (Clamshell)	Boom Length (ft)
	Block Classification N1			Block Classification N1 A2			Block Classification N1 A2: 6.09m (20')				9.14m (30')				12.19m (40')				15.24m (50')					
							Offset 10°		Offset 30°		Offset 10°		Offset 30°		Offset 10°		Offset 30°		Offset 10°		Offset 30°			
	Applicable Hook (t)			Applicable Hook (Main/Aux.)			Applicable Hook (Main/Auxiliary)																	
	65	32	19	65/B	32/B	19/B	32/B	19/B	32/B	19/B	32/B	19/B	32/B	19/B	32/B	19/B	32/B	19/B	32/B	19/B	32/B	19/B		
12.19	(04000)	04002	04003	(04100)	(04102)																		04004	40
15.24	05000	05002	05003	05100	05102																		05004	50
18.29	06000	06002	06003	06100	06102	06103																	06004	60
21.34	07000	07002	07003	07100	07102	07103																		70
24.38	08000	08002	08003	08100	08102	08103																		80
27.43	09000	09002	09003	09100	09102	09103																		90
30.48	10000	10000	10003	10100	10102	10103	(10212)	10213	(10232)	10233	10312	10313	10332	10333	(10412)	10413	(10432)	10433	10512	10513	10532	10533		100
33.53	11000	11000	11003	11100	11102	11103	11212	11213	11232	11233	11312	11313	11332	11333	11412	11413	11432	11433	11512	11513	11532	11533		110
36.58	12000	12000	12003	12100	12102	12103	12212	12213	12232	12233	12312	12313	12332	12333	12412	12413	12432	12433	12512	12513	12532	12533		120
39.62	13000	13000	13000	13100	13102	13102	13212	13213	13232	13233	13312	13313	13332	13333	13412	13413	13432	13433	13512	13513	13532	13533		130
42.67	14000	14000	14000	14100	14102	14102	14212	14213	14232	14233	14312	14313	14332	14333	14412	14413	14432	14433	14512	14513	14532	14533		140
45.72	15000	15000	15000	15100	15102	15102																		150
48.77	16000	16000	16000	16100	16102	16102																		160
51.82	17000	17000	17000																					170
Cartridge P/N	2480Q749D1			2480Q 750D1	2480Q 751D1		2480Q 752D		2480Q 753D1		2480Q 752D1		2480Q 753D1		2480Q 754D1		2480Q 755D1		2480Q 754D1		2480Q 755D1		2480Q 749D1	Cartridge P/N

NOTES: 1. "B" : Ball Hook
2. NORM=N BLOC1=1 N1=NORM BLOC1=Main Hook
AUX =A BLOC1=2 A2=AUX BLOC2=Aux. Hook
3. Code Number in ( ) : Basic Code Number

1. INTRODUCTION

1.1 GENERAL

Kobe Steel Ltd. provides a worldwide boom repair service using certified welders. We recommend that certified welders do boom repairs whenever possible. Contact your local KOBELCO Dealer to arrange for the services of a welder.

This procedure is provided as a guide to aid users in the proper repair of lattice boom sections when our welders are not available.

IMPORTANT

Repairs made by other than a certified welder are responsibility of the organization or person performing the repair. Kobe Steel Ltd. and its authorized dealers assume no liability for claims resulting from failures traceable to such repairs.

These instructions pertain to repair of laced bases, inserts, masts and jib sections. Instructions apply to both tubular and angle chord booms.

For repairs other than replacing lacing, as covered herein, contact the local KOBELCO Dealer Service Department.

Repairable Conditions Which Must Be Corrected:

- Broken, bent, kinked or missing lacings.

- Cracks in welds or braces other than chord members.

The inspection and Repair Procedures for Lattice Boom Sections cover the identification, inspection and repair of boom and jib sections manufactured by Kobe Steel Ltd., which has experienced certain specific types of damage.
The supporting lattice work and main chords on crane boom attachments must meet the requirements criteria for main chords, i.e. straightness, dents, dimples, corrosion, or abrasion.

1.2 WARNINGS, CAUTIONS AND NOTES

WARNINGS, CAUTIONS and NOTES are used throughout this manual to emphasize important and critical instructions. For the purpose of this manual, WARNINGS, CAUTIONS and NOTES are defined as follows:

WARNING An operating procedure, practice, etc., which, if not correctly followed, could result in personal injury, or loss of life.

CAUTION An operating procedure, practice, etc., which, if not strictly observed, could result in damage to, or destruction of, equipment.

NOTE An operating procedure, condition, etc., which is essential to highlight.

1.3 BOOM MATERIALS

KOBELCO booms are made of various high quality materials. To insure that replacement material is of the proper strength and size, it should be obtained from authorized KOBELCO dealers.

Individually coped lacings are recommended to be and can be obtained from any KOBELCO dealer by giving the part number and serial number of the boom section to be repaired, along with the machine model and serial number. Physical location of the lacings to be replaced can be identified by referring to the Appendix at the rear of this manual.

Bulk lacing material may be obtained from any

KOBELCO dealer by giving the part number and serial number of the boom section to be repaired, along with the machine model and serial number.

For a clear description of the required lacings, please refer to the Appendix.

NOTE

Typical boom marking showing the boom part number and serial number is shown in Fig. 1-1.

IDENTIFICATION CODE

Factory Code Markings

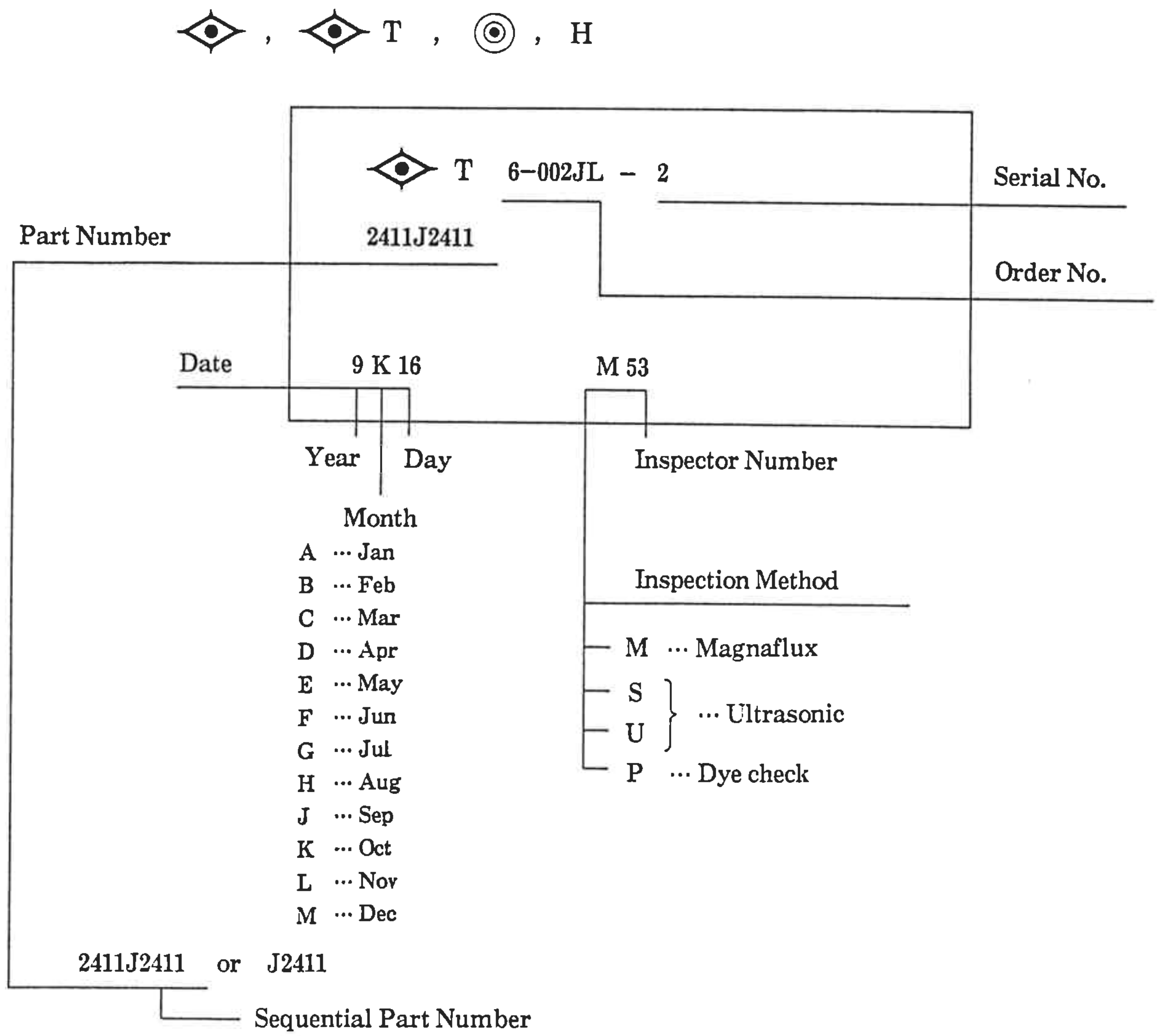
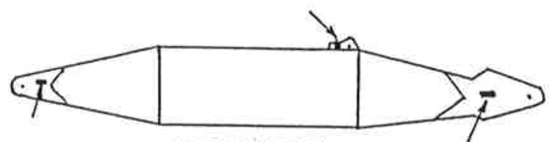


Fig. 1-1

For the location of the markings, refer to the Appendix on page A-2.



(RIGHT SIDE)

2. BOOM SECTION REPAIR

2.1 WELDING MATERIALS

Welding electrodes to be used must be high quality, dry and low–hydrogen type–Approved electrodes are AWS E–7018 and JIS D 5016.
Recommended electrode sizes are 2.4mm(3/32″) diameter or 3.2mm(1/8″) diameter.

NOTE

Do not use electrodes larger than 3.2mm(1/8″) diameter, as the thin lacing walls make it extremely difficult to prevent burn through when using large electrodes.

Electrodes must be purchased in 10 pound (approx. 4.5kgs) hermetically sealed containers and maintained in their "as manufactured" condition until used. Once opened, these electrodes must be warmed up to 300℃(572° F) to 350℃(662° F), and kept in a weld rod holding oven for one hour, after that the electrodes must be kept at 100 ℃(212° F) to 150 ℃(302° F) until used.
No more than a two hour supply be exposed to the atmosphere at any one time.

All welding shall be done with direct current reverse polarity (DCRP) or alternate current (AC). Welding equipment must be capable of delivering 200 amperes minimum.

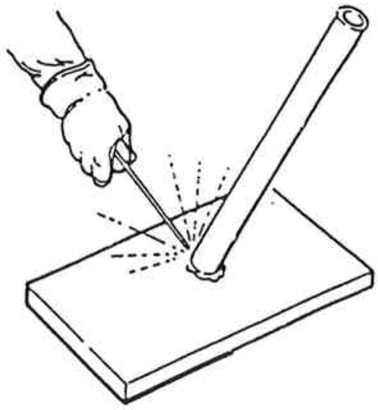
2.2 WELDER QUALIFICATION

Boom sections on a mobile crane are constructed from special alloy and heat treated steels requiring exact fit–up and welding skills.

Only an experienced, skilled and fully qualified welder may repair booms.

Practice before boom welding is very desirable. Since lacing material is for the most part, thin wall, high tensile strength material, a very delicate touch and a high degree of skill are required to produce the weld joint between the heavier chord member walls and thin wall lacing material. It is recommended that damaged lacing material removed from the boom section to be repaired be used for welding practice. Weld the removed lacing material to 10mm(0.4″) thick plate to obtain "feel" for the welding and proper welding machine settings (see Fig.2–1).

Step 1. Weld removed portion of damaged lacing to 10mm(0.4″) thick plate.



Step 2. Cut off lacing

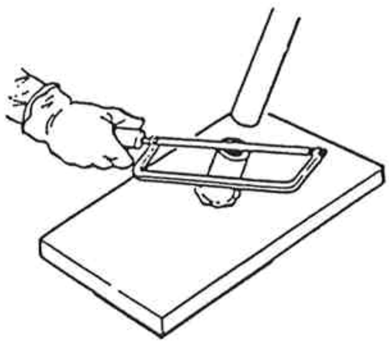


Fig. 2–1 Practicing Welding Technique
(to be continued)

Step 3. Do it again until settings and techniques are correct.

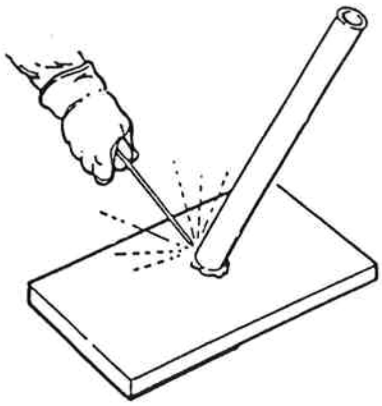


Fig. 2–1 Practicing Welding Technique (continued)

2.3 EXTENT OF REPAIR

No welding shall be done on the corner structural members (referred to as chords) except to attach lacing members (see Fig.2–2). No chord shall be replaced in whole or in part.

Heat shall not be used to straighten chords or lacings.

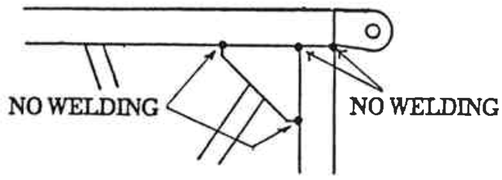


Fig. 2–2

The extent of repair in a factory authorized by Kobe Steel Shall be limited to the lacings shown in the classification of A and B in Table 2–1.

A: Number (%) of repairable lacings, which can not be used, on one side of the top, bottom and sides (four sides) of the boom section.

B: Number of repairable lacings, which are gathered to the chord (marked with ○ in Fig.2–3) and which cannot be used, of the two sides of the boom section.

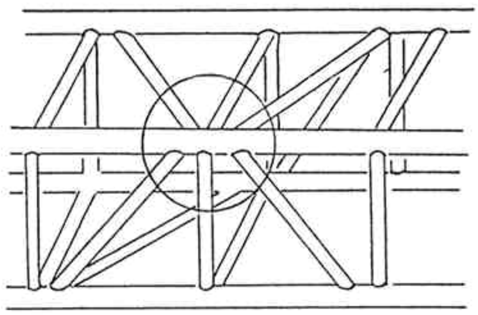


Fig. 2–3

Table 2–1. Extent of Boom Repair

Contents of Repair			Authorized Factory	KOBELCO Factory
Repair and replacement of chord			Not approved	Not approved
Lacings	Boom, under 50tons of crane capacity	A	Less than 30%	Less than 40%
		B	Less than 3 lacings	Less than 5 lacings
	Boom, more than 50tons to under 100tons of crane capacity	A	Less than 20%	Less than 30%
		B	Less than 2 lacings	Less than 4 lacings
	Boom, more than 100tons to under 200tons of crane capacity	A	Less than 10%	Less than 20%
		B	One lacing only	Less than 3 lacings
	Boom, more than 200tons of crane capacity	A	Not approved	Less than 10%
		B	Not approved	Not approved
Repair and replacement of diaphragm			Not approved	Approved
Replacement of clevis			Not approved	Approved

NOTE: Total number of repaired lacings in repairs of several times shall not exceed the above standard.

To insure structural integrity of the boom section, after repair, the chords shall meet the overall straightness requirements of Table 2–2 on page 2–3. In addition, the individual chords and lacings shall meet the requirements of Table 2–3 on page 2–5. as measured between any two adjoining panel points (see Fig.2–4).

These dimensions can be checked with a tightline or straightedge, and shall be checked in two directions, 90 degrees apart.

All bent lacings must be replaced, since they pull the chords out of true alignment and can cause deflections in the chords which can contribute to failure of the boom/jib section.

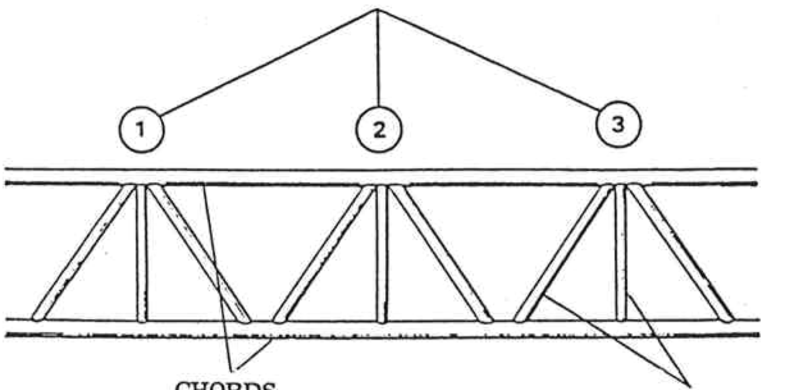
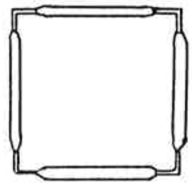
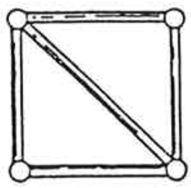


Fig.2–4



ANGLE CHORDS



TUBULAR CHORD

Smooth sweep bends in lacings may be straightened by jacking them back into alignment, taking extreme care not to kink or further damage bent lacings. If a lacing cannot be straighten within b_2=2mm+(ℓ_2/2000)mm (where, b_2: amount of lacing bend, ℓ_2:sectional width of boom), it must be removed and replaced. Lacing with a uniform bend/curvature not in excess of a ratio of 30mm in 1 meter (1 inch in 36 in.) may be straightened. Bend/curvature in excess of this amount requires replacement of lacings.

Angular distortion(twist), d_1, shall be no more than 1.5mm(1/16 in.) for a 3 meters (10 ft.) section or 3.0mm(1/8 in.) for longer sections (see Fig.2–5).

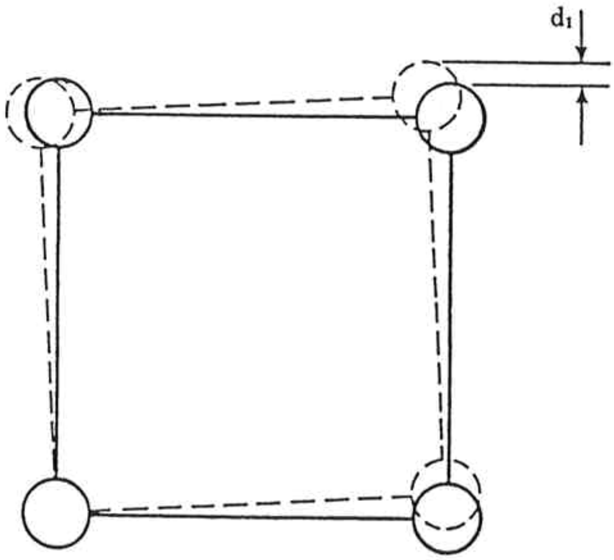


Fig. 2–5 Angular Distortion (Twist)

Table 2–2. Overall Main Chord Straightness

Chord Length	Maximum Deviation over Length of Chord
3 meters(10 ft.) or less	5mm (0.20 in.)
Over 3 meters(10 ft.) upto and including 9 meter(30 ft.)	6mm (0.24 in.)
Over 9 meters(30 ft.) upto and including 15 meter(45 ft.)	10mm (0.40 in.)

Dents or dimples in tubular chords shall not exceed those dimensions shown in Fig.2–6 and Table 2–4 on page 2–6. There shall be no more than 2 dents between panel points (see Fig.2–4) and defects shall be at least 150mm(6 inches) apart.

Corrosion or abrasion damage to chords shall not exceed the depth shown in Table 2–5 on page 2–12 and illustrated as dimension d_6 in Fig.2–7. Corrosion or abrasion which is not deeper than the values of the last column of Table 2–5 can be disregarded.

The sum of the greatest dimensions of all corrosion or abrasion defects between panel points (see Fig.2–4 on page 2–3) shall not exceed those values shown in Table 2–5. An example of this dimension is shown as d_5 in Fig.2–7.

2.4 TUBULAR BOOM LACING REPAIR PROCEDURE

Once a full and detailed inspection of the entire boom has been performed, and those lacing members that need to be replaced or straightened have been identified, the lacing replacement procedure for tubular chord boom is as follows:

1. If at all posible, replace only one lacing at a time and complete the repair before removing another so as to maintain the original chord alignment. If there is extensive damage and more than one lacing must be replaced at one time, extreme care must be used to hold the chord in alignment, both vertically and horizontally, during replacement. All damaged lacings must be replaced with tubing of equivalent material and properties, size and wall thickness as original.

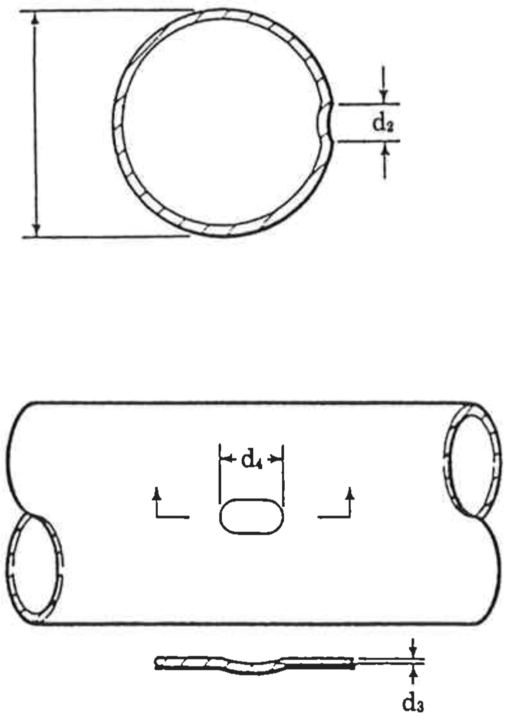


Fig. 2–6 Dents or Dimples

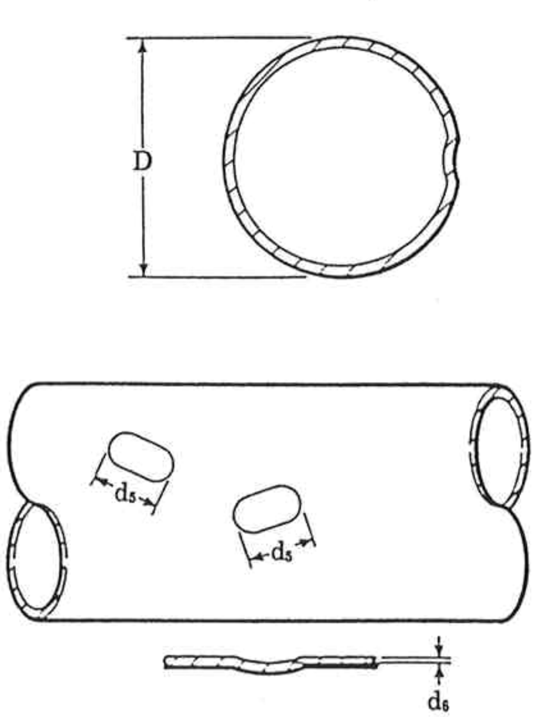


Fig. 2–7 Corrosion or Abrasion

Table 2–3. Main Chord Straightness between Panel Points

TUBE DIAMETER OR SHORTER LEG OF ANGLE LESS THAN		MAXIMUM DEVIATION BETWEEN PANEL POINTS	
mm	(Inches)	mm	(Inches)
50	(2)	1.6	(0.062)
60	(2.25)	1.7	(0.068)
70	(2.75)	2.0	(0.080)
75	(3)	2.2	(0.086)
80	(3.25)	2.3	(0.092)
90	(3.5)	2.5	(0.089)
95	(3.75)	2.6	(0.10)
100	(4.5)	2.8	(0.11)
110	(4.25)	2.9	(0.12)
115	(4.75)	3.1	(0.12)
120	(5)	3.2	(0.13)
130	(5.5)	3.4	(0.13)
140	(6)	3.7	(0.14)
150	(6.5)	4.0	(0.16)
165	(7)	4.3	(0.17)
180	(7.5)	4.6	(0.18)
190	(8)	4.9	(0.19)
200	(8.5)	5.2	(0.20)
215	(9)	5.5	(0.21)
230	(9.5)	5.8	(0.23)
240	(10)	6.1	(0.24)
255		6.4	(0.25)

NOTE: For an explanation of this table please refer to page 2–3.

Table 2–4. Dents or Dimples

D TUBE DIAMETER		d_2 DENT WIDTH		d_3 DENT DEPTH		d_4 DENT LENGTH	
mm	(Inches)	mm	(Inches)	mm	(Inches)	mm	(Inches)
25	(1)	2.8	(0.111)	See Note 2 below		4.6	(0.182)
30	(1.25)	3.5	(0.139)			5.8	(0.227)
40	(1.5)	4.2	(0.167)			6.9	(0.237)
45	(1.75)	4.9	(0.194)			8.1	(0.318)
50	(2)	5.6	(0.222)			9.2	(0.364)
60	(2.25)	6.4	(0.250)			10	(0.409)
65	(2.5)	7.1	(0.278)			12	(0.455)
70	(2.75)	7.8	(0.306)			13	(0.500)
75	(3)	8.5	(0.333)			14	(0.545)
85	(3.25)	9.2	(0.361)			15	(0.591)
90	(3.5)	9.9	(0.389)			16	(0.636)
95	(3.75)	11	(0.417)			17	(0.682)
100	(4)	11	(0.444)			18	(0.727)
110	(4.25)	12	(0.472)			20	(0.773)
115	(4.5)	13	(0.500)			21	(0.818)
120	(4.75)	13	(0.528)			22	(0.864)
130	(5)	14	(0.556)			23	(0.909)
140	(5.5)	16	(0.611)			25	(1.00)
155	(6)	17	(0.667)			28	(1.09)
165	(6.5)	18	(0.722)			30	(1.18)
180	(7)	20	(0.778)			32	(1.27)
190	(7.5)	21	(0.833)			35	(1.36)
200	(8)	23	(0.889)			37	(1.45)
215	(8.5)	24	(0.944)			39	(1.55)
230	(9)	25	(1.00)			42	(1.64)
240	(9.5)	27	(1.06)			44	(1.73)
255	(10)	28	(1.11)			46	(1.82)

NOTE: 1. For explanation of this table, refer to page 2–4.

2. d_3 should be less than one third thickness of tubular chord.

2. Tubular lacings to be replaced should be cut off mechanically, preferably with a hacksaw or disc grinder, directly above the fillet weld attaching it to the chord, leaving the original weld on the chord member.

Grind or file the remaining weld bead flush with the cord, using extreme care not to notch the chord or nick it in any way (see Fig.2–8).

NOTE

Lacings may be removed from heavier booms by careful use of the arc–air torch, slightly above the attaching fillet weld, again using extreme care not to damage the chord member in any way.

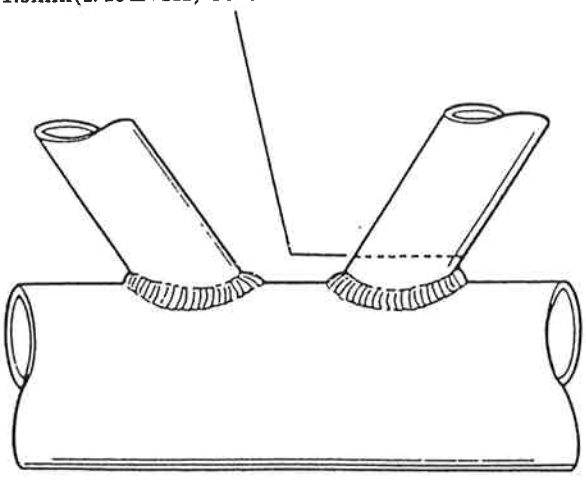


Fig. 2–8 Cutting Off Damaged Tubular Lacings

3. Remove the remaining material. Grind marks should be parallel to the chord to minimize the possibility of damaging the chord (see Fig. 2–9).

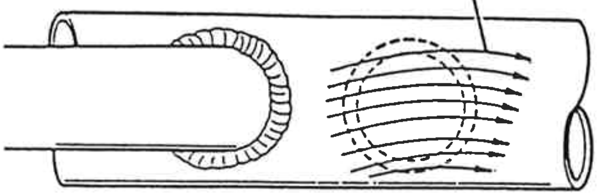


Fig. 2–9 Removing Remaining Material

NOTE

Due to the location of the lacing being removed in Fig.2–9, disc grinding the remoaining 1.5 mm(1/16 inch) of weld is difficult, if grind marks are to be kept longitudinal to the cord. Therefore, a large file should be used to remove the remaining 1.5mm(1/16 inch) weld. If no other member interferes with grinding, a fine grit disc grinder should be used. Note the direction of the grind marks in Fig.2–9.

NOTE

A smooth gouge free surface, as far as possible, is required on the chord before a replacement lacing is fitted into place.
Use emery cloth or a buff to polish the chord after grinding or filing.

4. When using bulk replocement lacings, cut the lacing to the proper length which will be 12mm(1/2 inch) longer than is actually required so as to leave sufficient material for contour fitting (see Fig.2–10 on page 2–8).

A. Hold a length of bulk lacing in proper a lignment with another undamaged lacing of the same length as the lacing to be replaced.

B. Cut at the points and at the angle shown in Fig.2–10.

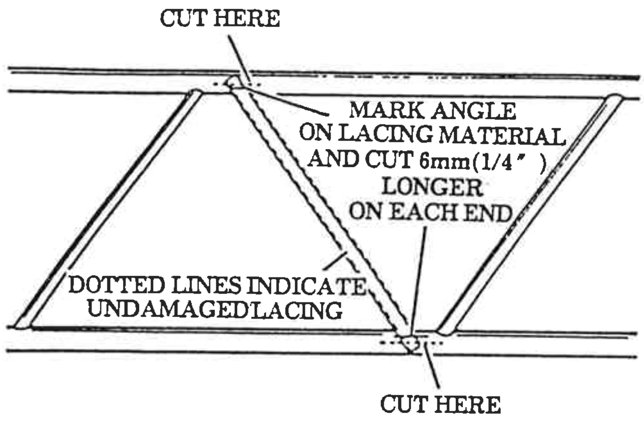


Fig. 2–10 Cutting Replacement Lacing

5. Cope the lacing as shown in Fig.2–11. Carefully contour fit the ends of the replacement lacing so that it fits within 1.2mm(3/64 inch) for the boom tip and base or within 0.8mm(1/32 inch) for the boom insert all around the join and a slight drive fit is required to aligh the lacing in its proper location (see Fig.2–11). This fitting is very important as excessive opening will result in greater weld metal deposit, excessive heat buildup which can materially weaken the joint and also result in very undesirable distortion and locked up stresses. Weld sizes required to attach the lacings to the chords can be determined by looking at the previous welds on the other unaffected joint on the boom. These will usually be from 3mm(1/8 inch) to 5mm(3/16 inch) leg size. It is extremely important that this fit and weld size be maintained so as not to induce a imbalance of weld shrinkage and locked up stresses.

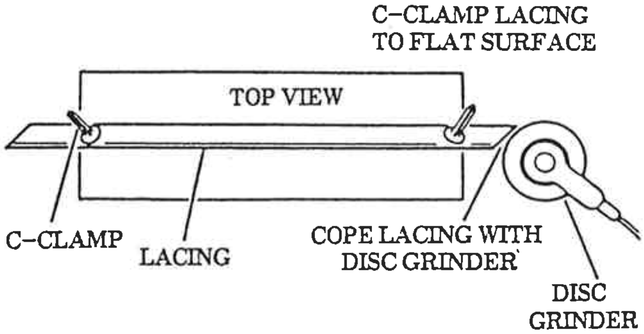


Fig. 2–11 Coping Lacing With Disc Grinder

NOTE

It is very important that the centerlines of the copes on each end of the replacement lacing be in the same plane (not twisted), to assure a good fit on both chords.

6. New lacings shall be installed in alignment with adjacent lacings. Accomplish this alignment by placing two straightedges on existing lacings, one on each side of the lacing being replaced. Clamp the straightedges firmly against existing lacings, bring the replacement lacing against the straightedges, and hold in this position while welding is performed (see Fig. 2–12).

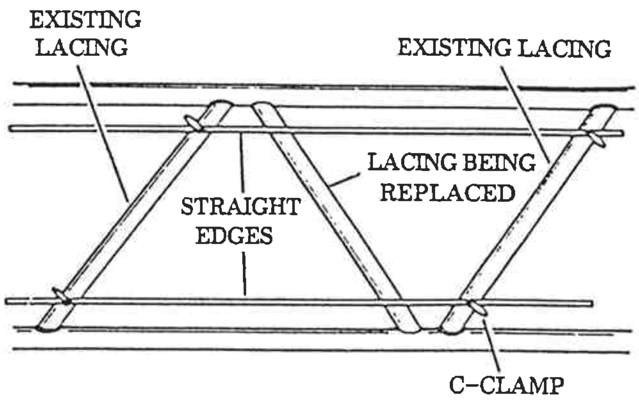


Fig. 2–12 Aligning Replacement Lacing

7. Welding must be performed in a dry, still atmosphere away from the wind, rain, and other adverse elements. If it is necessary to perform the weld outside a building, a suitable wind break or enclosure must be constructed over the area to be repaired.

All welding should be done in the flat or downhand position. The boom section should be rolled or turned to allow the welding to be done in this position.

Be sure that all grease, oil, water, and other contaminants are removed from the weld area.

Heat must be applied to the weld area very cautiously to bring the material within the recommended temperature range for welding. Use a temperature measuring device to determine maximum temperature.

The boom chords and lacings should be preheated to between 50 ℃(122° F) and 100℃(212° F) before starting to weld. Interpress temperature is to be no more than 200℃(392° F). Welding should never be performed on material colder than 20℃(68 ° F).

Each lacing weld should be performed in two distinct steps. Extreme care and skill are required for the proper overlap at the start and stop of the weld joints, or weld passes, so as not leave any unfilled craters, which are subject to crater cracks and weakening of the joint (see Fig.2–13). Do not weave the electrode while welding.

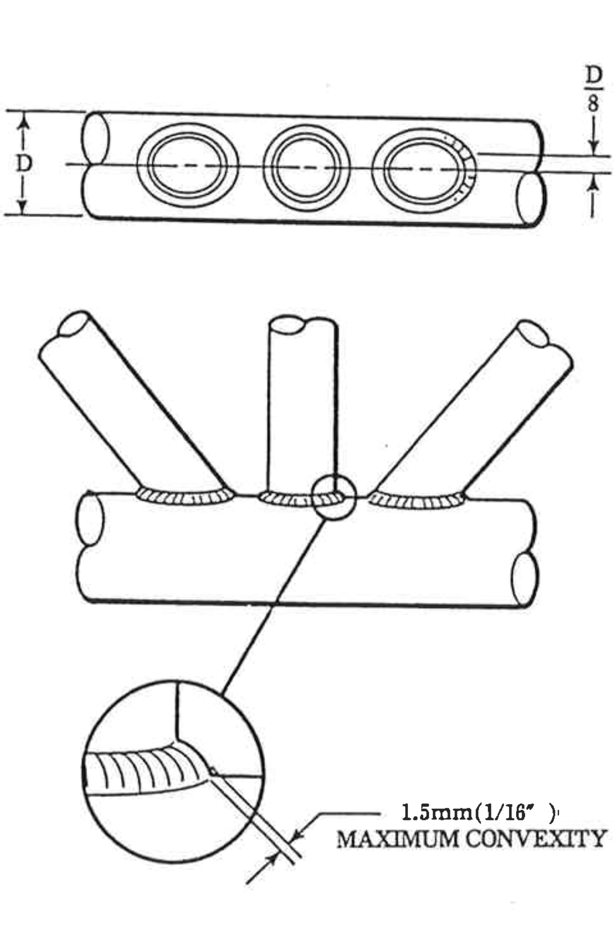


Fig. 2–13 Welding Lacings to Tubular Chord

Inspect completed welds as specified in the topic, Inspection, later in this section.

2.5 ANGLE CHORD BOOM LACING REPAIR PROCEDURE

Replacement of lacing in an angle chord boom section is similar in most respects to the procedure for lacing replacements in tubular chord boom sections. Only the differences will be discussed here.

Therefore, be sure to read the procedure for replacement of tubular boom lacings as well as this procedure. The major difference in the procedures is that the ends of the lacings must be crimped or flattened to permit proper fit–up with the edge of the angle chords (see Fig. 2–14).

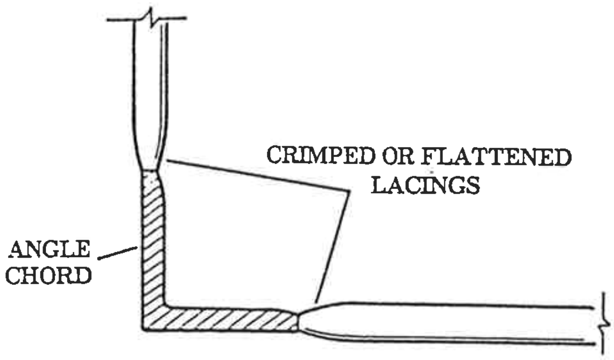


Fig. 2–14 Fit–up of Lacings to chord

Proceed in the following sequence.

1. Cut the lacing to be replaced off about 6mm(1/4 inch) above the weld, using a hacksaw, carbon arc torch, or disc grinder (see Fig.2–8 on page 2–7 and Fig.2–15 on page 2–10).

2. Disc grind the remaining lacing and weld material away until the angle is returned to its original shape (see Fig. 2–9 on page 2–7 and Fig. 2 –15).

3. Lacing ends must be flattened by pounding into the approximate shape shown in Fig.2–16 on page 2–10.

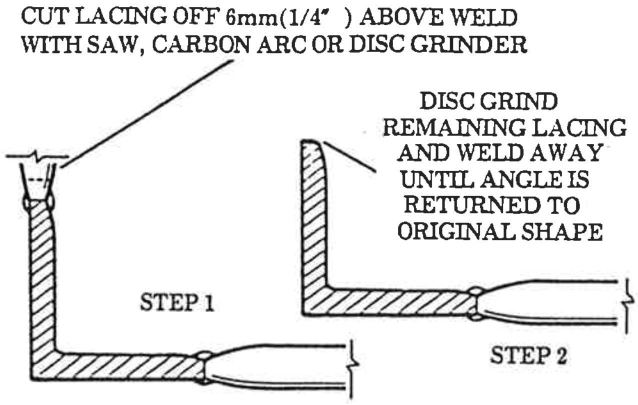


Fig. 2–15 Removing Damaged Lacing

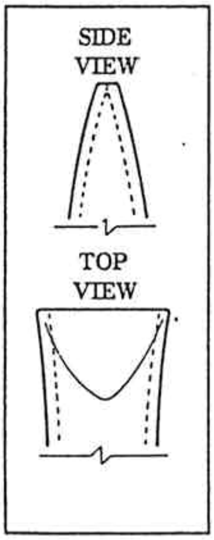


Fig. 2–16 Approximate Shape of Lacing Ends

4. When forming lacing ends with a hammer, the lacing will have a tendency to move backward. A holding device similar to the one shown in Fig.2–17 should be used to hold the lacing in place. This will make it easier to obtain the desired shape of the lacing end. Be sure that both ends of the lacing are flattened in the same plane (not twisted).

5. Determine the length of replacement lacings and the correct angle at which they should be cut by placing a length of lacing material against a lacing of identical construction in the boom section to be repaired. Mark the correct length and angle of cut needed and saw cut the lacing approximately 3mm (1/8 inch) longer than required.

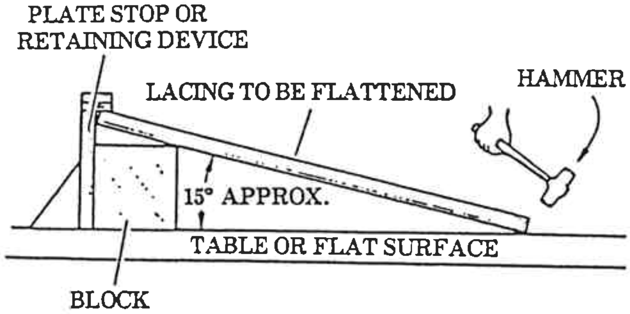


Fig. 2–17 Shaping Lacing Ends

6. Flatten the lacing ends as previously described, and check for correct fit in the position it will occupy in the boom section to be repaired. If necessary, grind the lacing end to the correct length and reshape the end which was ground off.

7. Make sure the lacing is placed in the exact position from which the damaged lacing was removed. Then tack weld the lacing to the chord angle on the side.

8. Weld the lacing in place, using the materials and techniques previously described in this manual (see Fig.2–18).

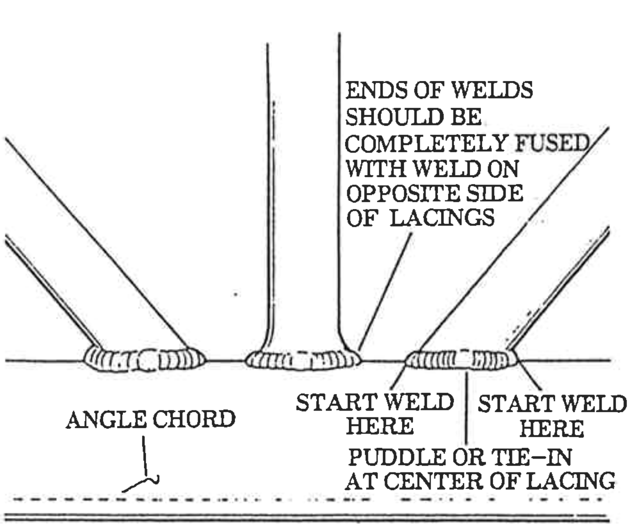


Fig. 2–18 Welding Lacings to Angle Cord

CAUTION

The "PUDDLE" or "TIE–IN" should not be concave. It must equal or exceed the contour of the rest of the weld.

2.6 INSPECTION

After welding repairs have been completed, a full visual inspection shall be made to assure that all craters are full, that there is no undercut around any of the weld, and that proper contours have been accomplished.

In addition, magnetic particle inspection or penetration inspection should be made.

Any defective weld shall be ground out and rewelded.

A full detailed report shall be made of the repair, including a serial number, its location, the date, the welder, and the circumstances under which the repair was made. This report should be forwarded to Kobe Steel regional office with photographs showing the damage before the repair.

Table 2–5. Corrosion or Abrasion (Tubular Chords)

D TUBE DIAMETER		d_5 SUM OF GREATEST PANEL POINTS		d_6 MAXIMUM DEPTH ALLOWABLE		DISREGARD UNLESS DEEPER THAN	
mm	(Inches)	mm	(Inches)	mm	(Inches)	mm	(Inches)
25	(1)	6.4	(0.25)	0.2	(0.008)	0.08	(0.003)
30	(1.25)	7.9	(0.31)	0.2	(0.009)	0.10	(0.004)
40	(1.5)	9.5	(0.38)	0.3	(0.011)	0.11	(0.005)
45	(1.75)	11	(0.44)	0.3	(0.013)	0.13	(0.005)
50	(2)	13	(0.5)	0.4	(0.015)	0.15	(0.006)
60	(2.25)	14	(0.56)	0.4	(0.017)	0.17	(0.007)
65	(2.5)	16	(0.62)	0.5	(0.019)	0.19	(0.008)
70	(2.75)	17	(0.69)	0.5	(0.021)	0.21	(0.008)
75	(3)	19	(0.75)	0.6	(0.023)	0.23	(0.009)
80	(3.25)	21	(0.81)	0.6	(0.024)	0.25	(0.010)
90	(3.5)	22	(0.88)	0.7	(0.026)	0.27	(0.011)
95	(3.75)	24	(0.94)	0.7	(0.028)	0.29	(0.011)
100	(4)	25	(1)	0.8	(0.030)	0.30	(0.012)
110	(4.25)	27	(1.06)	0.8	(0.032)	0.32	(0.013)
115	(4.5)	29	(1.12)	0.9	(0.034)	0.34	(0.014)
120	(4.75)	30	(1.19)	0.9	(0.036)	0.36	(0.014)
130	(5)	32	(1.25)	1.0	(0.038)	0.38	(0.015)
140	(5.5)	35	(1.38)	1.0	(0.041)	0.42	(0.017)
150	(6)	38	(1.5)	1.1	(0.045)	0.46	(0.018)
165	(6.5)	41	(1.62)	1.2	(0.049)	0.50	(0.020)
180	(7)	44	(1.75)	1.3	(0.053)	0.53	(0.021)
190	(7.5)	48	(1.88)	1.4	(0.056)	0.57	(0.023)
200	(8)	51	(2)	1.5	(0.060)	0.61	(0.024)
215	(8.5)	54	(2.12)	1.6	(0.064)	0.65	(0.026)
230	(9)	57	(2.25)	1.7	(0.068)	0.69	(0.027)
240	(9.5)	60	(2.38)	1.8	(0.071)	0.72	(0.029)
250	(10)	64	(2.5)	1.9	(0.075)	0.76	(0.030)

For explanation of this table refer to page 2–4.

1. SPECIFICATIONS

1.1 INDICATION OF MODEL

N [V] [120] [DT] – [1] [0] [1] [R] – R [ ] [ ] [ ] [ ] [ ]

(Regulator Type)

- L: for Left Rotation (seen from shaft end)
- R: for Right Rotation(")
- M: for Left/Right Rotations

- 0: Shaft End, JIS Involume Spline
- 1: Shaft End, SEA
- Special Mark for Other Shaft Ends

Special Mark for Special Parts
(gear pump attached or special valve cover)

- 1: for Single-side Tilting
- 2: for Both-side Tilting

- DT : Tandem-type Double Pump
- DP : Parallel-type Double pump
- No Mark: Single Pump

Size (Discharge Rate, cm^3)

- V: Variable Capacity Type
- X: Fixed Capacity Type

Series Mark

1.2 MAJOR DIMENSIONS

Type			Nominal Discharge Rate	Discharge Pressure		Revolution		*Weight (with Regulator)	
Group I	Group III	Group II	(cc/rev)	Rated (kg/cm^2)	Max. (kg/cm^2)	Max. (Closed Circuit) (rpm)	Max. (Self Suction) (rpm)	Single Pump (kg)	Tandem Double Pump (kg)
		50	55.8			3400	2500	(45)	(68)
60			60.6			3300	2400	52	90
	64		64.0			3250	2600	40	68
		70	73.4			3200	2300	52	90
80			81.0			3000	2200	(60)	109
	84		84.4			2900	2350	52	94
		90	96.4	350 (Group I)	400 (Group I)	2800	2100	62	109
	111		110.9			2700	2150		
120			119	320 (Group III)	350 (Group III)	2600	1900		
	137		136.9			2500	2000	75	146
		150	149	280 (Group II)	315 (Group II)	2450	1800		
	172		171.6			2350	1850		
210			206.2			2200	1600	(120)	–

*: without optional valve

2. CONSTRUCTION AND WORKING PRINCIPLE

2.1 SINGLE PUMP

The structure of the single pump is shown in Fig. 6. In general, this pump consists of a rotary group to rotate (main part of the pump), a swash plate group to change the discharge rate, and a valve cover ↗ to switch over between suction and discharge of oil.

The rotary group consists of drive shaft (111), cylinder (141), piston/shoe (151, 152), holder (153), spherical bushing (156) and disc spring (157). The drive shaft is supported on either side by bearings (123, 124).

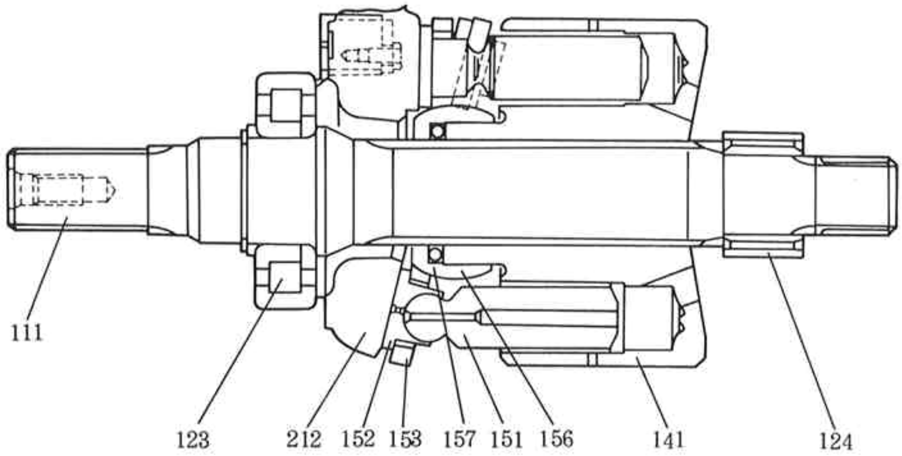


Fig. 1 Rotary Group

Shoe (152) is caulked with piston (151), forms a spherical joint, and has pockets for balancing oil pressure in order to lessen the thrust force by the load pressure to slide smoothly on swash plate (212).

The piston/shoe sub-group is pushed against swash plate (212) through holder (153), spherical bushing (156) by disc spring (157). This enables the sub-group to slide smoothly on swash plate (212). Cylinder (141) is also pushed against valve plate (314) by disc spring (157).

The swash plate group consists of swash plate (212), swash plate support (251) and bearing metal (253).

Swash plate (212) is supported over bearing metal (253) by swash plate support (251). Swash plate (212) swings on bearing metal (253) by means of the regulator as shown Fig. 3, and inclination angle (α) can be changed.

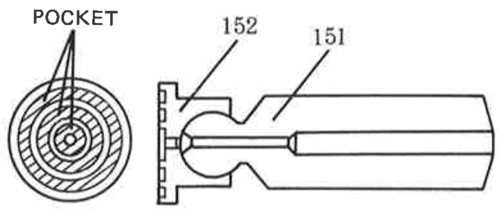


Fig. 2 Piston/Shoe

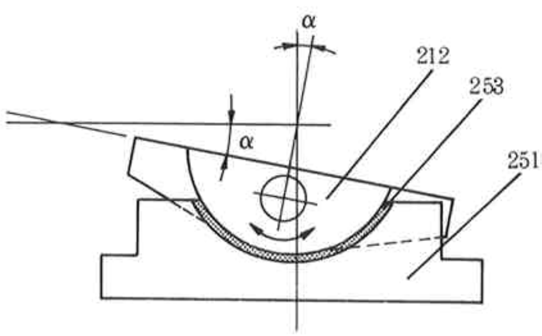


Fig. 3 Swash Plate Group

High pressure oil is fed to bearing metal (253) (high pressure side) on swash plate support (251) through stopper 1 (276), seal pipe F (274) or seal pipe R (278) and the oil passage in the swash plate holder.

On the back of the swash plate, there is an oil pocket which allows easy swing of the swash plate on bearing metal (253) by balancing piston oil pressure force (F_P) with oil pressure force (F_S) from behind the swash plate.

The valve cover group consists of valve cover (312), valve plate (314), guide ring (315) and valve plate pin (885). Valve plate (314) with two ellipse ports is attached to valve cover (312) through guide ring (315) and valve plate pin (885), and serves to supply oil to and withdraw it from cylinder (141). The oil switched over at valve plate (314) flows through valve cover (312) to the outside piping.

When the drive shaft is driven by a motor (electric motor or internal combustion engine), the cylinder turns simultaneously via the spline bonding. When the swash plate is inclined as shown in Fig. 3, the piston arranged inside the cylinder turns together with the cylinder and takes relatively reciprocating motion against the cylinder. Therefore if you look at a piston, you will see: while the cylinder turns once, the piston makes a 180° stroke for going away from the valve plate (the stroke to suck the oil), and the remaining 180° stroke for coming back to the valve plate (the stroke to discharge oil). When the inclination angle of the swash plate is null, the piston does not stroke or discharge oil. When the swash plate is reversed, the direction of suction and discharge is reversed as well. The direction of discharge varies depending on the rotating direction of the pump and the inclining direction of the swash plate. For these relationships, see each specification.

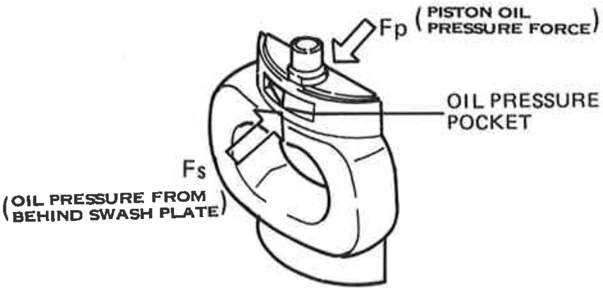


Fig. 4 Force Applied on Swash Plate

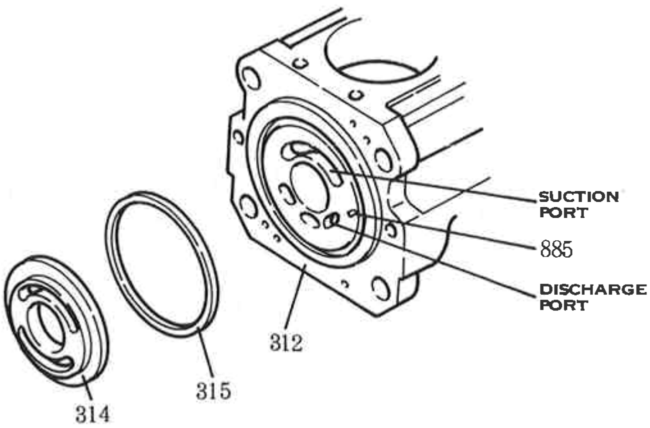


Fig. 5 Valve Cover Group

2.2 TANDEM DOUBLE PUMP

The pump is made by connecting two pumps through spiline coupling (114). The two pumps can be driven simultaneously by transmitting motor revolutions to drive shaft (111) on the front side. Oil suction and discharge holes are brought to the connecting part of the two pumps, i.e. at valve block (312). The suction hole is for both the front and rear pumps.

The principle of this pump's function is the same as the single pump's.

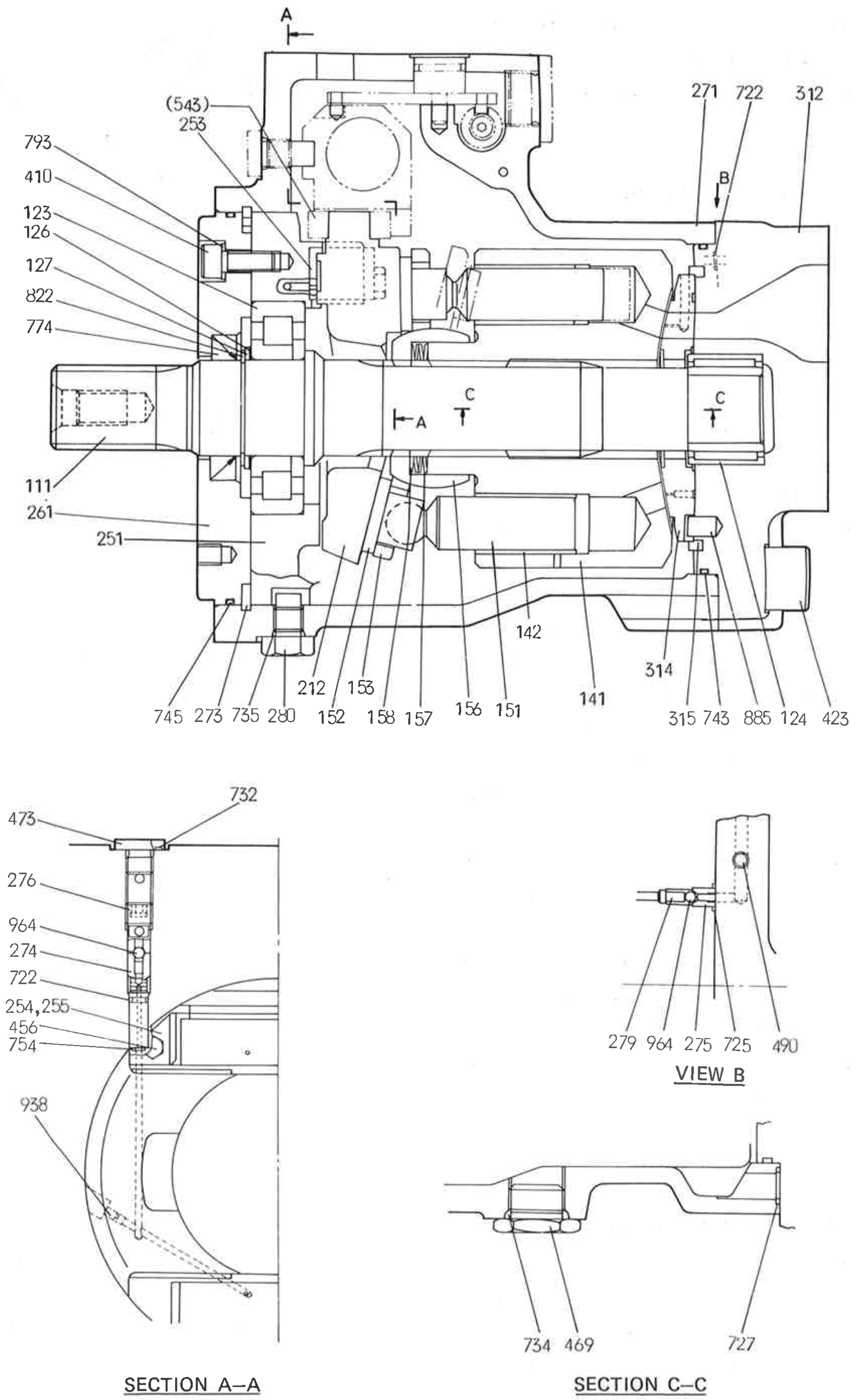
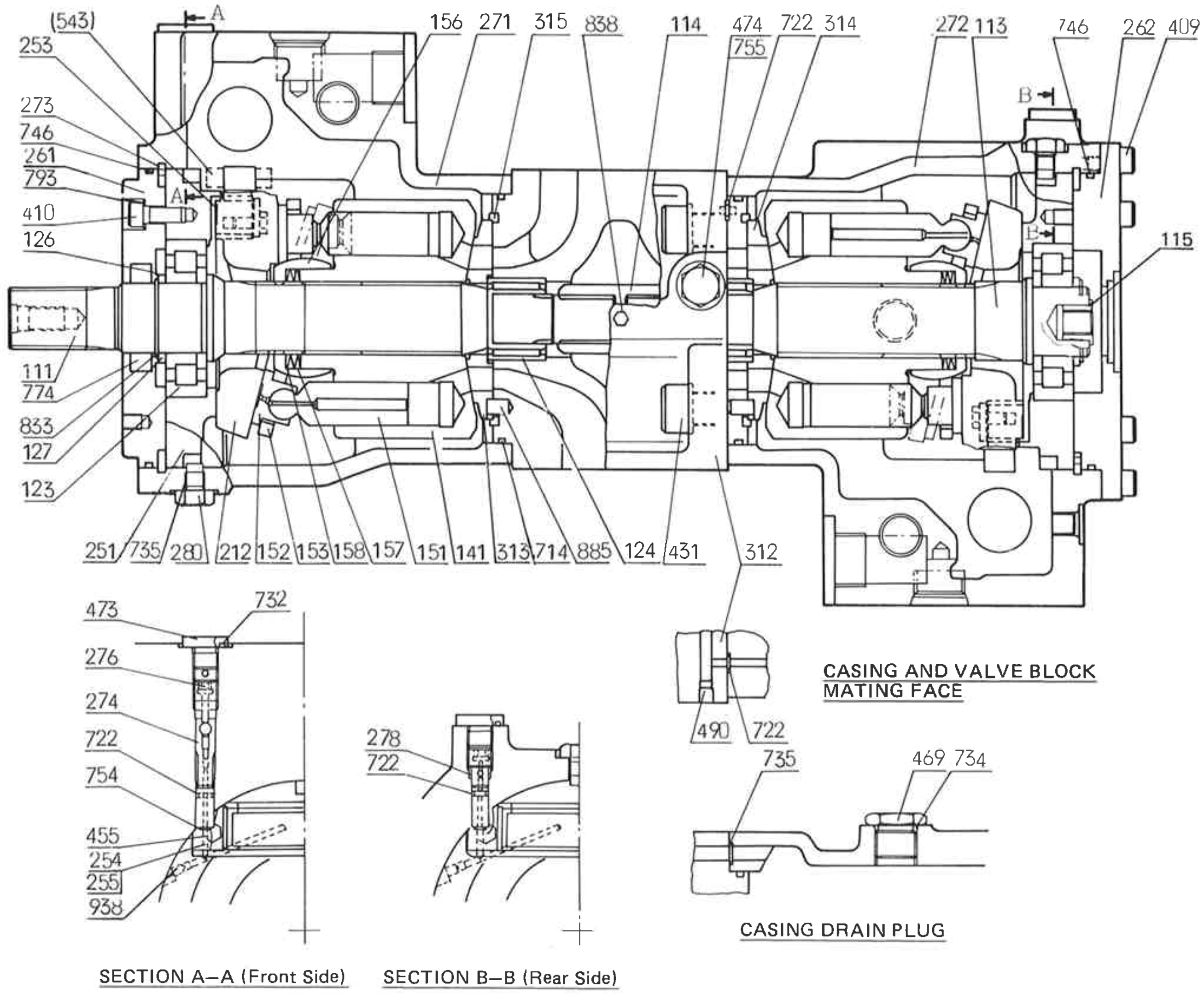


Fig. 6 Single Pump

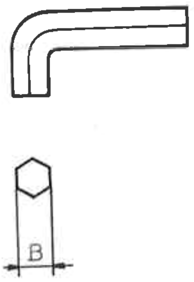
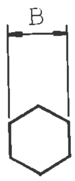


111. DRIVE SHAFT (F)
113. DRIVE SHAFT (R)
114. SPLINE COUPLING
115. SPLINE COUPLING
123. ROLLER BEARING
124. NEEDLE BEARING
126. INNER RACE SHIM
127. BEARING SPACER
141. CYLINDER
142. CYLINDER BUSHING
151. PISTON
152. SHOE
153. HOLDER
156. SPHERICAL BUSHING
157. DISC SPRING
158. DISC SPRING SHIM
212. SWASH PLATE
251. SWASH PLATE SUPPORT
253. BEARING METAL
254. FASTENING PLATE (R)
255. FASTENING PLATE (L)
261. FRONT COVER
262. REAR COVER
271. PUMP CASING (F)
272. PUMP CASING (R)
273. RETAINER
274. SEAL PIPE (F)
275. SEAT (S)
276. STOPPER (1)
278. SEAL PIPE (R)
279. STOPPER (2)
280. SWASH PLATE SUPPORT FIXING BOLT
312. VALVE COVER (BLOCK)
313. VALVE PLATE (R)
314. VALVE PLATE (L)
315. GUIDE RING
409. SOCKET BOLT
410. SOCKET BOLT
423. SOCKET BOLT
431. SOCKET BOLT
455. BOLT
456. BOLT
469. VP PLUG
473. PO PLUG
474. VP PLUG
490. PLUG
(543) SLIDE RING
714. O-RING
722. O-RING
725. O-RING
727. O-RING
732. O-RING
734. O-RING
735. O-RING
743. O-RING
745. O-RING
746. O-RING
755. O-RING
764. O-RING
774. OIL SEAL
793. SEAL WASHER
822. STOP RING
833. STOP RING
838. LOCK RING
885. VALVE PLATE PIN
938. PLUG
964. STEEL BALL

Fig. 7 Tandem Double Pump

3. DISASSEMBLY AND ASSEMBLY

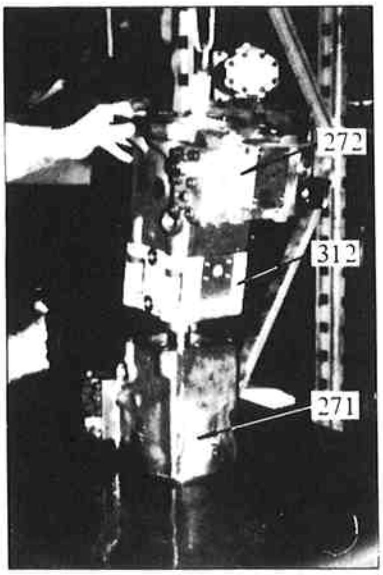
3.1 TOOLS

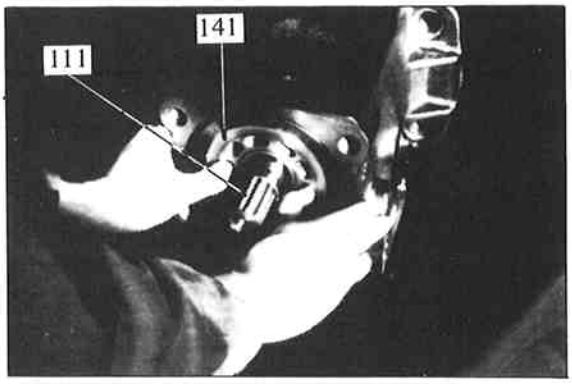
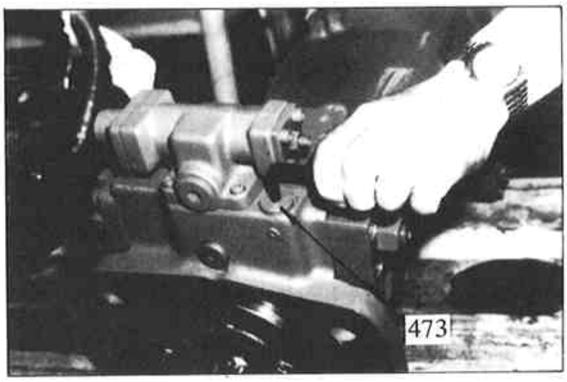
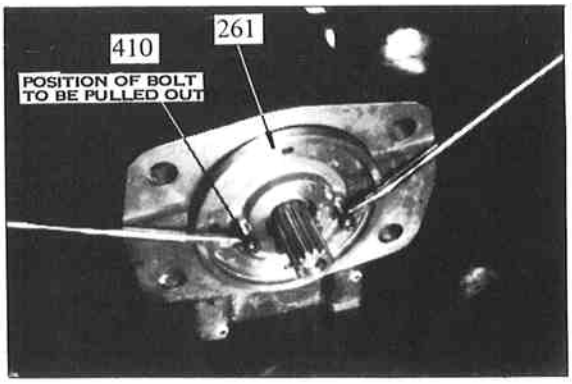
Tool Names and Size		Pump Model				Part Names			
Names	B	NV80	NV111	NV120	NV137	Socket Bolt	PT Plug (PT Screw)	PO Plug (PF Screw)	Set Screw (w/hex. hole)
Allen Wrench	2					–	–	–	M4
	2.5					–	–	–	M5
	3					–	–	–	M6
	4	○	○	○	○	M5	BP-$^{1}/_{16}$	–	M8
	5		○	○	○	M6	BP-$^{1}/_{8}$	–	M10
	6	○	○	○	○	M8	BP-$^{1}/_{4}$	PO-$^{1}/_{4}$	M12, M14
	8		○		○	M10	BP-$^{3}/_{8}$	PO-$^{3}/_{8}$	M16, M18
	10			○	○	M12	BP-$^{1}/_{2}$	PO-$^{1}/_{2}$	M20
	12					M14	–	–	–
	14	○	○		○	M16, M18	BP-$^{3}/_{4}$	PO-$^{3}/_{4}$	–
	17				○	M20, M22	BP-1	PO-1, 1¼, 1½	–
	19					M24, M27	–	–	–
	21					–	–	–	–
	22					M30	–	PO-2	–
Spectacle Wrench	B	NV80	NV111	NV120	NV137	Hex. Bolt	Hex. Nut	VP Plug (PF Screw)	
	8					M5	M5	–	
Socket Wrench	10	○	○			M6	M6	–	
Double(Single)-End Wrench	13		○	○	○	M8	M8	–	
	14					–	–	VP-$^{1}/_{8}$	
	17					M10	M10	–	
	19		○		○	M12	M12	VP-$^{1}/_{4}$	
	22				○	–	–	VP-$^{3}/_{8}$	
	24					M16	M16	–	
	27		○			M18	M18	VP-$^{1}/_{2}$	
	30				○	M20	M20	–	
	36	○	○	○	○	–	–	VP-$^{3}/_{4}$	
	41					–	–	VP-1	
	50					–	–	VP-1$^{1}/_{4}$	
	55					–	–	VP-1$^{1}/_{2}$	
Monkey Wrench		○	○	○	○	One medium size			
Screwdriver		○	○	○	○	Two medium size			
Hammer		○	○	○	○	One plastic hammer			
Pliers		○	○	○	○	For stop ring TSR-160			
Steel Bar		○	○	○	○	Steel bar for key, approx. 10 x 8 x 200			
Torque Wrench		○	○	○	○	Capable of tightening to specified torque			

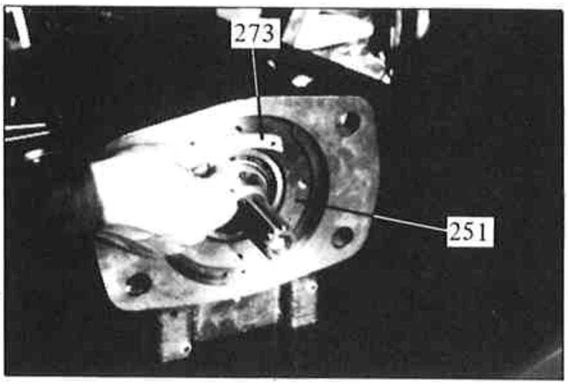
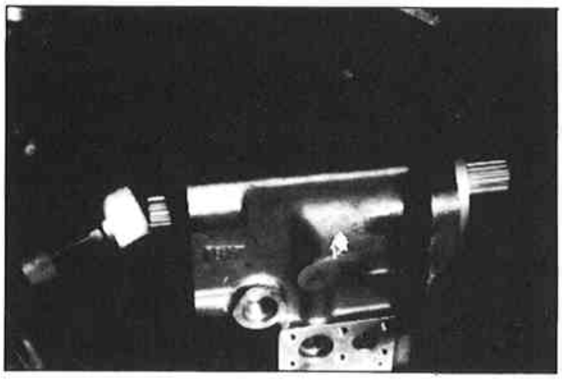
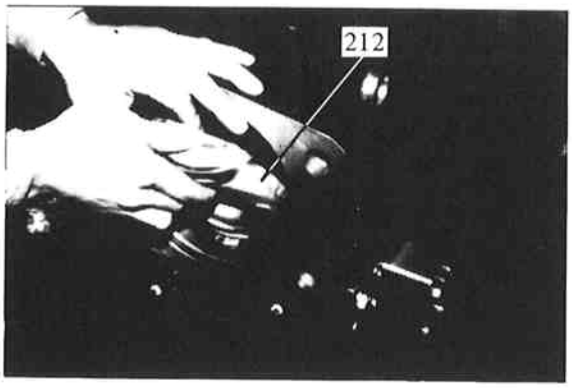
3.2 DISASSEMBLY PROCEDURES

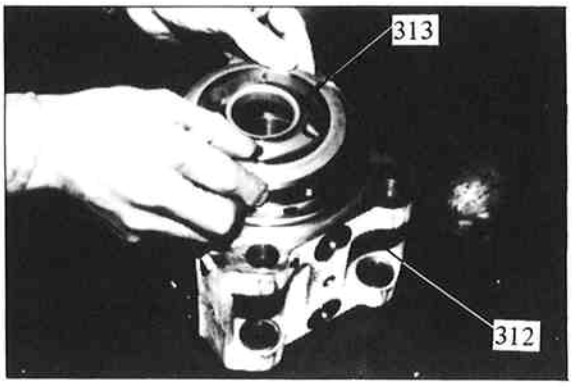
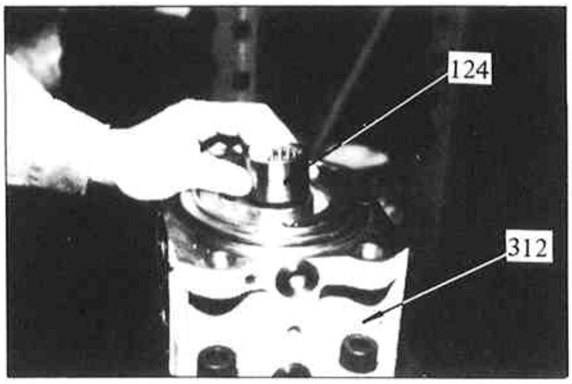
When disassembling the pump, read thoroughly this disassembly procedures and carry out in the following order. The numbers in parentheses after the part names correspond to those in Fig. 6 (Pump Structure).

This procedure is for both single and tandem pumps. Disassemble referring to the types in the table below. For double pump, be careful not to mix up the parts of each pump.

No.	Contents of Work	Notes	Type
1	Choose an appropriate place for disassembly.	1) Choose a clean place. 2) Spread rubber mat or cloth on a work bench and keep the parts from scratches.	All
2	Drain oil from the pump casing by removing drain port plug (469).	1) For the tandem pump, drain oil through each plug on rear and front pump.	All
3	Dismount valve block (312), pump casing R (272) and pump casing F (271) by detaching socket bolt (431).  	1) This work will be simpler if done as shown in the photo: Attach the eyebolt to the screw on the end of drive shaft (111), lift the front pump and remove the rear pump and valve block (312) first. In this case, keep in mind that the valve plate should not drop. Support it by hands or detach it immediately after removing the pump. 2) If deflection of the disc spring has to be measured, measure it at this point. 3) When separating the front pump and valve block, keep the end of the drive shaft up and the valve block down. 4) Do not mix up component parts of the front and rear pumps.	Tandem double pump
4	Remove socket bolt (423) and detach valve cover (312) from pump casing (271).	1) Be careful that valve plate (314) does not fall off from the valve cover. 2) If deflection of the disc spring has to be measured, measure it at this point. 3) If the gear pump or other parts are attached to the back of the valve cover, at first remove the gear pump and then start working.	Single pump

No.	Contents of Work	Notes	Type
5	Place the pump level and draw out cylinder (141) straight to drive shaft (111). Also draw out piston (151), holder (153) and spherical bushing (156). 	1) Be careful to keep the cylinder, spherical bushing and shoe (152) free from any scratches on their sliding faces.	All
6	Remove plug (473) on the regulator of the pump casing and detach stopper (276) and seal pipe (274) or seal pipe R (278). 	1) Swash plate support (251) can not come off unless this seal pipe is removed.	All
7	Remove front cover (261) and socket bolt (410). Insert bolts into two bolt holes on the front cover and detach the front cover with a screwdriver. 	1) Oil seal (774) is mounted on the front cover. When detaching, be careful not to damage it.	All
8	For the tandem double pump, remove rear cover of the rear pump by loosening rear cover (262) and socket bolt (409).		Tandem double pump

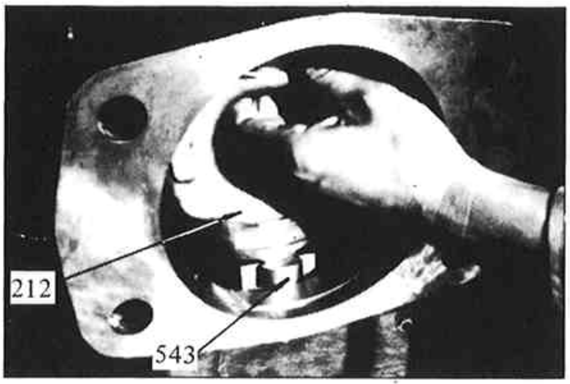
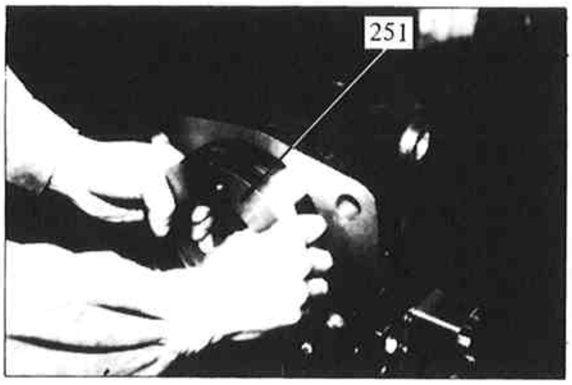
No.	Contents of Work	Notes	Type
9	Remove retainer (273), the stopper for swash plate support (251), from the groove of the casing.  	1) Some retainers (273) are lock rings depending on type.	All
10	Temporarily fasten front cover (261) to swash plate support (251) with socket bolt (410). Tap lightly the end of drive shaft (111) on the valve block side with a plastic hammer and pull out the swash plate support and drive shaft. 	1) If seal pipe (274 or 278) remains inside of the pump casing, the swash plate support can not be pulled out. It can be damaged if tapped with force. Do not fail to remove the seal pipe before starting this work.	All
11	Remove swash plate (212) and slide ring (543).  	1) When removing the swash plate and slide ring, do not use force. They can be removed easily by tilting the swash plate.	All

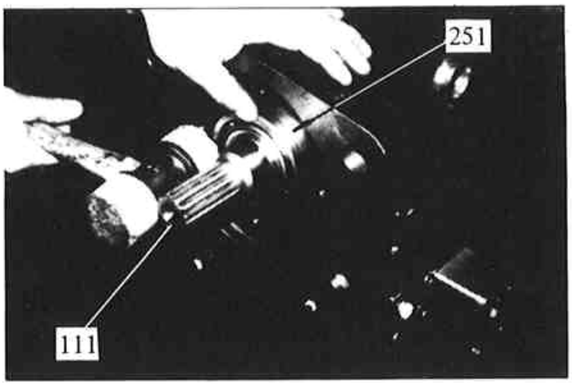
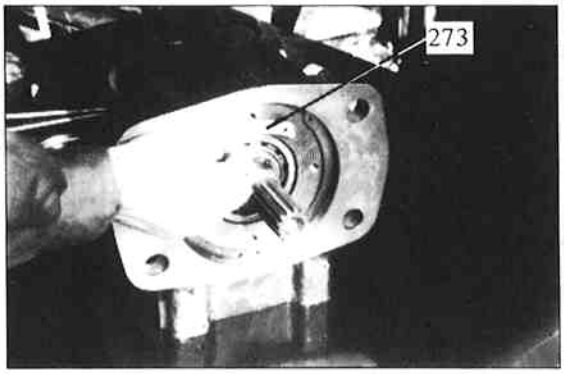
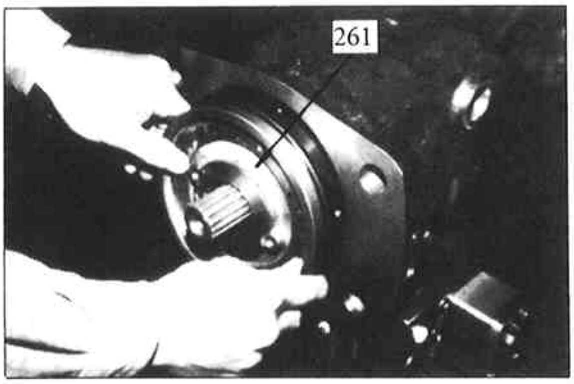
No.	Contents of Work	Notes	Type
12	Detach valve plates (313, 314) from the valve block or valve cover (312).  	1) They may come off during the work described in 3 or 4 above.	All
13	1) If necessary, pull needle bearing (124) and spline coupling (114) out of the valve block or valve cover (312). 2) Also, for roller bearing (123) of the drive shaft, the bearing can be pulled out by detaching the stop ring and tapping the bearing with a steel bar.  	1) Do not remove unless the bearing must be replaced.	All

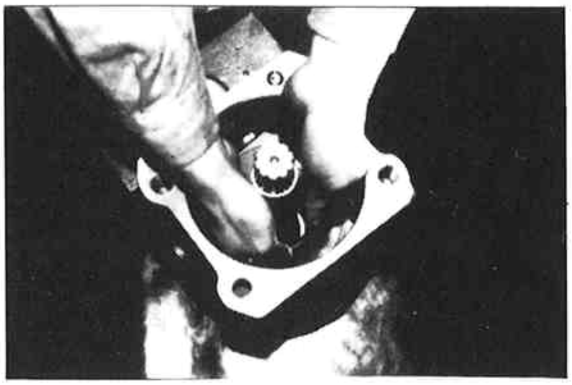
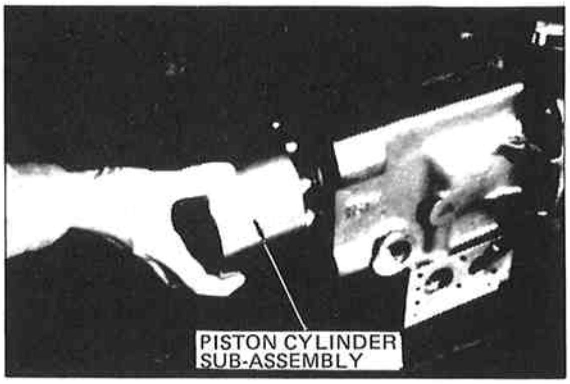
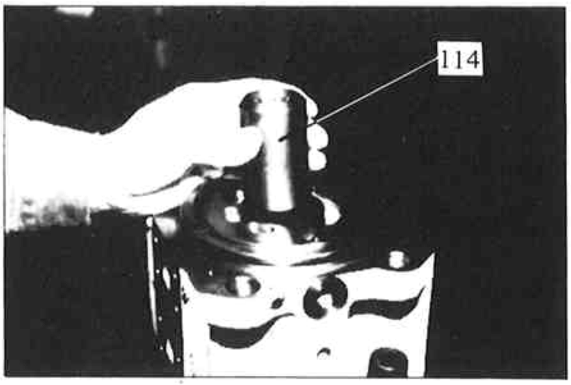
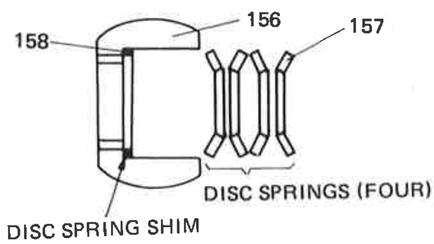
3.3 ASSEMBLY PROCEDURES

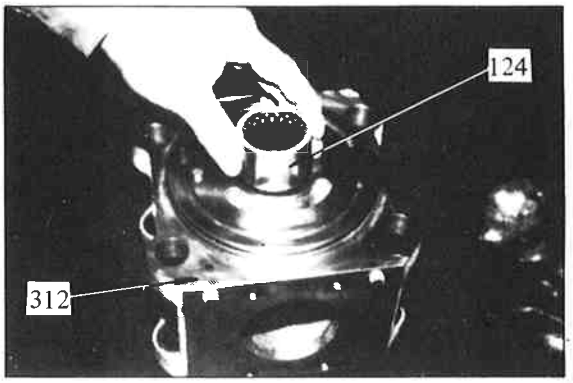
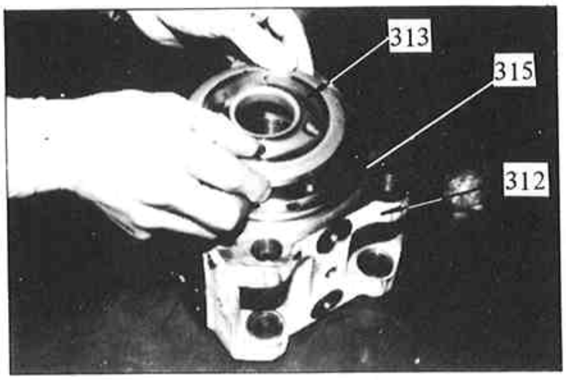
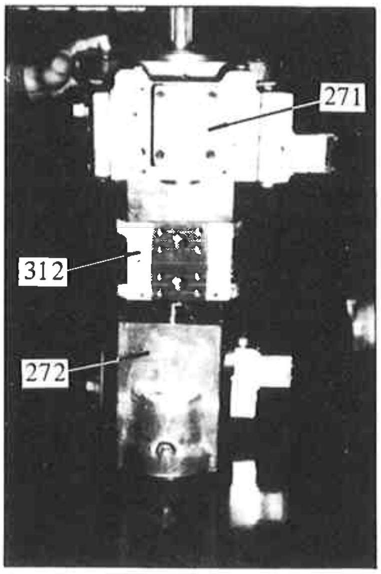
The assembly steps are the reverse order of disassembly. When assembling, pay attention to the matters described below:

1) Be sure to repair any part damaged during disassembly.
2) Clean each part thoroughly with washing oil and dry with compressed air.
3) Be sure to apply clean hydraulic oil to sliding places and bearings, and then assemble.
4) Sealing parts like O-rings or oil seals, should be replaced.
5) Use a torque wrench for each mounting bolt and plug, and tighten to specified torque.
6) For the double pump, do not mix up the parts of each pump.

No.	Contents of Work	Notes	Type
1	Insert slide ring (543) into swash plate (212). Put the swash plate into the pump casing making sure to place the slide ring into the groove of the regulator inclination lever. 		All
2	Insert swash plate support (251) into the pump casing. Be sure to place swash plate support fixing bolt (280) into the slit of the swash plate support. 	1) Pay attention to which way the swash plate support faces. Align it with the place where seal pipe (274 or 278) goes in. 2) When inserting the swash plate support, hold it with your hands so the swash plate does not move about inside the pump casing.	All

No.	Contents of Work	Notes	Type
3	Fix drive shaft (111) with bearing already set carefully into swash plate support (251). 	1) Do not tap the drive shaft with a hammer. Lightly tap the outer wheel of the bearing and fix.	All
4	Mount retainer (273) to the pump casing groove. 	1) A lock ring is sometimes used instead of a retainer. 2) Greasing the retainer before assembly makes the succeeding work easier.	All
5	Mount front cover (261) into the pump casing and fix it with a socket bolt. 	1) Apply a little grease on the oil seal inside the front cover. 2) Mount the front cover, taking care not to damage the oil seal. 3) For the rear pump of the tandem pump, mount rear cover (262) in the same way.	All Tandem double pump

No.	Contents of Work	Notes	Type
6	Change the direction of the pump with the front cover (or rear cover) facing down, and mount the swash plate to bearing metal (253) of the swash plate support. 	1) With the finger tips of both hands, make sure the swash plate moves smoothly.	All
7	Assemble the piston cylinder sub-assembly: piston (151), cylinder (141), holder (153), spherical bushing (156), disc spring (157) and disc spring shim (158). Align faces of the spherical bushing and the cylinder spline, and insert the piston cylinder sub-assembly into the pump casing, meshing with the spline of drive shaft (111).   	1) Pay attention to the position of the disc spring shim and the direction and number of disc springs.  2) For the tandem pump, as shown in the photos on the left, insert spline coupling (114) and needle bearing (124) into valve block (312).	All

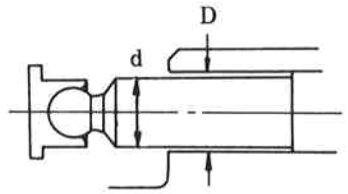
<table>
<tr><th>No.</th><th>Contents of Work</th><th>Notes</th><th>Type</th></tr>
<tr><td></td><td>
</td><td></td><td></td></tr>
<tr><td>8</td><td>Make sure that guide ring (315) is mounted correctly to the valve block or valve cover (312). Fix valve plate (313 or 314) to the valve block (or valve cover) meshing with a knock pin.

</td><td>1) Be careful not to get the wrong direction for suction and discharge of the valve plate.
2) For the tandem double pump, do not mistake front pump for rear and vice versa.
3) Greasing the mating surfaces of the valve plate and valve block keeps the valve plate from dropping off when facing down.</td><td>All</td></tr>
<tr><td>9</td><td>Attach the valve block or valve cover (312) to pump casings (271, 272) and fasten the socket bolt.

</td><td>1) For the tandem pump, connect the valve block to the front pump at first, lift the shaft end with a crane or block as shown in the left photo, then connect the rear pump. This method will make the work easier.</td><td>All</td></tr>
<tr><td>10</td><td>Mount seal pipe (274 or 278) into the pump casing, fasten stopper (276) and plug (473). This completes the assembling work.</td><td></td><td></td></tr>
</table>

4. MAINTENANCE STANDARDS

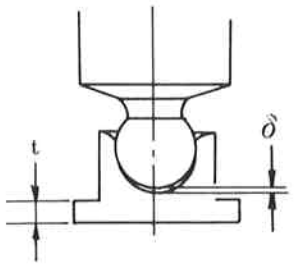
4.1 REPLACEMENT STANDARD FOR WORN PARTS

If a part is worn over the value indicated below, replace or readjust it. However, if it has considerable damage in appearance, always replace the part.

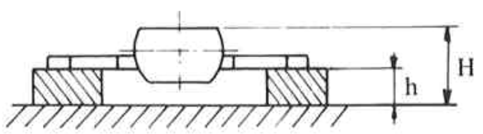
Part and Check Item		Model	Standard Value	Allowable Value	Remedy
Clearance between piston and cylinder bore	(D – d)	NV 80, NV111	0.032	0.064	Replace piston or cylinder.
		NV120, NV137	0.035	0.070	
Chatter at caulking part of piston and shoe	(δ)	NV 80, NV111	0	0.3	Replace piston shoe assembly.
		NV120, NV137			
Shoe thickness	(t)	NV 80, NV111	5	4.8	Replace piston shoe assembly.
		NV120, NV137	5.5	5.3	
Deflection of disc spring	(L – ℓ)	NV 80, NV120	2.9~3.1	2.5	Readjust disc spring shim.
		NV111, NV137	3.4~3.6	2.7	
Combined height of holder and spherical bushing	(H – h)	NV 80, NV111	24	23	Replace spherical bushing and holder as a set.
		NV120, NV137	27.5	26.5	



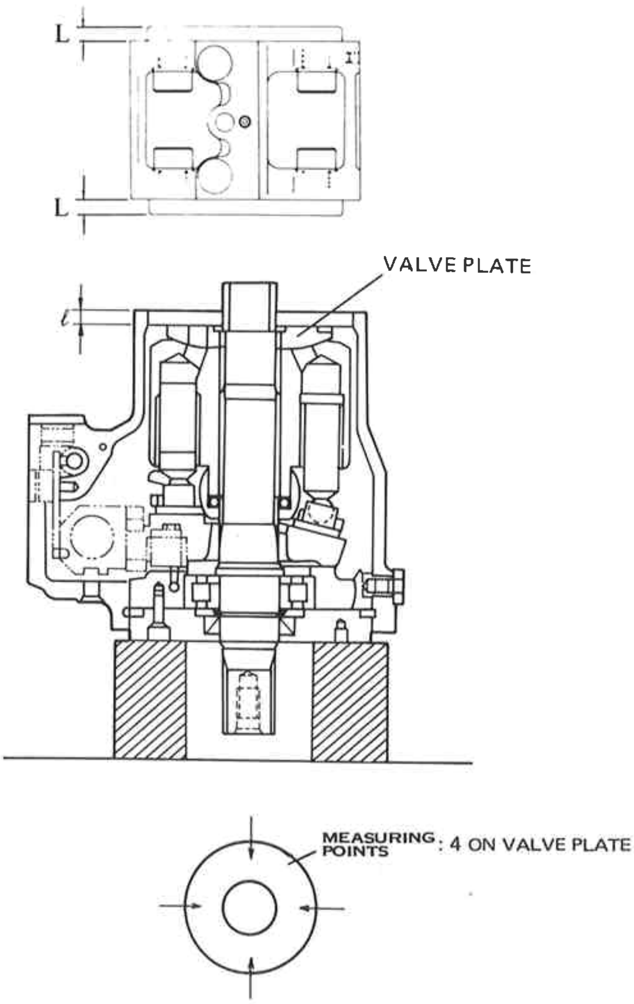
CLEARANCE BETWEEN PISTON & CYLINDER BORE : D – d



CHATTER BETWEEN PISTON & SHOE : δ
SHOE THICKNESS : t



COMBINED HEIGHT OF HOLDER & SPHERICAL BUSHING : H – h



DEFLECTION OF DISC SPRING : L – ℓ

4.2 REPAIRING STANDARDS FOR CYLINDER, VALVE PLATE AND SWASH PLATE

Finish of surface of cylinder, valve plate and swash plate	Finish to be corrected	:	3-Z
	Standard finish (corrected value)	:	Below 0.4-Z (lapping)
Hardness of valve plate and swash plate	Allowable hardness	:	Hs 84
	Standard hardness	:	Above Hs 90

NOTE: When correcting finish of cylinder and valve plate, lap together.

4.3 TIGHTENING TORQUE

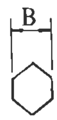
Part Name	Screw Size	Tightening Torque	Tool Name	
Socket Bolt (Material: SCM435)	M5	$70 kg/cm^2$	B = 4	 Allen Wrench
	M6	120 〃	5	
	M8	300 〃	6	
	M10	580 〃	8	
	M12	1000 〃	10	
	M14	1600 〃	12	
	M16	2400 〃	14	
	M18	3400 〃	14	
	M20	4400 〃	17	
PT Plug (Material: S45C) Wind seal tape 1.5~2 times around.	PT 1/16	70 〃	4	Allen Wrench
	PT 1/8	105 〃	5	
	PT 1/4	175 〃	6	
	PT 3/8	350 〃	8	
	PT 1/2	500 〃	10	
PO Plug (Material: S35C)	PF 1/4	300 〃	6	Allen Wrench
	PF 1/2	1000 〃	10	
	PF 3/4	1500 〃	14	
	PF 1	1900 〃	17	
	PF 1 1/4	2700 〃	17	
	PF 1 1/2	2800 〃	17	

4.2 REPAIRING STANDARDS FOR CYLINDER, VALVE PLATE AND SWASH PLATE

Finish of surface of cylinder, valve plate and swash plate	Finish to be corrected	:	3-Z
	Standard finish (corrected value)	:	Below 0.4-Z (lapping)
Hardness of valve plate and swash plate	Allowable hardness	:	Hs 84
	Standard hardness	:	Above Hs 90

NOTE: When correcting finish of cylinder and valve plate, lap together.

4.3 TIGHTENING TORQUE

Part Name	Screw Size	Tightening Torque	Tool Name	
Socket Bolt (Material: SCM435)	M5	70kg/cm²	B = 4	 Allen Wrench
	M6	120 〃	5	
	M8	300 〃	6	
	M10	580 〃	8	
	M12	1000 〃	10	
	M14	1600 〃	12	
	M16	2400 〃	14	
	M18	3400 〃	14	
	M20	4400 〃	17	
PT Plug (Material: S45C) Wind seal tape 1.5~2 times around.	PT 1/16	70 〃	4	Allen Wrench
	PT 1/8	105 〃	5	
	PT 1/4	175 〃	6	
	PT 3/8	350 〃	8	
	PT 1/2	500 〃	10	
PO Plug (Material: S35C)	PF 1/4	300 〃	6	Allen Wrench
	PF 1/2	1000 〃	10	
	PF 3/4	1500 〃	14	
	PF 1	1900 〃	17	
	PF 1 1/4	2700 〃	17	
	PF 1 1/2	2800 〃	17	

5. TROUBLESHOOTING

5.1 HOW TO INVESTIGATE DISORDER

Pumps are often equipped with regulator, auxiliary valves and auxiliary pumps; therefore it is difficult to pinpoint the cause of trouble. However, investigating the following rough check points will probably make the cause of trouble clear.

(1) Checking Filter and Drain Plug

Check the filter element. Look for a large quantity of abnormal impurities. A small amount of metal dust may be mixed in due to the wear of shoe and cylinder. A large amount of metal dust, however, shows the possibility of damage to the shoe. Check the drain oil in the pump casing as well.

(2) Abnormal Vibration or Noise

Check whether abnormal vibration or noise exist in the pump itself. Check whether the noise is the regular noise from regulator hunching or auxiliary vlave relief hunching. Abnormal vibration or noise indicates the possibility of cavitation or damage inside the pump.

(3) When Using Two Pumps

In the circuit where two single pumps or motors are in use, or in a double pump, change the piping for each pump. Then it will be clear whether the pump is out of order or the circuit after the pump is in disorder.

(4) Measuring Pressure of Each Part

When it is a question of control, begin to disassemble. Investigate abnormality by measuring pressure at each part.

5.2 TROUBLESHOOTING

(1) Engine is overloaded.

Cause	Remedy	Notes
1) Pump speed-pressure is higher than the set value.	1) Set as specified.	
2) Torque set in the regulator is high.	2) Readjust the regulator.	2) See the regulator manual.
3) Seizure or damage in the pump.	3) Replace damaged parts.	3) Check for abnormal amount of particles in the filter and drain oil.
4) Wrong piping from the regulator.	4) Correct the regulator piping.	

(2) Pump oil flow lowers drastically, discharge pressure does not rise.

Cause	Remedy	Notes
1) Trouble in the regulator.	1) Repair the regulator.	1) See the regulator manual.
2) Seizure or damage in the pump.	2) Replace damaged parts.	2) Check the filter and drain oil.
3) Failure of auxiliary pump.	3) Replace damaged parts.	3) Remove the auxiliary pump and check the shaft coupling.
4) Failure of auxiliary valve.	4) Check the auxiliary valve; especially the poppet, seat and spring.	4) See the auxiliary valve manual.
5) Wrong piping from the regulator.	5) Correct the regulator piping.	

(3) Abnormal noise and vibration.

Cause	Remedy	Notes
1) Cavitation.	1) Prevent cavitation. See if hydraulic oil is cloudy.	1) Hydraulic oil is insufficient. Air is sucked through suction pipe. Suction resistance is large.
2) Damage in the caulking part of shoe.	2) Replace the piston shoe and shoe plate.	2) Check the filter and drain oil.
3) Crack in the cylinder.	3) Replace the cylinder.	
4) Faulty attachment of the pump.	4) Attach correctly.	
5) Regulator hunching.	5) Repair the regulator.	5) See the regulator manual.

1. GENERAL

1.1 FUNCTION

The drive gear is meshed with the driven gear in the pump body. When the shaft for the drive gear is connected with the motor and turned in the direction of the arrow shown in the figure, the driven gear turns in the direction of the arrow on it.

By this rotation, the fluid (hydraulic oil) on the side of port "B" is carried along the inner periphery of the body to the side of port "A" by both gears. At the side of port "A", such space formed between gear teeth disappears as both gears are firmly meshed, whereby the fluid is forced out of port "A", and a negative pressure is produced at port "B".

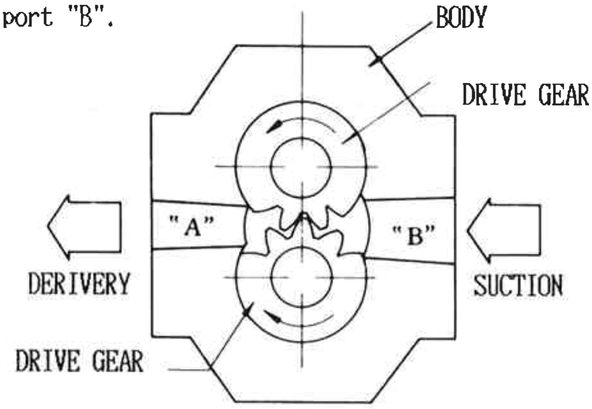


Fig. 1-1

When port "B" is connected with the hydraulic oil tank, oil is sucked into the pump and flows into the cylinder by way of the pipeline to port "A". In this case, if there is a load in the cylinder, a pressure to resist the load is created. The greater the load, the higher the pressure. Therefore, a larger force will be required to turn the gear pump.

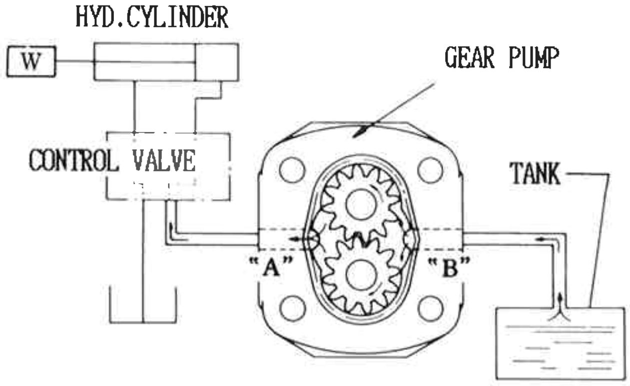


Fig. 1-2

1.2 PRESSURE COMPENSATION MECHANISM

When the pressure increases accordingly to the load increase at the pipeline to port "A", oil will flow through the side of the gears and the narrow space at the inner periphery of the gear pump to return to port "B" where pressure is low, thereby reducing the amount of oil delivery by both gears.

The ratio of the actual discharge of a pump to the theoretical output (the output of a pump calculated on the assumption that there is no reverse flow of oil) expressed as a percentage is called the volumetric efficiency, which is taken as one of the guide-lines for judging the quality (performance) of the pump.

The hydraulic energy of the oil flowing in the reverse direction (generally referred to as leakage and composed mostly of oil that flows along the sides of the gears) is converted into thermal energy, which causes so much loss in energy that it results in an abnormal high temperature in the pump and a rise in the oil temperature. Under an extreamery high pressure, the clearance is expanded by the pressure to increase the leakage considerably (as the amount of leakage through the clearance increases in direct proportion to the cube of the area of the clearance). Conversely, if the clearance is made unduly narrow, it tends to cause such troubles as seizure of the pump. This is why the maximum pressure for a pump must be limited to a low level.

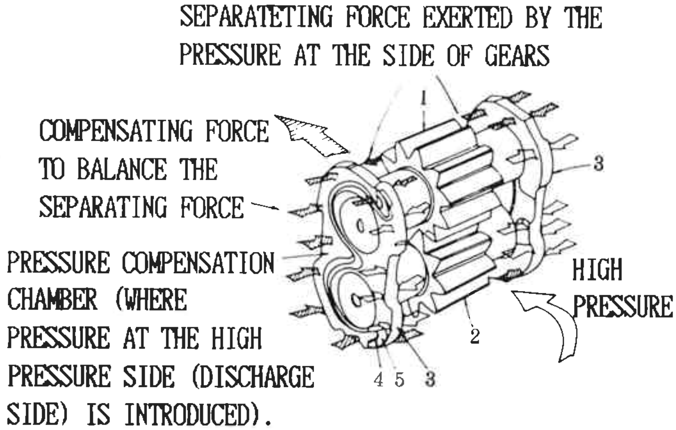


Fig. 1-3

To offset this disadvantage, the gear pump is equipped with a pressure compensation machanism that automatically adjusts the clearance at the side of the gears when the pressure increases.
Two wear plates(3) are facing each other, sandwiching gears(1) and (2). At the rear of the wear plates, there is a pressure compensation chamber sectioned with seal(4) and back-up(5).
Even when the increasing pressure tries to expand the clearance at the side of the gears, the pressure offseting it is applied to the pressure compensation chamber. As a result, the wear plates are pressed against the side of the gear to prevent oil leakage there.

When the discharge pressure is low, the elasticity of the seal which sections the pressure compensation chamber presses the wear plates against the side of the gears. The elasticity of the seal and the area of the pressure compensation chamber are so designed that optimum clearance will be obtained according to the change in the pressure. This permits high efficiency of the pump maintained throughout different operating conditions, from low to high pressures and from slow to fast rotational frequencies of the pump.

2. TROUBLESHOOTING

2.1 [PHENOMENON 1]

TRUOBLE	PROBABLE CAUSE	REMEDY
Pump does not deliver fluid.	Fluid level in reservoir too low.	Fill the reservoir with the proper grade and type of fluid. Check for possible external leaks.
	Pump inlet line plugged.	Remove and clean. Check filters and reservoir for other possible obstructions.
	Air leak in pump inlet line.	Repair leak.
	Pump speed too slow.	Increase speed.
	Fluid viscosity too high.	Use only recommended fluids.
	Broken or worn parts inside the pump.	Analyze the conditions that brought on the failure and correct them.
No pressure.	Pump not delivering fluid.	Follow the remedies given above.
	Fluid recirculating back to reservoir and not going to functions.	Mechanical failure of some other part of the system, especially a relief valve. If contamination is involved, clean and refill the system with clean fluid.
Low or erratic pressure.	Cold fluid.	Warm up system. Operate only at recommended operating temperature range (see Operator's Manual).
	Fluid viscosity wrong.	Use only recommended fluids.
	Air leak or restriction at inlet line.	Repair or clean.
	Pump speed too slow.	Increase speed.
	Internal parts of pump are worn excessively.	Replace pump.

2.2 [PHENOMENON 2]

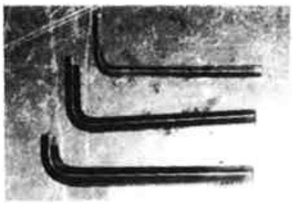
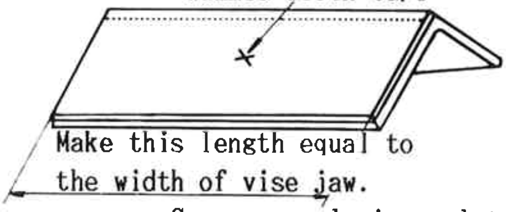
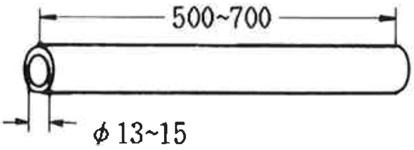
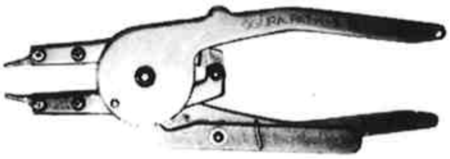
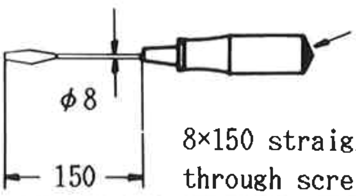
TRUOBLE	PROBABLE CAUSE	REMEDY
Pump making noise.	Restricted or clogged inlet line.	Clean or repair.
	Air leakes in intake line or air drawn through inlet line.	Repair. To check for leaks, pour fluid around joints and listen for a change in sound of operation.
	Low fluid level.	Fill to proper level with the grade and type of recommended fluid.
	Air in the system.	Check for leakes. Bleed air from the system.
	Fluid viscosity too high.	Fill only with recommended fluids.
	Pump speed too fast.	Check engine speed.
	Worn or broken parts.	Check and correct cause of failure. Replace pump.

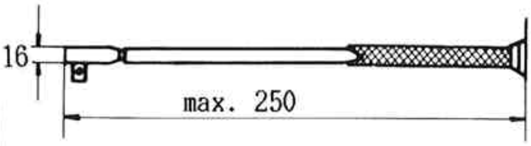
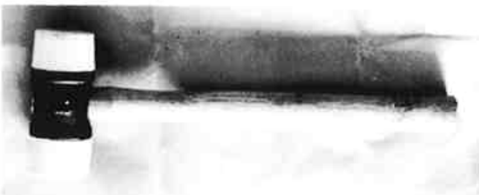
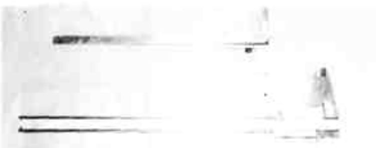
3. DISASSEMBLY AND ASSEMBLY (PHS & PLS Series)

Select a clean place free from dust for the work, and have ready cleaning oil, hydraulic oil, grease and other tools needed. A proper lifting device, such as a crane will be convenient for carring the pump. Also, a suitable work bench and vise are needed for the work.

3.1 TOOLS

Prepair the following tools for disassembly of the pump.

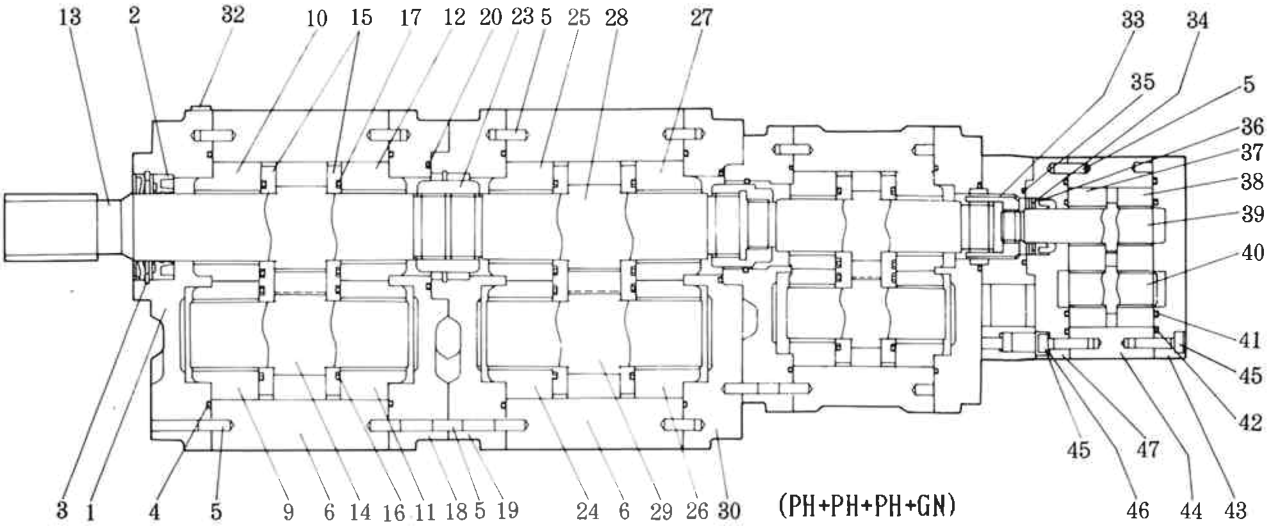
No.	Tool	Sketch	Remarks
1	Allen Wrench (Hex. Key)	 Width 8 mm 10 mm 12 mm	(1) Use to tighten capscrews connecting body and cover. (2) For tandem pump, used to tighten capscrews connecting each pump segment.
2	Adapter plate (copper or aluminum)		Used as a cushoning plate to prevent machined surfaces of pump from being damaged when the pump is clamped in a vise.
3	Pipe		Use as an extention for the allen wrench(hex. key)
4	Spatula		Formed by pointing one end of a wire and shaping the other end in the form of a spatula. Used to remove O-ring.
5	Snap-ring Pliers		Used to remove C-shaped snap-rings for holes.
6	Screwdriver		Straight-through screwdriver Used to remove oil seals.

No.	Tool	Sketch	Remarks
7	Torque Wrench and Sokets	 Pre-set torque type Hexagonal socket  Width 8 mm 10 mm 12 mm	※ Must be able to be set to 12 kg•m. ※ Used to tighten socket head screws. (1) for tightening body and cover. (2) for tightening each pump segment of the tandem type.
8	Carrier (for turning)	 for ϕ28~38 mm	Used to turn the pump shaft at no load after pump reassembly is over.
9	Soft-faced Hammer (plastic or wooden mallet)	 ϕ35~50 mm	
10	Oil-seal Insertion Tool		Used for inserting oil seal into cover.
11	Slide Calipers and Micrometer (mesuring instruments)	 	For mesurement.

3.2 CONSTRUCTION

NOTE

The numbers in the figure below corresponding to those in the following explanation describing disassembly and assembly.



1. COVER
2. SEAL
3. SNAP RING
4. O-RING
5. DOWEL PIN
6. BODY
7. CAPSCREW
8. LOCK WASHER
9. BEARING
10. BEARING
11. BEARING
12. BEARING
13. DRIVE GEAR (FRONT)
14. DRIVEN GEAR
15. WEAR PLATE
16. BACK-UP
17. SEAL
18. COVER (REAR)
19. COVER
20. O-RING
21. LOCK WASHER
22. CAPSCREW
23. COUPLING
24. BEARING
25. BEARING
26. BEARING
27. BEARING
28. DRIVE GEAR
29. DRIVEN GEAR
30. COVER (REAR)
31. CAPSCREW
32. NAME PLATE
33. SNAP RING
34. SNAP RING
35. O-RING
36. OIL SEAL
37. BEARING
38. BEARING
39. DRIVE GEAR
40. DRIVE GEAR
41. RUBBER RING
42. O-RING
43. COVER (REAR)
44. BODY (CASING)
45. CAPSCREW
46. LOCK WASHER
47. COVER

The casing consists of a body and covers (each, the front and rear). The casing incorporates a pair of gears (the drive gear and the driven gear), four bearing housings including special bushing type bearings that support these gears, and a pair of wear plates that seal against oil leaking through the side of the gears.
The wear plates are installed with back-ups and seals which form the pressure compensation chamber.
The construction including the main parts in the casing as shown in the figure above, provides the pump with the high efficiency of the performance stable in long use.

To prevent oil from leaking out, the rear cover is installed with an O-ring, while the front cover is installed with an O-ring and an oil seal.
The oil seal prevents the dust from comming in from the out side, the oil from leaking to the outside and suction of the air.

3.3 REPLACEMENT OF THE OIL SEAL

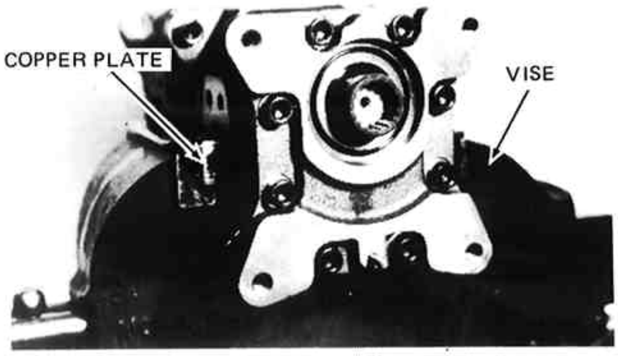
Replacement of the oil seal should proceed as follows:

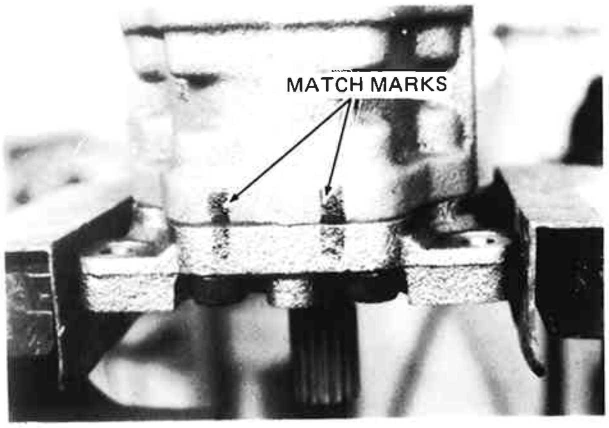
3.3.1 DISASSEMBLY

1) Clean the exterior of the pump assembly throughly and secure it, clamping the body or the port flange of the pump with a vise.

NOTE

1. Apply mach mark to avoid wrong assembly.
2. Before holding the pump with a vise, be sure to place the copper plates or waste cloths between the jaws and pump to protect the flange surface.
3. Do not apply excessive force to hold the pump because too much tightening might cause deformation.

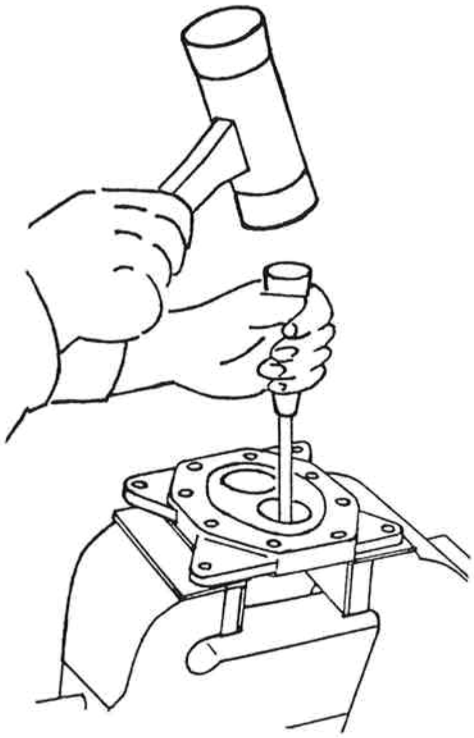




2) Remove capscrews(31) with an allen wrench. Remove front cover(1) using a soft hammer.
3) Take out dust seal using driver(6) and hammer(9), or spatula. (Some units not fitted with dust seals.)
4) Remove snap ring(3) from the front using a snap ring plier.
5) Remove oil seal(2) downward, using driver and hummer or press.

CAUTION

1. When removing this seal, do not damage the inside of front cover(1).
2. Do not reuse the oil seals that are removed once. It is recommended that the seals should not be removed unless they are exactly defective or damaged.



3.3.2 ASSEMBLY

1) When inserting the oil seal, first grease the periphery and the lip part of the seal. Confirm the direction in which the seal is installed, then insert the seal carefully into the cover. At the time, pushing in the seal evenly by hand to the end of the bore of the cover.

NOTE

If any scoring or damage is found on the seal fitting hole or inlet part, remove it with fine sandpaper before press-setting oil seal in.

2) Set the oil seal fitting jig on the oil seal that is already pushed manually in the bore of the cover. Tap the jig lightly with a plastic mallet to further press the seal into the right position in the bore where it is grooved for the snap ring to fit in.

NOTE

Stop pressing the oil seal when it was just passed the snap ring groove. It is recommended to use the fitting jig shown in figure below.

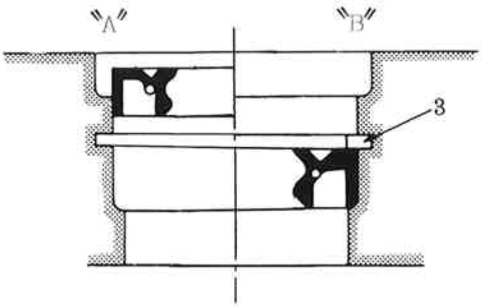
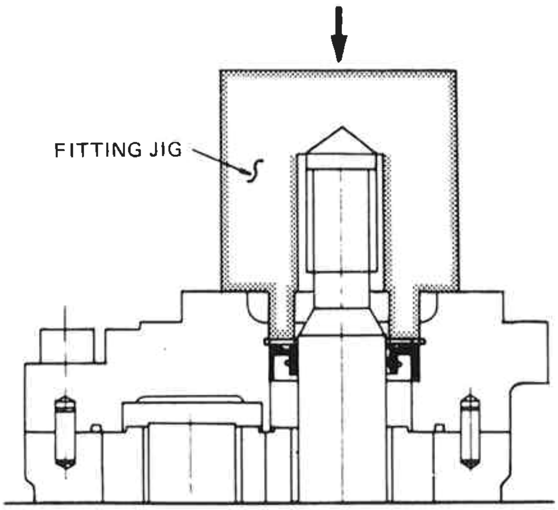


Figure at "A" side shows the position to which the oil seal should be pushed in manually and at "B" side shows right position to which the oil seal should be further pressed in.



3) Insert snap ring(3) into the groove with a plier.
4) If equipped with dust seal, assemble in the same way as for inserting oil seal.
5) Secure the front cover with capscrews. This completes the oil seal replacement.

3.4 DISASSEMBLY

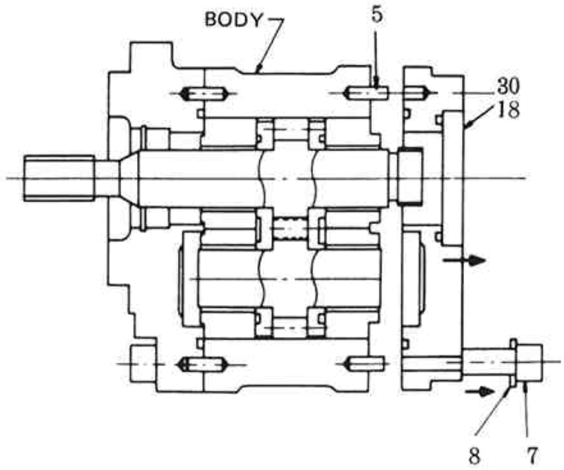
Thoroughly clean the outside of the pump before disassembly. Place each part in order as it is disassembled, so that it can be reassembled in the correct order and direction.

The pump may be either a single or tandem type. For the tandem type, remove capscrews connecting the mating faces before starting to disassemble.

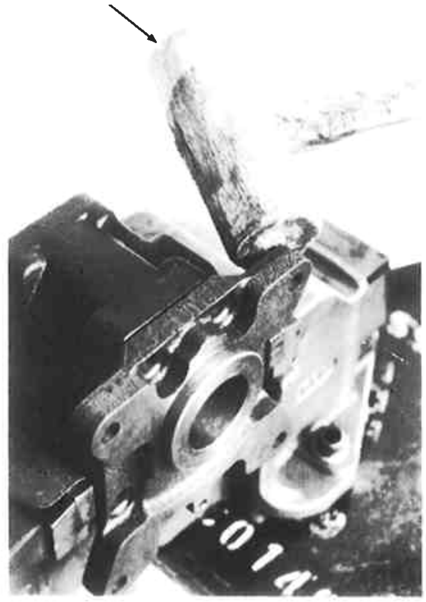
1) Secure the pump assembly at the body(6) or the flange with a vise. Put the mating markes on the faces of the parts which mate each other.

NOTE

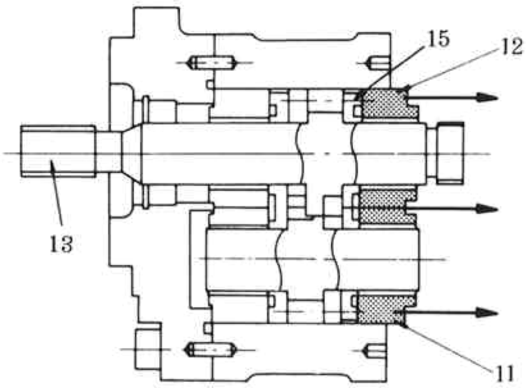
1. When securing the pump with a vise, put a copper plate or rug between the pump and the jaws as padding.
2. Do not apply excessive force to hold the pump, too much tightening might cause deformation of the pump.



2) Remove capscrew(7), using the wrench and lock washer(8), covers(18) and (30) are ready to be disassembled.
   Dowel pin(5) is installed between body(6) and cover(18). When the cover doedsn't easely come off, tap it lightly with a plastic mallet along the mating face in the direction of removal while holding the cover by hand.



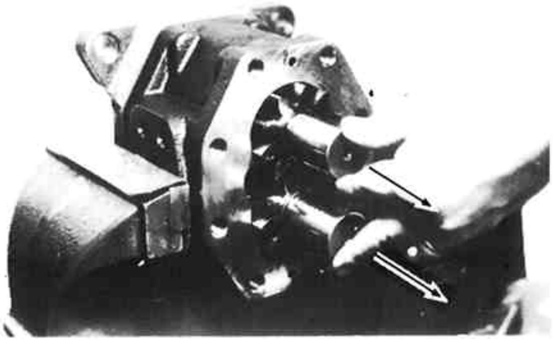
3) Push drive gear(13) toward cover(18), and bearings(11)(12) and plate(15) at the side of the cover become to float. Then draw them out by hand.



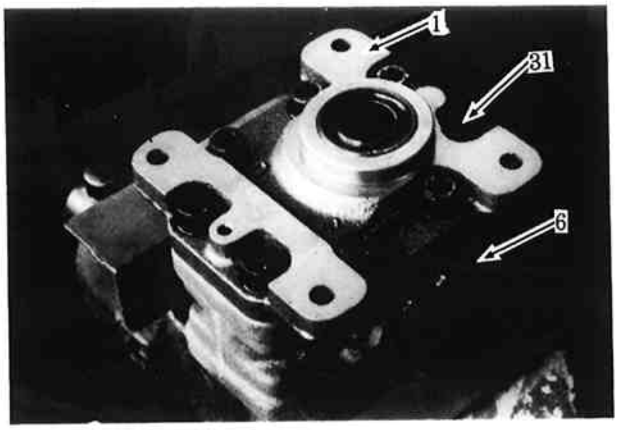
4) Remove drive gear(13)(28) and driven gear (14)(29) by pulling them out in the direction of the arrow.

NOTE

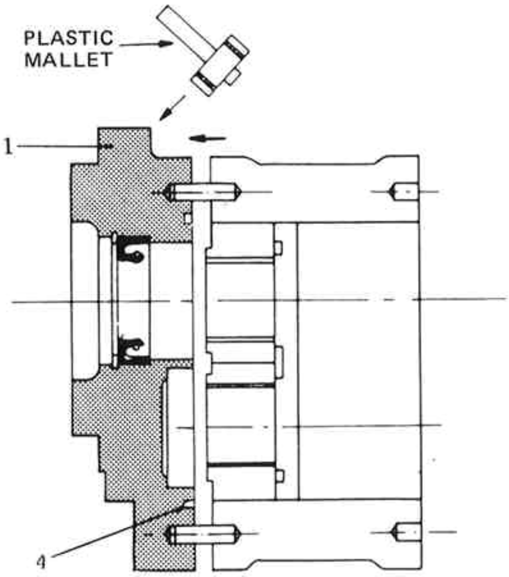
1. Disassembled parts should be kept in sets to avoid mixing parts between sets.
2. Mark the drive and driven gears to see front and rear.



5) Remove capscrew(31) which fixes cover(1) and body(6), then remove lock washer(8) and cover(1)(19).



If cover(1)(19) is stuck and hard to remove, tap the flange part of the cover with the plastic mallet in the direction of removal while holding the cover by hand.



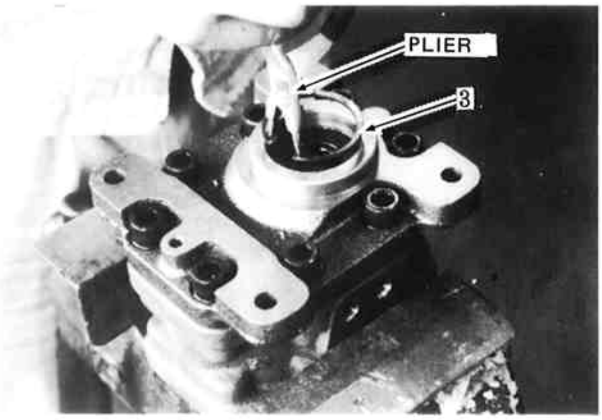
6) Bearing(9)&(10) and wear plate(15) may be taken out by pressing wear plate(15) with your hand towards the cover side.

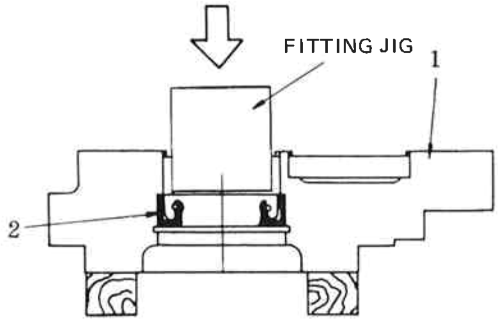
CAUTION

If the wear plate is removed forcibly by hitting it hard, the bore of the body may be deformed or damaged. Never strike it hard to removed.

7) To remove O-ring(4) in the cover, use a spatula or a wire rod with its end sharpened not to damage the groove for the O-ring.

8) Remove snap ring(3) in cover(1) in the same procedure as in 3.3.1(4) and push oil seal(2) using the oil seal fitting jig.





As the above procedure, the disassembly of the pump has been completed.

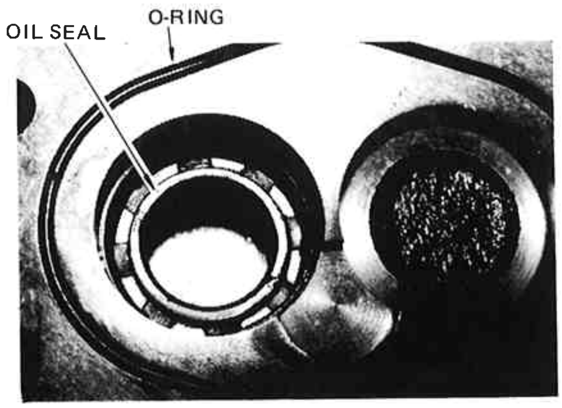
NOTE

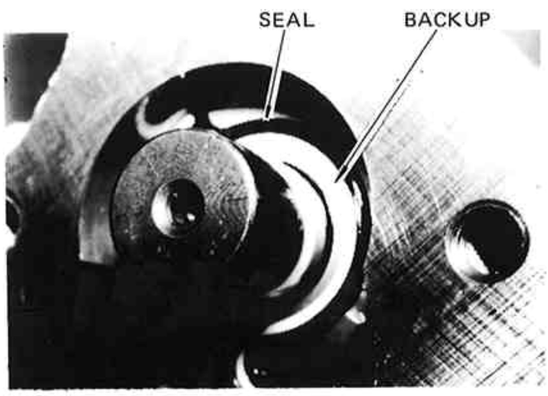
If the cover and the bearing are installed in the wrong direction of the assembly, the pump can be assembled but the pump can not function properly.

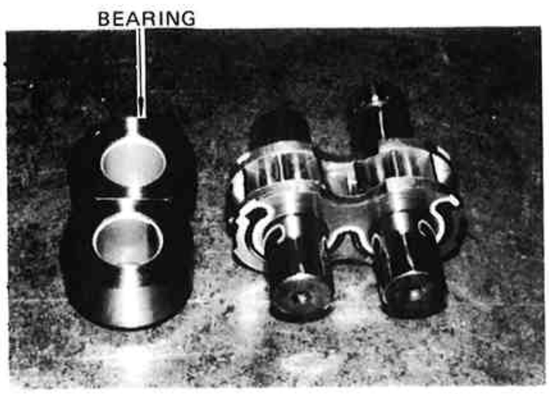
3.5 MAINTENANCE STANDARD

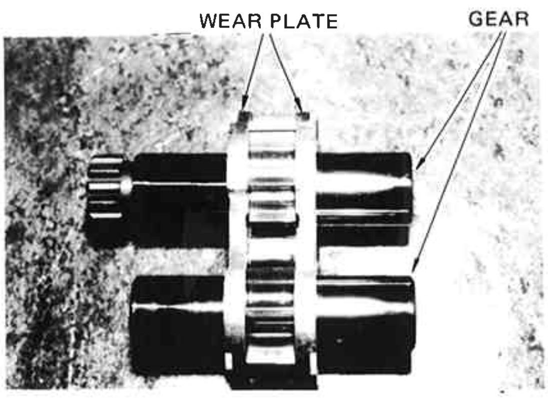
Item	Part	Replacement Standard
1	Seal	Replace whenever pump is disassembled.
2	Gear	(1) If journal or gear portion is damaged, seized, pitted, replace the pump section as an assembly. (2) If gear side is worn over 0.01mm in difference of gear thickness, replace the pump section as an assembly.
3	Bearing with bushing	(1) If bushing is damaged by foreign matter, replace the pump section as an assembly. (2) If bearing bore is worn over 0.2mm unevenly or if Teflon layer on internal surface of bushing is peeled, replace the pump section as an assembly.
4	Wear plate	(1) In case of seizing or abnormal wear, replace the pump section as an assembly. (2) If sliding face is uneven over 0.02mm, replace the pump section as an assembly.

If replacement is made in items 2,3 and 4, break-in is required by means of pump testing equipment. Therefore, if internal components are to be replaced, it is recommended as a general rule that the section should be replaced as an assembly.









3.6 ASSEMBLY

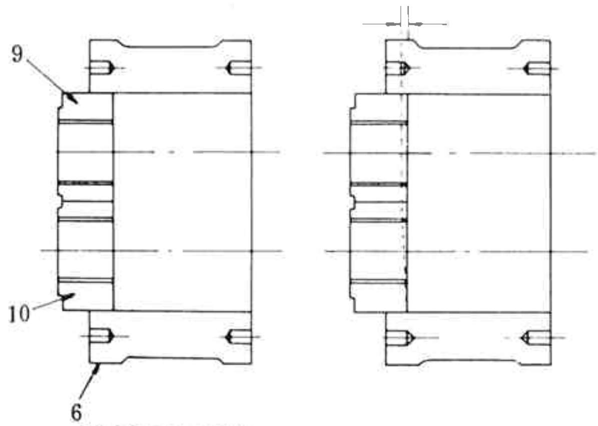
Seals, once removed, should, in plinciple, not be used again. Assembly new seals by applying high quality grease. When assembling, clean all parts other than seals with cleasing oil; then, remove all foreign matter with pressurized air and place them in order on the work bench.

If the body, cover, etc. is dented, remove by applying an oil stone lightly.

1) Confirm bearings(9) and (10) facing in proper direction (for drive and driven sides) and insert them in one set in body(6) as shown in Figure(A).
   They can be lightly inserted. If they are inserted forcibly in a tilted condition, bearing(9),(10) and the body may get damaged.
   Apply grease around the inner periphery of the cover before inserting the bearing and they can be smoothly inserted.

   CAUTION

   Make sure of the oil groove in the inner face of the bushing being positioned at the discharge side.

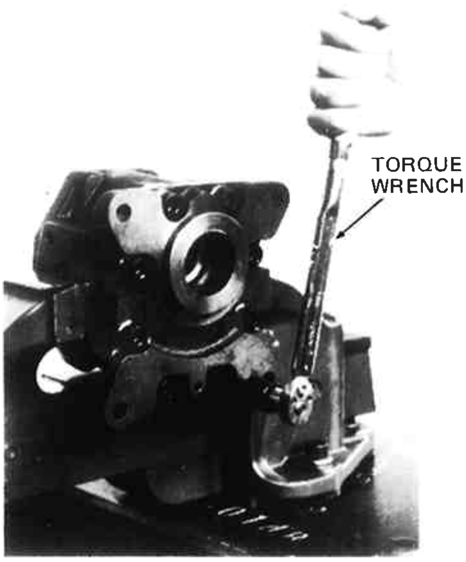


GOOD EXAMPLE (A)　　BAD EXAMPLE (B)

2) Install cover(1) to body(6) by putting dowel pin(5) in the body, tapping the cover alternately and evenly around its flange part.
   Make sure aligning the mating marks which were put when disassembling.

3) Set lock washer(8) and provinsionally tighten capscrew(31) to an even torque. If O-ring(4) does not protrude, evenly tighten capscrews diagonally in sequence to the following torque.

Series	Tightening torque(kgf·m)
PHS,PLS25	7
PHS,PLS30	12
PHS,PLS35	12
PHS,PLS40	19

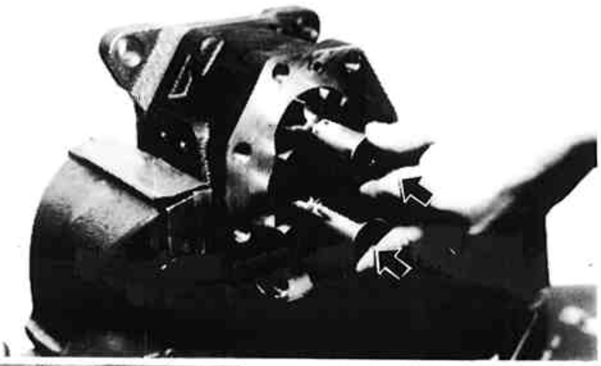


4) Gradually insert wear plate(15) in the case from the cover(18) and (30) side, taking care that they don't tilt. Before this step, insert seal(17) and back-up ring(16) into the wear plate. It can be inserted by using the bearing or the gear, too.

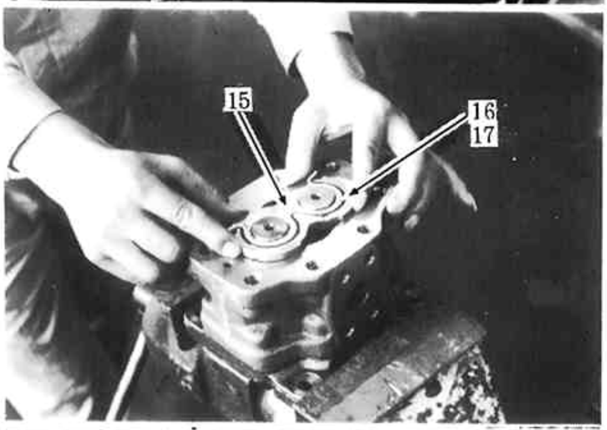
NOTE

Before pushing in, confirm with fingers inserted through two holes that the seal and back-up ring are surely in its groove.

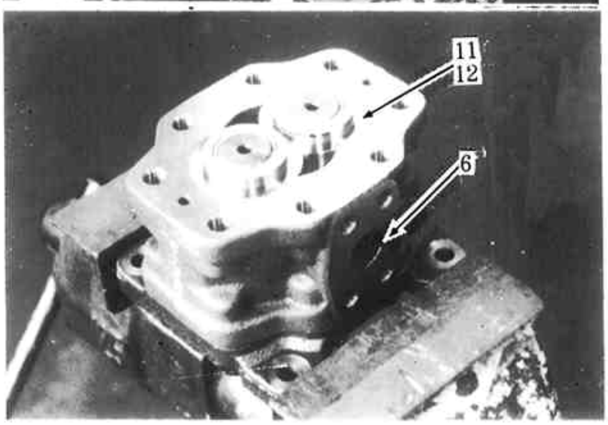
5) Coat the inner face of wear plate(15) with hydraulic oil, then insert drive gear(13),(28) as shown by the arrow(←) in Figure right.



6) Insert drive gear(14),(29) to the position in the case shown in Figure right. Install seal(17) and back-up ring(16) in wear plate(15). Make one set of these three parts contact with the end of the gear and push it together with the gear into the regular position. In this case, the seal and the back-up ring come off the groove, therefore push them back to the right position.

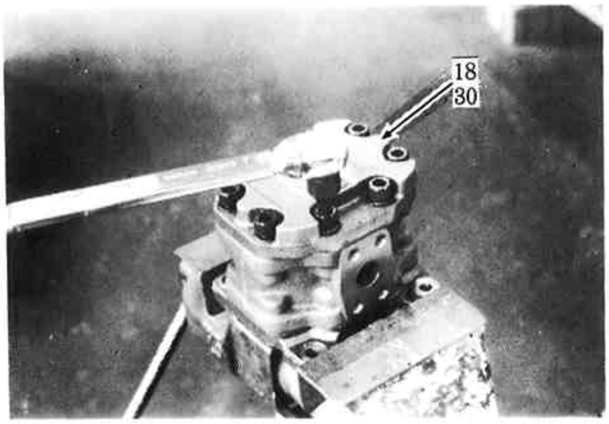


7) Slowly push bearing(11),(12) as a set into body(6) as shown in Figure right.



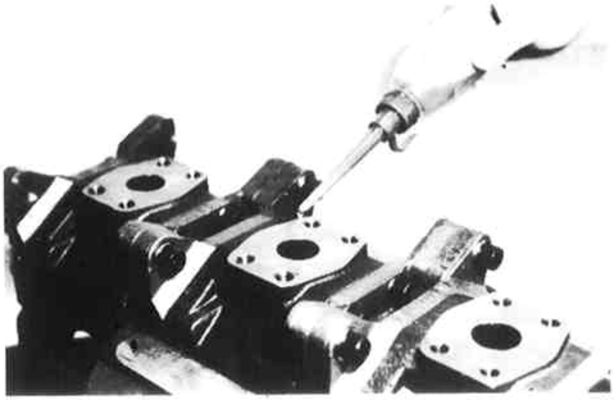
CAUTION

1. Bearing for the drive gear and driven gear can be distinguished by the position of the oil passage in the internal surface of the bushing. Therefore, make sure that the oil passages are located on the delivery port side.
2. When the bearings are assembled in position, they project above the body side about 0.5 to 0.8mm. If this projection is over 1mm, it is an indication that the seal, etc. is not seated properly. In that case, reassemble again.



8) Set covers(18) and (30) by matching their match marks, preliminary tighten capscrew(7) with lock washer(8). Tighten capscrews diagonally in sequence to an even torque.

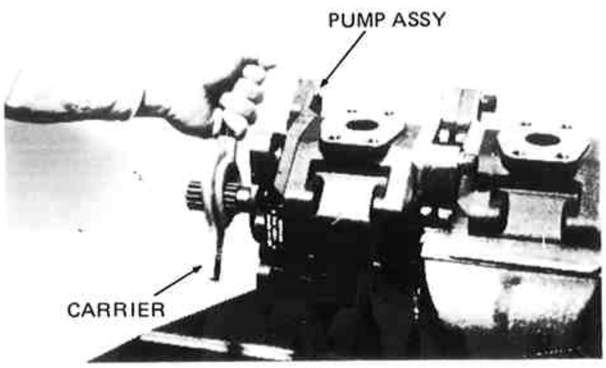
Series	Tightening torque(kgf•m)
PHS,PLS25	7
PHS,PLS30	12
PHS,PLS35	12
PHS,PLS40	19



9) Apply hydraulic oil through the port and clamp the splined part of the drive gear with an arm (the carrier as shown in the Tool Table) to check to see that the shaft lightly rotates.

CAUTION

If it is too heavy to rotate the shaft, the seal or the back-up ring might be floated also foreign materials mixed. In such a case, take them out and reinstall them correctly as instructed.

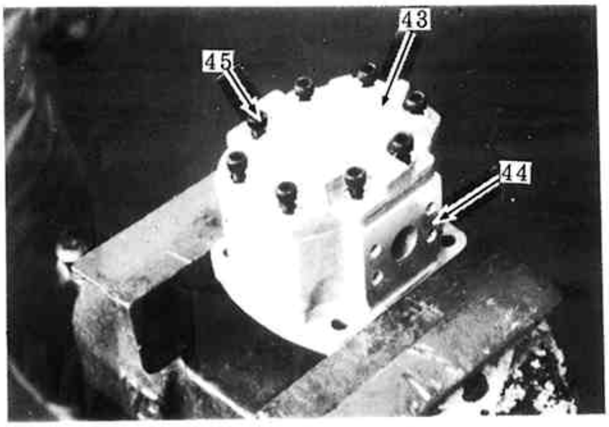


4. DISASSEMBLY AND ASSEMBLY (GN Series)

Place the hydraulic pump on the work bench. Place all disassembled parts in the proper order and direction.

4.1 DISASSEMBLY

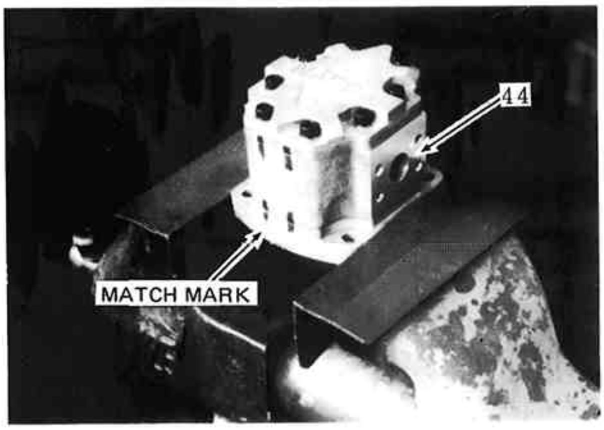
1) Apply match marks to covers(43) and (47), and fix pump with vise.



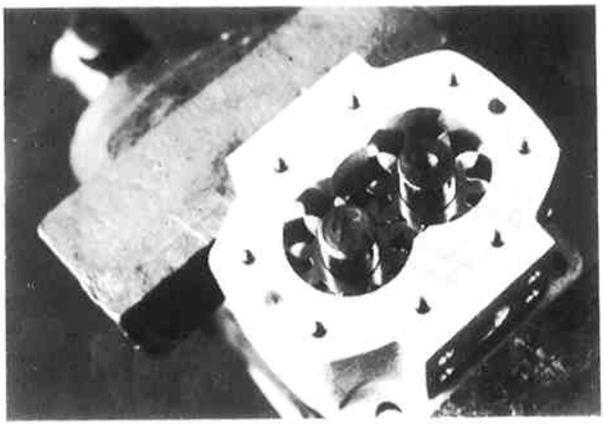
CAUTION

1. When holding pump with a vice, apply copper plates to prevent dent or damage.
2. Do not secure it excessively. Too much tightening might cause deformation of the pump.

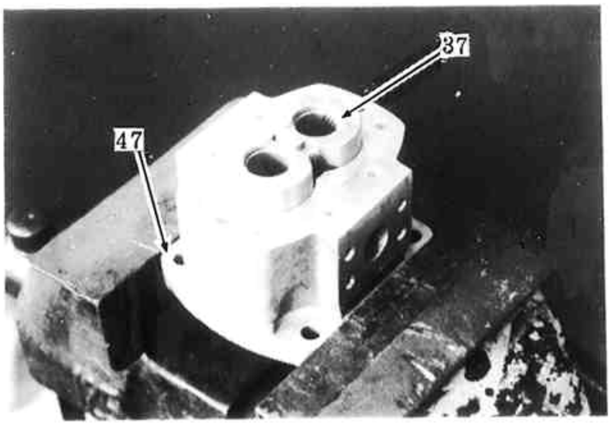
2) Remove capscrew(45) and take off cover(43). Take out dowel pin(5) at the same time.



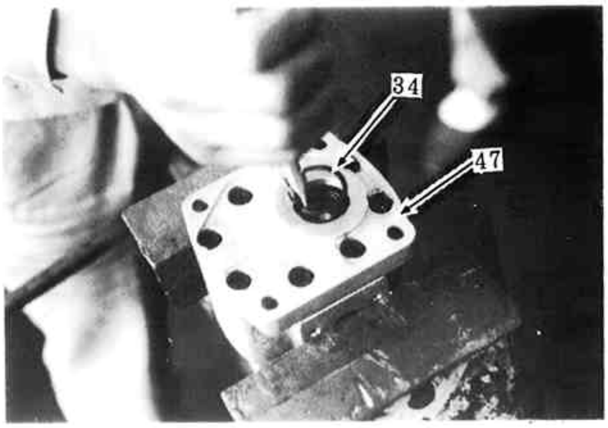
3) Bearing(38) will come up by pushing drive gear(39) upwards. Remove bearing by hand.
4) Remove driven gear(40) and driven gear(39) from body(44). Pay attention at this time that the oil seal is not damaged by the spline part.



5) Take out bearing(37); If it is hard to do so, remove cover(47) and push it out.



6) Remove oil seal of cover(47) after taking out snap ring(34).

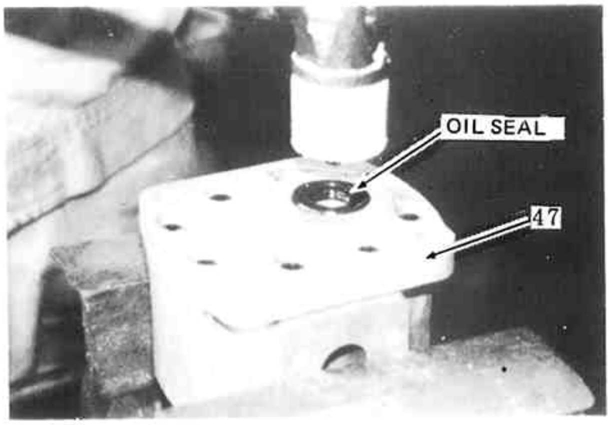


This completes disassembly. For maintenance standards, refer to the relevant part for the PHS-series.

4.2ASSEMBLY

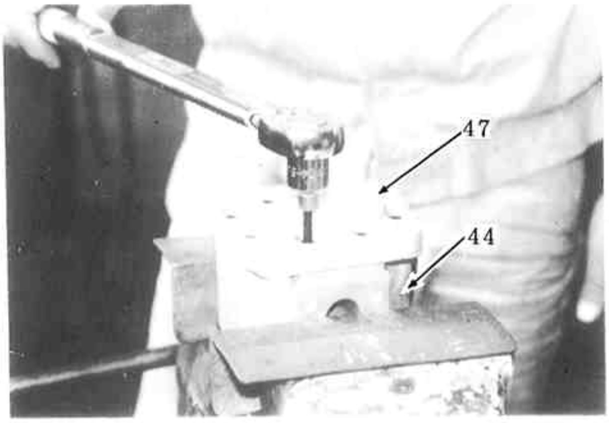
Carry out assembly by reversing the order of disassembly. Replace all seals.

1) Insert oil seal into cover(47) and set snap ring.

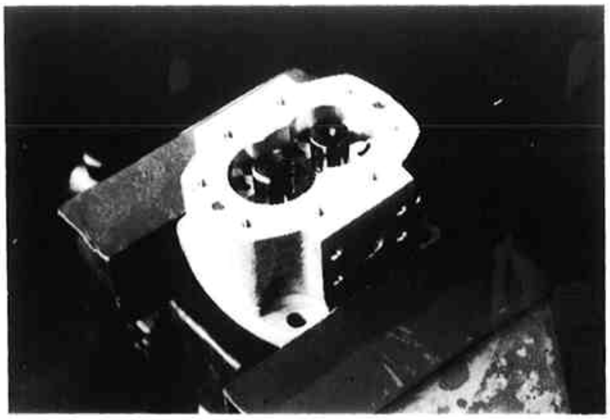


2) Place O-ring in cover(47) and assemble with knock pin onto body(44). Install capscrew(45) at the following torque.

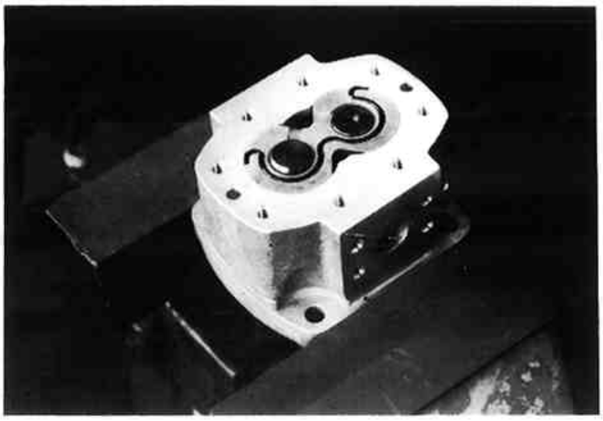
Series	Torque(kgf·m)	Notes
GN1	1.8 ~ 2.0	M6
GN2	1.8 ~ 2.0	M6
GN3	6.5 ~ 7.0	M10



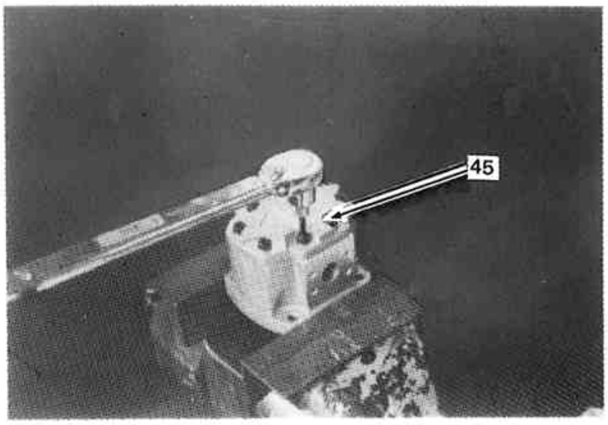
3) Insert bearing(37). After winding tape onto the spline shaft of the drive gear, assemble the drive gear.
4) Insert driven gear so that the "Chamfered part" comes to cover(43) side.



5) First insert bearing(38) into body. Then set O-ring into cover. (Insert knock pin, if applicable.)



6) Put cover(43) on body and tighten capscrew(45) with lock washer. This completes assembly.



5. TEST PROCEDURES

After assembly is over, cap each port to prevent entry of foreign matter before storage. To perform a delivery test with hydraulic testing bench, proceed as follows:

1) Loosen the adjusting screw on the relief valve to prevent pressure rise.
2) Operate the pump for about 5 minutes without load.
3) Raise the oil temperature to 50 to 60°C. Then, gradually raise the pressure with the adjusting screw.
4) At the specified pressure without load, check the pump for oil leakage, noise, vibration, etc.

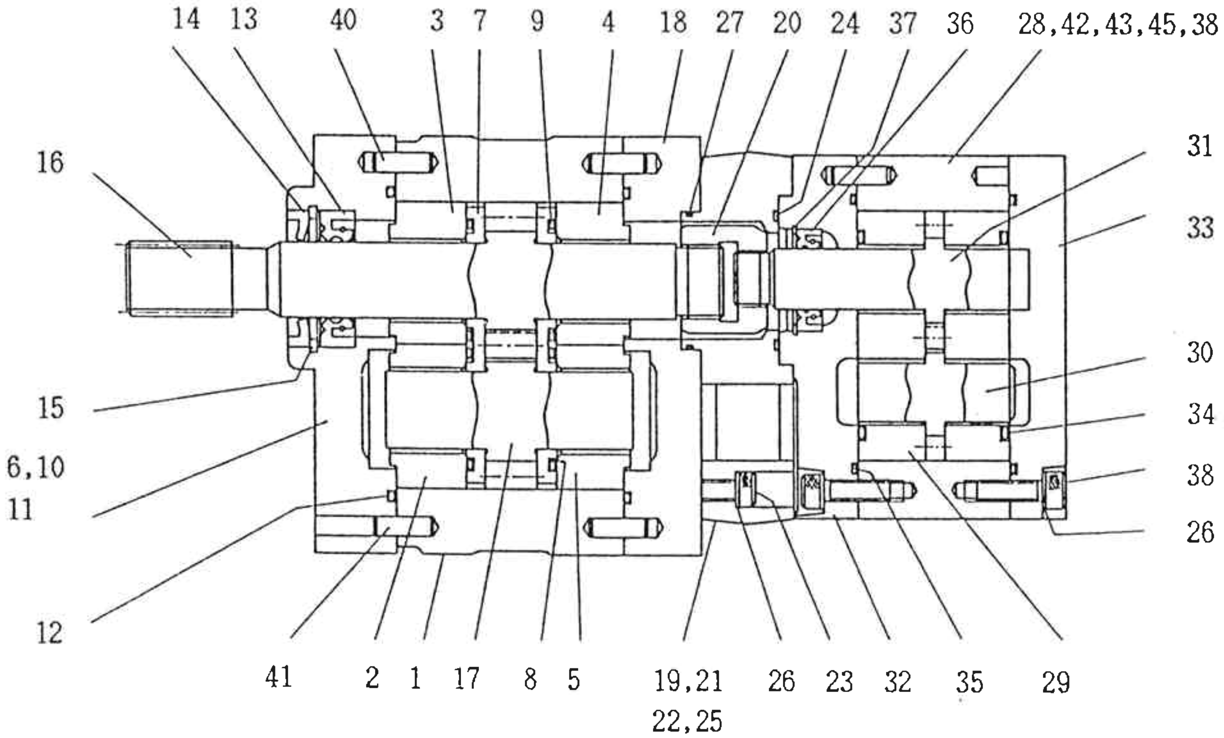
6. SPECIFICATIONS

(1) 7055·7065(Std.) ··· PHS2519-GN208 AAL

Item \ Pump No.		No.1 Pump	No.2 Pump
Type		PHS2519	GN208
Displacement (cc/rev.)		19.0	8.25
Relief set pressure (kgf/cm²)		210	115
Used revolution range (rpm)		630 ~ 2100	
Actual delivery (l/min.)		35.5	16.2
Rated	Pressure (kgf/cm²)	250	160
	Revolution range (rpm)	500 ~ 3000	1000 ~ 3500

Weight : about 12 kg

←NOTE : Each delivery are values at rated pressure, 2100 rpm and 37 cst.



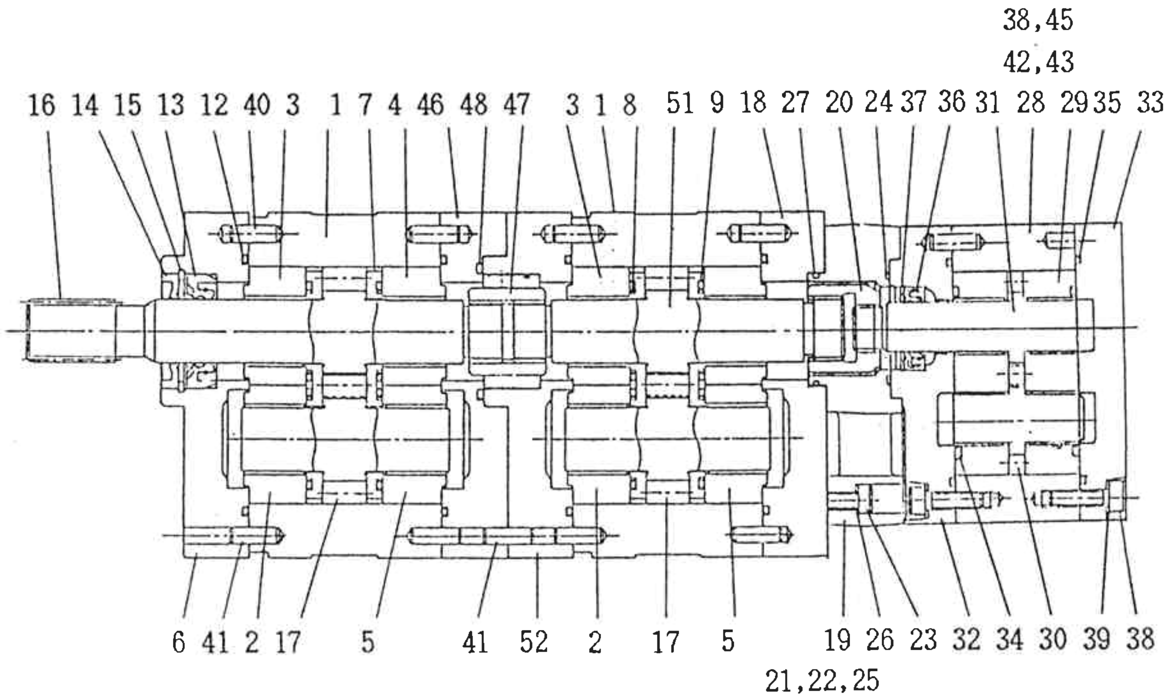
1. BODY
2. BEARING
3. BEARING
4. BEARING
5. BEARING
6. FRONT COVER
7. WEAR PLATE
8. BACK-UP RING
9. SEAL
10. CAPSCREW
11. LOCK WASHER
12. O-RING
13. OIL SEAL
14. DUST SEAL
15. SNAP RING
16. DRIVE GEAR
17. DRIVEN GEAR
18. COVER
19. MOUNT
20. COUPLING
21. CAPSCREW
22. CAPSCREW
23. CAPSCREW
24. O-RING
25. WASHER
26. WASHER
27. O-RING
28. BODY
29. BEARING
30. DRIVEN GEAR
31. DRIVEN GEAR
32. FRONT COVER
33. COVER
34. RUBBER RING
35. O-RING
36. OIL SEAL
37. SNAP RING
38. CAPSCREW
40. SPRING PIN
41. DOWEL PIN
42. FLANGE
43. FLANGE
45. O-RING

(2) 7055·7065(Opt.) ··· PHS2519-2519-GN208 AAL

Item \ Pump No.		No.1 Pump	No.2 Pump	No.3 Pump
Type		PHS2519	PHS2519	GN208
Displacement (cc/rev.)		19.0	19.0	8.25
Relief set pressure (kgf/cm^2)		210	210	115
Used revolution range (rpm)		630 ~ 2100		
Actual delivery (l/min.)		35.5	37.1	16.2
Rated	Pressure (kgf/cm^2)	250	250	160
	Revolution range (rpm)	500 ~ 3000	500 ~ 3000	1000 ~ 3500

Weight : about 20 kg

NOTE : Each delivery are values at rated pressure, 2100 rpm and 37 cst.



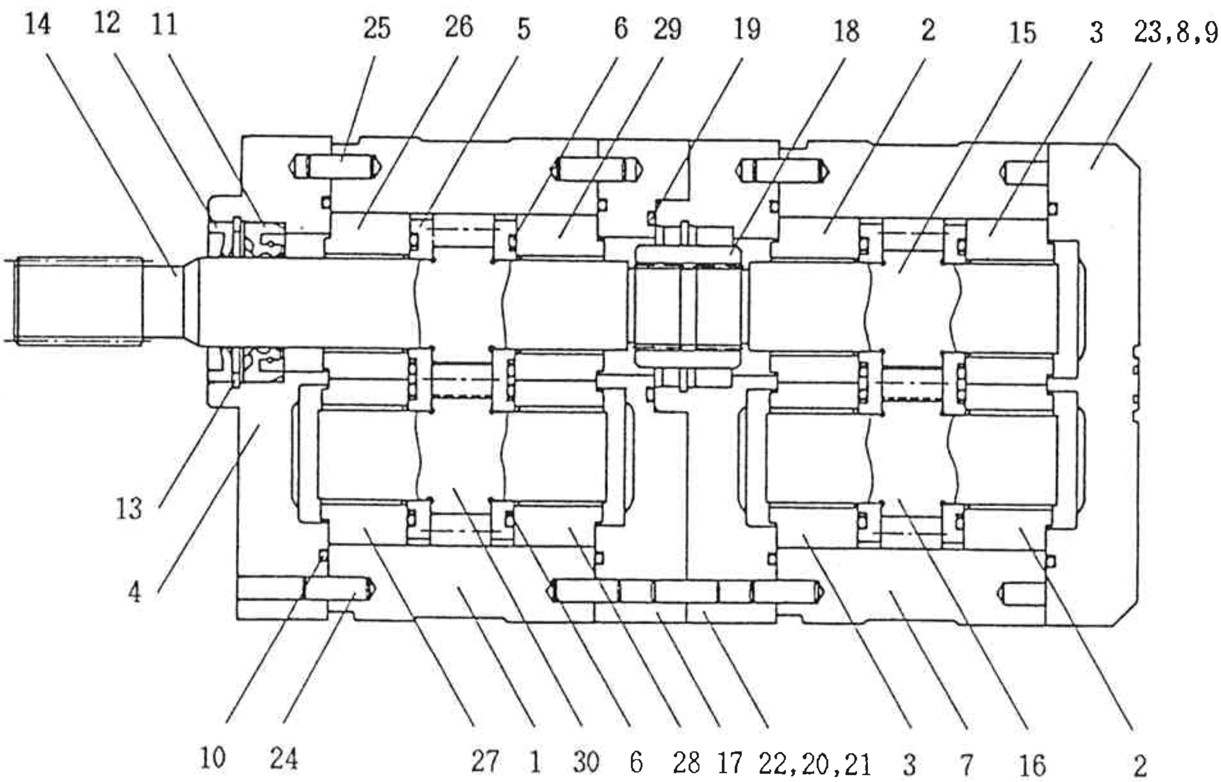
1. BODY
2. BEARING
3. BEARING
4. BEARING
5. BEARING
6. FRONT COVER
7. WEAR PLATE
8. BACK-UP RING
9. SEAL
10. CAPSCREW
11. LOCK WASHER
12. O-RING
13. OIL SEAL
14. DUST SEAL
15. SNAP RING
16. DRIVE GEAR
17. DRIVEN GEAR
18. COVER
19. MOUNT
20. COUPLING
21. CAPSCREW
22. CAPSCREW
23. CAPSCREW
24. O-RING
25. WASHER
26. WASHER
27. O-RING
28. BODY
29. BEARING
30. DRIVEN GEAR
31. DRIVE GEAR
32. FRONT COVER
33. COVER
34. RUBBER RING
35. O-RING
36. OIL SEAL
37. SNAP RING
38. CAPSCREW
39. WASHER
40. SPRING PIN
41. DOWEL PIN
42. FLANGE
43. FLANGE
45. O-RING
46. COVER
47. COUPLING
48. O-RING
49. CAPSCREW
50. LOCK WASHER
51. DRIVE GEAR
52. COVER

(3) 7080 ····· PLS2519-2525 AAL (Left Turn : Viewed from Input Shaft)
7150 ····· PLS2519-2525 AAR (Right Turn : Viewed from Input Shaft)

Item \ Pump No.		No.1 Pump	No.2 Pump
Type		PLS2519	PLS2525
Displacement (cc/rev.)		19	25
Relief set pressure (kgf/cm^2)		175	60
Used revolution range (rpm)		630 ~ 2010	
Actual delivery (l/min.)		30.9	43.8
Rated	Pressure (kgf/cm^2)	210	210
	Revolution range (rpm)	500 ~ 3000	500 ~ 3000

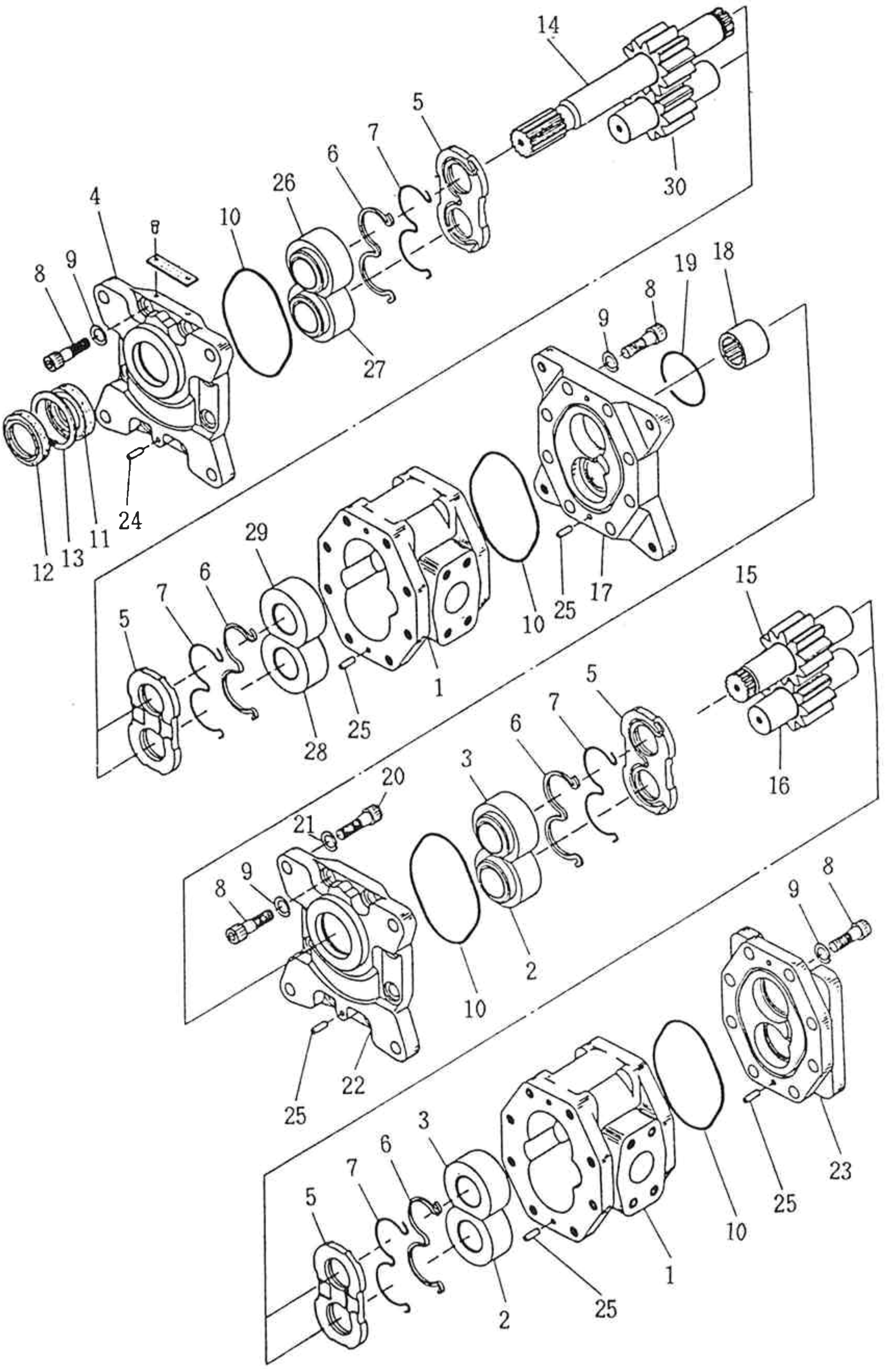
Weight : about 12 kg

←NOTE : Each delivery are values at rated pressure, 1830 rpm and 37 cst.



1. BODY
2. BEARING
3. BEARING
4. FRONT COVER
5. WEAR PLATE
6. SEAL
7. BODY
8. CAPSCREW
9. LOCK WASHER
10. O-RING
11. OIL SEAL
12. DUST SEAL
13. SNAP RING
14. DRIVE GEAR
15. DRIVE GEAR
16. DRIVEN GEAR
17. COVER
18. COUPLING
19. O-RING
20. CAPSCREW
21. LOCK WASHER
22. FRONT COVER
23. COVER
24. DOWEL PIN
25. SPRING PIN
26. BEARING
27. BEARING
28. BEARING
29. BEARING
30. DRIVEN GEAR

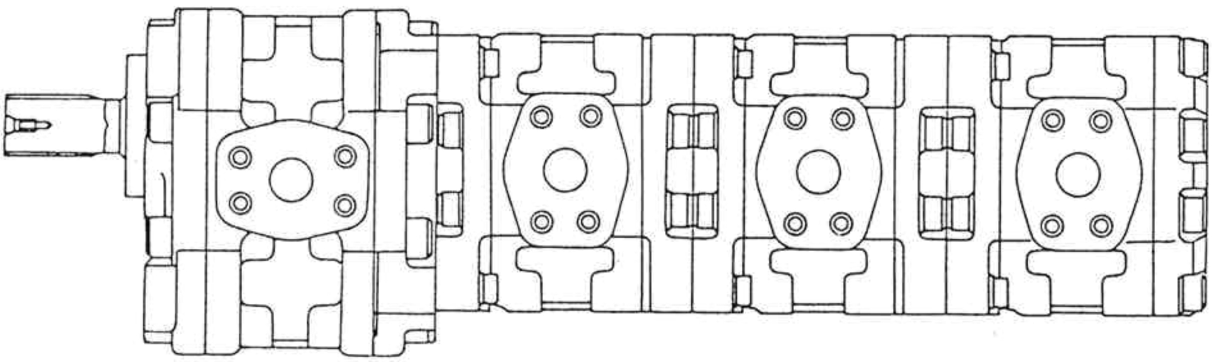
(Reference) Tandem Gear Pump PHS30



(4) 7450 ····· PHS3040-2519-2516-2516 Weight : about 38 kg

Item \ Pump No.		No.1 Pump	No.2 Pump	No.3 Pump	No.4 Pump
Type		PHS3040	PHS2519	PHS2516	PHS2516
Displacement (cc/rev.)		42.7	19	16	16
Relief set pressure (kgf/cm^2)		60	120	175	175
Used revolution range (rpm)		500 ~ 2100			
Actual delivery (l/min.)		72.1	31.3	25.1	25.1
Rated	Pressure (kgf/cm^2)	250	250	250	250
	Revolution range (rpm)	500 ~ 3000	500 ~ 3000	500 ~ 3000	500 ~ 3000

NOTE : Each delivery are values at rated pressure, 2100 rpm and 37 cst.



1. GENERAL

1.1 SPECIFICATION (MWP*25 Type)

Max. Pressure : 315 kgf/cm^2

Rated Flow : 240 ℓ/min.

Operation : Pilot operation --- Pilot pressure 10, 15, 20, 25 kgf/cm^2

: Manual operation -- Spring back type, Detent type

Connection :

Port \ Style	SAE Flange	JIS O-ring Port
P (Pump) T (Tank)	3000psi - 1", 1-1/4" 6000psi - 1"	PF - 1", 1-1/4"
A (Actuator) B (Actuator)	3000psi - 3/4", 1" 6000psi - 3/4"	PF - 3/4", 1"
a (Pilot) b (Pilot)	—	PF - 1/4" PT - 1/4"

Weight :

One valve section	Two sections	Three sections	Four sections
about 38 kg	about 50 kg	about 63 kg	about 75 kg

1.2 TYPE INDICATION

MW P 3 25 2ST 501 _

- Revision Mark : A, B, ･･･
- Series Number
- Kind of Valve Sections
  P:pallarel T:tandem S:series
  (ex. 1st and 2nd sections:series,
  3rd one:tandem)
- Size : 25
- Quantity of Valve Sections
- P : pilot operation
  Non : manual operation
- Multiple Control Valve Type MW

2. CONSTRUCTION AND FUNCTION

2.1 CONSTRUCTION

The basic construction of a control valve is described herein.
The control valve body is composed of a P end-section with a pressure oil inlet port, valve sections with actuator ports, and an R end-section with a oil outlet port.
The above sections are connected by tie rods with O-rings installed between the sections.
The P end-section has a main relief valve, in addition to the oil inlet port. Also a by-pass passage and a parallel passage to the valve sections are included in the P end-section.
The valve section has, in addition to a spool for directional control, an overload relief valve, an anti-cavitation check valve, a load check valve, and a combination valve according to machine requirements. On the spool ends, the following are installed according to the spool operation systems.

- Hydraulic pilot system...hydraulic pilot mechanism(spring, spring seat, and end cover)
- Manual operation system...clevis or fork, and spring for centering the spool or detent mechanism
- Direct servo system...direct servo-valve assembly

The R end-section is equipped with a return (outlet) port to the tank and/or carry-over port if necessary.

NOTE

There is a type of hydraulic pilot mechanism which has a spool cushioning device built into the end cover.

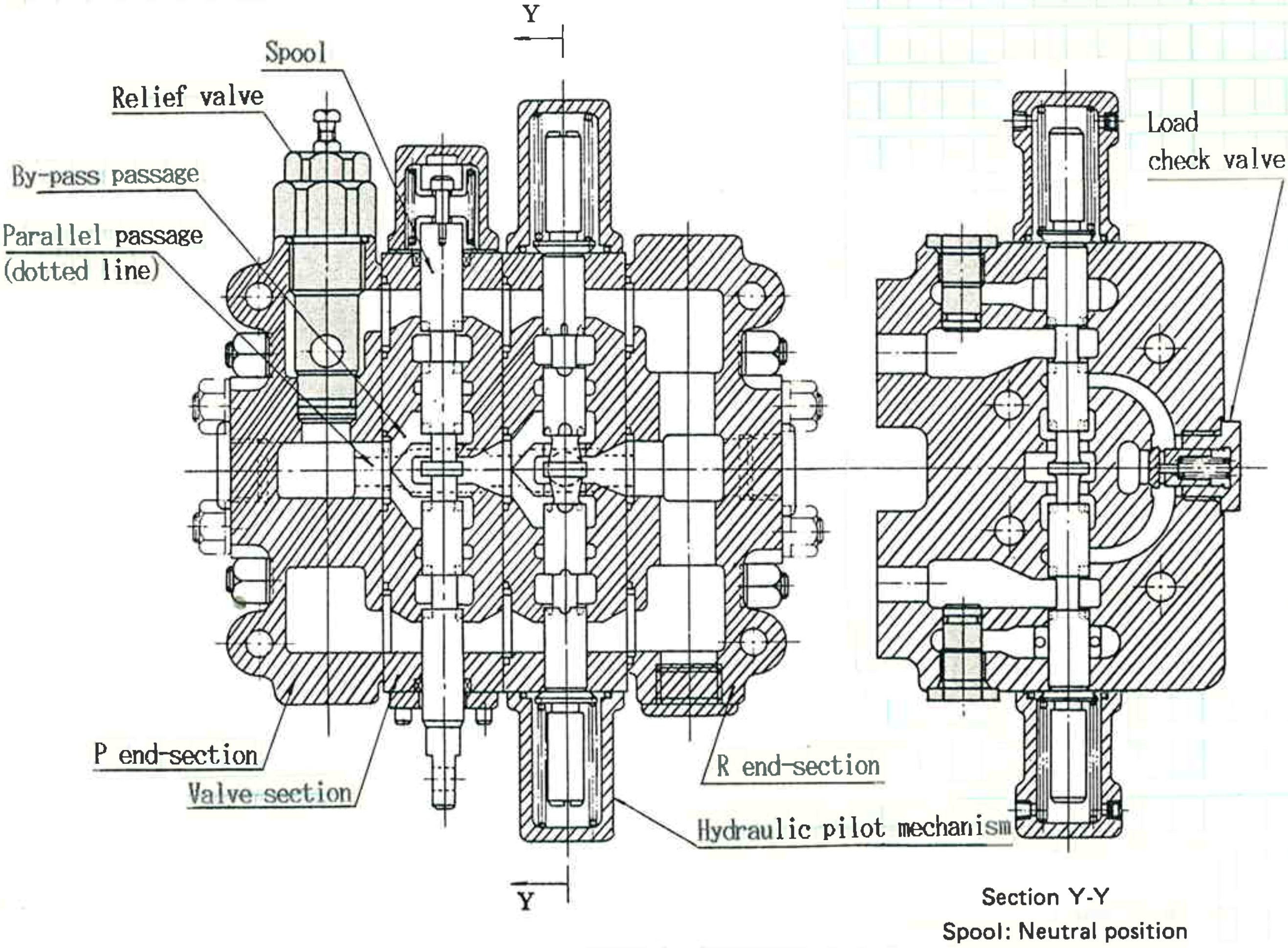


Fig.1 Basic Construction

2.2 FUNCTION

(1) Directional Control

The oil flow from the hydraulic pump is divided into the by-pass passage and pararell passage at the P end-section. The by-pass passage is connected to the R end-section when the spool is in neutral position.

[Parallel Circuit]

The parallel passages of each valve sections are connected with the P end-section, but blocked at the R end-section. Therefore, at the spool neutral position, discharged oil is fed to the R end-section through the by-pass circuit. Fig.2 shows the oil flow when the spool is shifted. When the spool is shifted, the valve section by-pass passage is blocked and the parallel passage pressure rises. Oil is fed in the direction of the arrow, opens the load check valve, and flows from port P to port A. Port A is connected to a hydraulic motor or a cylinder which is operated by hydraulic pressure (load check valves are not always installed). Return flow from the motor or cylinder is fed in the direction of the arrow and returns to port T of the R end-section from port B.

Additionally, if the spools of other valve sections are operated simultaneously, oil flows into the circuit with the smaller load, rather than into the circuit with the larger load.

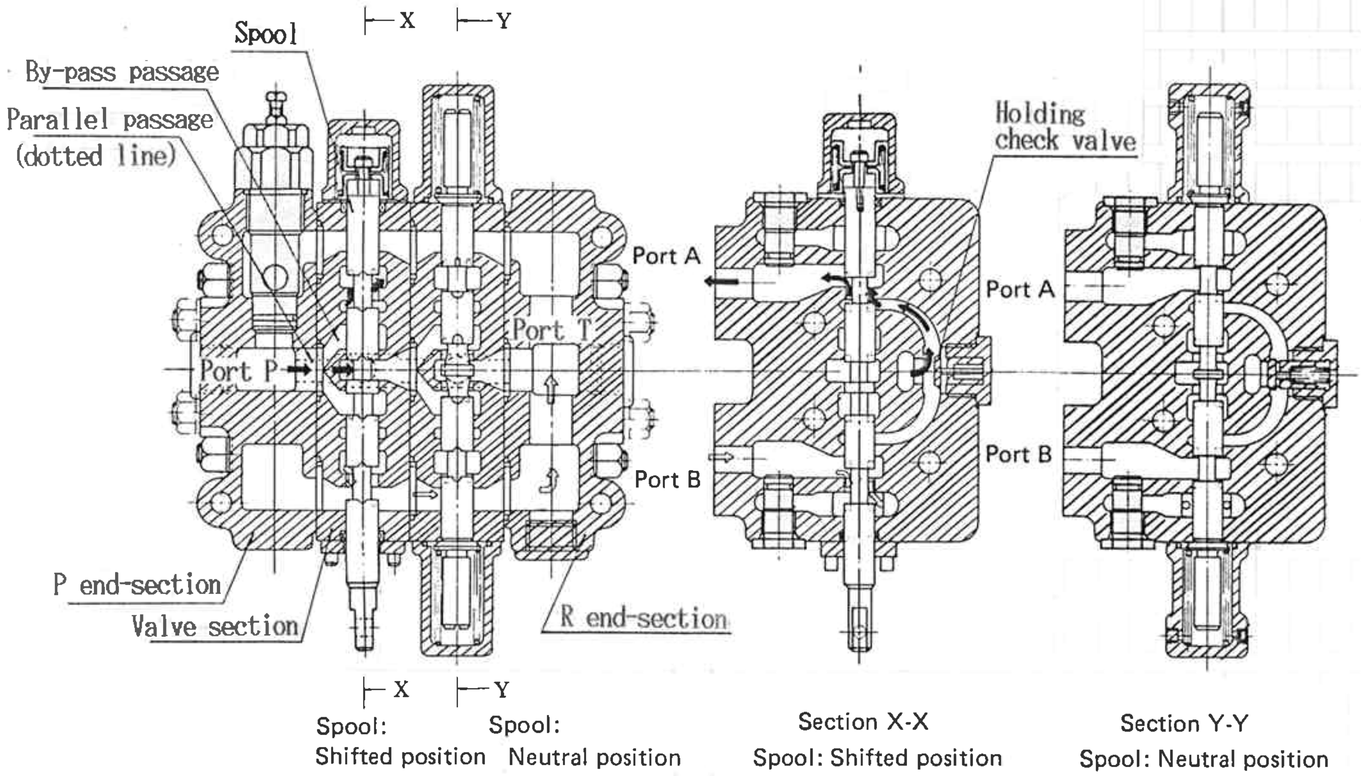


Fig.2 Parallel Circuit

[Tandem Circuit]

Each valve section is connected by only by-pass passege. When a spool is fully shifted, the pump discharge of all is led to the actuator port through the by-pass passage, and return oil flows to the tank through the return passage. Then, the actuator port of the downstream can get no oil even if the spool is shifted.

[Series Circuit]

As same as tandem circuit, by the shifting of the spool the pump discharge is led to the actuator port through by-pass passege. But the return flow from the actuator is led to by-pass passage. So the actuator port of the downstream can get full flow simultaneously.

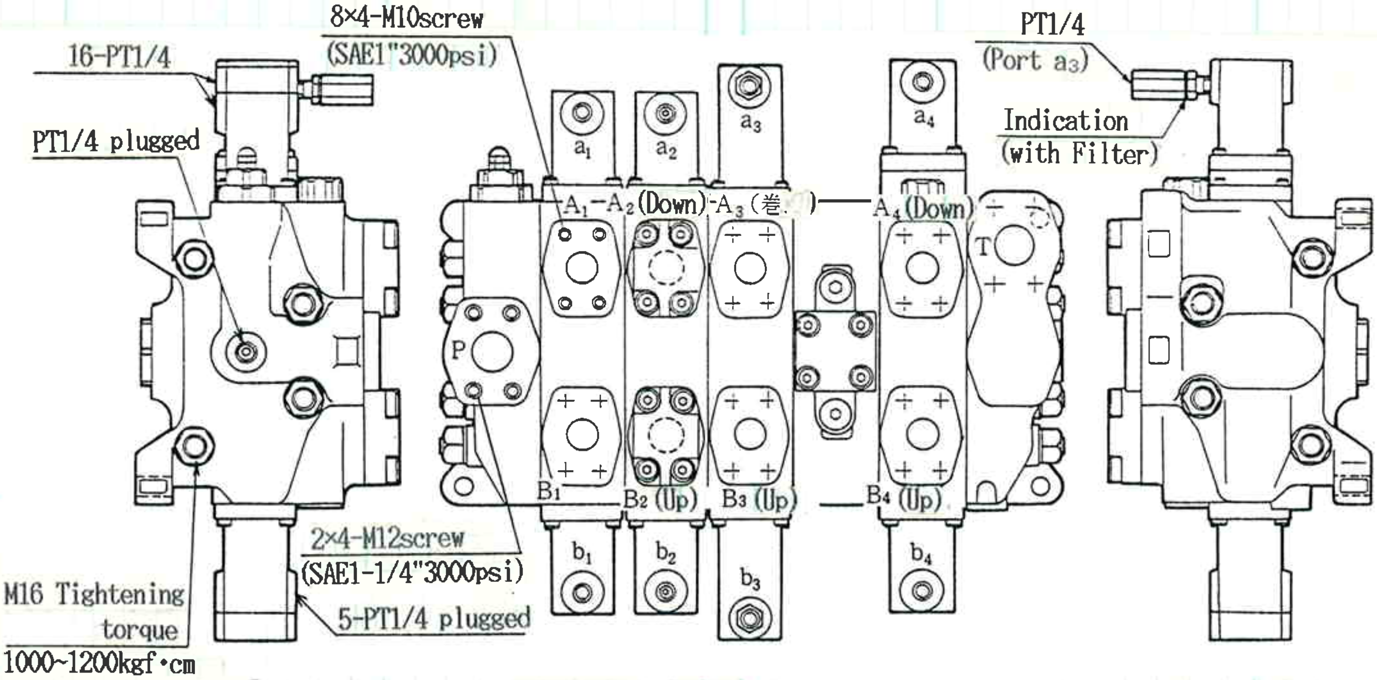


Fig.3A MWP425/3SC515(for7055·7065)

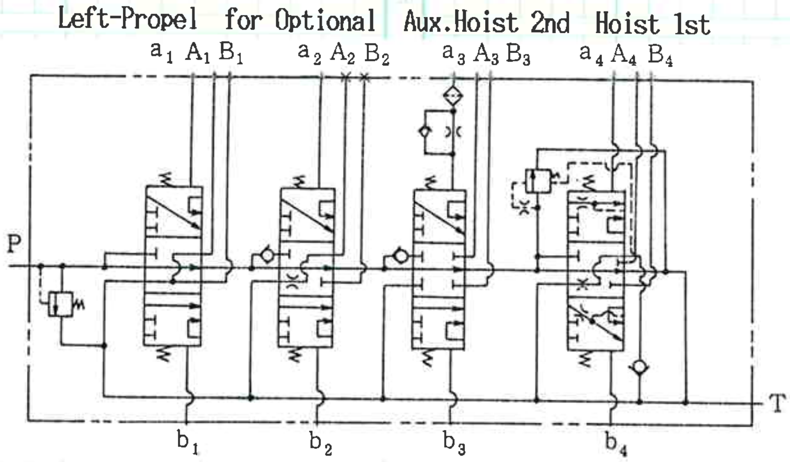
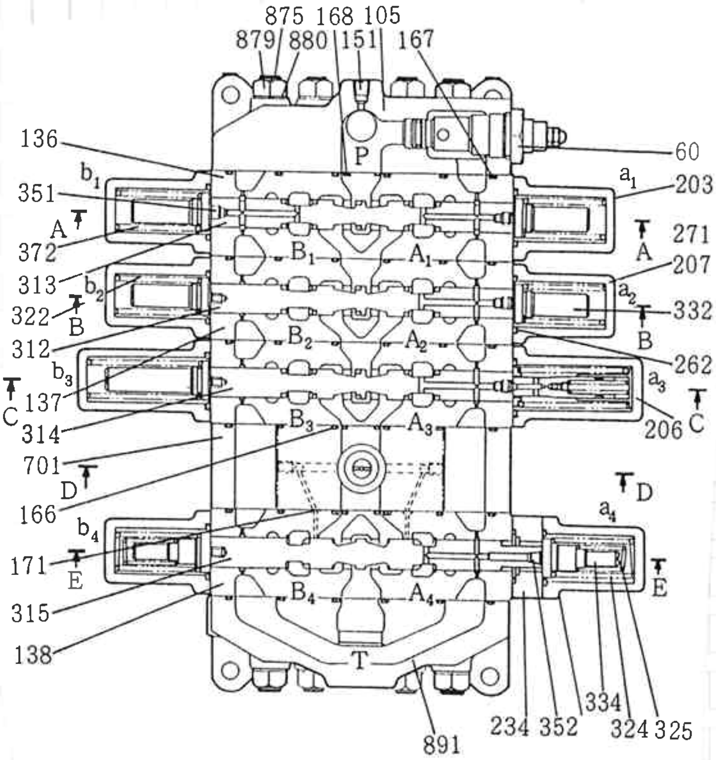
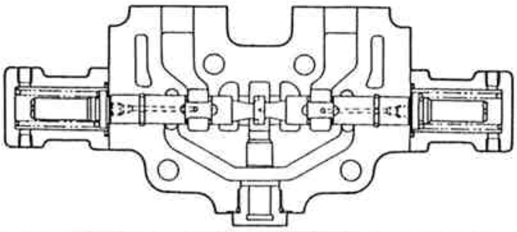


Fig.3C Circuit Symbols

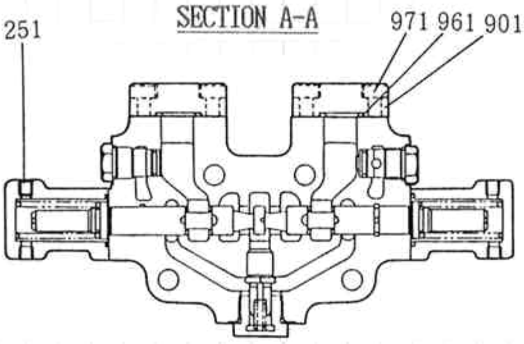
105. P END-SECTION
114. R END-SECTION
136. VALVE SECTION
137. VALVE SECTION
138. VALVE SECTION
151. PLUG
154. PLUG
164. O-RING
165. O-RING
166. O-RING
167. O-RING
168. O-RING
171. O-RING
203. END COVER
206. END COVER
207. END COVER
234. LOCK PLATE
250. CONNECTOR (with Filter)
251. PT PLUG
262. O-RING
264. O-RING
271. CAPSCREW
272. CAPSCREW
312. SPOOL E1(S)
313. SPOOL E2(S)
314. SPOOL E(S)
315. SPOOL(COMPEN.)
322. SPRING
323. SPRING
324. SPRING
325. SPRING
326. SPRING
327. SPRING
328. SPRING
329. SPRING
332. SPRING SEAT
333. SPRING SEAT
334. SPRING SEAT
335. SPRING SEAT
342. BUSHING(1)
344. ROD
351. PLUG
352. PLUG
353. BALL
354. THROTTLE
501. ANTI-CAVITATION CHECK VALVE
511. POPPET
521. SPRING
551. CAP
561. O-RING
601. RELIEF VALVE
701. COMPEN-CASING(1)

Caution : Insert spool(312) exactly shown below.
Plugged side of the spool is a_2 side.

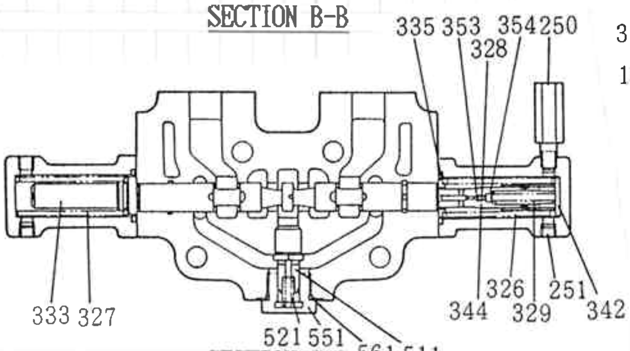




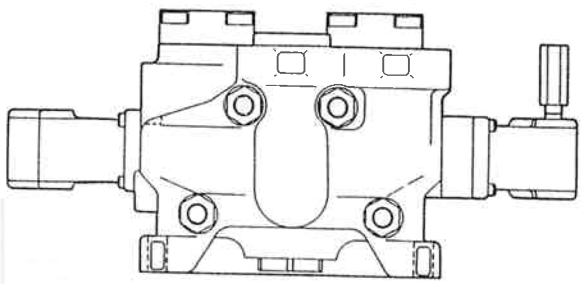
SECTION A-A



SECTION B-B

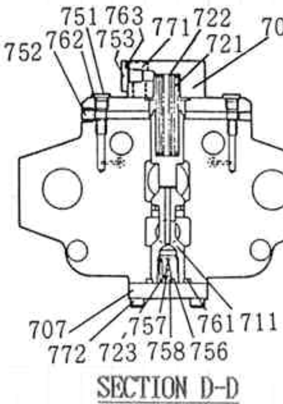


SECTION C-C

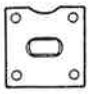


Relief valve Setting : 280 kgf/cm^2
(at 175ℓ/min.)

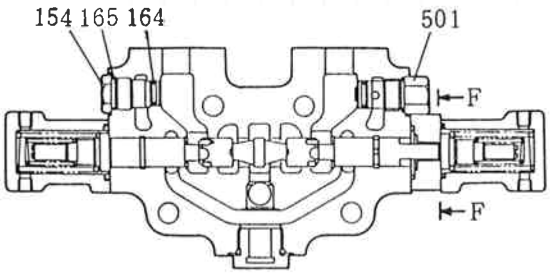
Weight : 78 kg



SECTION D-D



SECTION F-F



SECTION E-E

706. COVER
707. COVER
711. COMPEN. SPOOL
721. SPRING
722. SPRING
723. SPRING
751. RO-PLUG
752. PLUG
753. PO-PLUG
756. PLUG
757. THROTTLE
758. BALL
761. O-RING
762. O-RING
763. O-RING
771. CAPSCREW
772. CAPSCREW
875. TIE ROD
879. NUT
880. LOCK WASHER
891. NAME PLATE
901. FLANGE
961. O-RING
971. CAPSCREW

Fig.3B Sectional View (3SC515)

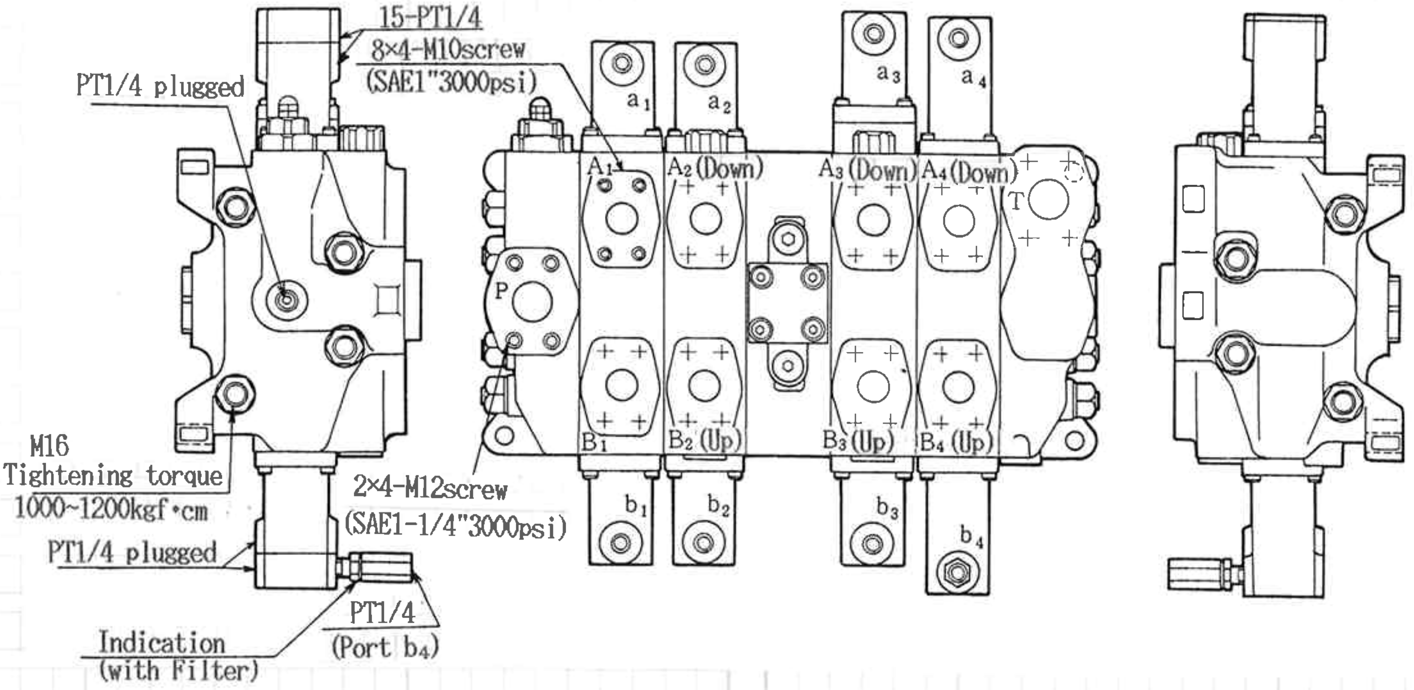


Fig.4A MWP425/2SCT516(for7055·7065)

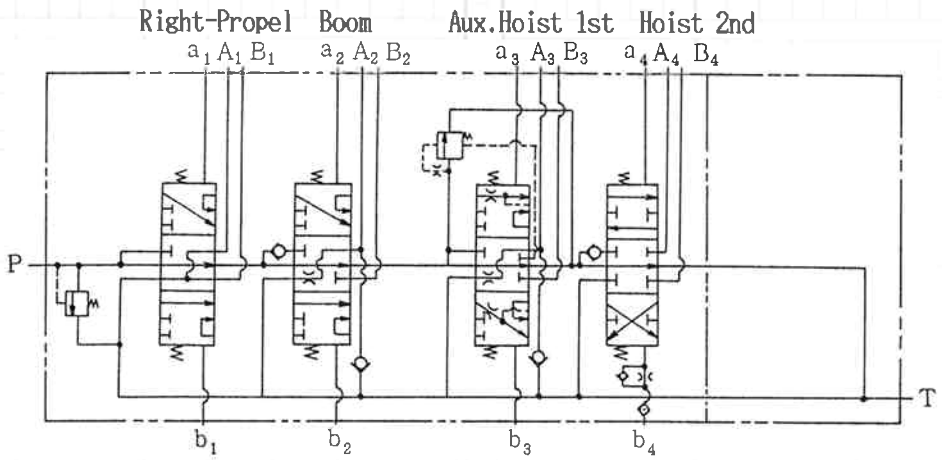
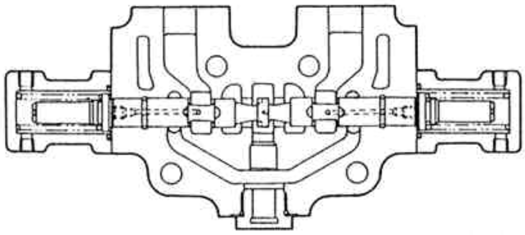
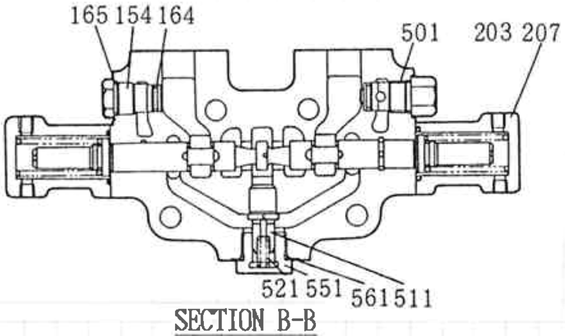


Fig.4C Circuit Symbols

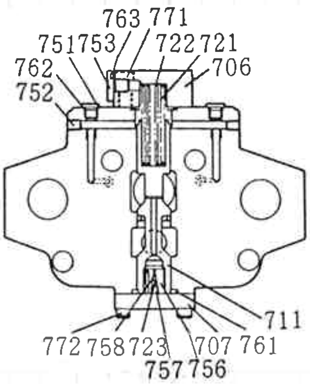
105. P END-SECTION
114. R END-SECTION
131. VALVE SECTION(T)
136. VALVE SECTION(S)
137. VALVE SECTION(S)
138. VALVE SECTION(S)
151. PLUG
154. PLUG
164. O-RING
165. O-RING
166. O-RING
167. O-RING
168. O-RING
171. O-RING
172. O-RING
203. END COVER
206. END COVER
207. END COVER
234. LOCK PLATE
250. CONNECTOR (with Filter)
251. PT-PLUG
262. O-RING
264. O-RING
271. CAPSCREW
272. CAPSCREW
302. SPOOL E(T,P)
312. SPOOL E1(S)
313. SPOOL E2(S)
315. SPOOL(COMPEN.)
322. SPRING
324. SPRING
325. SPRING
326. SPRING
327. SPRING
328. SPRING
329. SPRING
332. SPRING SEAT
333. SPRING SEAT
334. SPRING SEAT
335. SPRING SEAT
342. BUSHING(1)
344. ROD
351. PLUG
352. PLUG
353. BALL
354. THROTTLE
501. ANTI-CAVITATION CHECK VALVE
511. POPPET
521. SPRING
551. CAP
561. O-RING
601. RELIEF VALVE



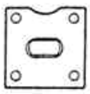
SECTION A-A



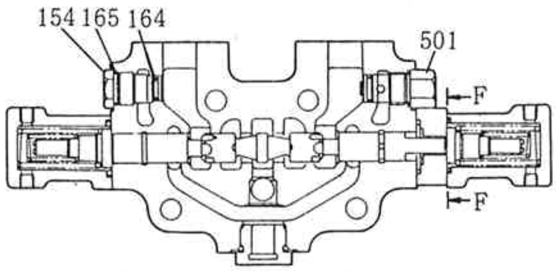
SECTION B-B



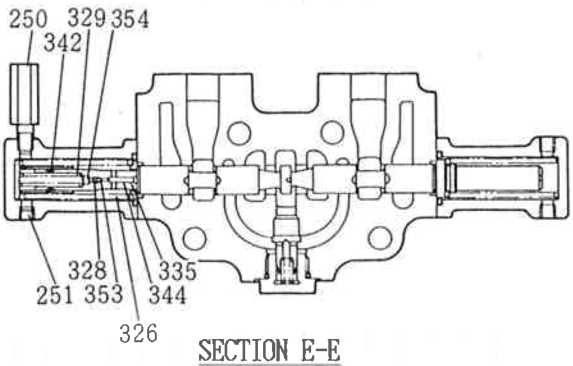
SECTION C-C



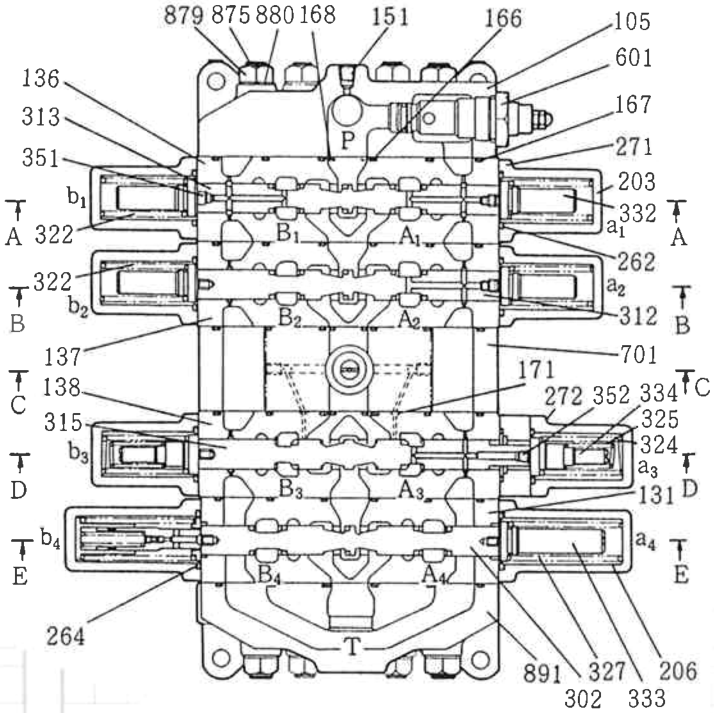
SECTION F-F



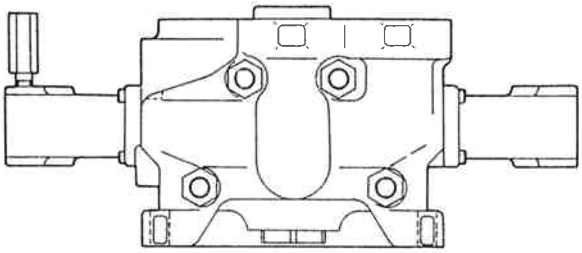
SECTION D-D



SECTION E-E



Caution : Insert spool(312) exactly shown above.
Plugged side of the spool is a_2 side.



Relief valve Setting : 280 kgf/cm^2
(at 175 ℓ/min.)

Weight : 78 kg

701. COMPEN-CASING
706. COVER
707. COVER
711. COMPEN. SPOOL
721. SPRING
722. SPRING
723. SPRING
751. RO-PLUG
752. PLUG
753. PO-PLUG
756. PLUG
757. THROTTLE
758. BALL
761. O-RING
762. O-RING
763. O-RING
771. CAPSCREW
772. CAPSCREW
875. TIE ROD
879. NUT
880. LOCK WASHER
891. NAME PLATE

Fig.4B Sectional View (2SCT516)

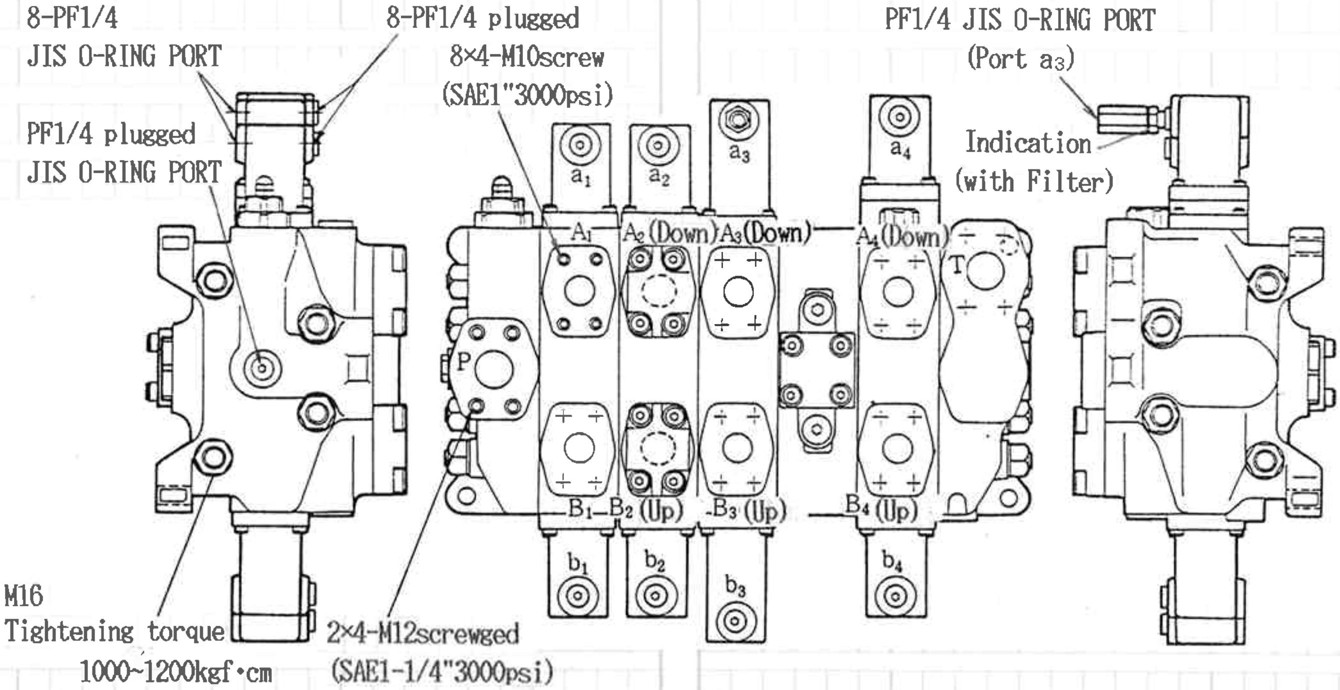


Fig.5A MWP425/3SC527(for7080·7150)

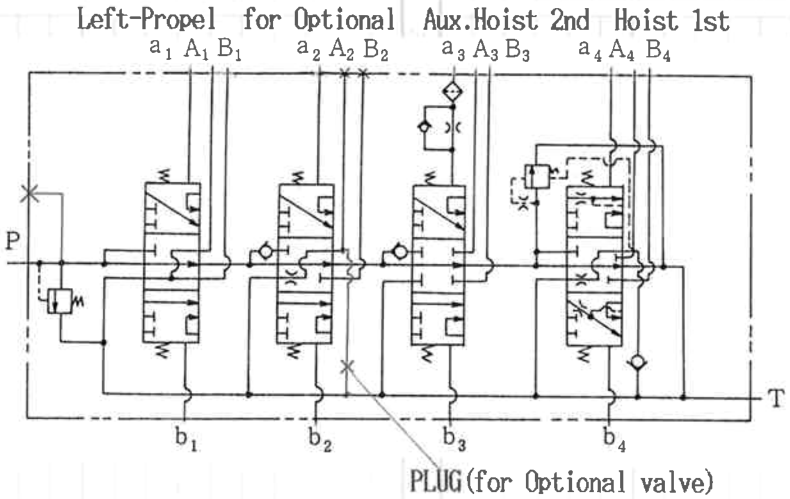
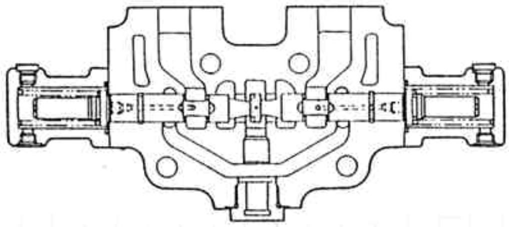


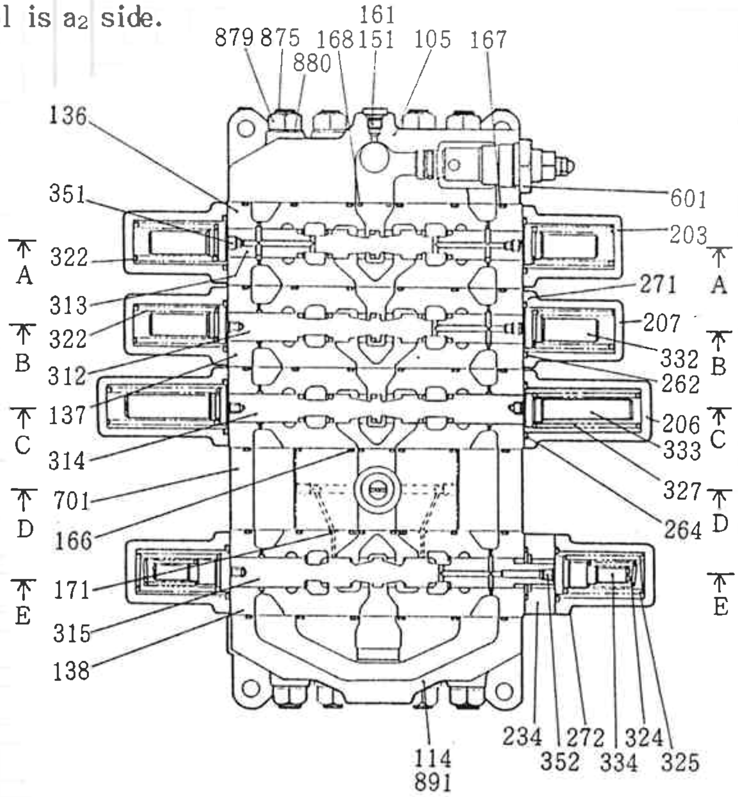
Fig.5C Circuit Symbols

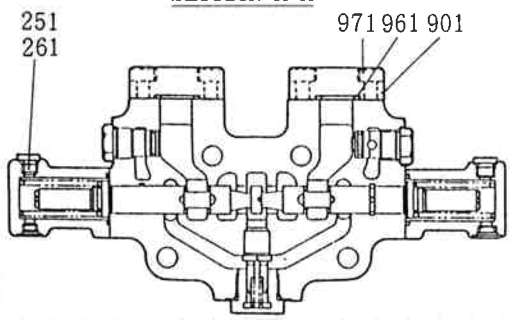
105. P END-SECTION	203. END COVER	314. SPOOL E(S)	511. POPPET
114. R END-SECTION	206. END COVER	315. SPOOL(COMPEN.)	521. SPRING
136. VALVE SECTION(S)	207. END COVER	322. SPRING	551. CAP
137. VALVE SECTION(S)	234. LOCK PLATE	324. SPRING	561. O-RING
138. VALVE SECTION(S)	250. CONNECTOR (with Filter)	325. SPRING	601. RELIEF VALVE
151. RO-PLUG	251. RO-PLUG	327. SPRING	701. COMPEN-CASING(1)
154. PLUG	261. O-RING	332. SPRING SEAT	706. COVER
161. O-RING	262. O-RING	333. SPRING SEAT	707. COVER
164. O-RING	264. O-RING	334. SPRING SEAT	711. COMPEN. SPOOL
165. O-RING	271. CAPSCREW	351. PLUG	721. SPRING
166. O-RING	272. CAPSCREW	352. PLUG	722. SPRING
167. O-RING	312. SPOOL E1(S)	501. ANTI-CAVITATION CHECK VALVE	723. SPRING
168. O-RING	313. SPOOL E2(S)		751. RO-PLUG
171. O-RING			

Caution : Insert spool(312) exactly shown below.
Plugged side of the spool is a_2 side.

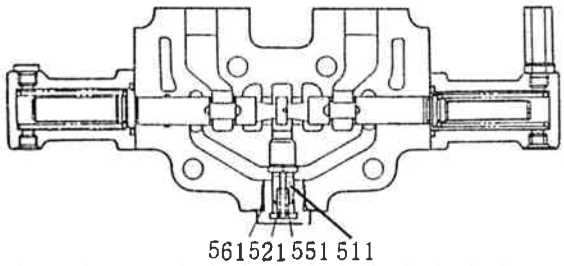


SECTION A-A

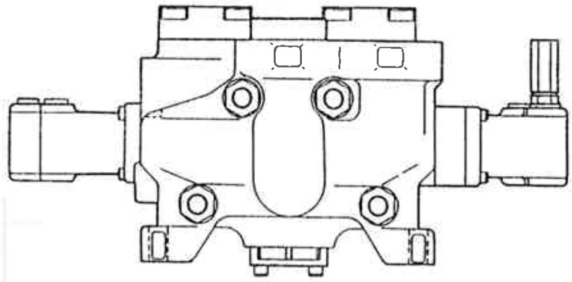


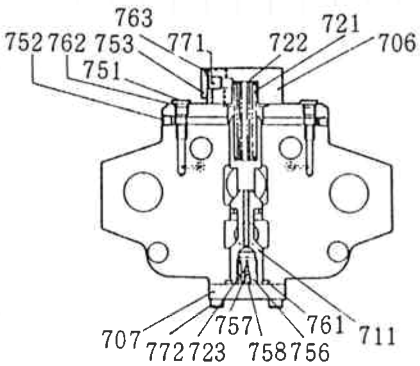


SECTION B-B

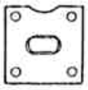


SECTION C-C





SECTION D-D

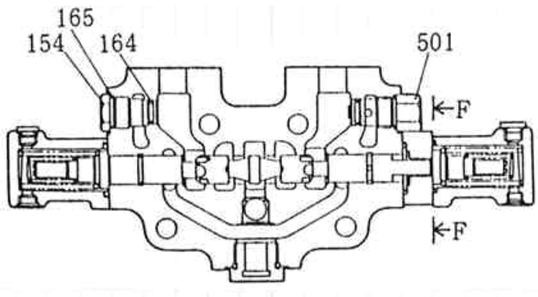


SECTION F-F

Relief valve Setting :
[7080] 280 kgf/cm^2 (at 220 ℓ/min.)
[7150] 280 kgf/cm^2 (at 160 ℓ/min.)

Weight : 78 kg

752. PLUG
753. PO-PLUG
756. PLUG
757. THROTTLE
758. BALL
761. O-RING
762. O-RING
763. O-RING
771. CAPSCREW
772. CAPSCREW
875. TIE ROD
879. NUT
880. LOCK WASHER
891. NAME PLATE
901. FLANGE
961. O-RING
971. CAPSCREW



SECTION E-E

Fig.5B Sectional View (3SC527)

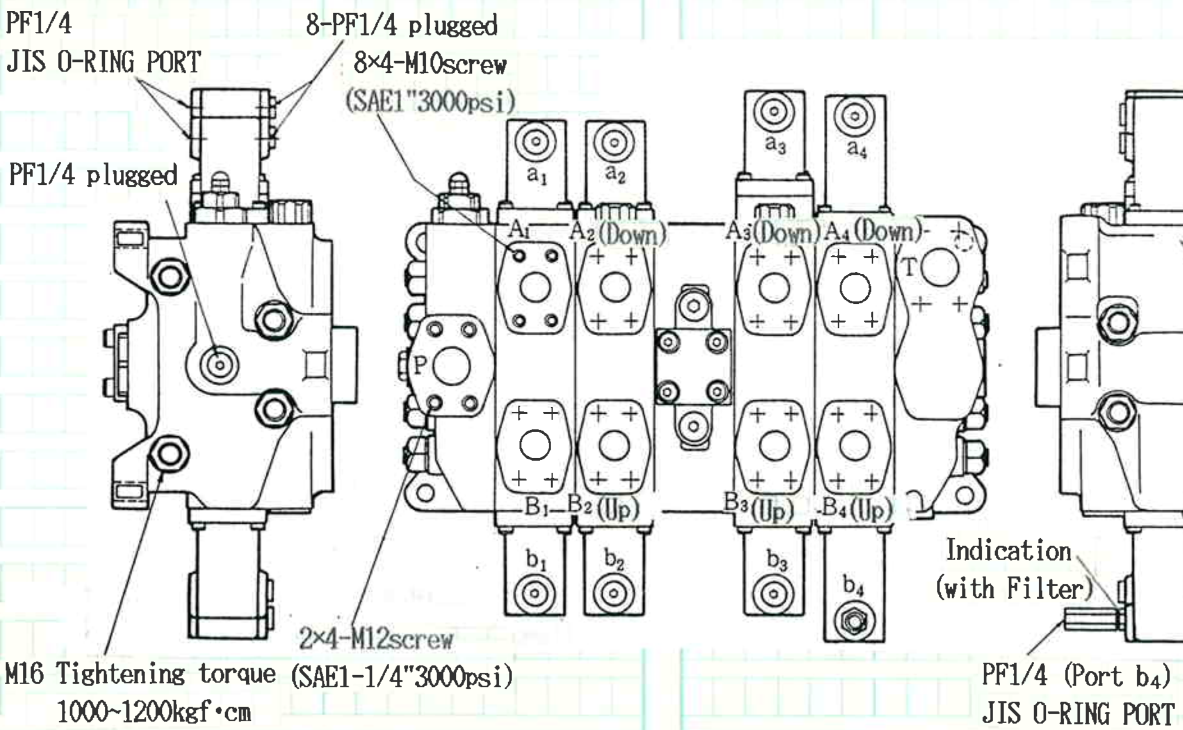


Fig.6A MWP425/2SCT526(for7080)

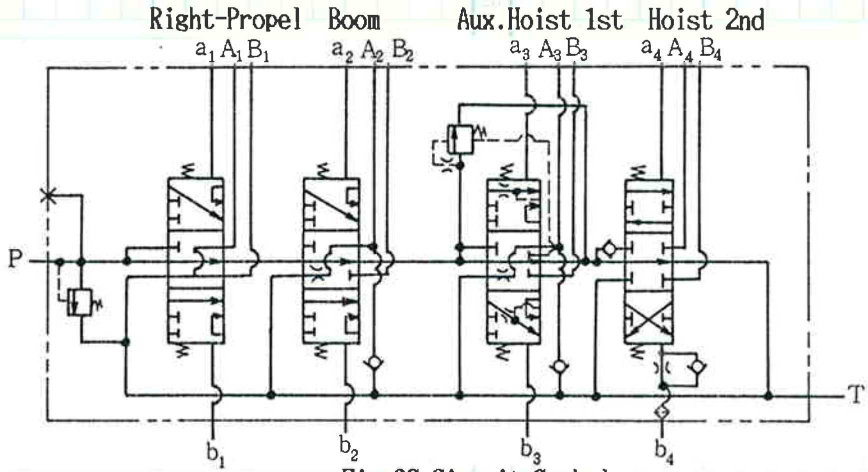
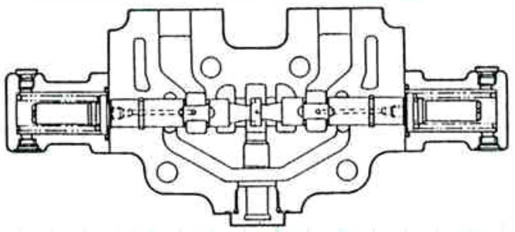


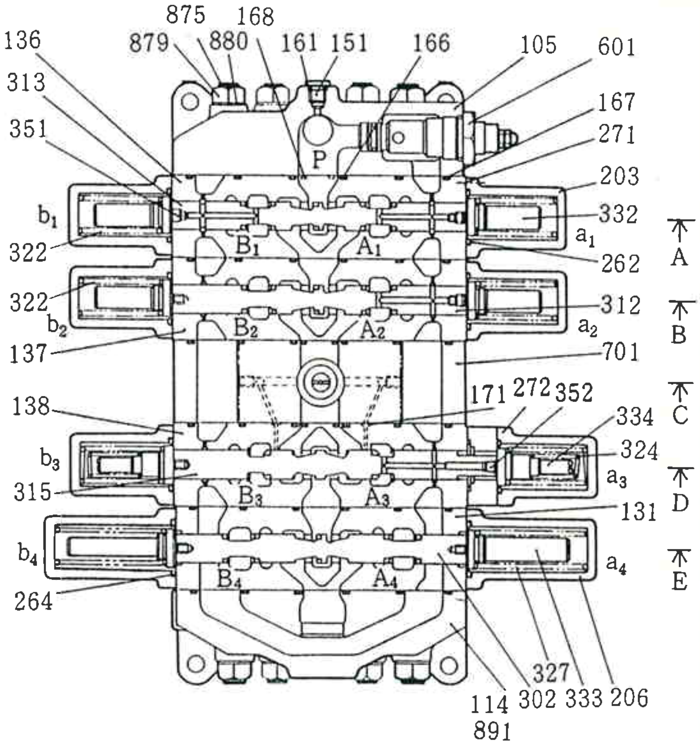
Fig.6C Circuit Symbols

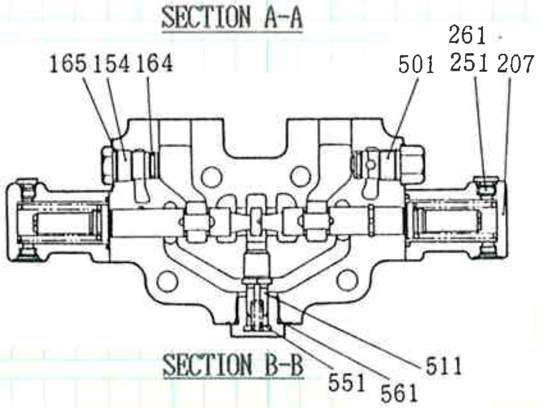
105. P END-SECTION
114. R END-SECTION
131. VALVE SECTION(T)
136. VALVE SECTION(S)
137. VALVE SECTION(S)
138. VALVE SECTION(S)
151. RO-PLUG
154. PLUG
161. O-RING
164. O-RING
165. O-RING
166. O-RING
167. O-RING
168. O-RING
171. O-RING
203. END COVER
206. END COVER
207. END COVER
234. LOCK PLATE
250. CONNECTOR (with Filter)
251. RO-PLUG
261. O-RING
262. O-RING
264. O-RING
271. CAPSCREW
272. CAPSCREW
302. SPOOL E(T,P)
313. SPOOL E2(S)
315. SPOOL(COMPEN.)
322. SPRING
324. SPRING
325. SPRING
327. SPRING
332. SPRING SEAT
333. SPRING SEAT
334. SPRING SEAT
351. PLUG
332. SPRING SEAT
352. PLUG
501. ANTI-CAVITATION CHECK VALVE
511. POPPET
521. SPRING
551. CAP
561. O-RING
601. RELIEF VALVE
701. COMPEN-CASING(1)
706. COVER
707. COVER
711. COMPEN. SPOOL
721. SPRING
722. SPRING
723. SPRING

Caution : Insert spool(312) exactly shown below.
Plugged side of the spool is a_2 side.

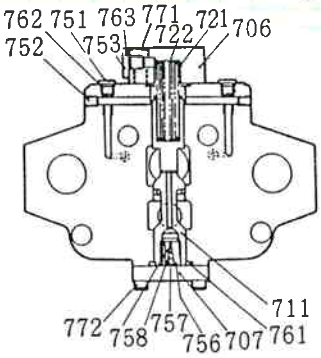


SECTION A-A

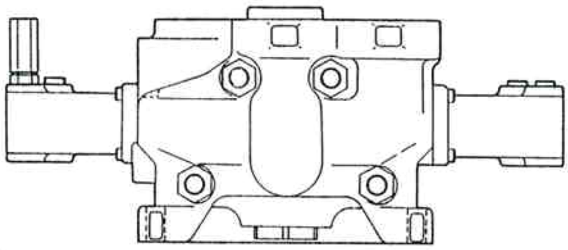


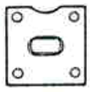


SECTION B-B

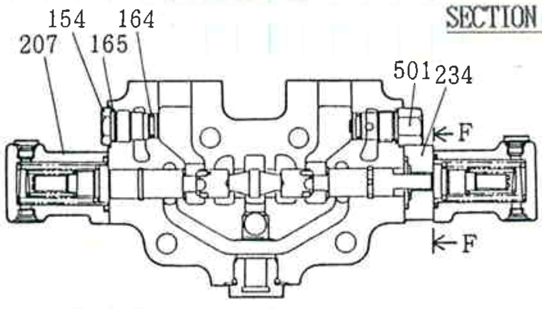


SECTION C-C





SECTION F-F

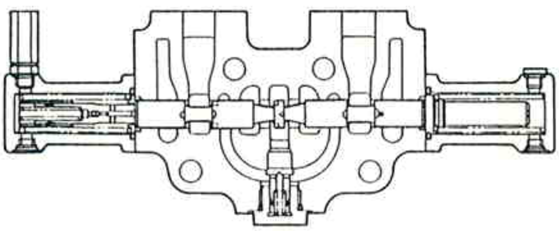


SECTION D-D

Relief valve Setting :
$280\ kgf/cm^2$ (at 220 ℓ/min.)

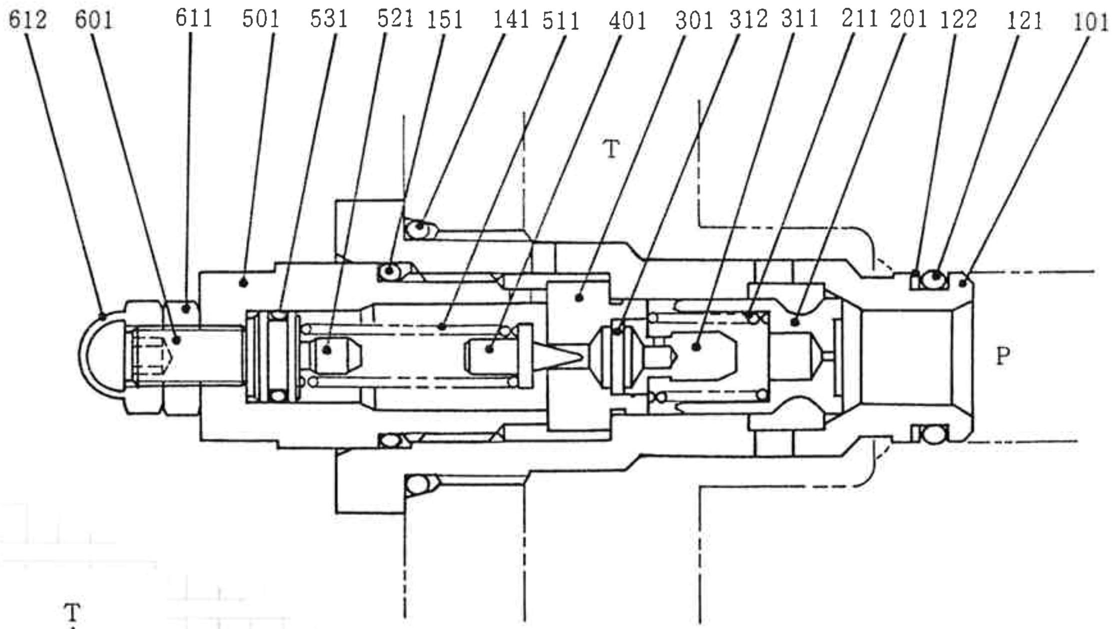
Weight : 78 kg

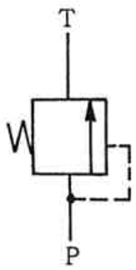
751. RO-PLUG
752. PLUG
753. PO-PLUG
756. PLUG
757. THROTTLE
758. BALL
761. O-RING
762. O-RING
763. O-RING
771. CAPSCREW
772. CAPSCREW
875. TIE ROD
879. NUT
880. LOCK WASHER
891. NAME PLATE



SECTION E-E

Fig.6B Sectional View (2SC526)

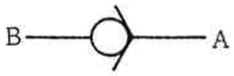




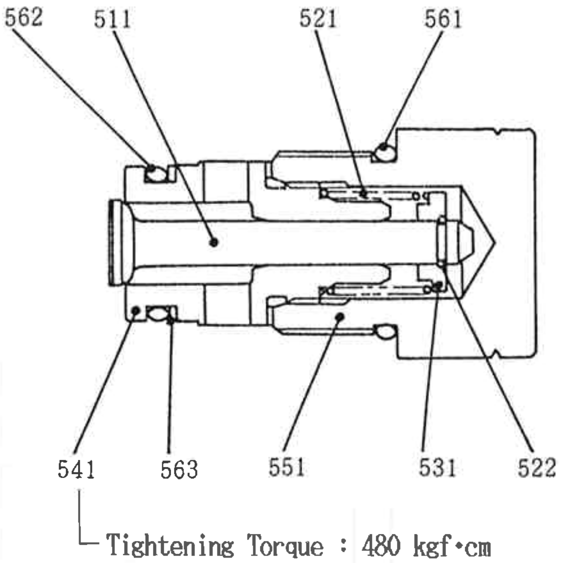
SYMBOL

101. BODY
121. O-RING
122. BACK-UP RING
141. O-RING
151. O-RING
201. PLUNGER
211. SPRING
301. SEAT
311. SPRING SEAT
312. FILTER
401. POPPET
501. PLUG
511. SPRING
521. SPRING SEAT
531. O-RING
601. ADJUSTING SCREW
611. LOCK NUT
612. CAPNUT

Fig.7 Relief Valve(item 601)



SYMBOL



511. POPPET
521. SPRING
522. C-RING
531. SPRING SEAT
541. SEAT
551. PLUG
561. O-RING
562. O-RING
563. BACK-UP RING

Fig.8 Anti-cavitation Check Valve(item 501)

(2) Holding Check Valve

The holding check valve is installed to prevent back-flow from port A(B) to P. Therefore, it is necessary for circuits that may have back-flow.

When the spool is operated, pressurized oil from port P opens the holding check valve and flows into port A. However, if load(W) is applied to the cylinder, the oil flows in the direction of the arrow. In this case, the holding check valve closes and prevents back-flow.

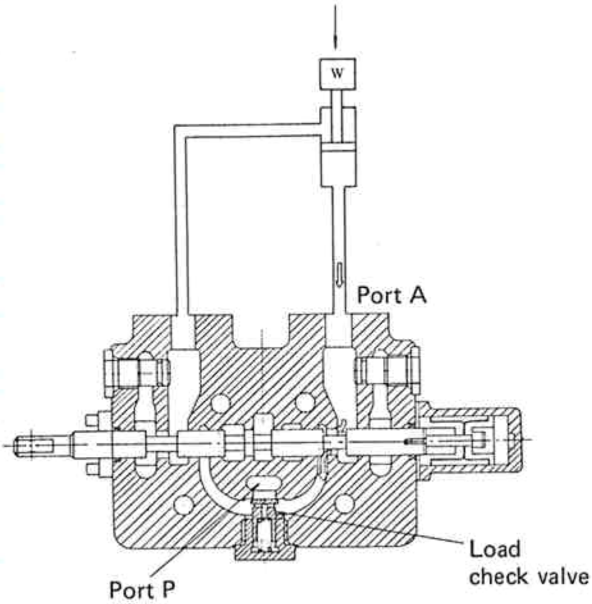


Fig.9

(3) Main Relief Valve

The main relief valve is installed at the P end-section and R end-section as necessary.

It is the balance piston type and controls the maximum pressure at port P.

If pressure at port P exceeds the set pressure, high pressure oil pushes up the pilot relief poppet(401) and flows into the tank port. This flow causes a pressure differential on both sides of the plunger(201), moving it to send a large quantity of high pressure oil into the tank port.

(4) Anti-cabitation Check Valve

The anti-cabitation check valve is installed at port A and B (the inlet and outlet ports of various motors or cylinders) of each valve section as necessary.

The anti-cavitation check valve prevents cavitation(negative pressure such as vacuum) on the low pressure side of various motors or cylinders by inertial force, for example.

If the pressure of ports A and B becomes lower than that of port T, port T pressure pushes up the plunger(511) to open, and the oil from port T flows into port A.

(5) Conflux Function

When the control system is the hydraulic pilot drive type, plural spools can be stroked in optional timing to conflux oil by combination of one pilot pressure and the springs in the spool end chambers.

(6) Co-operation with Remote Control Valve and Variable Displacement Pump

This Multi-Valve can form an efficient system with a variable displacement pump and a remote control valve which is a reducing valve for remote hydraulic control.

When remote control valves are used in the hydraulic system, the spool of the Multi-Valve strokes freely in proportion to the stroke of the remote control valve. In this case the secondary(pilot) pressure of the remote control valve is led to the regulator of the variable displacement pump to control the delivery in proportion to the pilot pressure. In such a hydraulic system the delivery flow changes accordingly to the stroke of the Multi-Valve and the rate of the excess flow in the by-pass passage is set minimum. So the efficiency of the system is very high.

(7) Spool Cushioning Device

The spool cushioning device controls the speed of shifting the spool by hydraulic pressure and of returning the spool by the centering spring. So it prevents shock when a cylinder or a motor of the circuit starts or stops.

A filter-equipped connector is installed at the inlet/outlet of the device to keep out dirt.

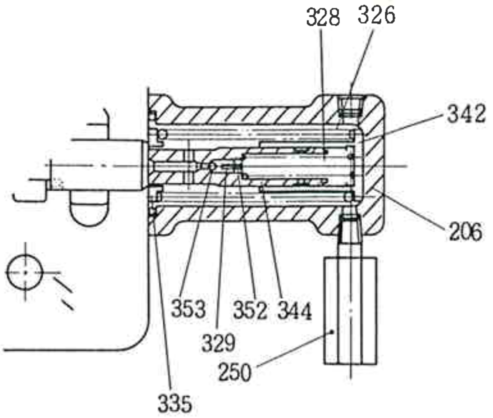


Fig.10

a) When Shifting Spool

If pilot pressure rises inside of the right-hand end cover(206), it pushes the spool in direction A. Oil within the rod flows out only from throttle hole(c) located near the collar of bushing(342) after a certain positional change (section where holes(a) and (b), which are made on the outer circumference of bushing(342) and rod(344), mach up). Thus the hydraulic cushion serves to control the speed of shifting the spools.

b) When Returning Spool to Newtral Position

When the spool is returned to the neutral position by centering spring(326) in end cover(206), the cushion device on the opposite side functions, as in para(a) above.

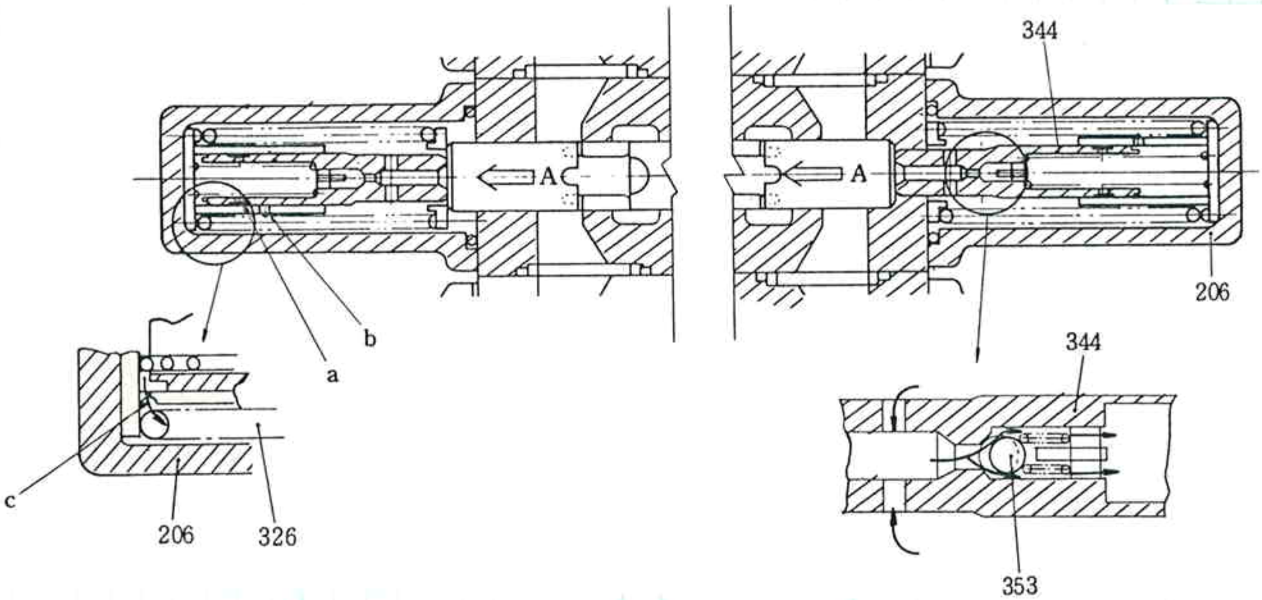


Fig.11

3. DISASSEMBLY AND ASSEMBLY

3.1 PREPARATION

3.1.1 TOOLS

Item	Name	Size	Application	Q'ty
a	Allen Wrench (Screw Key)	width 5mm 6 17	for M6 Screw M8 Screw PO-Plug	1 each
b	Spanner Wrench	width 12,13,19, 24,26,30, 32,41,46, 50 mm		1 each
c	Torque Wrench	30~2000 kgf·cm		1

3.1.2 TIGHTENING TORQUE

Item	Name	Tightening Torque
601	Relief Valve	1400 kgf·cm
501	Anti-cavitation Check	1000~1200 kgf·cm
154	Plug	
551	Cap	2000 kgf·cm
875	Tie Rod	1000~1200 kgf·cm

Screw Size	Tightening Torque
M6	110~ 130 kgf·cm
M10	520~ 640 kgf·cm
M16	1000~1200 kgf·cm
NPTF1/16 Plug	60~ 80 kgf·cm
PT1/8 Plug	150~ 200 kgf·cm
PT1/4 Plug	350~ 400 kgf·cm
PF1/8 Plug	75~ 95 kgf·cm
PF1/4 Plug	350~ 390 kgf·cm

3.1.3 GENERAL PRECAUTIONS

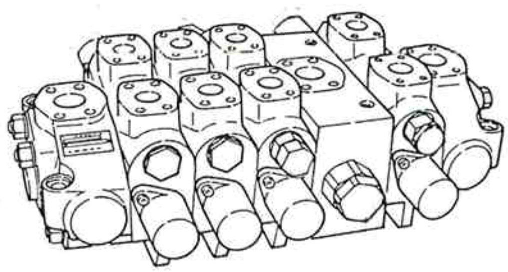
1) Do not allow any foreign matter, dust, dirt and so on to enter the valves.
2) Work on a suitable bench which is covered with a clean paper or a rubber mat.
3) After disassembly, wash all the parts with cleaning oil and dry them with compressed air.
4) When assembling, apply clean hydraulic oil to all sliding sections.
5) When assembling, make sure that all sliding sections have no dents or scratches, and move smoothly.
6) When reassembling, grease each seal and O-ring.

3.2 DISASSEMBLY

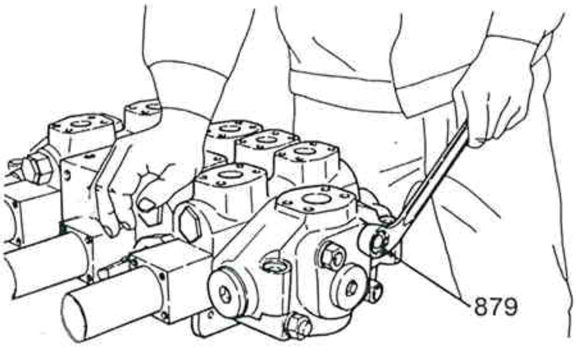
This manual describes the procedure for disassembling the control valve by sections. The valve figures are representative, and therefore may be slightly different from the units that are to be actually disassembled. However, there are no substantial variations in procedure.

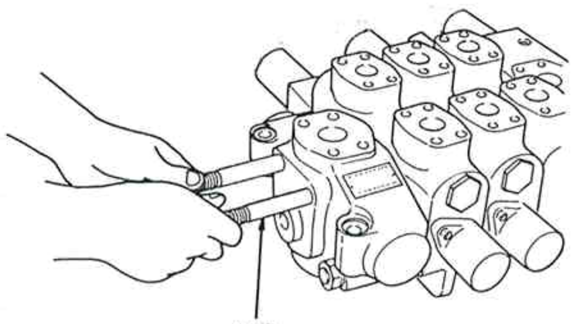
3.2.1 DISASSEMBLY OF SECTIONS

1) Place valve on bench with ports A and B facing upward.



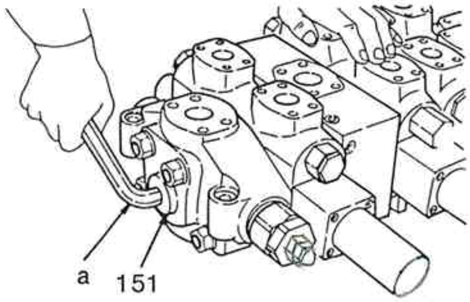
2) Give mating marks to the jointing parts of each sections.
3) Remove lock nut(879) and remove the four tie rods(875). Now each section can be separated.

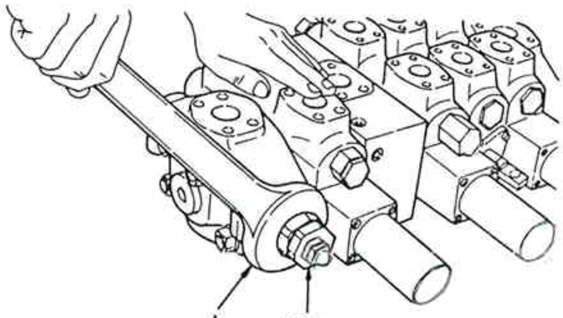


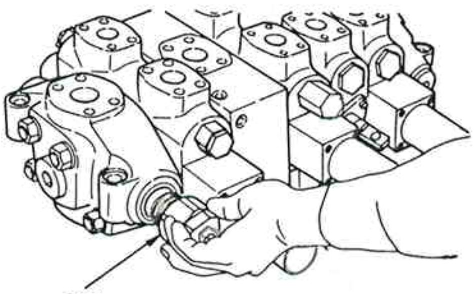


3.2.2 DISASSEMBLY OF P END-SECTION

Plug(151) and the main relief valve(601) in the P end-section can be taken off by the allen wrench(a) and spanner wrench(b) respectivery.



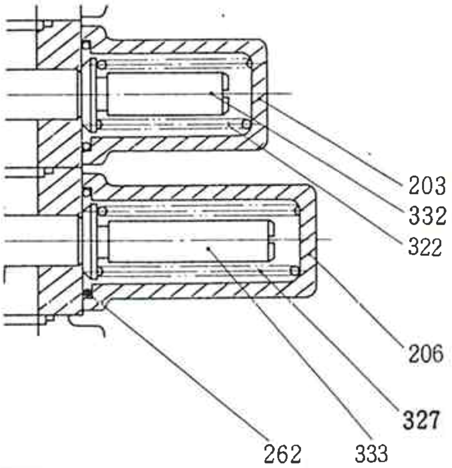




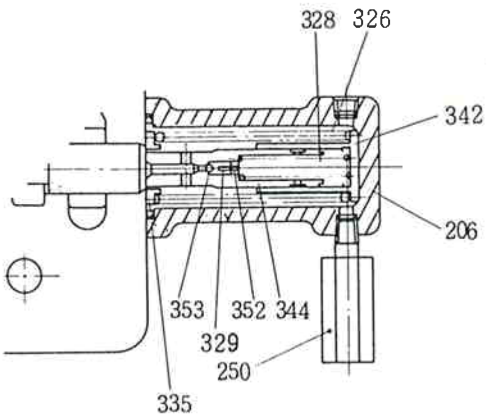
3.2.3 DISASSEMBLY OF VALVE SECTION

(1) Removal of Spool [Hydraulic Pilot Spool]

a) For the standard hydraulic pilot spool, once end covers(203,206) have been removed, springs(322,323) and spring seats(332,333) can be removed. Then remove the spool.



b) In case of a hydraulic pilot spool with a spool cushion, spring(326), bushing (342), rod(344), and spring(328) can be removed together with end cover(206). Then remove the spool.



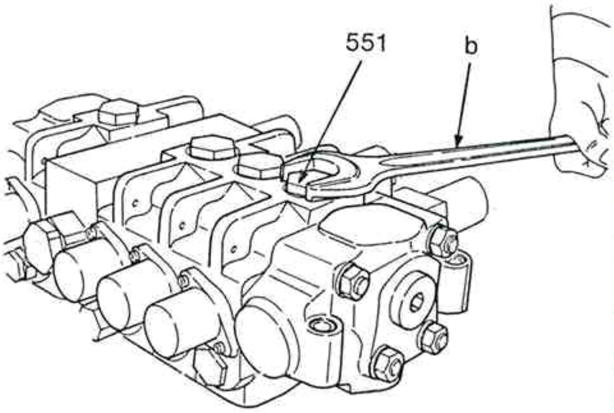
NOTE

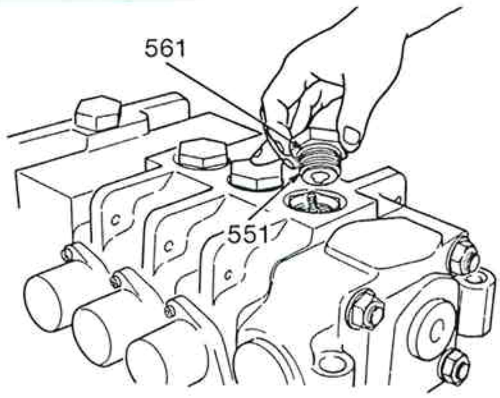
1. Ball(353), spring(328), and throttle (354) cannot be disassembled, because the throttle is fixed to rod.
2. Give mating marks for the correct combination and direction of the spool and valve body at the time of disassembly.

(2) Disassembly of Holding Check Valve

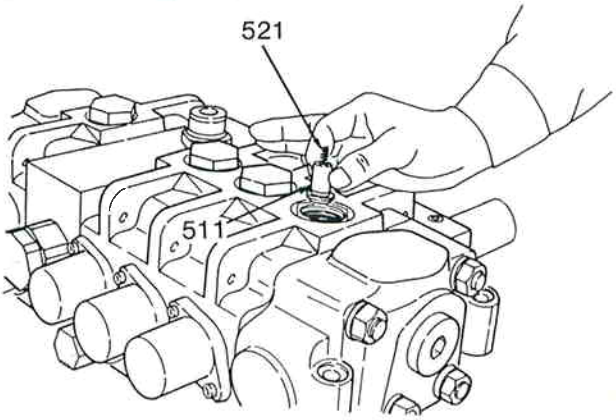
a) Place the valve assembly on a bench with ports A and B facing downward.

b) Remove cap(551) with spanner wrench(b).

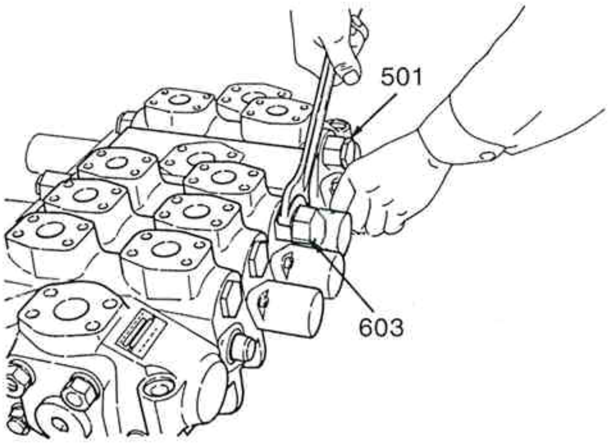




c) Remove spring(521) and poppet(511).

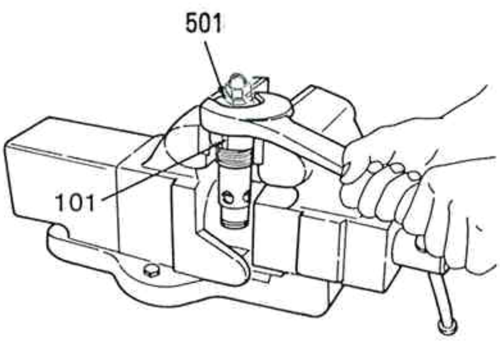


(3) Removal of Accessory Valve
Remove the accessory valve such as anti-cavitation check valve located on the side of the valve section with spanner wrench(b). Remove the plugs in the same manner.



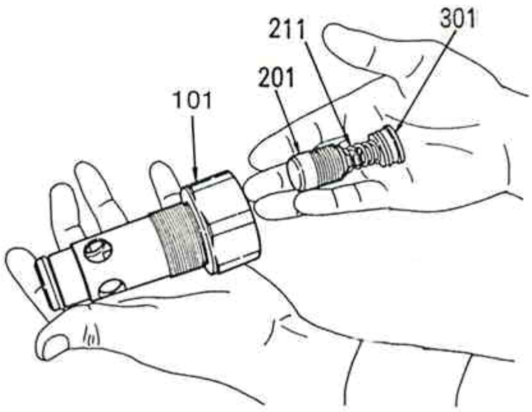
3.2.4 Disassembly of Main Relief Valve

a) Secure body(101) and loosen plug(501).



b) Remove poppet(401) and spring(511).

c) Plunger(201), spring(211), and seat(301) will remain inside body(101). However, they can be removed by pushing up the plunger.



NOTE

Unless the relative position of adjusting screw(601) and plug(501) is changed, the set pressure at reassembly will be almost the same as before disassembly even if the other parts have been disassembled.

d) Remove spring seat(521) by tightening the adjusting screw.

3.2.5 Disassembly of Anti-cavitation Check Valve

Remove plug(551) and remove C-ring, then remove plunger(511), spring(521), and spring seat(531).

3.3 ASSEMBLY

3.3.1 GENERAL PRECAUTIONS

(1) Cleaning of Parts
Wash all parts by cleaning oil, and dry them by compressed air. Do not use waste.

(2) Replace O-ring with new ones.

(3) If any parts have defect, repair or replace the part. Lublicate sliding section of the parts and assemble them as they had been installed.

3.3.2 ASSEMBLY OF ANTI-CAVITATION CHECK VALVE

(Reffer to Fig.8)

a) Install spring(521) and spring seat(531) onto seat(541), and insert poppet(511) and lock it with C-ring(522).

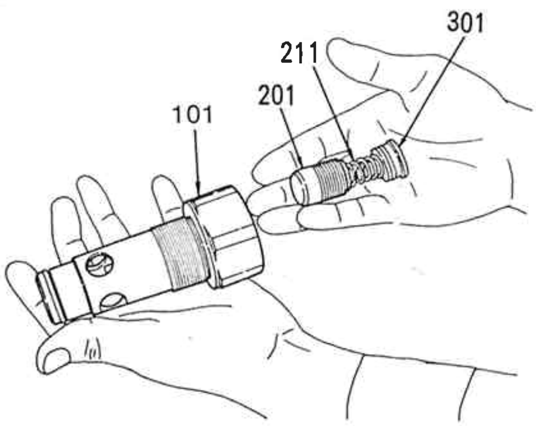
b) Screw in seat(541) into the plug(551), and set O-ring(561,562) and back-up ring.

NOTE

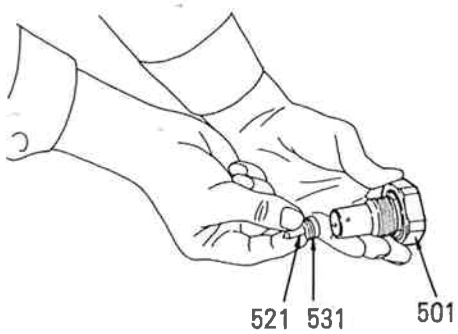
Coat O-ring(561,562) with grease.

3.3.3 ASSEMBLY OF MAIN RELIEF VALVE

a) Install plunger(201) and spring(211) into body(101), and install seat(301).



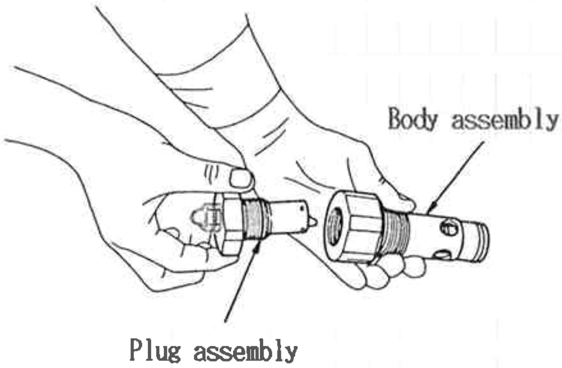
b) Install spring seat(521) which is equipped with O-ring(531) into plug(501). Screw in adjusting screw(601) and lock nut(611) into the plug(531) keeping loose.



NOTE

Coat O-ring(531) with grease.

c) Install spring(511) and poppet(401) into plug(501) and screw it into the prepared body assembly.



3.3.4 ASSEMBLY OF VALVE SECTION

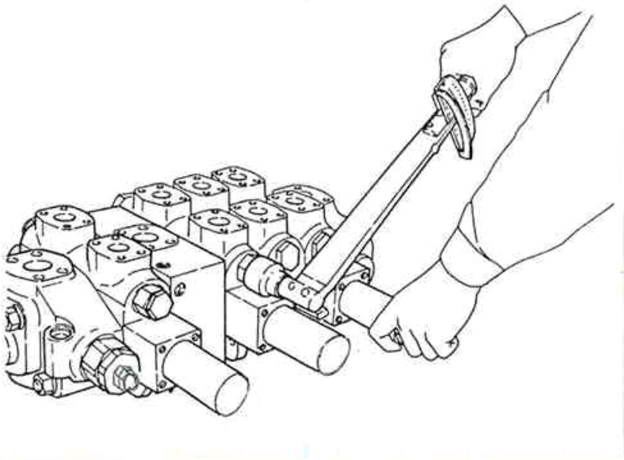
(1) Installation of Accesory Valve

Tighten the accesory valves located on the valve sides such as anti-cavitation valve(501) to the specified torque. Apply the same procedure to the plugs.

- Tightening torque for accessory valve and plug 1000~1200kgf・cm

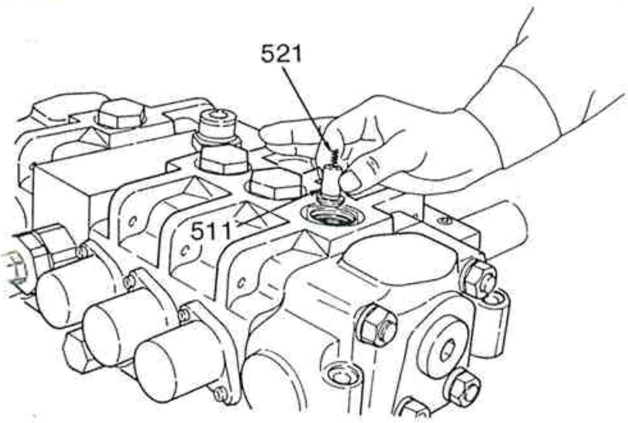
NOTE

Coat O-ring part with grease not to damage it when the valve is assembled.



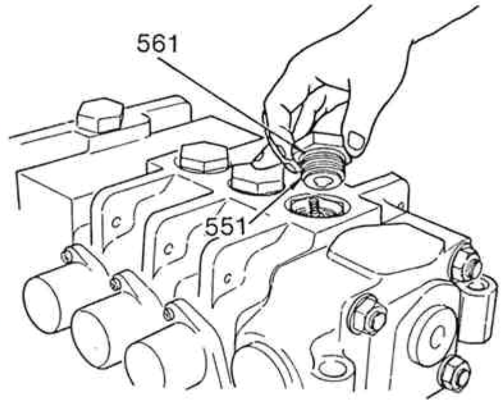
(2) ASSEMBLY OF HOLDING CHECK VALVE

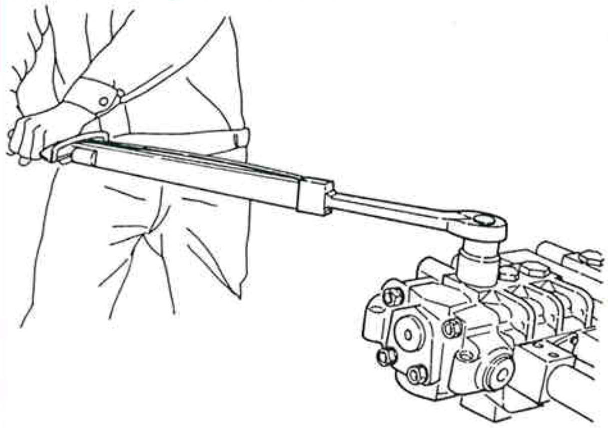
a) Place valve assembly on the bench with ports A and B facing downward. Install poppet(511) and spring(521).



b) Screw in cap(551) which is equipped with O-ring(561), and tighten it to the specified torque.

- Tightening torque 2000kgf・cm





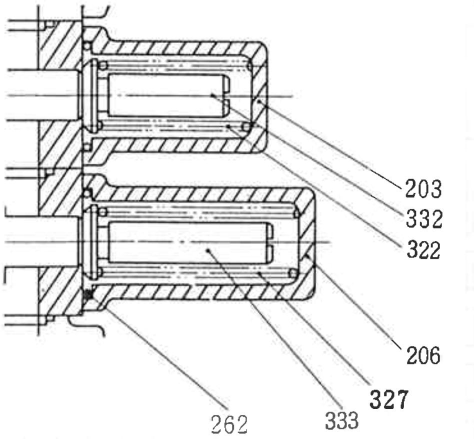
NOTE

Screw in the cap(551) with O-ring only at the section where holding check is not equipped.

(3) Installation of Spool [Hydraulic Pilot Spool]

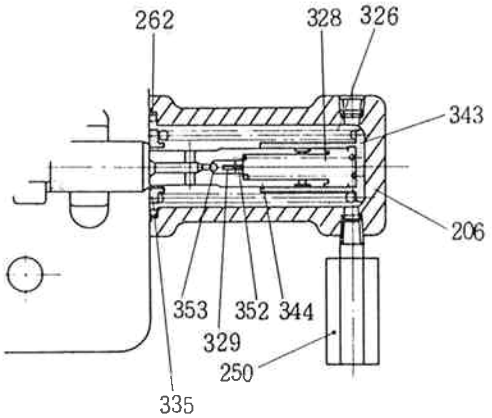
a) For the standard hydraulic pilot control, insert spool to the body and install springs(322,323) and spring seats(332,333) inside end covers(203,206). Then, install O-rings(262) to the end covers and secure them with capscrew(271).

- Tightening torque 100~120kgf·cm



b) If the cushion device is used, insert spool to the body and install bushing(342), spring(328), rod(344), spring(326), and spring seat(335), in that order, inside end cover(206). Then, install O-ring(262) to the end cover and secure it with capscrews(271).

- Tightening torque 100~120kgf·cm



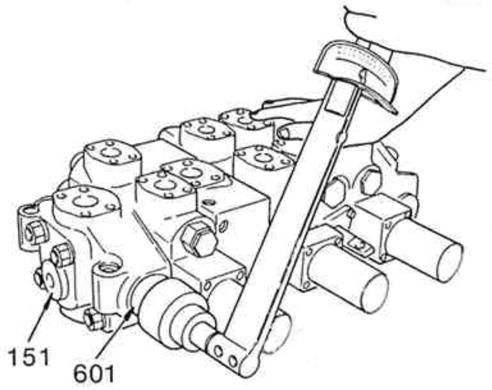
NOTE

1. This cushion device has a small throttle hole. Do not allow any foreign matter to get into the end cover.
2. Check the spool combination and direction by the mating marks.

3.3.5 ASSEMBLY OF P END-SECTION

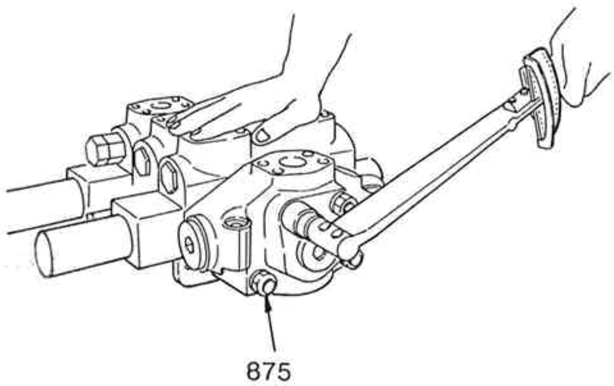
Install plug(151) with O-ring(161), and main relief valve(601).

- Tightening torque for main relief valve 1400kgf·cm



3.3.6 ASSEMBLY OF SECTIONS

1) Install O-rings(166~168) for mating face into the end-section and valve section. Then arrange them according to the mating marks.
2) Install tie rod(875) into valve sections and tighten with lock nut(879) to the specified torque.
   - Tightening torque 1000~1200kgf·cm



4. TROUBLESHOOTING

TROUBLE	CAUSE	REMEDY
When the spool is working, the pressure is not raised. (The speed is in-sufficient)	1. The clearance between the casing and the spool is too large. 2. The spool stroke is uncomplete. 3. Malfunction of main relief valve. • Foreign matter sticks between the plunger and the body. • Foreign matter sticks between the poppet and seat. • Stick of the plunger. • The spring is broken or worn out. • The adjusting screw is loosened. • The orifice of the plunger is clogged. • The clearance between the plunger and the body is too large. • The viscosity of the hydraulic oil is too low.	1. Change the spool or the valve section assembly. 2. [Pilot operation] • Check the pilot pressure. • Check the part of the end cover. 3. • Disassemble and clean it up. Change the assembly if the damage is severe. • Ditto. • Repair the part by an oil stone. • Change the spring. • Adjust again and tighten the lock nut well. • Clean up (by compressed air) and removed foreign matter. • Change the plunger or the relief valve assembly. • Lower the oil temperature or exchange the oil for one of suitable viscosity.
The load falls down in a moment right after the spool is shifted.	1. The holding check valve works uncompletely. • Foreign matter sticks between the poppet and the seat. • Stick of the poppet. • The torque of tightening the plug is too high.	1. • Disassemble and clean it up. Change the valve section assembly if the damage is severe. • Repair the part by an oil stone. • Tighten it with the torque within the standard.
The load falls down when the spool is in neutral position.	1. The clearance between the spool and the casing is too large. 2. The spool does not return back completely.	1. Change the spool or the valve section assembly. 2. [Pilot operation] • Check the pilot pressure. • Check the part of the spool end cover.
The spool does not stroke.	1. The clearance between the spool and the casing is too little. 2. Stick of the spool.	1. Change the spool or the valve section assembly. 2. Repair the part by an oil stone or change the valve section assembly.

TROUBLE	CAUSE	REMEDY
The spool does not return back by the spring.	1. Stick of the spool.	1. Repair the part by an oil stone or change the valve section assembly.
	2. The pressure is higher than the standard.	2. Adjust the setting pressure of the main relief valve again.
	3. The spring is broken or worn out.	3. Change the spring.
	4. The spring seat is broken or worn out.	4. Change the spring seat.

1. LOCATION AND FUNCTION

These valves are used to control winch drum brakes and located under the floor plate below the brake pedals.

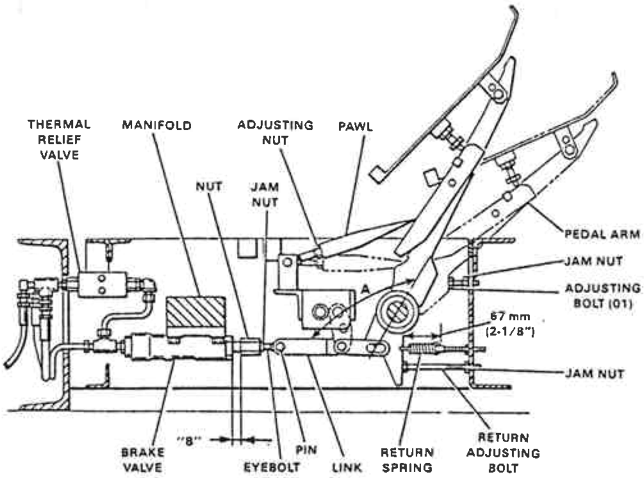


Fig.1 Location

When pedal is in free position, pressure in the wheel cylinder, tubing and cylinder room is closely atmospheric pressure.

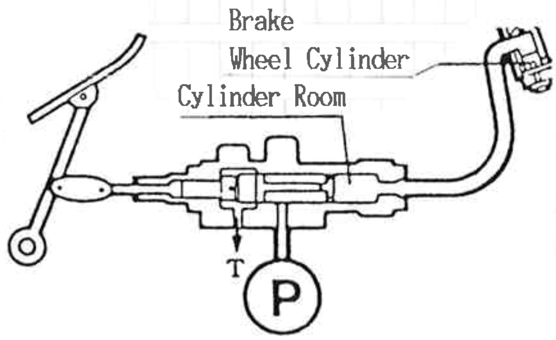


Fig.2 Newtral

When pedal is depressed.
The piston is pushed by the rod, and oil is pressurised and sent to wheel cylinder according to the stroke.

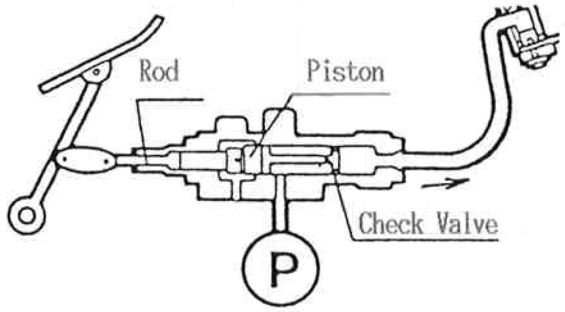


Fig.3 Action(Start)

When pedal is depressed at the maximum stroke. Just before pedal is depressed to the stroke-end, pressurised oil from pump is led to directly the wheel cylinder through the piston in order to provide the maximum brake force.

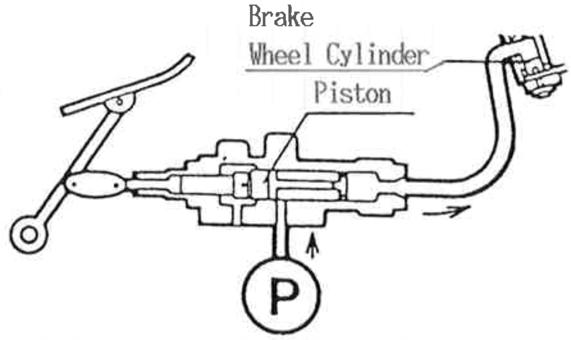
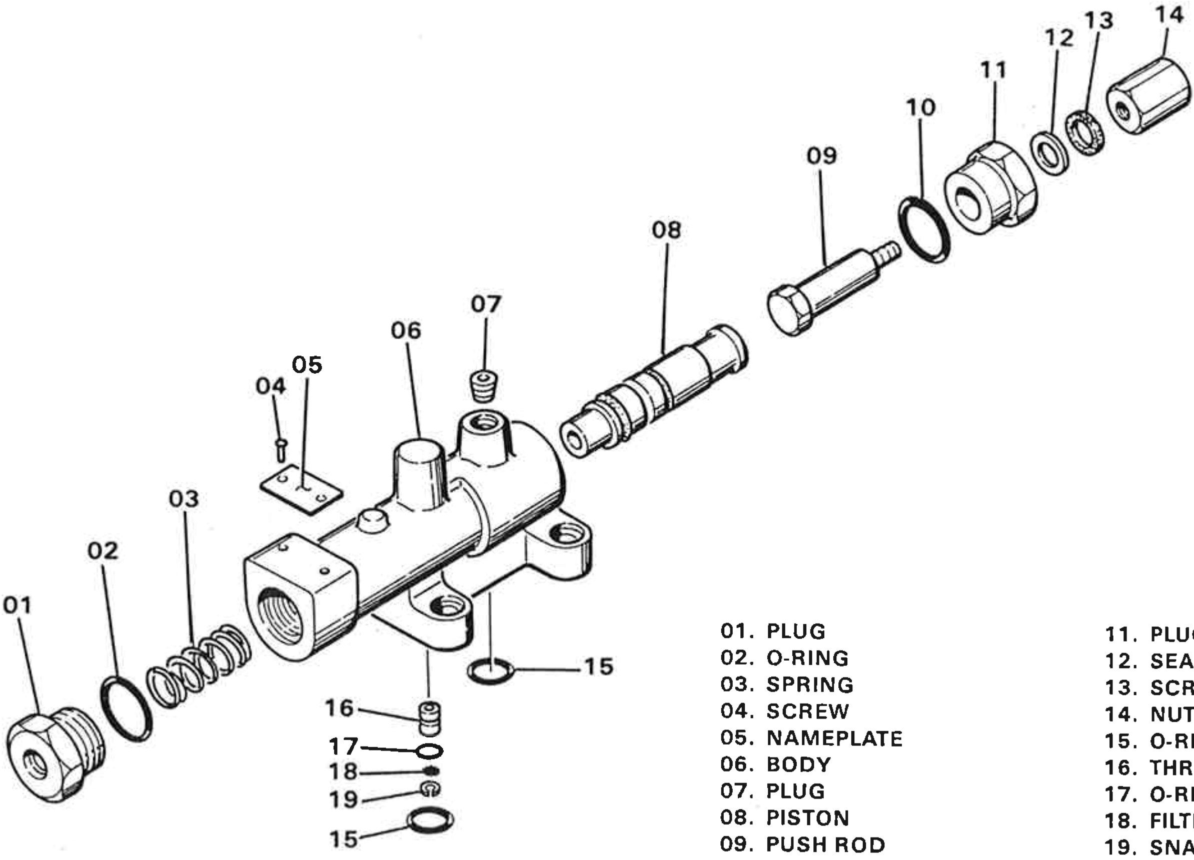


Fig.4 Action(Max.Stroke)

2. CONSTRUCTION



01. PLUG
02. O-RING
03. SPRING
04. SCREW
05. NAMEPLATE
06. BODY
07. PLUG
08. PISTON
09. PUSH ROD
10. O-RING
11. PLUG
12. SEAL
13. SCRAPER
14. NUT
15. O-RING
16. THROTTLE
17. O-RING
18. FILTER
19. SNAP RING

Fig.5 Exploded View (HF25-B5)

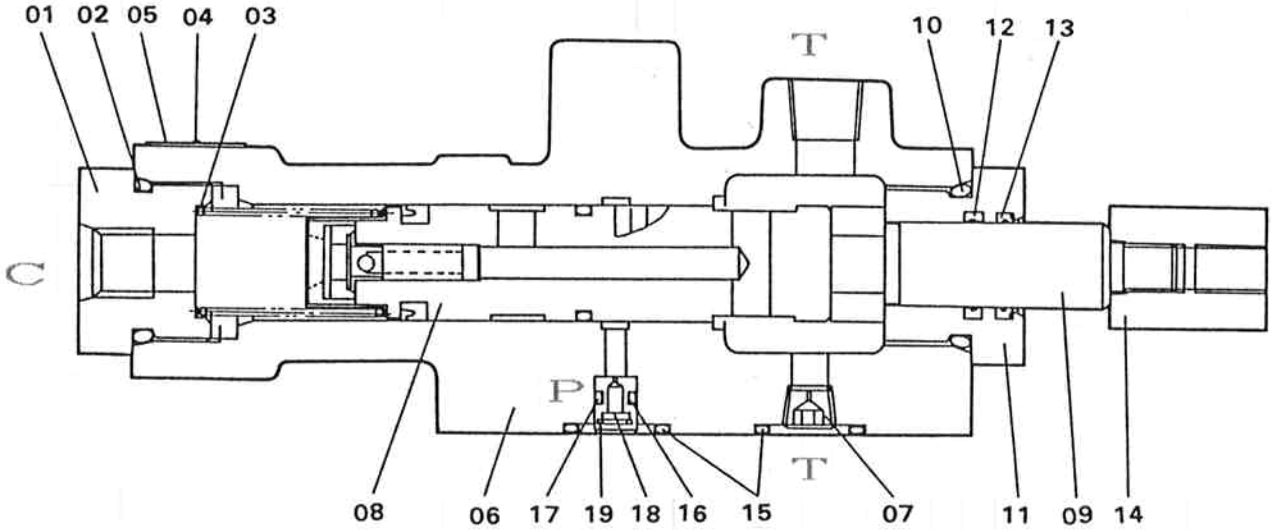


Fig.6 Sectional View (HF25-B5)

3. DISASSEMBLY AND ASSEMBLY

3.1 DISASSEMBLY

Use the following procedures to disassemble the valve.

1) Remove plug(01) and O-ring(02).
2) Remove spring(03) and piston(08).
3) Remove plug(11) together with nut(14), push rod(09), O-ring(10), seal(12) and scraper(13).
4) Unscrew nut(14) from push rod(09) and remove O-ring(10), seal(12) and scraper(13) from plug(11).
5) Remove O-ring(15), snap ring(19), throttle (16), filter(18) and O-ring(17).

3.2 INSPECTION AND REPAIR

Thoroughly clean all parts and dry with compressed air. Inspect the piston for excessive wear, burrs or scratches. Check the piston assembly to make sure there is a good seat. Check the push rod, spring and throttle for excessive wear. Replace all seals, scraper and O-rings.

NOTE

Valve seal and repair kits are available. See the Replacement Parts Manual.

3.3 ASSEMBLY

To assemble the brake valve, proceed as follows.

1) Generously coat all parts to be assembled with hydraulic oil.
2) Install O-ring(10) on, and seal(12) and scraper(13) in plug(11).

   NOTE

   Scraper(13) prevents dirt and water from entering the valve, therefore face the lip outward.

3) Place push rod(09) in plug(11) and tighten nut(14) on push rod(09).
4) Install plug(11) in valve body(06).
5) Install piston assembly(08) and spring(09).
6) Install O-ring(02) on plug(01) and install the plug. Do not overtighten.
7) Place O-ring(17) and filter(18) on throttle(16). Install throttle(16) and O-ring(17) in the valve and secure with snap ring(19).
8) Install O-ring(15).

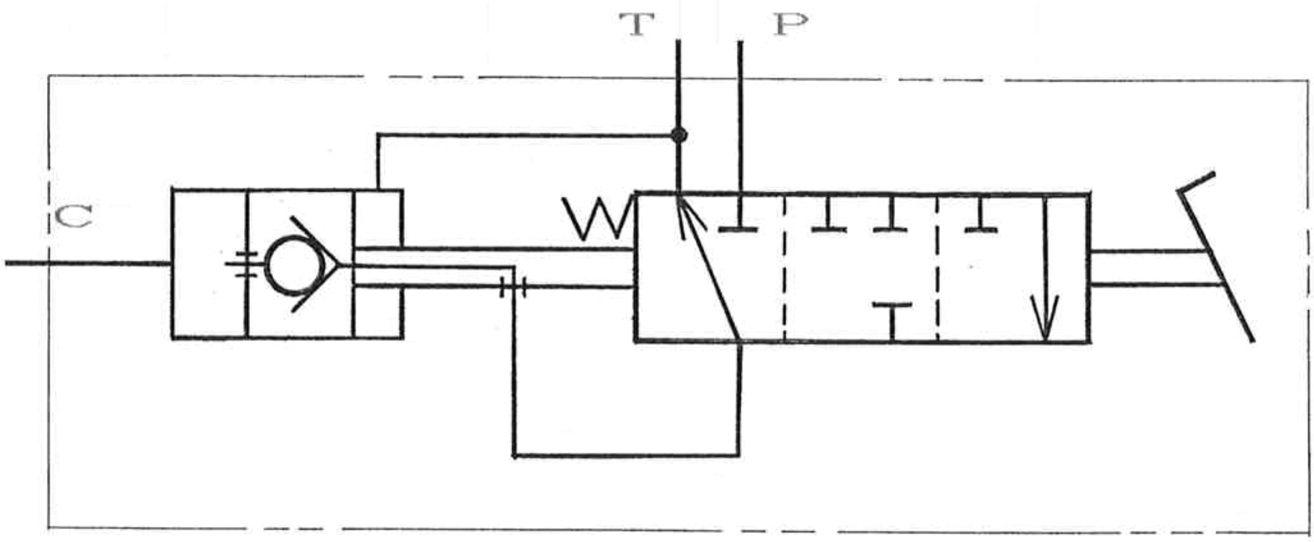


Fig.7 Symbol (HF25-B5)

4. TROUBLESHOOTING

TROUBLE	PROBABLE CAUSE	REMEDY
1. Output pressure does not rise when the piston is pushed in.	1) Malfunction of the check valve in the piston. 2) Damaged oil seal on the piston. 3) Excessive clearance between the piston and body, due to wear.	1) Replace the piston. 2) Replace the piston. 3) Replace the valve assembly.
2. Output pressure does not rise max. at the piston stroke end.	1) Slottle(16) is plugged. 2) Filter(18) is clogged. 3) Insufficient pump pressure.	1) Clean or replace the slottle. 2) Clean or replace the filter. 3) Inspect and repair the pressure unit.
3. Piston does not return when brake pedal is released.	1) Broken spring. 2) Stick of piston. 3) Malfunction of the pedal link mechanism.	1) Replace. 2) Clean, repair or replace assembly. 3) Repair or adjust.

1. CONSTRUCTION

1.1 GENERAL

In this remote contraol valve, two sets of remote contraol valves are installed to one body.

One set of remote control valve, for example, the hoist remote control valve consists of two pressure reducing valves which match each other such as raising and lowering.

Therefore, one body is provided with four pressure reducing valves.

The shapes of some parts in these remote control valves such as the spring, which arranges the relation between the lever stroke and secondary pressure, and the cam which fixes the detent form are different according to the purpose of use, such as hoist and propel, but the construction of the valve body is identical.

1.2 CONSTRUCTION

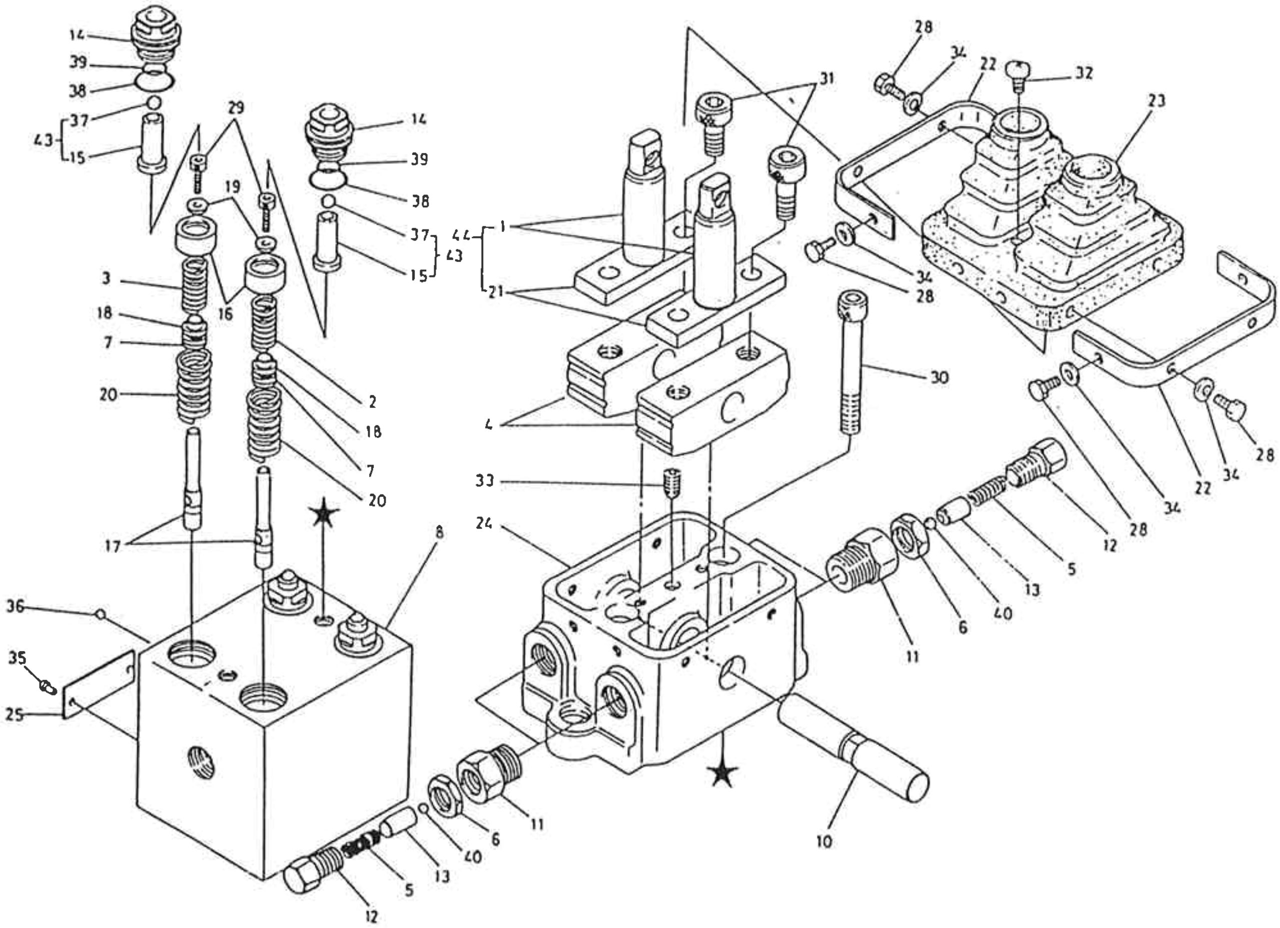
Fig. 1-1 shows the construction of this remote control valve.

Body (8) is provided with four parallel vertical shaft holes, and a pressure reducing valve is installed in the each vertical shaft hole. The pressure reducing valve section consists of spool (17), secondary pressure setting springs (2 and 3), return spring (20), spring guide (16), spring holder (18) and hexagon socket head bolt (29).

Secondary pressure setting springs (2 and 3) are provided with tensile force corresponding to the required secondary pressure. Spool (17) is pressed against spring guide (16) by secondary pressure setting springs (2 and 3).

By tilting the operating section, pusher (43) is lowered, and spring guide (16) slides on the rod section of the spool to change the setting of the secondary pressure setting springs.

The oil inlet (primary pressure) port and the outlet (tank) port are provided on the side wall of body (8), and the secondary pressure is taken out from the port provided in the bottom side of the vertical shaft hole.



1. LEVER
2. COMPRESSION SPRING
3. COMPRESSION SPRING
4. CAM
5. COMPRESSION SPRING
6. LOCKNUTE
7. SHIM
8. BODY
10. PIN
11. GUIDE
12. ADJUSTING SCREW
13. STEEL BALL HOLDER
14. SLEEVE
15. PUSHER
16. SPRING GUIDE
17. SPOOL
18. SPRING HOLDER
19. WASHER
20. COMPRESSION SPRING
21. PLATE
22. PLATE COVER
23. COVER
24. DETENT HOUSING
25. NAME PLATE
28. BOLT
29. BOLT
30. BOLT
31. BOLT
32. SCREW
33. SCREW
34. WASHER
35. RIVET SCREW
36. STEEL BALL
37. STEEL BALL
38. O-RING
39. SEAL
40. STEEL BALL
43. PUSHER
44. LEVER

Fig. 1-1. Remote Control Valve

2. OPERATION

2.1 WHEN THE LEVER IS IN NEUTRAL

The primary pressure which has entered from port P is cut by spool (17), and does not go to any circuit. Besides, the secondary pressure generating port is connected to port T, and pressure does not generate.

When the lever is placed in the neutral position, spool (17) is held in the fixed position by springs (2 and 20).

2.2 WHEN THE LEVER IS STROKED

The diameter of the horizontal hole provided in spool (17) is arranged to the same length as the width of land A in housing (8).

By this, when the spool (17) is stroked, the secondary pressure generating port is cut to port T, and is set to timing when port P begins to open at the same time. The primary pressure which has entered from port P passes the horizontal hole of spool (17), and is led to the secondary pressure generating port.

Since the force against spool (17) is the reaction force of spring (2) only, when the generated secondary pressure becomes larger than the reaction force of spring (2), spool (17) is pushed to return, port P is cut, and the secondary pressure does not rise more.

As such, a pressure corresponding to a load which bends spring (2) is generated as the secondary pressure by operating the lever.

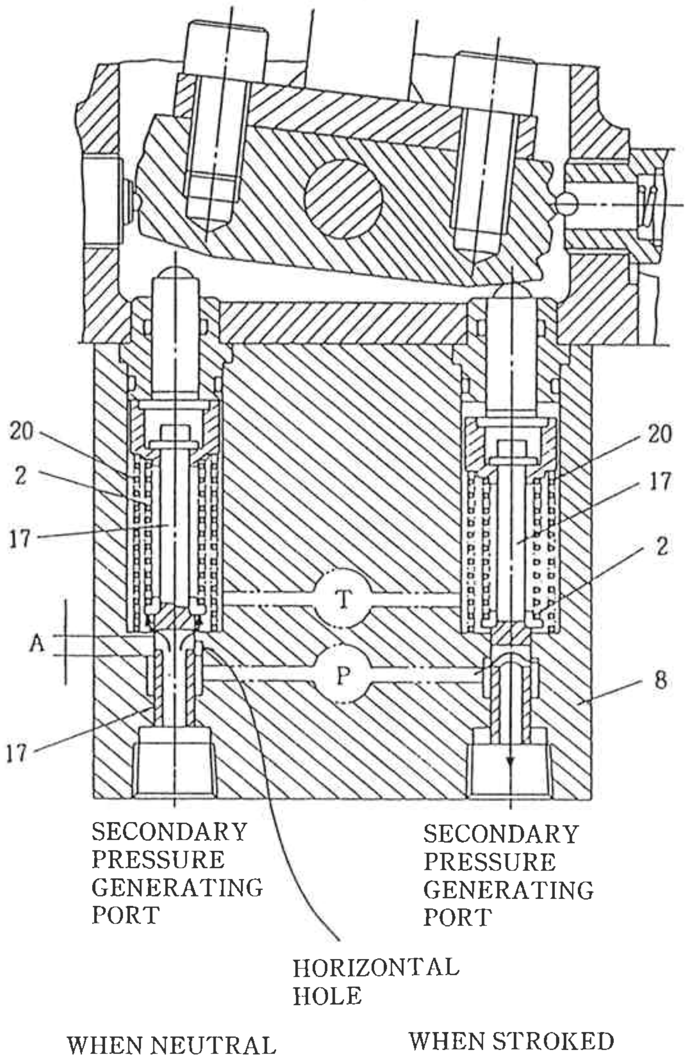


Fig. 2-1 Operation of Remote Control Valve

3. DISASSEMBLY AND ASSEMBLY

3.1 DISASSEMBLY

To disassemble the remote control valve, proceed as follow (see Fig. 1-1) :

1. Remove four bolts (28) and two screws (32), and remove six washers (34) and cover (23).
2. Remove socket bolt (31), and remove plate (21).
3. Loosen nut (6).
4. Turn guide (1), and remove the detent assembly from housing (24).
5. Remove screw (33).
6. Tap to pull out pin (10) from the side.
7. Remove cam (4).
8. Remove socket bolt (30), and remove housing (24).
9. Push spool (17) up from the bottom side, and pull sleeve (14) out upward with pusher (15), O-ring (38) and seal (39) attached.
10. Remove pusher (15).
11. Using a thing such as a sharp pointed needle, remove O-ring (38) and penta-seal (39) from sleeve (14).
12. Pull the spool assembly (2, 3, 7, 11, 17, 18, 19 and 29) out.
13. Remove socket bolt (29), and disassemble the spool assembly.
    At this time, be careful not to sbsolutely injure spool (17).
14. Remove spring (20) from body (8).

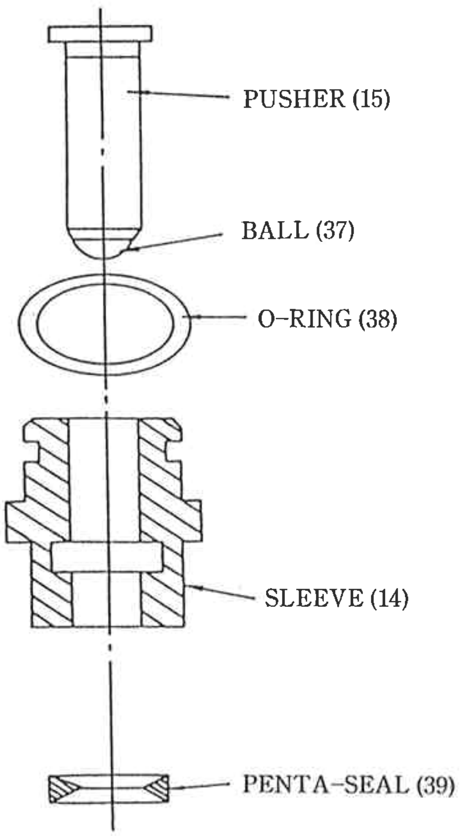


Fig. 3-1 Sleeve Assembly

3.2 ASSEMBLY

To assemble the remote control valve, proceed as follows :

1. Before assembling, sufficiently wash the all parts, and coat them with clean oil. Replace all sealing parts such as the O-ring and pentaseal with new ones.
2. Inset spring (20) into body (8).
3. Assemble the spool assembly (2, 3, 7, 11, 17, 18, 19 and 29). The tightening torque of socket bolt (29) is 1 kg-m (7.2 ft-lbs).
4. Insert the spool assembly into body (8). At this time, be careful not to injure the spool sliding section of the body.
5. Assembly of the sleeve assembly.
   5.1 Referring to Fig. 3-1, be carefull for the direction of the lip, and insert penta-seal (39) into sleeve (14).
   5.2 Insert O-ring (38) into sleeve (14).
   5.3 Being careful not to injure the lip of penta-seal (39), insert pusher (15) into sleeve (14).
6. Insert the sleeve assembly into body (8).

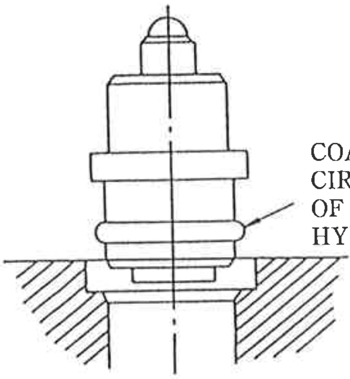


Fig. 3-2 Installation of Socket Assembly

7. Install housing (24) to body (8) with socket bolt (30), and tighten the bolt with 5 kg-m (36 ft-lbs) of torque.
8. Insert cams (4) into housing (24). Lightly tapping with a plastic hammer, insert pin (10). At this time, pay attension to the direction and position of the cam.
9. Apply Loctite #262 to screws (30), and tighten them with 1.2 kg-m (8.7 ft-lbs) of torque.
10. Referring to Fig. 3-3, assemble the detent assembly.

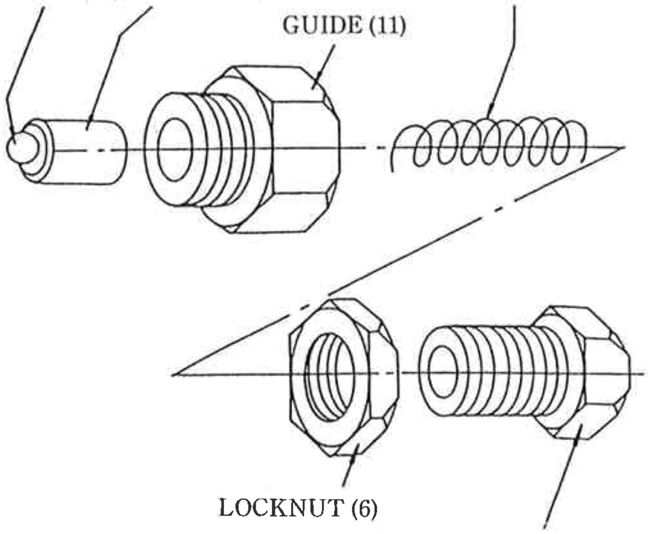


Fig. 3-3 Assembly of Detent Assembly

11. Apply grease of 2 to 3cm³ (0.12 to 0.18 in³) per one place of the detent groove section of cam (4). Tighten guide (11) with 5 kg-m (36 ft-lbs) of torque.
    However, leave nut (16) as it is temporarily tightened.
12. Install plate (21) to cam (4) with socket bolt (31). Tightening torque is 5 kg-m (36 ft-lbs).
13. Adjust the detent releasing force with adjusting screw. After adjustment, tighten nut (6) with 4 kg-m (29 ft-lbs) of torque, and lock it.
14. Install cover (23) with hexagon bolts (28), washers (34) and screws (32).

4. TROUBLESHOOTING

No.	Trouble	Probable Cause	Remedy
1.	Secondary pressure does not generate.	a. Damge of springs (2 and 3) b. Spool (17) does not move.	a. Replace springs (2 and 3). b. Disassemble, wash and reassemble spool section. If injury is detected on body and spool sliding section, replace kits of body and spool.
2.	Secondary pressure fluctuates.	a. Small dusts bite sliding section of spool. b. Wear of of cam (4) c. Wear of steel bll (13)	a. Same as No. 1, b. b. Replace cam (4). c. Replace holder assembly.
3.	Even when lever is returned, some secondary pressure generates.	a. Looseness of socket bolt (29).	a. Retighten socket bolt (29) with 1 kg-m (7.2 ft-lbs).
4.	Secondary pressure is low.	a. Looseness of socket bolt (29). b. Weakened springs (2 and 3). c. Wear of detent section.	a. Same as No. 3, a. b. Replace springs (2 and 3). c. Same as No. 2, b.
5.	Detent releasing force is weak (low).	a. Weakened spring (5). b. Wear of detent section.	a. Replace spring (5). b. Same as No. 2, b and c.
6.	Detent releasing force is strong (high).	a. Broken spring (20). b. Deficiency of oil in detent section.	a. Replace spring (20). b. Grease detent section.
7.	Play of lever is large.	a. Looseness of socket bolt (31). b. Wear of detent section.	a. Retighten socket bolt (31). (Apply Loctite #262) b. Same as No. 2, b and c.
8.	When supplied flow is little, secondary pressure does not rise to specified pressure.	a. Internal leak is much, and wear of body and spool.	a. Replace kits of body (8) and spool (17).
9.	External leak.	a. Wrong seal.	a. Replace seal kit. At this time check O-ring contacting surface for bruise and injusty.

1. GENERAL

1.1 DESCRIPTION

A counterbalance valve is mounted on the top of the hoist motor.

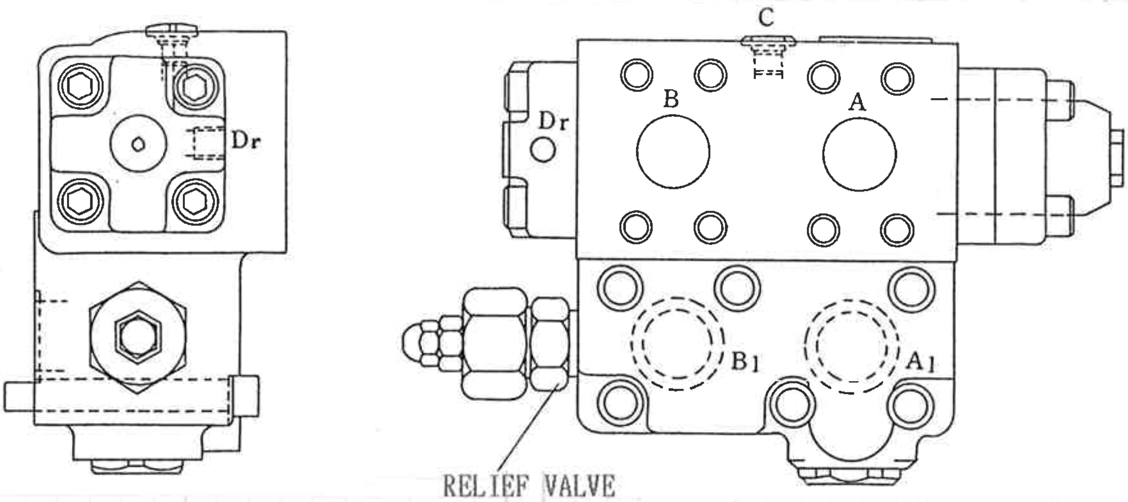


Fig.1 General View

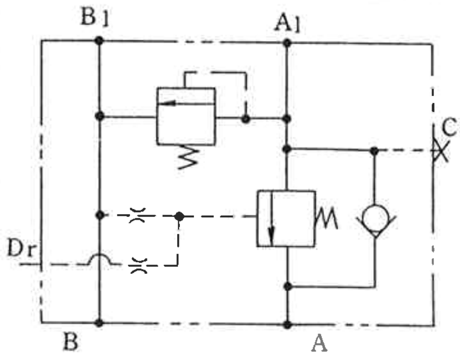


Fig.2 Symbol

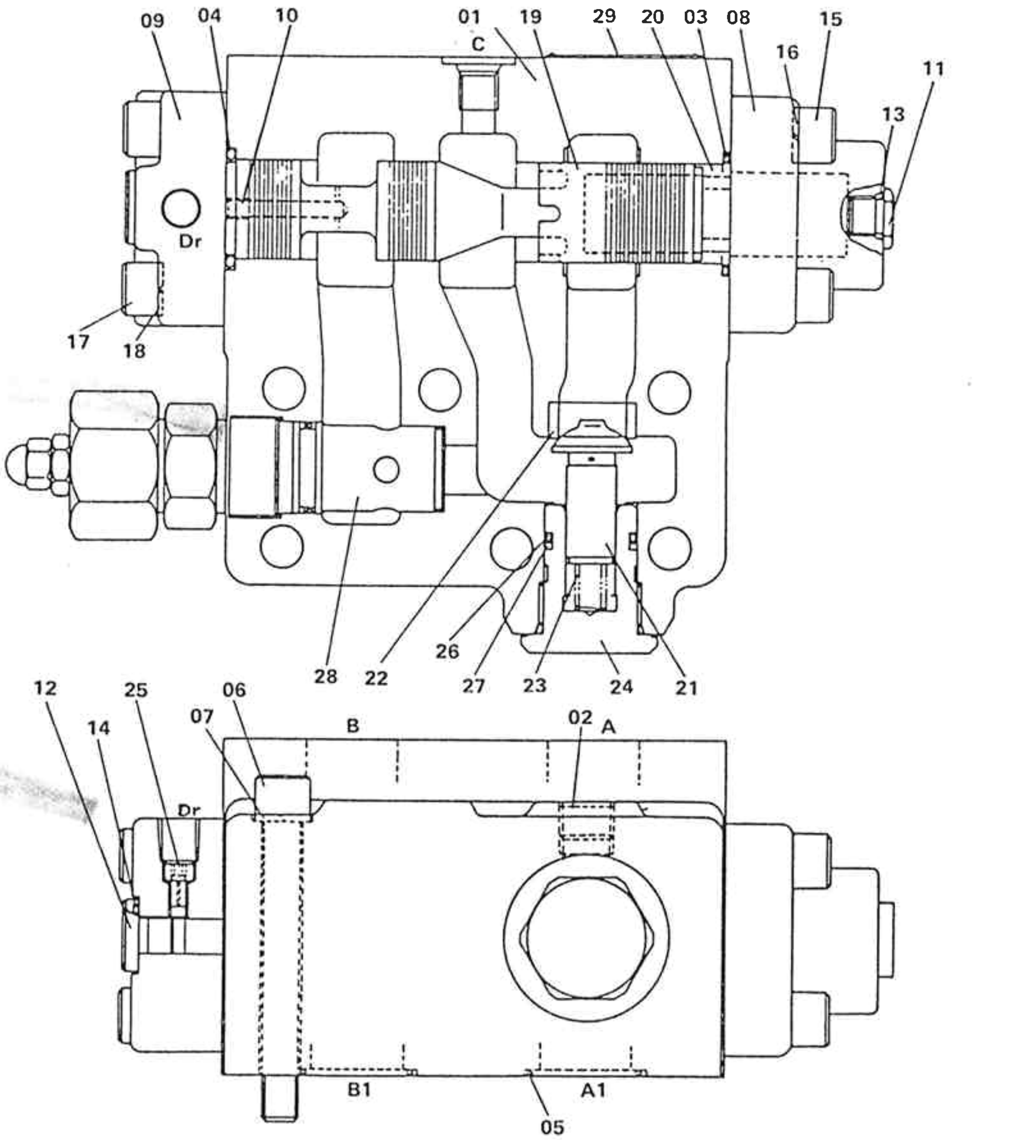
1.2 SPECIFICATION

The general specification of the counter-balance valve is as follows:

Standard flow volume ..... 10 to 350ℓ/min.
Maximum pressure .... 315 Kgf/cm^2
Pilot cracking pressure .... 7 Kgf/cm^2
Check valve cracking pressure . 0.3 Kgf/cm^2
Weight .... 20 Kgs

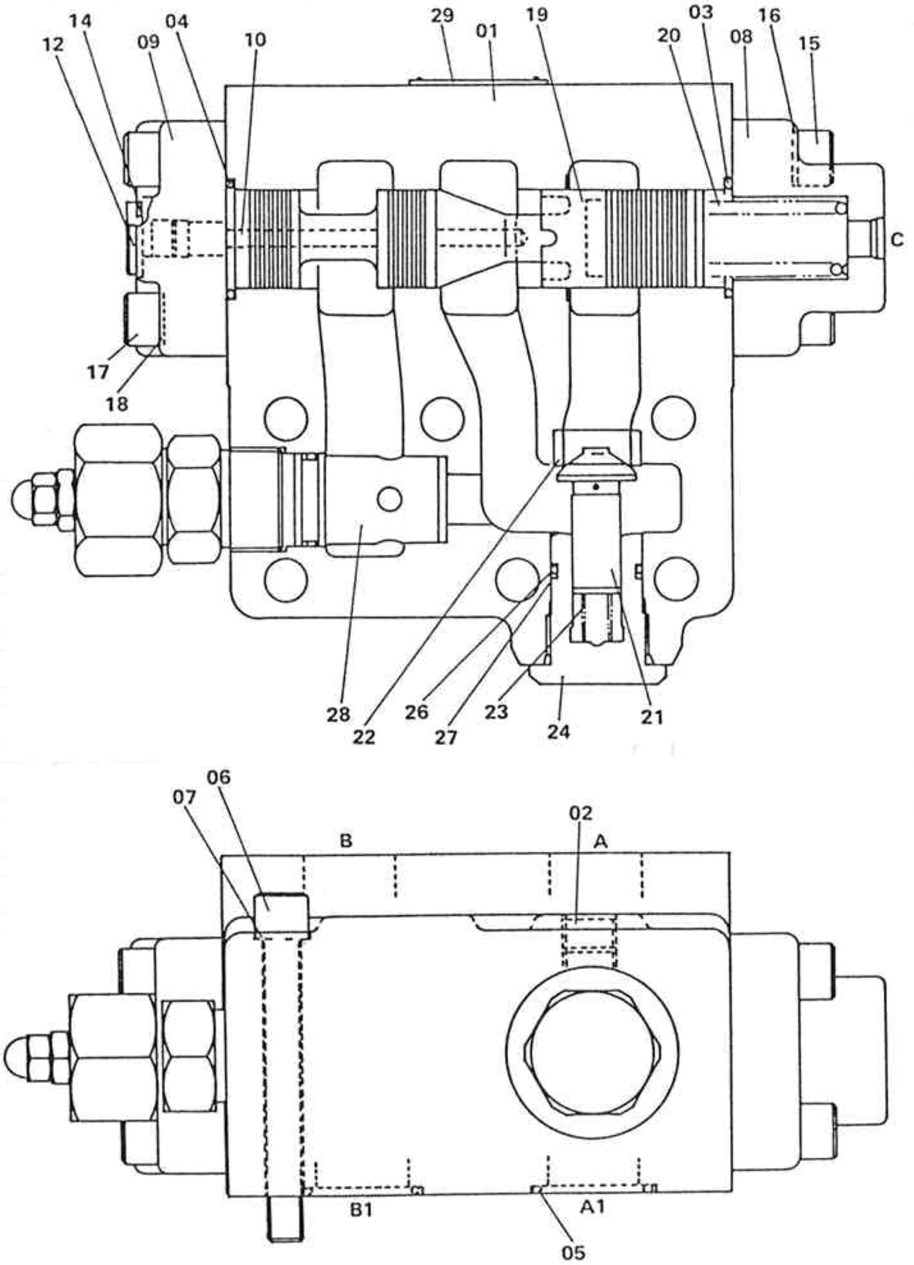
2. CONSTRUCTION

The construction of the counterbalance valve is shown in Figures 3A and 3B, and consists of valve body, spool, spring, check valve, and rerief valve.



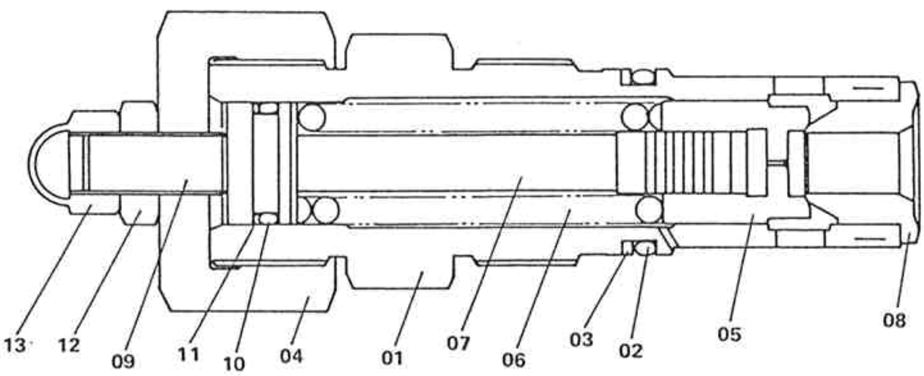
01. CASING
02. PLUG
03. O-RING
04. O-RING
05. O-RING
06. SOCKET HEAD CAPSCREW
07. LOCKWASHER
08. COVER-I
09. COVER-II
10. RESTRICTOR
11. PLUG
12. PLUG
13. O-RING
14. O-RING
15. SOCKET HEAD CAPSCREW
16. LOCKWASHER
17. SOCKET HEAD CAPSCREW
18. LOCKWASHER
19. SPOOL
20. SPRING
21. PLUNGER } CHECK VALVE
22. SEAT } CHECK VALVE
23. SPRING } CHECK VALVE
24. PLUG
25. RESTRICTOR
26. O-RING
27. BACKUP RING
28. RELIEF VALVE (SEE FIGURE 3C)
29. NAME PLATE

Fig.3A Main Counterbalance Valve
(KDC30MRH-A5.0/315-701)



01. CASING
02. PLUG
03. O-RING
04. O-RING
05. O-RING
06. SOCKET HEAD CAPSCREW
07. LOCKWASHER
08. COVER-I
09. COVER-II
10. RESTRICTOR
11. —
12. PLUG
13. —
14. O-RING
15. SOCKET HEAD SAPSCREW
16. LOCKWASHER
17. SOCKET HEAD CAPSCREW
18. LOCKWASHER
19. SPOOL
20. SPRING
21. PLUNGER } CHECK VALVE
22. SEAT } CHECK VALVE
23. SPRING } CHECK VALVE
24. PLUG
25. —
26. O-RING
27. BACKUP RING
28. RELIEF VALVE (SEE FIGURE 3C)
29. NAME PLATE

Fig.3B Auxiliary Counterbalance Valve
(KDC30MRH-A6.0/315-101)



01. BODY
02. O-RING
03. BACKUP RING
04. COVER
05. POPPET
06. SPRING
07. SPRING SEAT
08. SEAT
09. ADJUSTING SCREW
10. O-RING
11. BACKUP RING
12. LOCK NUT
13. CAP NUT

Fig.3C Relief Valve (KRD16EK1.01)

3. OPERATION

These valves are used for single motors or twin motors, and control them independently or simultaneously.
As shown in Figure 4 Hydraulic Circuit, main counterbalance valve K1 (Figure 3A) is mounted on the main drum hydraulic motor, and auxiliary counterbalance valve K2 (Figure 3B) is mounted on the auxiliary motor.
Port A1 of the counterbalance valve is connected to the inlet side of the hydraulic motor in raising, and port B1 is connected to the inlet side of the hydraulic motor in lowering (see Figure 4).
Port C of counterbalance valve K1 is connected to port C of counterbalance valve K2.
Hydraulic oil from the hydraulic pump is supplied to port A when raising and to port B when lowering (Figure 4).

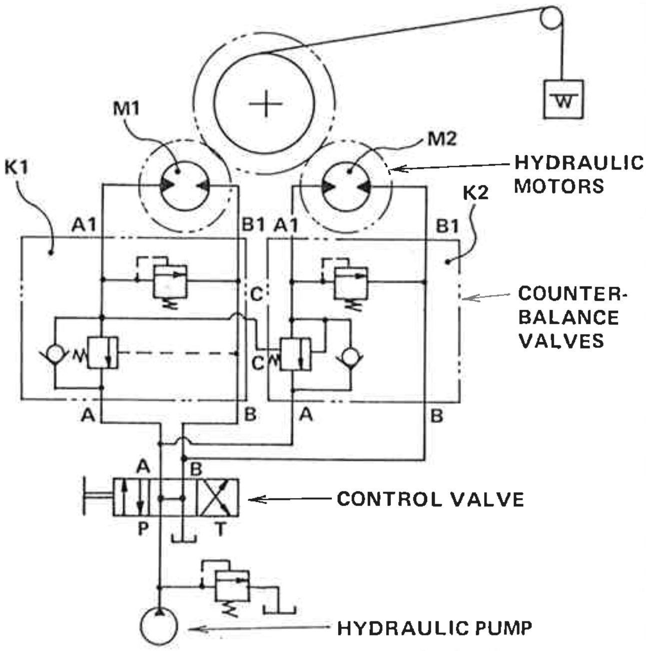


Fig.4 Hydraulic Circuit

(1) RAISING

When the control valve spool is pushed in, the delivery oil from the hydraulic pump flows to port A to push the check valve up, and reaches the each hydraulic motor from port A1. While, the return oil from the hydraulic motor passes ports B1 and B and returns to the tank.
Therefore, when raising, only the check valve functions, and the counterbalance valve does not perform any control function.

(2) SUSPENDING

When the control valve spool is returned to the neutral position, ports A and B are connected to the tank, and pressure lowers to the tank pressure.
Therefore, the pressure actuating to the counterbalance spool is low, and the spool is pushed up with the spring to be closed.
The pressurised hydraulic oil generated by a load is going to flow to port A from port A1 of the counterbalance valve, but cannot flow because the check valve and spool are closed. Therefore, the load will be held in the suspending condition.

(3) LOWERING

When the control valve spool is drawn out, the pressurized oil from the hydraulic pump is supplied to port B of counterbalance valve. While, the return oil from the hydraulic motor is confined with the check valve and counterbalance spool. Therefore, the hydraulic pressure supplied from the hydraulic pump is raised. In counter-balance valve K1, this hydraulic pressure is a force to move the spool. Pushing to compress the the spring, the spool moves to open the path from port A1 to port A of the counterbalance valve. Therefore, the braking pressure of hydraulic motor M1 will be lowered.
At this time, since the braking pressure of hydraulic motor M2 is raised on the contrary in order to hold the load, the hydraulic balance of the spool in counterbalance valve K2 will be broken, and the spring is pushed to be compressed.
Therefore, the path from port A1 to port A will be opened.
Then, motors M1 and M2 start to rotate, and the load will be lowered.

When the amount of oil supplied to the hydraulic motors is increased, resistance of path A1 - A of counterbalance valve K1 is also increased, and hydraulic pressure in the suction side of the hydraulic motor is raised. Then, force actuating to the spool of counterbalance valve K1 is also increased, bending of the spring is increased, opening of the path will be larger, and braking pressure of hydraulic motor M1 is going to lower.
Therefore, the spool of counterbalance valve K2 also moves, the opening of the path is larger, and rotation of the hydraulic motors will be accelerated.
When the amount of oil supplied to the motors is decreased, the opening of the path is reduced, and rotation of the hydraulic motors is decelerated, holding the necessary braking pressure.

When the load is increased while lowering, the spool moves to make the path narrow and to raise the pressure in proportion with increase of the load.
As described above, lowering speed of the load is controlled with amount of oil supplied to the hydraulic motor from the hydraulic pump.

(4) EMERGENCY
Since the counterbalance valve is operated with hydraulic pressure supplied from the hydraulic pump, the load will be suspended safely and will not free fall even in emergency of pump stops.

4. TROUBLESHOOTING

Trouble	Probable Cause	Remedy
1. When lowering a load, speed control is impossible.	1) Malfunction of counter-balance valve due to air existing.	1) Operate raising and lowering with no load several times to bleed air.
	2) Clogged restrictor of counter-balance valve spool.	2) Blow and clean with compressed air.
	3) Low pilot pressure.	3) Replace complete valve, or replace spring for spool.
	4) Spool sticking.	4) Replace complete valve, or correct sticking part with a oil stone.
	5) Check valve sticking.	5) Replace complete valve, or correct sticking part with a oil stone.
2. When suspending a load, the load slides down.	1) Spool sticking.	1) Correct tightening torque of each mounting capscrew. Replace valve or repair sticking part.
	2) Spool clearance is increased.	2) Replace.
	3) Check valve sticking.	3) Replace complete valve, or repair sticking part.
	4) Low preset pressure of relief valve.	4) Correct preset pressure. Replace relief valve.
	5) Relief valve poppet sticking.	5) Replace complete valve, or repair sticking part.

5. REPAIRS

It is recommended that the complete counter-balance valve be replaced if the valve is faulty. If disassembly and reassembly are required, proceed as follows:

5.1 DISASSEMBLY

(1) Disassembly of Spool(see Figures 3A and 3B).

a) Remove covers (08 and 09) from casing (01).

b) Take spring (20) out of casing (01).

c) Draw spool (19) out of pushing it from the other side.

CAUTION

Disassembly should be performed in a clean place. Be careful not to scratch the flange face and matching face.

(2) Disassembly of Check Valve (see Figures 3A and 3B).

a) Loosen and remove plug (24).

b) Take spring (23) out from the casing.

c) Remove plunger (21) from the casing.

NOTE

Since seat (22) is pressed in, the seat cannot be removed.

(3) Disassembly of Relief Valve(see Figure 3C). To remove the cartridge without changing the preset pressure of the relief valve, loosen body (01) by applying a wrench to only the hexagon part of the body.
If seat (08) has fallen into the casing by being pushed with spring (06), take the seat out carefully.

5.2 ASSEMBLY

(1) Clean All Disassembled Parts.
Remove dust with compressed air if possible. It is better not to use cloth, but if used, be careful sufficiently not to leave any lint.

CAUTION

1. If any scratch or dent is found in the disassembled parts, be sure to repair or replace.
2. Apply lubricant to the moving parts before assemble.
3. Assemble the parts in the same position as before disassembling.
4. Do not use the removed O-rings. Be sure to use new ones.

(2) Assembly of Spool (see Figures 3A and 3B).

a) Install spool (19) into casing (01).

b) Install O-rings (03 and 04) after lubricating.

c) Install spring (20).

d) Install covers (08 and 09), and secure them with capscrews (15 and 17). Tighten the capscrews to 7.0 Kgf•m (50.6 ft•lbs.)

CAUTION

Be careful for direction of the spool.

(3) Assembly of Check Valve (see Figures 3A and 3B).

a) Install plunger (21). Install spring (23).

b) Install O-ring (26) into the groove of plug (24), and insert the plug with the O-ring into casing (01). Torque required to the plug is 20 Kgf•m (144 ft•lbs.).

CAUTION

Carefully and slowly screw the plug not to damage the the O-ring when the O-ring is inserted.

(4) Assemby of Relief Valve.

a) The relief valve removed without loosening adjusting screw (09, Figure 3C) as a cartridge should be screwed in carefully so that seat (08) does not go out.

b) If the adjusting screw was loosened when disassembled, assemble the poppet, spring seat, O-ring, and back-up ring into the body, then install the cover (see Figure 3C). Install seat (08) into the body, and install the relief valve into the casing with torque of 15 to 20 Kgf•m (108 to 144 ft•lbs.).
Screw the adjusting screw into the body, and secure with the lock-nut.

1. SPECIFICATIONS

1.1 EXTERNAL VIEW

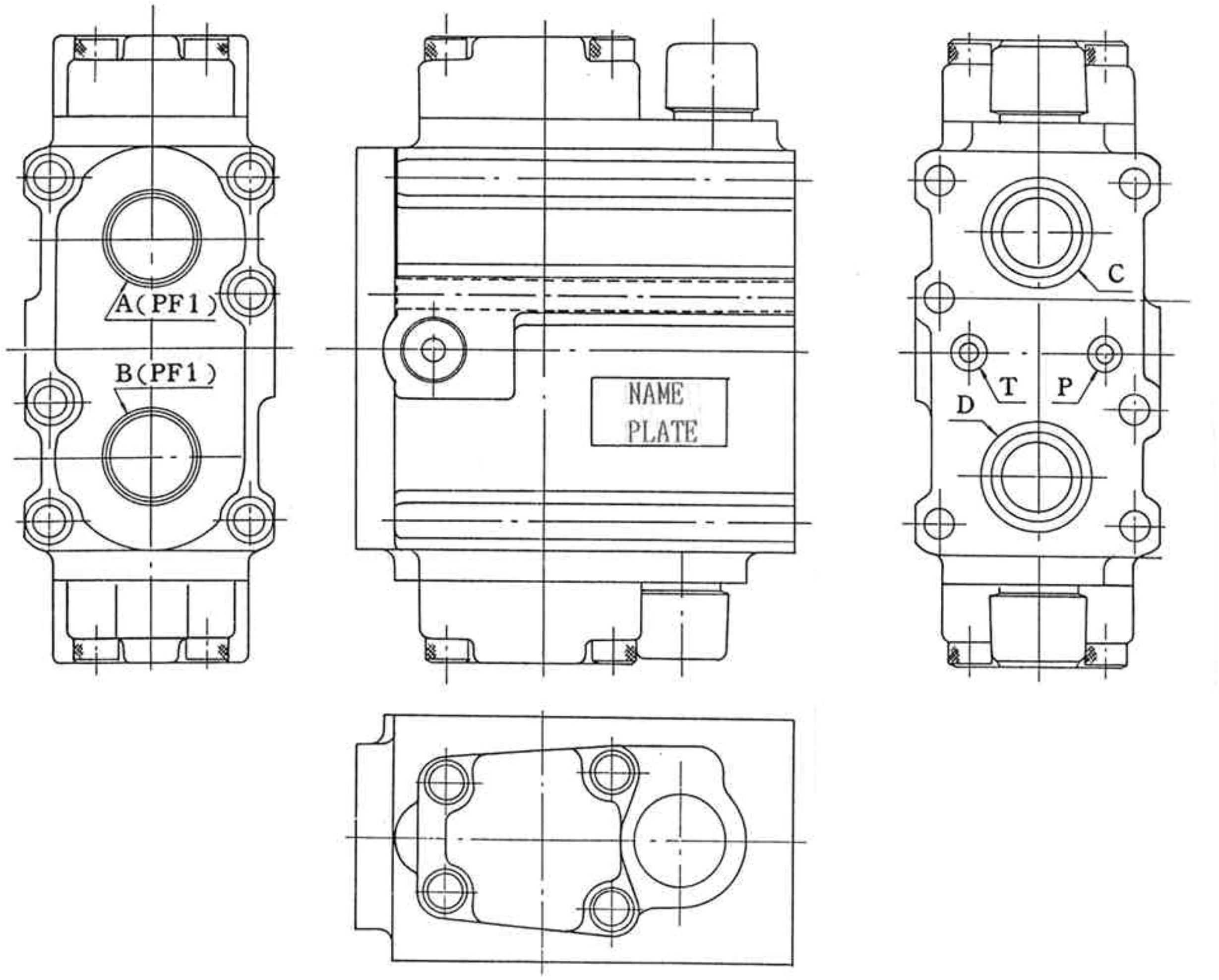


Fig.1 External View (Spec.1)

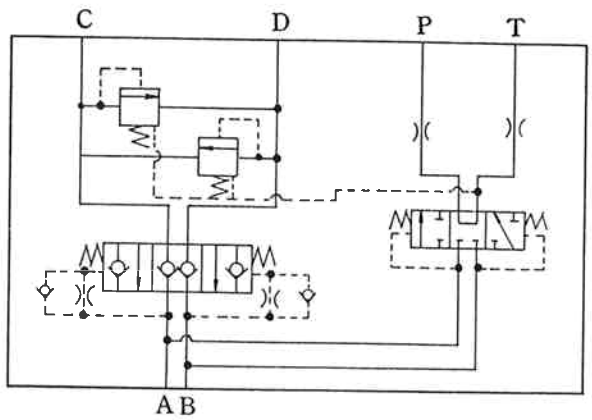


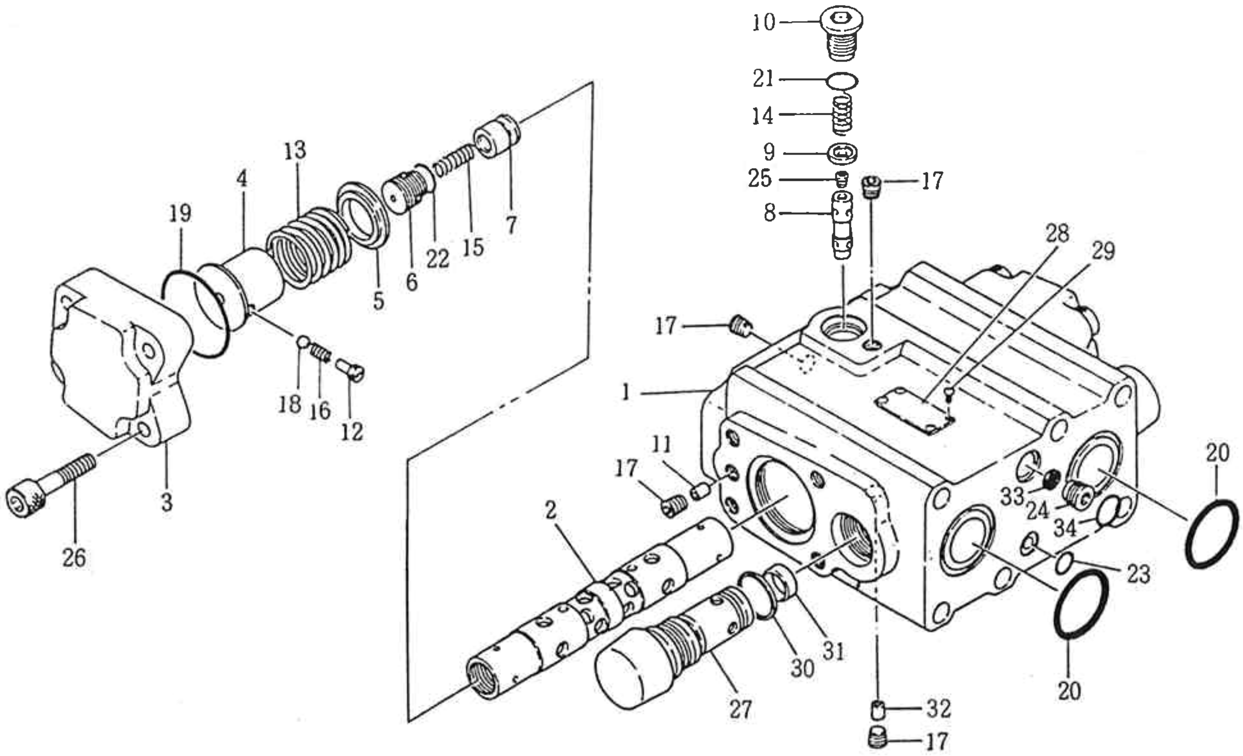
Fig.2 Symbol (Spec.1)

1.2 SPECIFICATION

Type	RF2A25L	
	Spec.1	Spec.2
Rated pressure kgf/cm^2	300(Work at $230kgf/cm^2$)	300(Work at $280kgf/cm^2$)
Rated flow l/min.	175(Work at 154l/min.)	200
Leak $cm^3/min.$	Below 200(at$210kgf/cm^2$)	←
C/V Spool Pilot pressure kgf/cm^2	13.5±2.5(Open/Close)	←
Shuttle valve change-over P. kgf/cm^2	7±2 (Open/Close)	←
Check valve cracking P. kgf/cm^2	0.35	←
Set pressure of relief valve kgf/cm^2	230^{+5}_{-0} (at 5l/min.)	280^{+5}_{-0} (at 5l/min.)
Weight kgf	13	

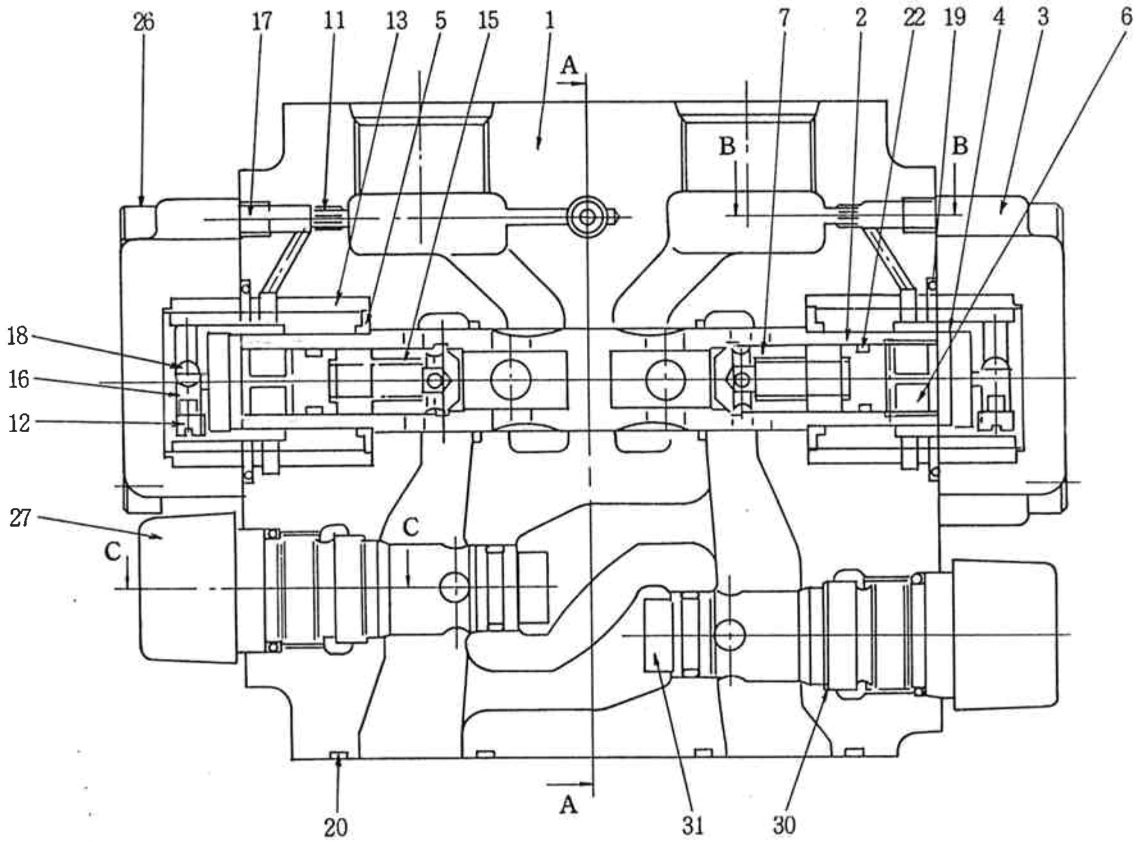
2. CONSTRUCTION AND FUNCTION

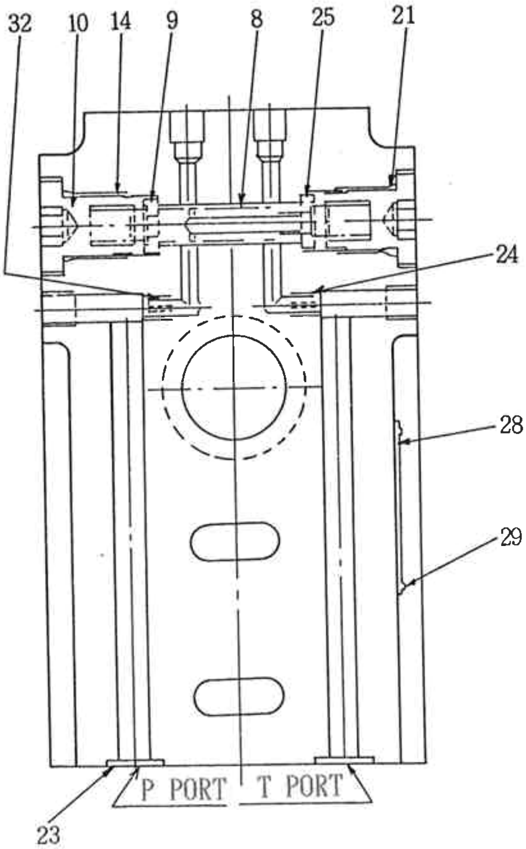
2.1 COSTRUCTION



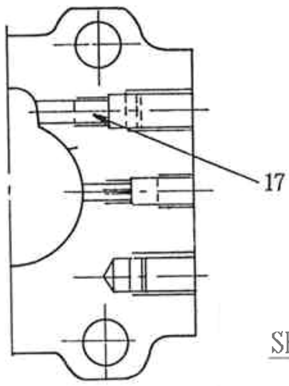
1. BODY	13. SPRING	25. SET-SCREW
2. SPOOL	14. SPRING	26. CAPSCREW
3. COVER	15. SPRING	27. RELIEF VALVE
4. DAMPER	16. SPRING	28. NAME PLATE
5. SPRING SEAT	17. PLUG	29. TAPPING-SCREW
6. PLUG	18. STEEL BALL	30. COLLAR
7. PLUNGER	19. O-RING	31. BUSHING
8. SPOOL	20. O-RING	32. ORIFICE
9. SPRING SEAT	21. O-RING	33. FILTER
10. PLUG	22. O-RING	34. O-RING
11. ORIFICE	23. O-RING	
12. SPRING SEAT	24. ORIFICE	

Fig.3 Exploded View (Spec.2)

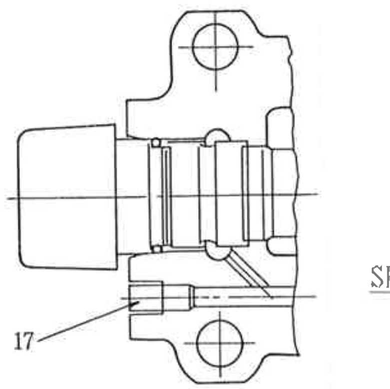




SECTION A-A

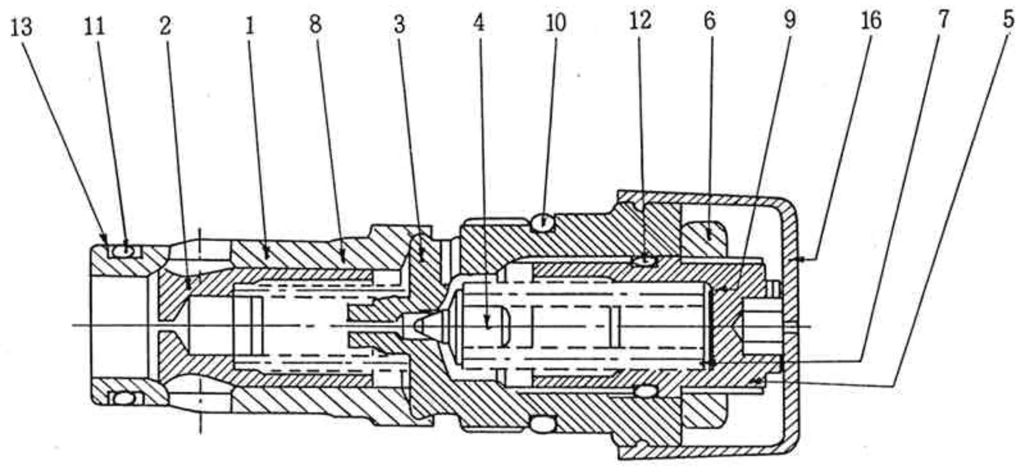


SECTION B-B



SECTION C-C

Fig.4 Sectional view (Spec.1)



1. BUSHING
2. PLUNGER
3. SEAT
4. POPPET
5. SET-SCREW
6. NUT
7. SPRING
8. SPRING
9. SHIM
10. O-RING
11. O-RING
12. O-RING
13. BACKUP RING
16. CAP

Fig.5 Relief Valve (Symbol 27)

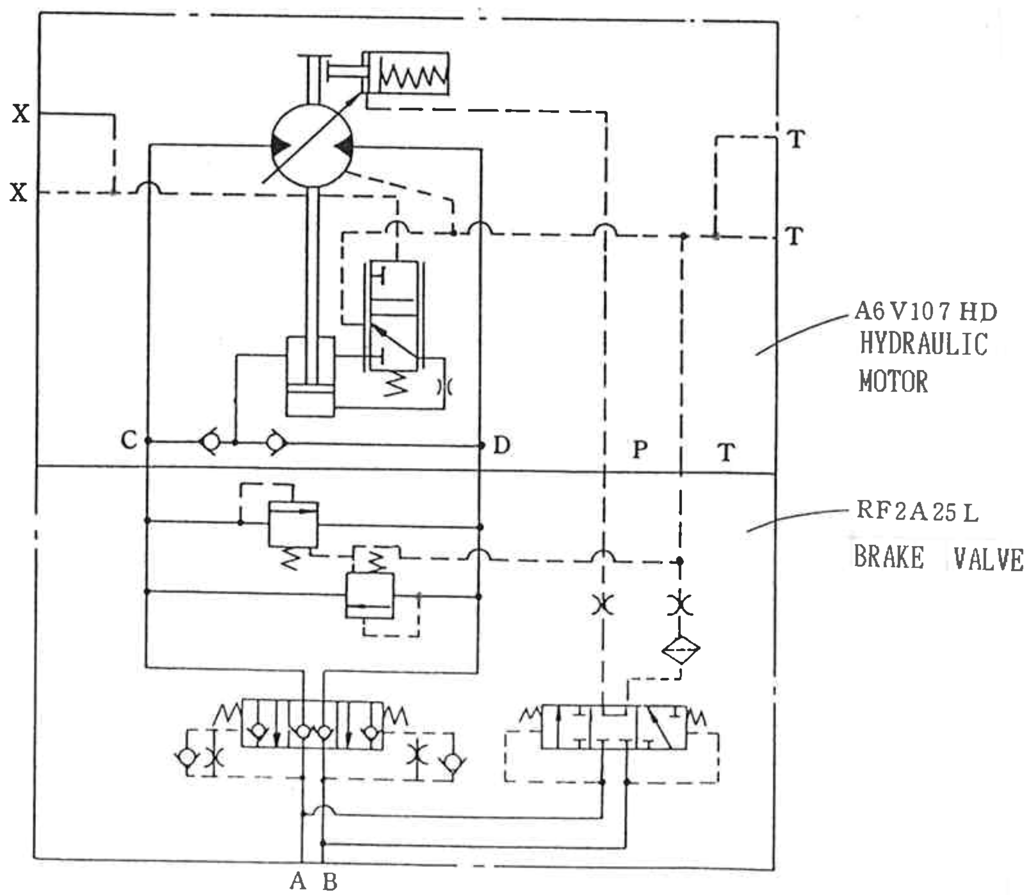


Fig.6 Circuit of Motor and Valve (Spec.2)

2.2 FUNCTION

The brake valve consists of the circuit shown in the figure 6. C,D,P and T ports are connected to the motor at the gasket face and A,B ports are connected to the control valve.

(1) Function in Freeflow (Full Open) (Refer to Fig.7)

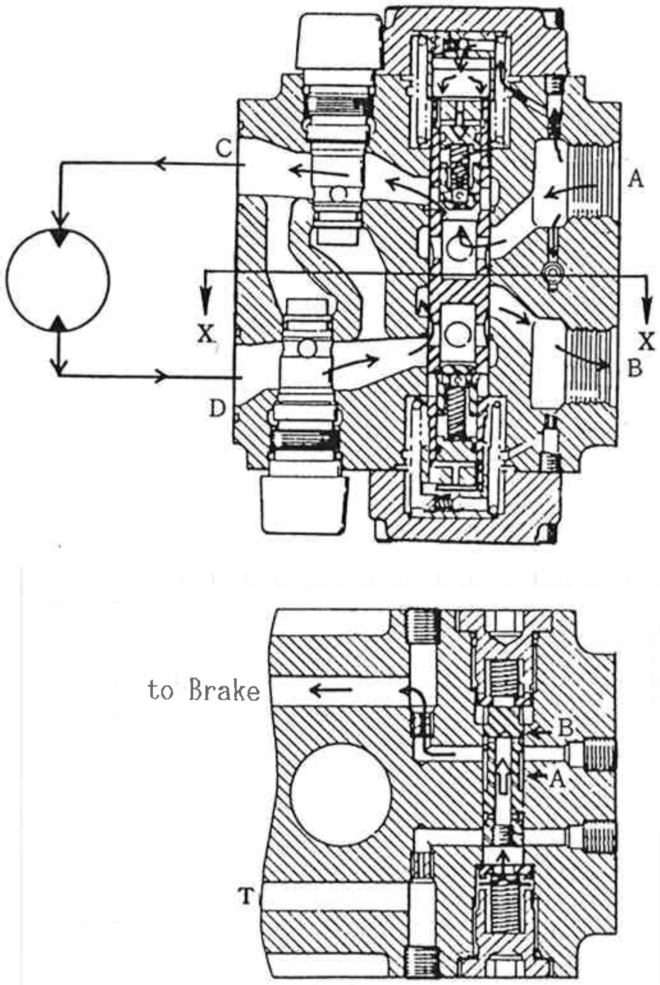
When control valve is changed over, the oil delivered from hydraulic pump enters A(B) ports of the brake valve and flows to motor from C(D) by opening check valve in counter-valance spool, and at the same time fully opens counterbalance spool. Further, the return oil from motor passes from D(C) through counterbalance spool that is fully opened and returns to the tank from B(A) port through control valve.

When control valve is changed over, shuttle valve opens at pressure that is lower than the pressure at which counterbalance spool is changed over, and after parking brake is released, counterbalance spool is changed over and the motor starts running.

(2) Function at Neutral (Refer to Fig.8)

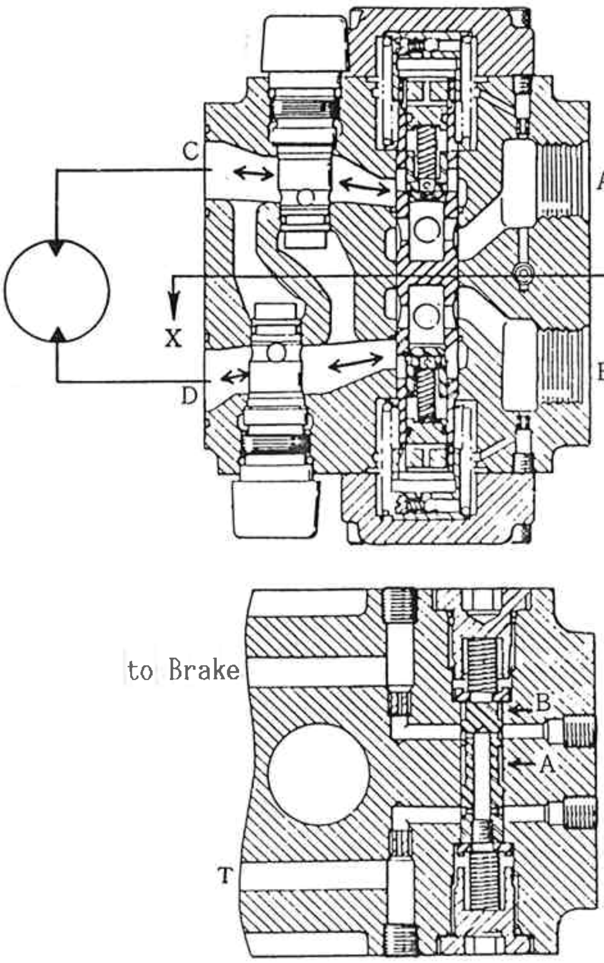
When control valve is at neutral, A(B) port pressure is the same as tank pressure, and furthermore counterbalance spool is at neutral because the same pressure acts on both ends of counterbalance spool.

The oil pressure generated by load tries to flow from C(D) to A(B), but it can not flow and motor does not run because the check valve in counterbalance spool and spool are closed. Since shattle valve of caurse, maintains neutral, the parking brake works.



Magnified Section X-X (Shattle)

Fig.7



Magnified Section X-X (Shattle)

Fig.8

(3) Function in Control Flow (Control) (Refer to Fig.7)

When control valve is changed over, the oil from pump is supplied to A(B) port, and since the oil returning from motor is closed by check valve in counterbalance spool and spool,the pressure of oil from pump increses.

When this pressure becomes larger than the force of spring closing counterbalance spool,the opening of spool becomes graduary larger,causing oil to flow from D(C) to B(A) port, and the motor starts running.

If oil flow rate to motor is increased, resistance in D→B (C→A) in brake valve increases, and pressure at motor inlet side also increases making the force to press spring larger. This increases the spool opening and the motor rotate faster. If, on the contrary, oil supply decreses, the resistance becomes smaller and the force to press spring becomes smaller. This decreases the opening of spool and the motor rotates slowly.

If load increses at the time of control flow, prerssure generated by load also increses, and flow rate of the oil through passage thereby tries to be larger, but since the pressure on the motor inlet side drops if motor rotates faster, counterbalance spool is closed by spring to make passage narrow. Thus, motor speed in control flow is controlled by the oil volume supplies to motor from pump, independently of the largeness of load.

(4) Function at Stopping (Refer to Fig.8)

When control valve is set back to neutral and oil supply to A(B) port is stopped, counterbalance spool takes neutral position by means of spring, and motor stops,because the pressure of A(B) port drops. Since pressure to change-over shuttle spool is lower than the change-over pressure of counterbalance spool, shuttle spool takes neutral position after counterbalance spool is closed (that is, after the motor stops). The oil in parking brake therby returns to oil tank through shuttle spool , and the parking brake starts braking action.

3. DISASSEMBLY AND ASSEMBLY

3.1 TOOLS

Prepare in advance all tools necessary for disassembly and assembly.
Sufficient care should be taken not to damage the surface of the parts and that dirt does not enter or adhere during disassembly or assembly work. Always change the O-rings for new ones.
The part names ( ) show the symbols in Fig.3 and 4.

Tools	Nominals,etc.
Hexagon Key Wrench	2.5, 4, 8
Spanner	30
Screw Driver(-)	
Torque Wrench	0.28~10 kgf·m
Close	Clean Close

3.2 DISASSEMBLY PROCEDURES

(1) Remove O-rings (20),(23) and (34) from brake valve dismounted from motor.

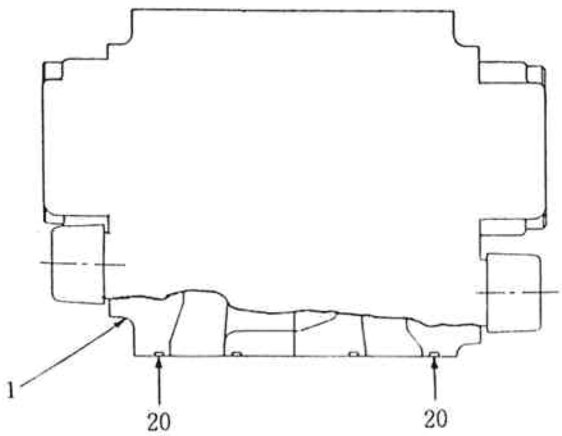


Fig.9 O-Ring Removal

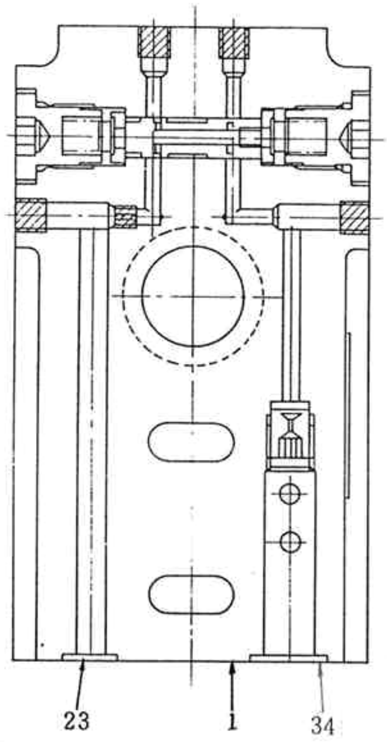


Fig.10 O-Ring Removal (Spec.2)

(2) Remove socket head capscrew (26) and cover (3) in order to take out spool (2). After removing damper (4), spring seat (5) and O-ring (19), push the end face of spool (2) and pull out spool (2) in the opposite direction.

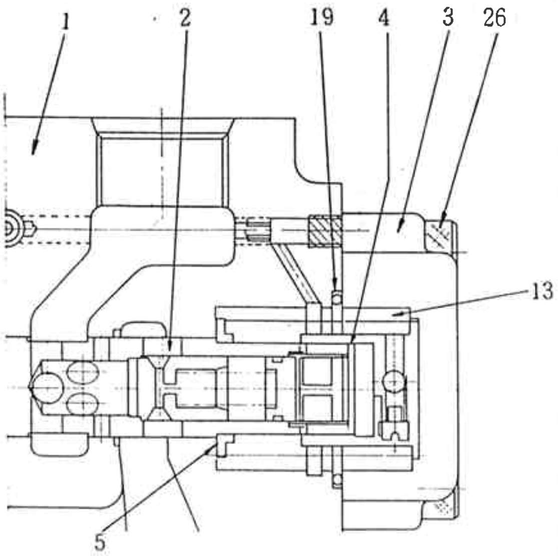


Fig.11 Spool Removal

(3) Remove plug (10) in order to take out spool (8), and then pull out spool (8) by pushing it from one side to the other side, after spring (14) and spring seat (9) are removed.

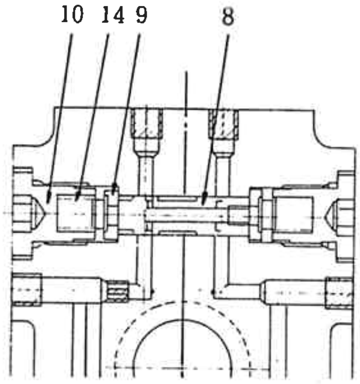


Fig.12 Spool Removal

(4) Remove relief valve (27) from body (1) after removing cap, and then take out collar (30) from body (1).

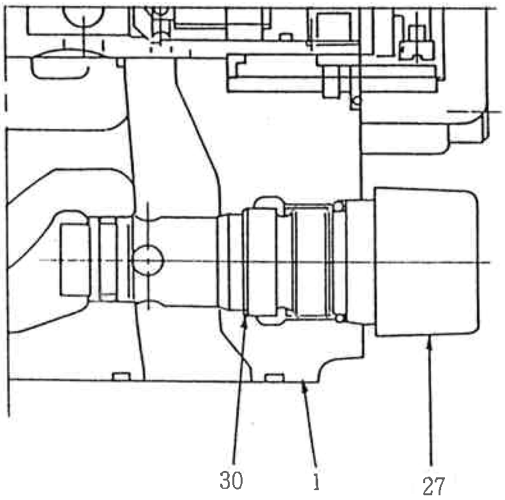


Fig.13 Relief Valve Removal

(5) Remove socket head plug (17) and orifice (11),(24),(32). Since there are three kinds of orifices, be careful so that the position at which each plug is removed is not mistaken.

3.3 ASSEMBLY PROCEDURES

(1) Assembly orifices (11),(24) and (32) to body (1). (Refer to Fig.3 and 4)
   Tighten to torque: 0.28 kgf•m

(2) Assemble socket head plug (17) to body (1). (Refer to Fig.3 and 4)
   Tighten to torque: 0.3 kgf•m

(3) When assembling relief valve (27), assemble it to body (1) after collar is first assembled to body (1).
   Tighten to torque: 10 kgf•m
   Use a new collar as far as possible. (Refer to Fig.13)

(4) Insert spool (8) into the body, and after assembling spring seat (9) and spring (14), assemble plug (10). (Refer to Fig.12)
   Tighten to torque: 3.8 kgf•m

(5) Insert spool (2) into body (1). After assembling O-ring (19), spring seat (5), spring (13),and damper (14),tighten cover (3) with socket head capscrew (26).
   Tighten to torque: 7 kgf•m

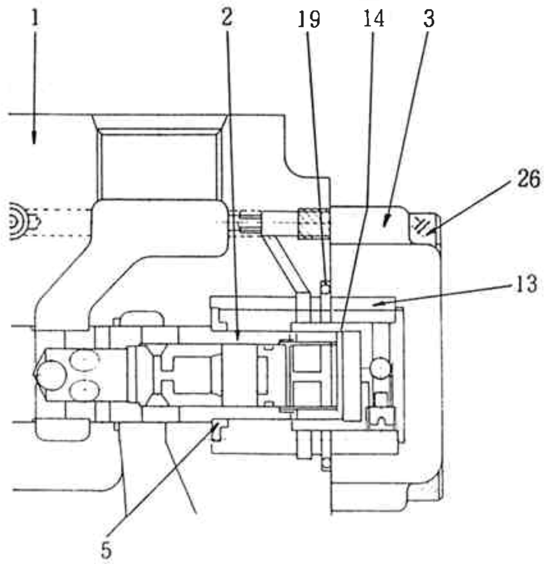


Fig.14 Spool Assembly

CAUTION

When tightening socket head capscrew (26), uneven tightening may cause spool (2) and damper (4) sticking. Tightening four capscrew evenly.

(6) Assembly cap to relief valve (24).

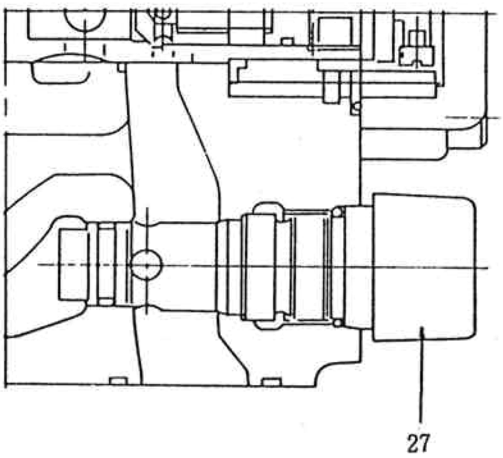


Fig.15 Relief Valve Assembly

(7) Assembly O-ring (20),(23) and (24) to body (1).

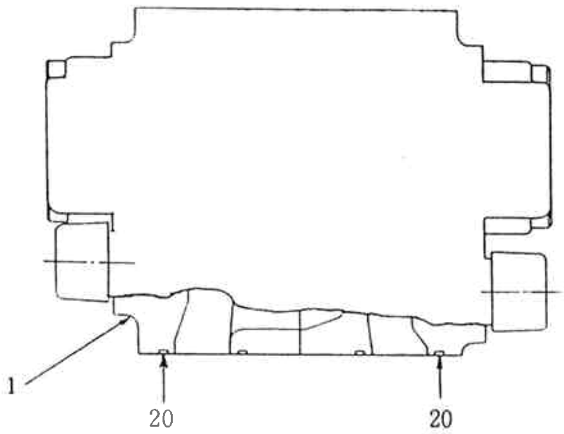


Fig.16 O-Ring Assembly

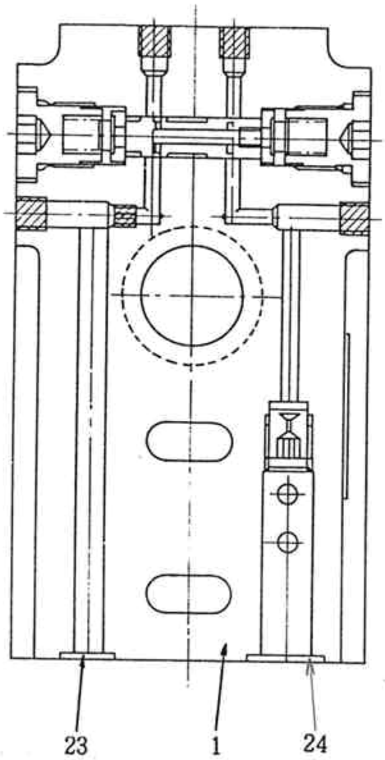


Fig.17 O-Ring Assembly

4. MAINTENANCE STANDARDS

(1) Air Bleeding
In order to bleed air completery after assembly, drive sufficiently with no-load before starting a loaded drive.

(2) Pressure Adjustment
The relief valve is set at a cracking pressure. For adjustment, remove cap-nut and loosen lock-nut. A turn to the right will raise the pressure, and a turn to the left will lower the pressure.
The increase in pressure per turn of the adjustscrew is about 150 kgf/cm^2.

(3) Tightening Torque
- Mounting bolt for valve body: 5~7 kgf•m
- Mounting bolt for piping flange: 8~9 kgf•m

5. TROUBLESHOOTING

Phenomenon	Probable Cause	Remedy
1.Motor speed can not be controlled.	(1) Faulty operation because of air in the hydraulic oil. (2) Clogged throttle and orifice. (3) Faulty operation of counterbalance spool. (4) Incorrect pressure setting of relief valve.	(1) Perform sufficient no-load operation in order to bleed air completely. (2) Disassemble and remove clogging foreign material. (3) Tighten all the assembly bolts to proper tightening torque. If scratch or any other defect is found, correct it. (4) Set to specified pressure. If the relief valve is out of order, replace it with new one.
2.Motor runs,when control valve is at newtral.	(1) Poor operation of counterbalance spool. (2) Incorrect pressure setting of relief valve.	(1) Tighten all the assembly bolts to proper tightening torque. (2) Set to specified pressure. If the relief valve is out of order, replace it with new one.
3.Motor does not run when control valve is changed over.	(1) Clogged throttle and orifice. (2) Faulty operation of shuttle spool. (3) Incorrect pressure setting of relief valve.	(1) Disassemble and remove the foreign material. (2) Tighten all the assembly bolt to proper tightening torque. If scratch or any other defect is found, correct it. (3) Set to specified pressure. If the relief valve is out of order, replace it with new one.

1. CONSTRUCTION AND FUNCTION

1-1 CONSTRUCTION

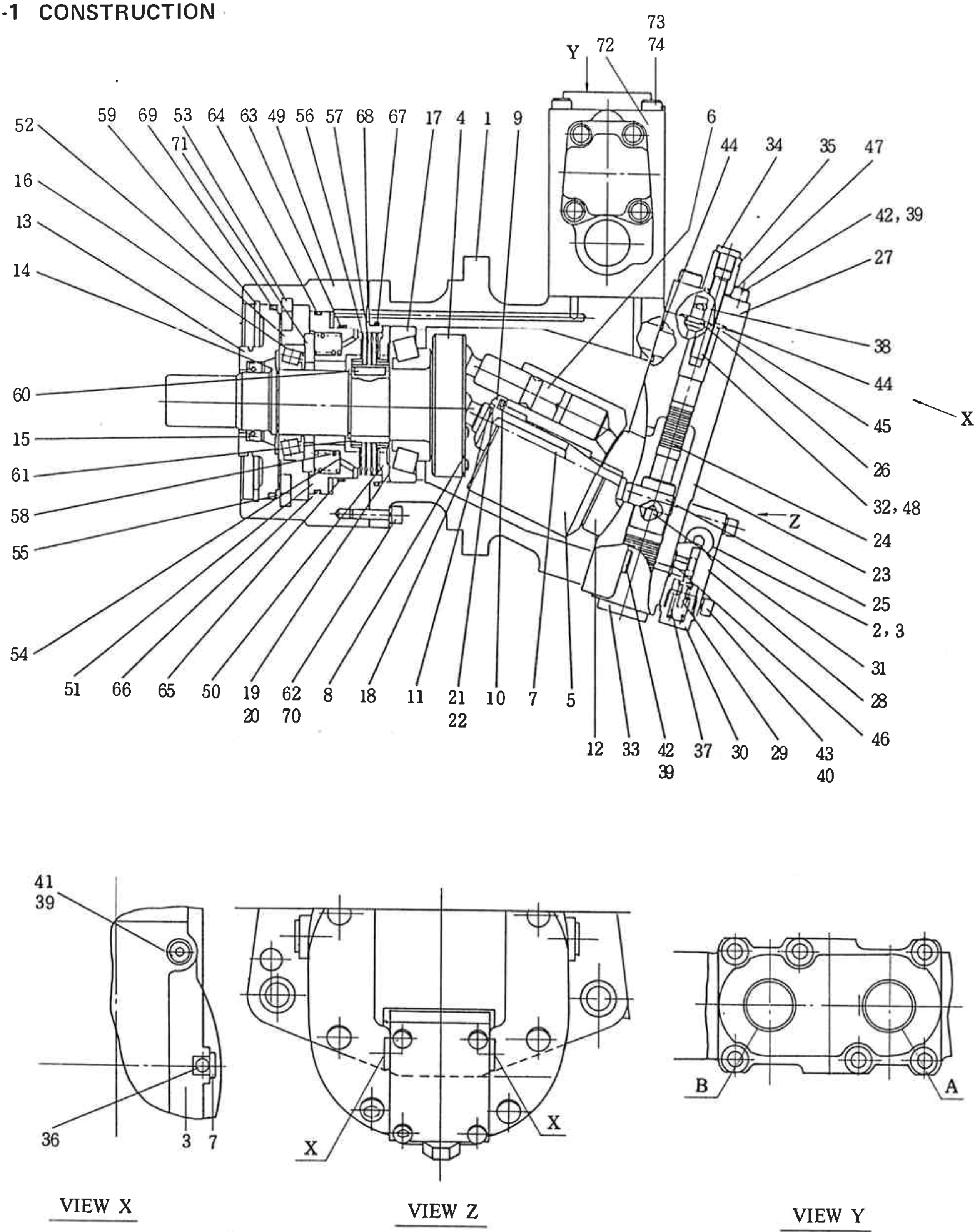


Fig. 1 Hydraulic Motor (axial piston)

1. Housing B
2. Blind plug
3. O ring
4. Drive shaft
5. Cylinder block
6. Piston, piston rod
7. Center pin
8. Retaining plate
9. Spring guide
10. Spring
11. Ring
12. Port plate
13. Oil seal case
14. C-shaped stop ring for shaft
15. Oil seal
16. Conical roller bearing
17. Conical roller bearing
18. Round flat machine screw with cross hole
19. Shim
20. Shim
21. Shim
22. Shim
23. Control main body
24. Control piston
25. Connecting rod
26. Plug
27. Regulator cover
28. 2-speed select valve
29. Spool
30. Plug
31. Hexagon socket head set screw
32. Hexagon socket head set screw
33. Plug
34. Plug
35. Lock nut
36. Parallel pin
37. Spring
38. Steel ball
39. Spring washer
40. Spring washer
41. Hexagon socket head capscrew
42. Hexagon socket head capscrew
43. Hexagon socket head capscrew
44. O ring
45. O ring
46. O ring
47. O ring
48. Copper packing
49. Housing A
50. Retaining plate A
51. Retaining plate B
52. Spacer
53. Collar
54. Shim
55. Shim
56. Iron plate
57. Brake plate
58. Spring
59. C-shaped stop ring for hole
60. Round key
61. Gear for brake
62. Hexagon socket head capscrew
63. Back up ring
64. Back up ring
65. O ring
66. O ring
67. O ring
68. O ring
69. O ring
70. Lock washer
71. Distance piece
72. Double counterbalance valve
73. Hexagon socket head capscrew
74. Hexagon socket head capscrew

This hydraulic motor is connected to a planetary reduction unit, and it is sized so as to be installed in the width of the crawlers. The speed of the motor can be shifted to high speed and low speed.

This motor is also provided with a wet type, multi-plate negative brake as a parking brake.

Cylinder block (5) rotates without receiving moment by means of center pin (7) and port plate (12). When the motor is running under no load, cylinder block (5) is pushed against port plate (12) by means of spring (10) which is installed in spring guide (9). When the pressure rises, hydraulic pressure sets up balance, and an oil film is always formed between cylinder block (15) and port plate (12). Drive shaft (4) is provided with bearings (16 and 17). Those bearings are subjected to load in axial and radial directions. For sealing the driving mechanism for outside, oil seal (15) and O-rings (69 and 44) are used. The driving mechanism is fixed to the housing by means of stop ring (59).

1-2 FUNCTION

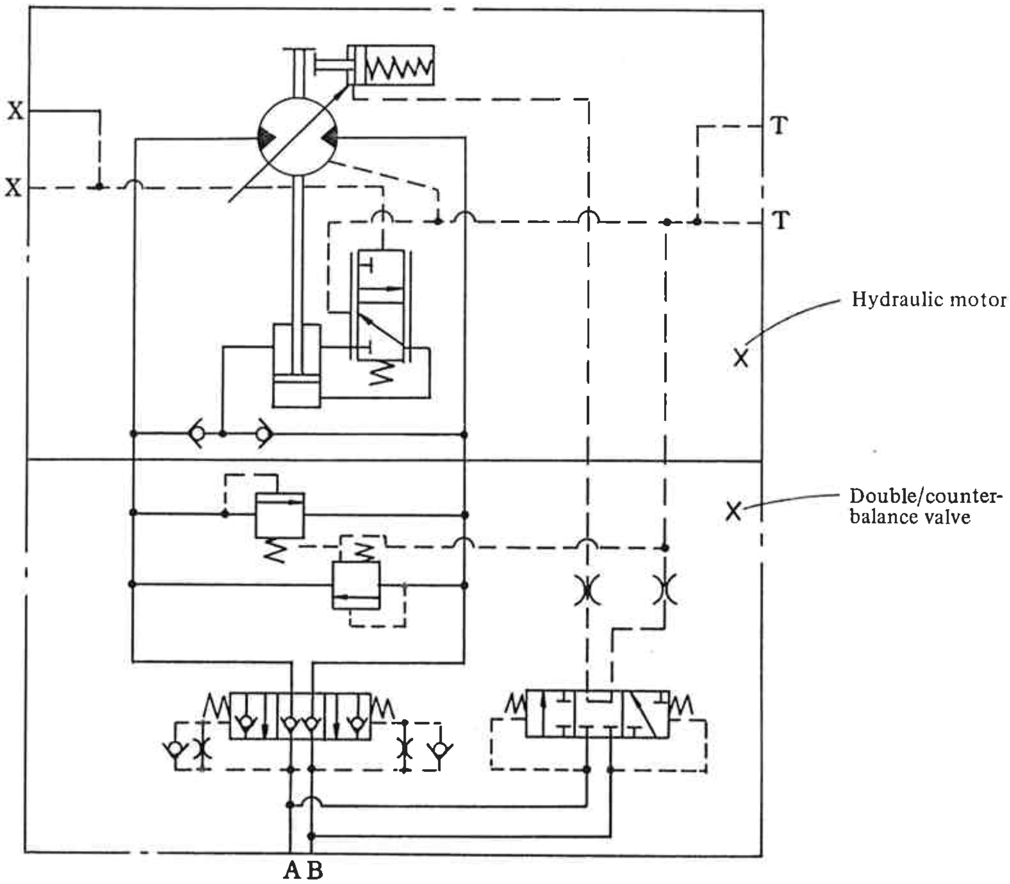


Fig. 2 Control Circuit of Hydraulic Motor

Fig. 2 shows the control circuit of the hydraulic motor. As for the function of the double counterbalance valve, refer to separate Shop Manual for double counterbalance valve.

When pressurized oil works on the "A" or "B" port, the shuttle valve under pressure for releasing the parking brake actuates, and the parking brake is released. Then the double counterbalance valve actuates, and hydraulic pressurized oil is applied to the hydraulic motor.

The pressurized oil is transmitted through port plate (12) and cylinder block (5), and rotates drive shaft (4) via piston (6).

The return oil passes in reverse through cylinder block (5) and port plate (12), through the control main body, and flows into double counterbalance valve (72).

The high speed and low speed shifting is carried out by the signal (hydraulic pressure) to the "X" port from a two-speed control valve. For the actuating pressure, the high pressure from "A" and "B" line is used via a check valve in the control main body.

When the drive shaft rotates, the cylinder block is rotated by seven movable piston rods and pistons which are installed to the drive shaft in such a way as to write a circle. At this time, the cylinder block slides on the port plate which has two slits.

In this rotation, all of the seven pistons move between the upper dead point (UT) and lower dead points (OT). and obtain stroke (h) by inclination angle (α). In the piston stroke of UT → OT, the flow volume which corresponds to the sectional piston area (F) x piston stroke (h) is sucked in through the slit on one side of the valve plate, and further, in the piston stroke of OT → UT, the oil is delivered from the other slit.

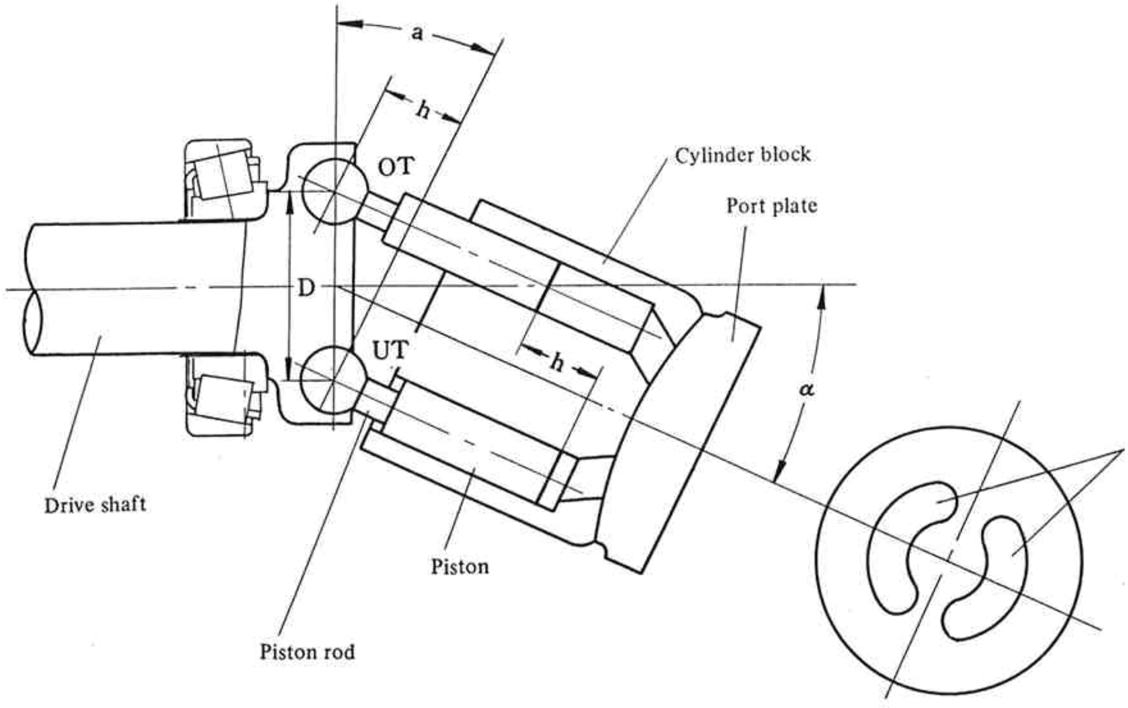


Fig. 3 Explanation of Function

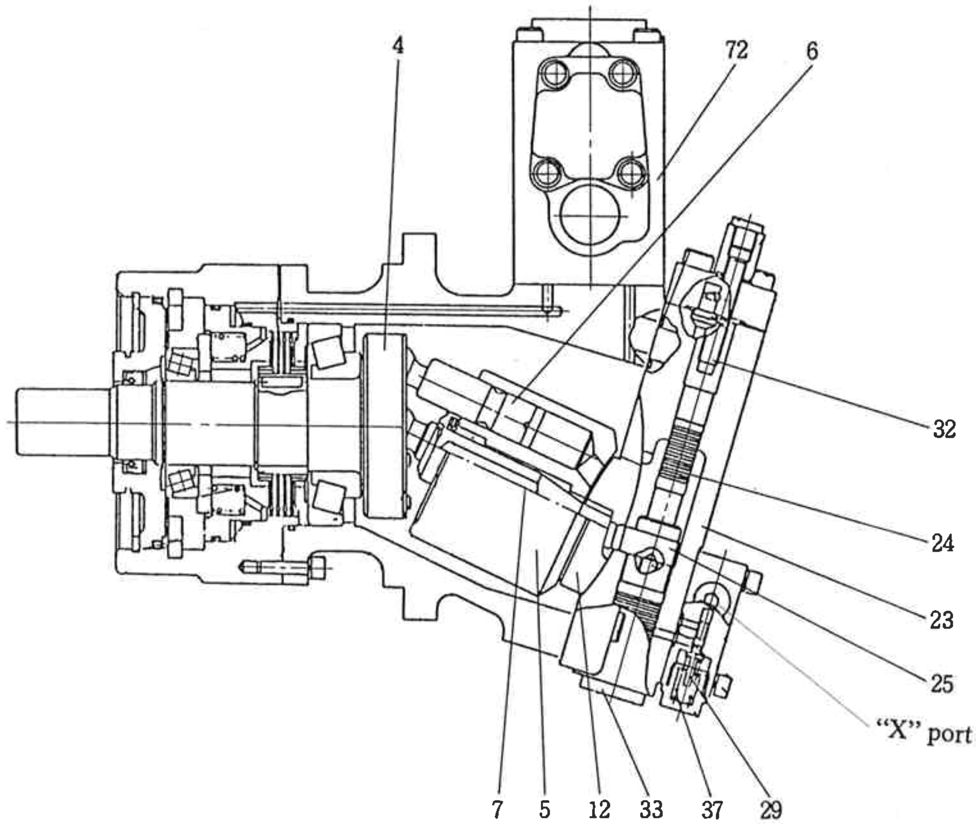


Fig. 4 Hydraulic Motor (axial piston)

If the angle made between axial center of drive shaft (4) and that of cylinder block (5) becomes smaller, the delivery volume becomes smaller. The function of control main body is to keep this angle constant or change it to a required angle. When connecting rod (25) in the control main body moves, the tip end of rod slides along the slit in the housing of control main body (23), and center pin (7) changes its angle against drive shaft (4) by port plate (12).

(1) Rotating direction of the hydraulic motor is determined by the flow direction of the pressurized oil.

Rotational direction	Flow of hydraulic oil
Rotation to the right	A → B
Rotation to the left	B → A

* Rotational direction means the direction as seen from the output shaft.

(2) Selection of high speed and low speed is determined by pressurized oil to the "X" port.

	"X" port pressure
High speed	80 kgf/cm^2 min.
Low speed	20 kgf/cm^2 max.

* Intermediate speed for 25 ~ 75 kg/cm^2.

(a) When the hydraulic pressure to "X" port is low.

Spool (29) is pushed by compression spring (37), the pressurized oil from the pump is applied to the small diameter room of piston (24) and the large diameter room is communicated to the tank.

Accordingly, control piston (24) is pushed against plug (33), port plate (12) is also on the maximum inclination side, and the flow volume becomes maximum.

(b) When the hydraulic pressure to "X" port is high.

Hydraulic pressure applied to spool (29) compresses spring (37), applying the pressure to the small diameter room and the large diameter room of piston (24).

Accordingly, control piston (24) is pushed against hexagonal socket head set screws (32) side, port plate (12) is also on the minimum inclination side, and the flow volume becomes minimum.

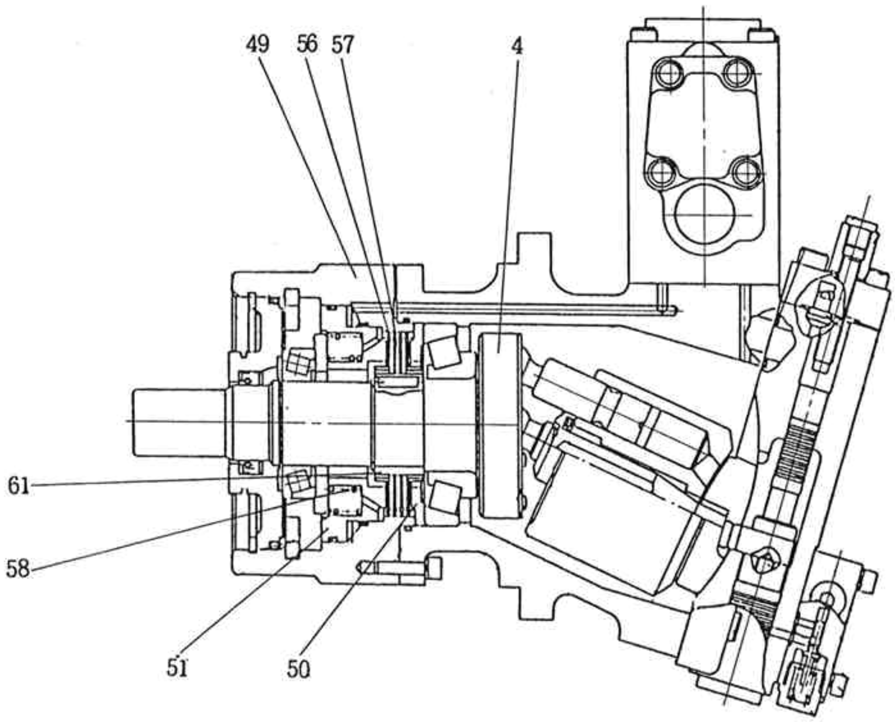


Fig. 5 Hydraulic Motor (axial piston)

(3) Parking brake is determined by the pressure in "A" or "B" port.

If the pressure is more than 5 kgf/cm^2, the parking brake torque is zero.

If the pressure is at 0 to 5 kgf/cm^2, the parking brake torque decreases as the pressure increases. Therefore, be careful for the back pressure.

This brake is a negative brake, and is released by applying the hydraulic pressure from the high pressure select valve to retaining plate "B" (51). If there is not pressure, braking force always develops.

The braking force is generated by the friction force between iron plate (56) connected to housing (49) by spline and brake plate (57) connected also by spline to the housing via brake gear (61).

Now, if the pressure is not applied on retaining plate "B" (51), the retaining plate "B" is pushed by spring (58), and develops the friction force due to the pushing force between itself and retaining plate "A" (50) with the brake plate and iron plate in between. This friction force constrains the drive shaft (4), and braking force is thus applied.

2. SPECIFICATIONS

Item	Low speed	High speed
Type	A6V107	
Theoretical suction volume	107 cc/rev.	57 cc/rev.
Volume efficiency	1.0	1.0
Mechanical efficiency	0.9	0.9
Maximum flow-in volume	153.9 ℓ/min.	
Set pressure of relief valve	230 kg/cm^2	
Effective pressure	220 kg/cm^2	
Maximum motor speed	1438 rpm	2700 rpm
Maximum motor output torque	33.7 kg·m	18.0 kg·m

3. DISASSEMBLY

Disassembly should be carried out as follows:
Tools that are needed are listed below. They should be on hand before disassembly starts. In disassembly work, place parts on a spot that is covered with clean cloth not to scratch the surfaces (especially sliding surfaces) of parts, and keep dusts off parts.

The figures in (   ) after part name correspond to parts number in Fig. 1 and Fig. 4 through Fig. 16.

Tool Name	Size and Quantity	
Allen wrench	Nominal size: 6, 8, 10 mm	1 each
Screw driver	Nominal size: 8 x 150 mm	2
Monkey wrech	Nominal size: 250 mm	1
Hammer	Plastic hammer	1
Snap ring pliers	For hole (large size) For shaft (Medium size)	1 each
Thread Lock	Loctite #270	
Liquid packing	Loctite #515	
Grease		
Bolt	Bolt more than M5 x 50mm	2

This hydraulic motor can be roughly divided into three groups, brake section, control section and rotary group, but rotary group can not be disassembled by itself. It can be disassembled after the brake section and the control section are disassembled.

3-1 DISASSEMBLY OF BRAKE SECTION

Double counterbalance valve (72) is removed by removing hexagon socket head capscrews (73 and 74). For disassembly of the brake section, place the hydraulic motor with its output shaft pointing upwards, and care should be taken so as not to tip it.

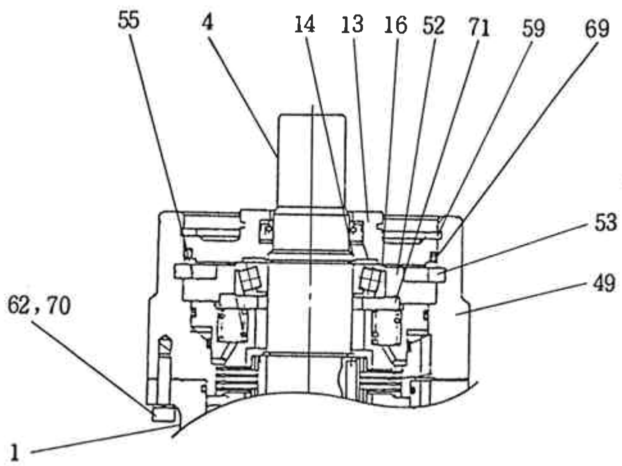


Fig. 6 Disassembly of Brake Section

(1) Pull out stop ring (59) from housing "A" (49).

(2) Use minus screw driver to the groove on the case, and pull out oil seal case (13) using housing "A" (49) as a fulcrum. Remove O ring (69) and shim (55).

(3) Loosen hexagon socket head capscrew (62) and lock washer (70) which secure housing "A" (49) and housing "B" (1), and extend the matching faces of both housings to 3 to 4mm distance.

(4) Remove split collar (53), and remove spacer (52). Since spacer (52) has two pull-out tap holes of M5, use an M5 bolt in the hole and pull out it.
(5) Remove C-shaped stop ring (14) which is attached to drive shaft (4).
(6) Remove the inner and the outer races of bearing (16) and distance piece (71).
(7) Remove springs (58) and shims (54) which are installed in retaining plate "B" (51). However, pay attention to the number of shims because it is different for adjusting the parking brake.

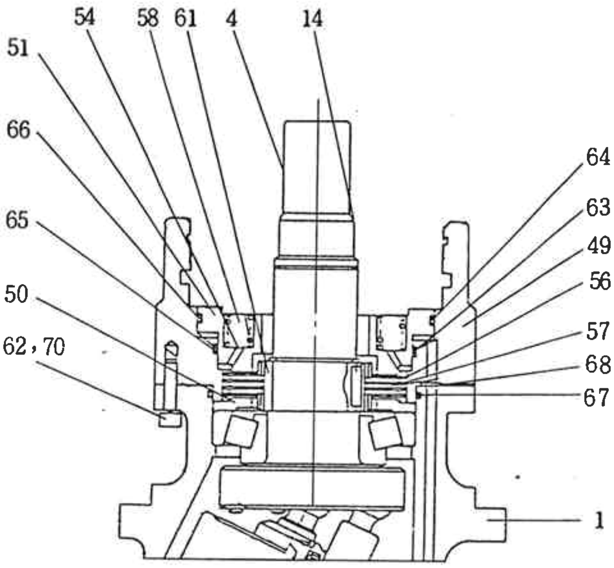


Fig. 7 Disassembly of brake section

(8) Remove hexagon socket head capscrews (62) and lock washers (70), and remove housing "A" (49).
(9) Remove retaining plate "B" (51) by tapping it with a plastic hammer from the side which has spline machining because the retaining plate "B" is in the housing "A" (49).
(10) Remove iron plate (56), brake plate (57) and retaining plate "A" (50).
(11) Remove C-shaped stop ring (14) from drive shaft (4), and remove gear (61) for brake.
(12) Remove each of O rings (65, 66, 67 and 68). When backup rings (63 and 64) are removed, do not pull them too hard or they will expand.

3-2 DISASSEMBLY OF CONTROL SECTION

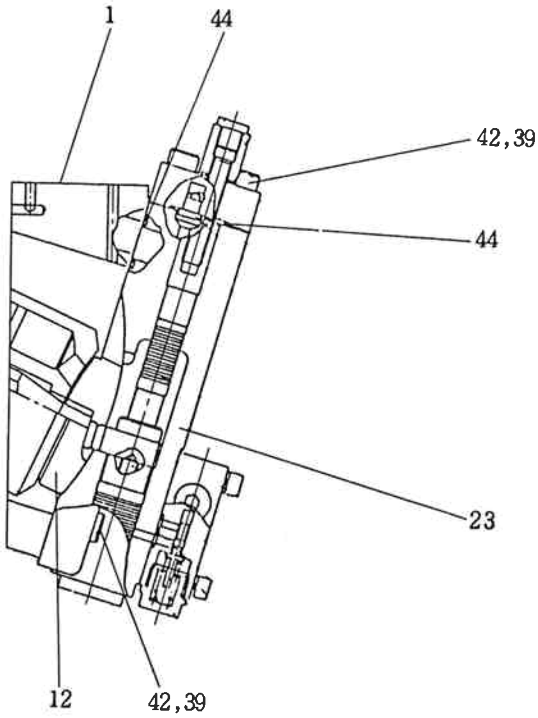


Fig. 8 Removal of Control Section

(1) Remove eight hexagon socket head capscrews (41 and 42) and washers (39) which secure control main body (23) to housing "B" (1).
(2) Remove control main body (23) by tapping it with a plastic hammer. There are two parallel pins (36) and O rings (44) between housing "B" (1) and control main body (23).

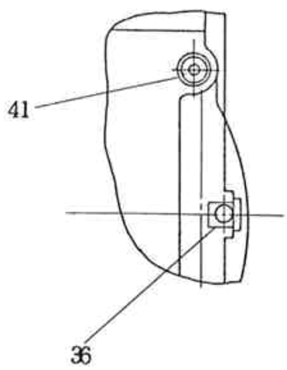


Fig. 9 Removal of Control Section

Take care so as not to drop port plate (12) during disassembly.

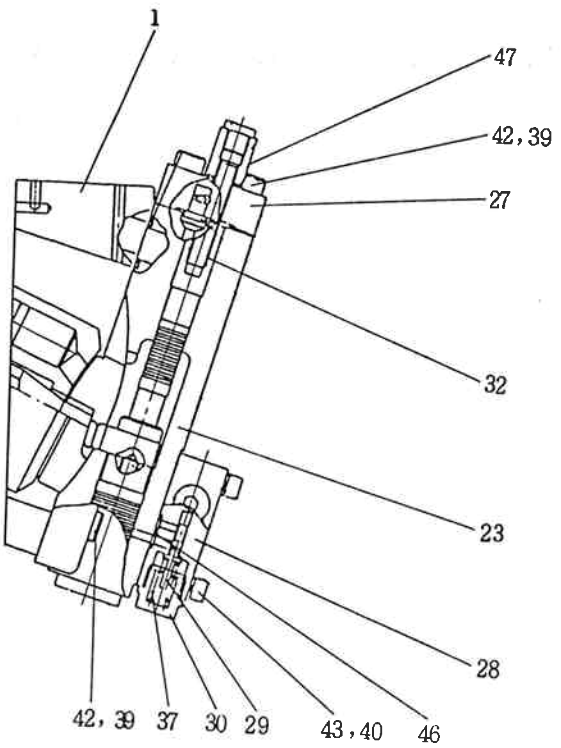


Fig. 10 Disassembly of Control Section

(3) Remove regulator cover (27) by removing four hexagon socket head capscrews (42) and four lock washers (39).

(4) There are four O rings between regulator cover (27) and control main body (23).

(5) Remove regulator cover (27) without moving the hexagon socket head capscrews (32) which set up the minimum inclination angle.
The regulator cover is mounted with four hexagonal socket head capscrews (42).

(6) Remove 2-speed select valve (28) by removing hexagon socket head capscrews (43) and lock washers (40).
There are three O rings (46 and 47) at the matching faces.

(7) Spool (29) of 2-speed select valve (28) comes out with spring (37) by removing plug (30).

3-3 DISASSEMBLY OF ROTARY GROUP

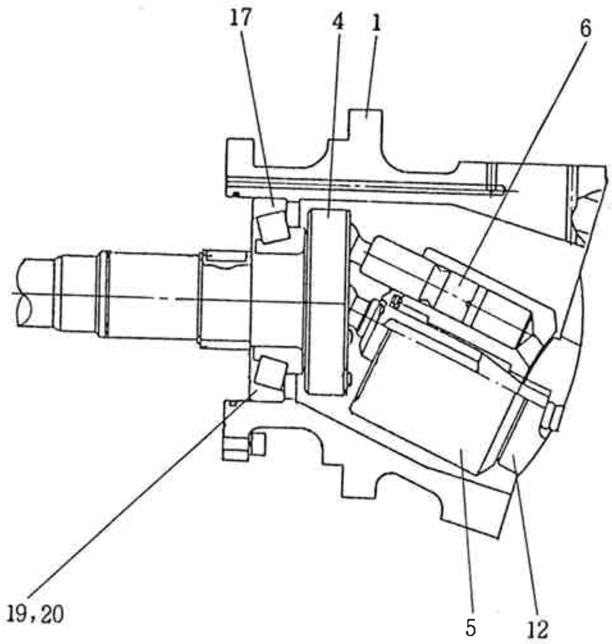


Fig. 11 Disassembly of Rotary Group

After disassembling the brake and the control sections by the topics 3-1 and 3-2, disassemble the rotary group.

(1) Remove port plate (12).

CAUTION

Be careful not to drop cylinder block (5).

(2) Drive shaft (4), bearing (17), piston (6) and cylinder block (5) can be taken out as a group.

CAUTION

Be careful in the above removal because shims (19 and 20) are inserted between the outer race of bearings (17) and housing "B" (1). Since they are for adjusting dimension, take note of the number of shims.

(3) Drive shaft (4), piston section (6), and cylinder block (5) are adjusted for dimension. They should be, therefore, left as one body without further disassembly.

4. ASSEMBLY

Take the steps of disassembly in reversed order for assembly. After the rotary group is assembled, assemble the brake section and control section.

4-1 ASSEMBLY OF ROTARY GROUP

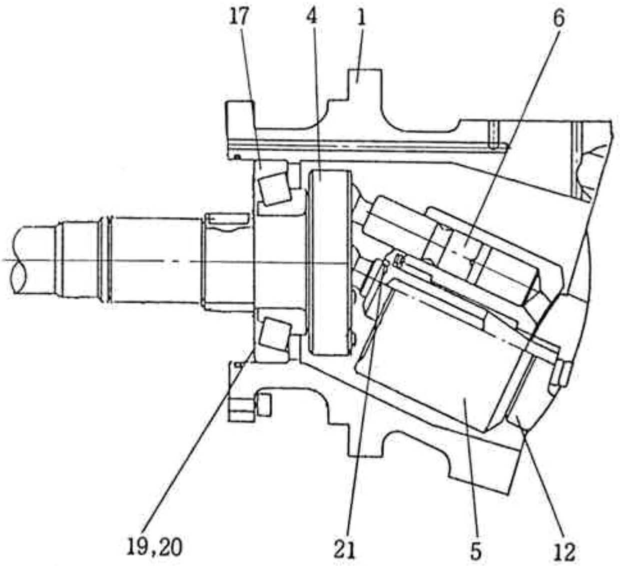


Fig. 12 Assembly of rotary group

(1) Install the assembly of drive shaft (4), piston section (6) and cylinder block (5), etc. which were removed as a one body to housing "B" (1) so that this assembly does not touch the outer race of bearing (17) in the housing "B".

NOTE

Assemble by pushing cylinder block (5) against drive shaft (4) so that ring (21) will not fall.

(2) Install port plate (12) without scratching the spherical surface of cylinder block (5).

NOTE

Apply clean hydraulic oil on the sliding faces before assembly.

4-2 ASSEMBLY OF CONTROL SECTION

(1) Install spool (29) and spring (37) to 2-speed select valve (28), and cover it with plug (30).
The tightening torque for plug (30) is 6 Kgf·m.

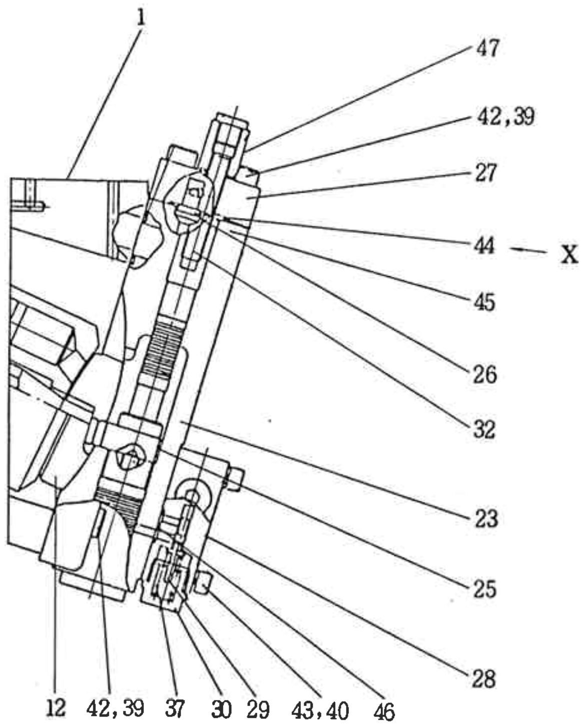


Fig. 13 Assembly of Control Section

(2) Confirm the dimension of the protruding section of minimum inclination angle setting screw (32) from regulator cover (27).

(3) Install check plug (26) by applying "Loctite #270" on the thread and tighten it with 2 kgf·m.

(4) Install plug (26) to control main body (23) so as to make the head of the plug go in, paying attention to four spots of O rings (44 and 45) on the matching faces of regulator cover (27), and secure it with hexagon head capscrews (42) and lock washers (39). The tightening torque of the hexagon head capscrew is 12.5 kgf·m.

(5) Apply "Loctite #515" on the matching faces, paying attention to two faces of O rings (44) at the matching faces of control main body (23).
Install parallel pin (36) to control main body (23), and insert connecting rod (25) into the center hole of port plate (12), then install control main body (23) to housing "B" (1).
Secure the control main body with hexagon socket head capscrews (41 and 42) and washer (39). Pay attention to the length of the hexagon socket head capscrews.
Their tightening torque of the hexagon socket head capscrew is 12.5 kgf•m.

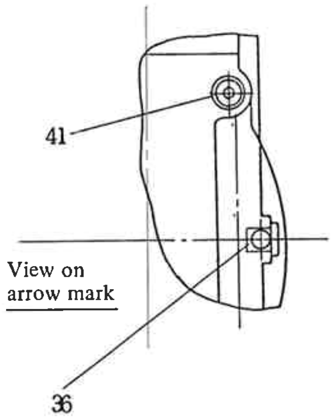


Fig. 14 Assembly of Control Section

4-3 ASSEMBLY OF BRAKE SECTION

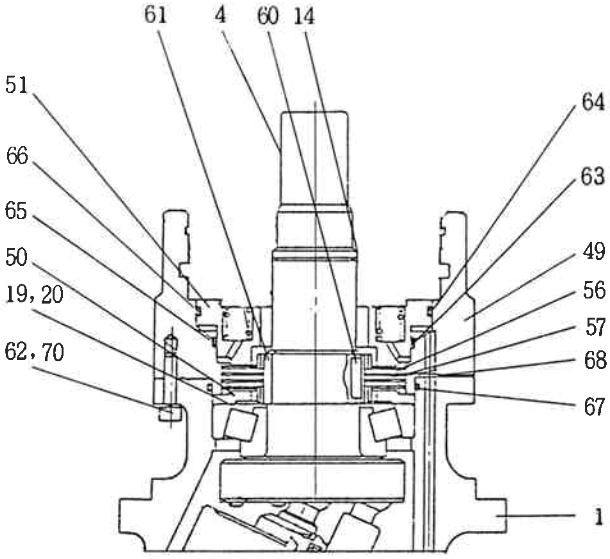


Fig. 15 Assembly of Brake Section

Make the output shaft of the control section point upwards after assembly of the rotating group and control section.

(1) Install shims (19 and 20) and retaining plate (50) to the housing "B" (1).
(2) Install key (60) to drive shaft (4), and install gear (61) for brake. After the installation, secure them with C-shape stop ring (14).
(3) After confirming O ring (67) of housing "B" (1) and O ring (68) of housing "A" (49), install the housing "A" (49) to the housing "B" (1) in such a way that the hydraulic puressure circuit of brake release comes to the same position.
Secure it with hexagonal socket head capscrews (62) and lock washers (7), but leave 3 to 4mm clearance.
(4) Install alternately iron plate (56) and brake plate (57) in this order. The first and the last are iron plates (56).
(5) Confirm O ring (65) and backup ring (63) in the housing "A" (49), and apply grease on them.

(6) Install O ring (66) and backup ring (64) to the outer periphery of the retaining plate "B" (51). At this time be careful not to expand backup ring (64) by pulling it too hard.

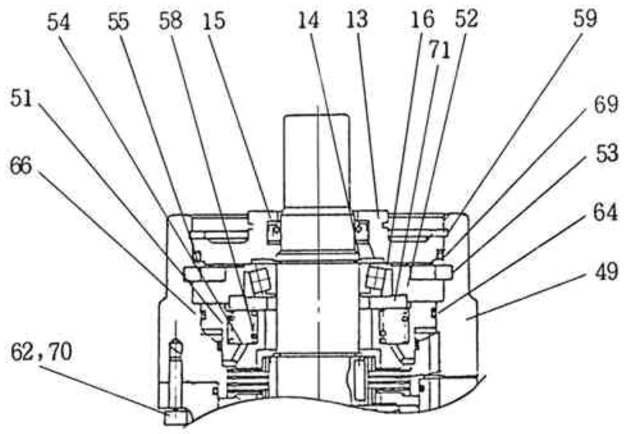


Fig. 16 Brake Assembly

(7) Apply grease to outer periphery of retaining plate (51), and install it to housing "A" (49). Because there is resistance from the seal, install it not to bend it by tapping it with a plastic hammer evenly.

(8) Install shims (54) and springs (58) to the retaining plate "B" (51). There are eight holes for spring in the retaining plate "B", but the number of springs (58) is six. Three springs as a group are to be positioned to form symmetry with other group of three springs.

(9) Install distance piece (71), and next install bearing (16).
Install C-shape stop ring (14).

(10) Install spacer (52).

(11) It is required to make housing "A" (49) float up by 3 to 4mm in order to install collars (53).
After two collars (53) are installed in the housing "A" (49), tighten hexagon socket head capscrews (62) and lock washers (70) with tightening torque 3.6 kgf·m.
Confirm that collars (53) are entirely in the housing "A" (49).

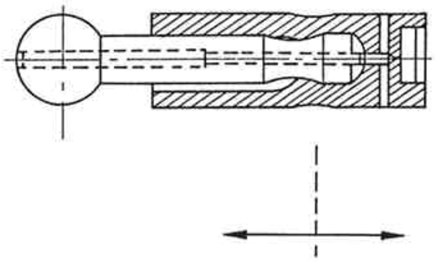
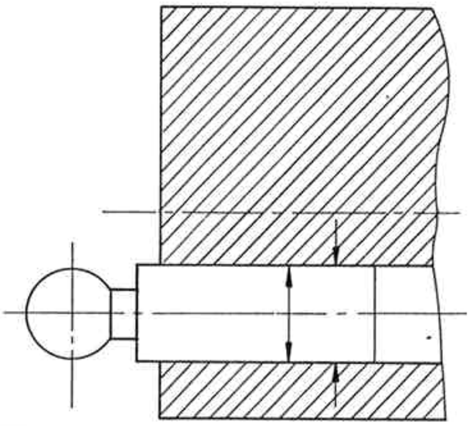
(12) Install the shims (55). Apply grease on O ring (69), and install it.

(13) Install oil-seal case (13) to housing "A" (49). Be careful not to scratch oil seal (15). Using a plastic hammer makes the installation easier.

(14) Install C-shape stop ring (59). Confirm that it is surely inserted.

(15) Confirm that starting torque for the drive shaft is 10 to 12 kgf·m.
If it is less than 8 kgf·m, it is necessary to adjust the brake torque. Disassemble the brake section, and adjust with the shims (54).
Difference of 1mm thickness of shim gives 3 kgf·m braking torque variation.
Install double counterbalance valve (72) to the hydraulic motor. Take note that one of the hexagon socket head capscrews (73 and 74) for mounting is shorter. The tightening torque is 7 kgf·m.

5. INSPECTION AND MAINTENANCE PROCEDURES

Inspection Item	Maintenance Procedures
1. Inspect the state of groove in the snap ring of drive shaft.	1. If damaged, repair or replace.
2. Inspect the state of spline of the drive shaft.	2. If there is step or wear in the spline section, replace it.
3. Inspect the state of installation of drive shaft and bearing.	3. Replace for cases below. · No smooth rotation. · Large play. · Noises. · Scratch the rolling face of the ball.
4. Inspect the state of installation of housing and bearing.	4. The same as above.
5. Inspect the spherical receiving face of drive shaft.	5. Repair by lapping between piston and center pin. Replace if there is unrepairable damage or crack or scratch in nitrified surface.
6. Inspect the retaining plate.	6. Inspect flatness and scratch. If there is abnormality, replace it.
7. Inspect the state of heads of piston pin and centerpin.	7. If there is peeling-off or scratch in the nitrified surface, replace it.
8. Check for play in axial direciton of piston pin. 	8. Maximum allowable play: 0.5mm. Replace if it exceeds this value.
9. Check for play in axial direction between cylinder block and piston pin 	9. Maximum allowable play: 0.05mm Replace if it exceeds this. Replace if scratches on the outer periphery of piston or inside cylinder block are detected.
10. Inspect sliding face of cylinder block.	10, 11. Replace if there is scratch in the sliding face. Sometimes scratch can be removed by lapping between port plate and cylinder block (Using #360 ~ #750 lapping agent). Replace, even if scratch is removed, if the hardness is below 750 Hv10 at the sliding face.
11. Inspect sliding face of port plate.	

CAUTION

Adjustment points are: 1; 2-speed select value, 2; minimum inclination angle. Both are adjusted at the time of shipment. Never change this.

6. INSPECTION AND TEST PROCEDURES

The following inspection should be carried out before operation in order to check function.

Inspection and Test Procedures	Maintenance Standards
1. Inspection before operation. Pay attention to the following before operation. (1) Is piping as in the circuit chart? Are joints correctly tightened? (2) Are the reduction unit and hydraulic motor properly installed? (3) Is oil in the hydraulic motor casing? (4) Is the pressure in "X" port below 20 kgf/cm^2? When starting, allow the engine to run in idle. (5) Be careful for back pressure at "T" port. Keep the gauge pressure under 2 kgf/cm^2.	
2. No load running test. (1) At start, perform idling for about 15 minutes. (2) Turn on the signal to 2-speed select value, and confirm the function at high speed and low speed.	(1) There should be no oil leakage, abnormal noises, abnormal vibration and temperature rise. (2) Rotational direction should be correct.
3. Load test If there is no abnormality in step 2, increase the load gradually, and bring the pressure to the operating pressure, and run the engine at this pressure for 1 ~ 2 minutes.	There should be no oil leakage, abnormal noises, abnormal vibration and excessive temperature rise.
4. Confirmation after test. After stopping the engine, check looseness in bolts and couplings. Retighten it if necessary.	

7. TROUBLESHOOTING

Phenomenon	Probable cause	Remedy
1. Motor speed can not be controlled.	(1) Malfunction due to air. (2) Clogging in throttle and orifice plug. (3) Malfunction of counterbalance valve spool. (4) Improper pressure setting of relief valve. (5) Insufficient incoming oil. (6) High temperature and much leakage. (7) Excessive wear in piston, cylinder block or valve plate.	(1) Sufficient no load running and bleed air. (2) Disassemble and remove foreign material. (3) Retighten mounting bolts by proper tightening torque. Repair, if scratched when disassembled. (4) Set properly. If defective or out of order, replace it. (5) Check for pump delivery and leakage from valves up to the motor. (6) Lower the temperature of hydraulic oil. (7) Replace.
2. Motor runs at neutral of control valve.	(1) Malfunction of counterbalance valve spool. (2) Improper pressure setting of relief valve.	(1) Retighten the mounting bolts by proper tightening torque. If scratch is found upon disassembly, replace it. (2) Set properly. Replace it if out of order.
3. Motor does not run by changing over control valve.	(1) Clogging in throttle and orifice plug. (2) Malfunction of shuttle valve. (3) Improper pressure setting of relief valve. (4) Over loading (5) Seizure in moving section. (6) Damage to drive shaft (break and wear)	(1) Disassemble and remove foreign material. (2) Retighten mounting bolts with proper tightening torque. If scratch found in disassembly, correct it. (3) Set properly. Replace it if it is out of order. (4) Release the load. (5) Inspect piston, cylinder block, valve plate, etc., and repair or replace. (6) Replace it.
4. Oil leakage from oil seal.	(1) Lip caught dust. (2) Scratch or wear on shaft. (3) Shaft is rusty. (4) Abnormally high casing pressure.	(1) Replace oil seal. (2) Replace it. (3) Disassemble, correct shaft and replace oil seal. (4) If drain pipe is clogged, correct it.
5. Oil leakage from joint.	(1) Installation of an O ring forgotten. (2) Scar or cut in O ring. (3) Scratch on seal surface. (4) Bolt is loose or broken.	(1) Install correctly and reassemble. (2) Replace it. (3) Disassemble and correct. (4) Tighten with proper torque or replace it.
6. Abnormal noise.	(1) Damage to bearing. (2) Seizure in other moving part. (3) Faulty installation by for example, loose bolts.	(1) Replace it. (2) Replace damaged part. (3) Tighten properly.

1. GENERAL

1.1 DESCRIPTION

These motors are axial piston, fixed displacement type, and contain negative brakes.

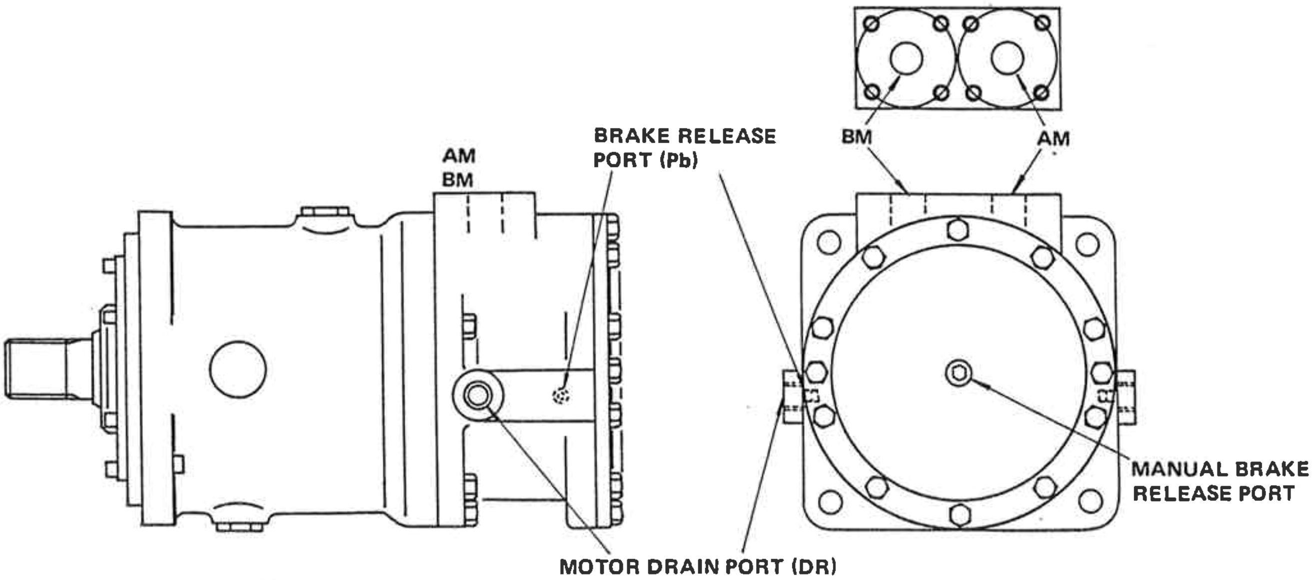


Fig.1 MX250B0

1.2 SPECIFICATIONS

1.2.1 Motor Section

Table 1

Model	Theoretical Displacement cc/rev.	Pressure (kg/cm^2)		Rotation (rpm)		Theoretical Output Torque (kg·m)	Theoretical Output Horse-power (KW)	Weight (kg)	Variation within Similar Model ( ) denotes Displacement
		Rating	Max.	Rating	Max.	1)	2)	3)	
MX45	45.3	250	350	1400	2400	18	44	15	
MX64	64.0			1250	2100	25	55	20	MX55 (55.8)
MX84	84.4			1150	1950	33	67	28	MX80 (78.9)
MX111	111			1000	1700	44	77	40	MX90 (96.4)
MX160	160			950	1400	64	85	49	MX120 (119) MX130 (128) MX150 (149)
MX250	252			800	1200	100	123	62	
MX500	485			640	960	193	190	114	MX450 (451) MX530 (535)
MX750	737			560	830	293	250	165	MX700 (686)
MX950	947			500	760	377	290	210	

NOTE

1) A theoretical value which does not include mechanical efficiency at rated pressure.
2) A theoretical value at rated pressure and maximum rotation.
3) A weight of the Motor Section.

1.2.2 Brake Section

Table 2

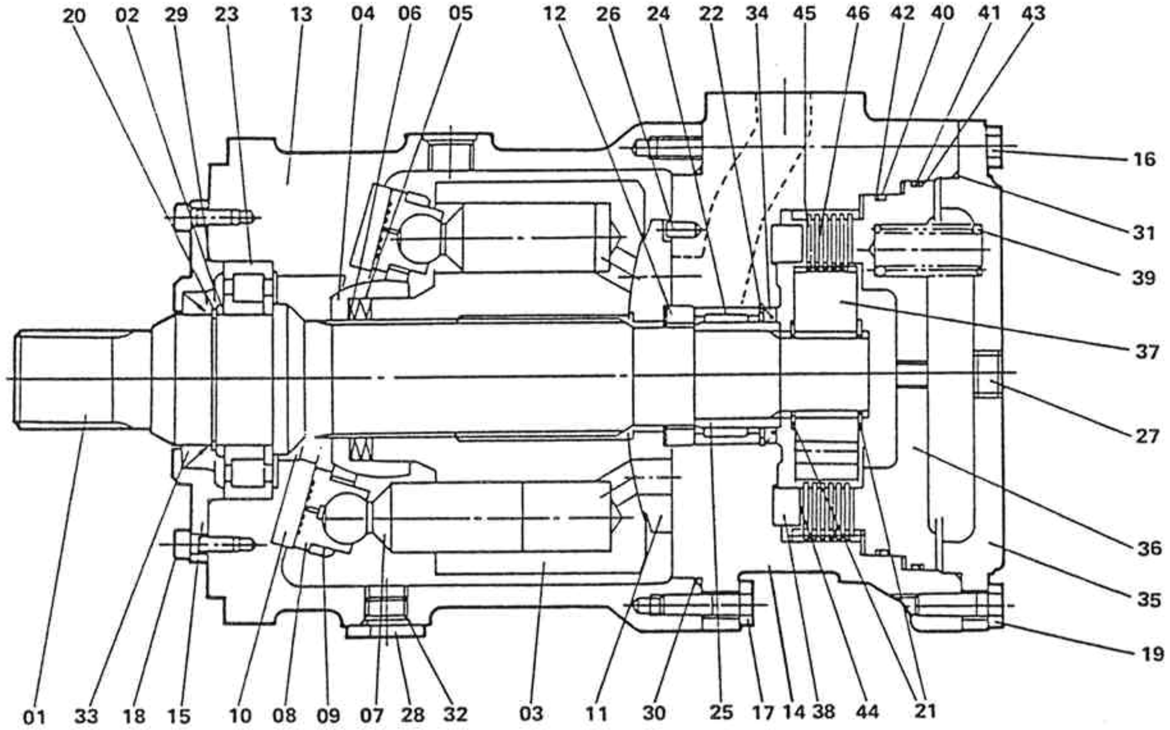
Model	Max. Brake Torque(kg·m)	Releasing Pressure(kg/cm^2)
MX250B	110^{+20}_{-0}	23^{+5}_{-0}
MX500B	170	10
MX750B	293	10

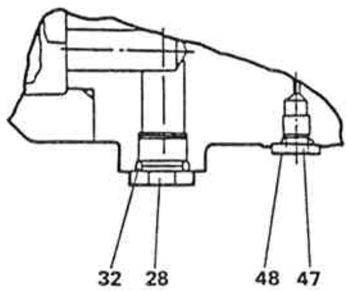
1.2.3 Weight (Overall Weight)

MX250B ... Approx. 80 kg

2. CONSTRUCTION

Construction of the motor with the negative brake is shown in Figure 2. The item numbers in the following description in this manual correspond to the numbers in Figure 2.





01. DRIVE SHAFT
02. SPACER
03. CYLIDER BLOCK
04. BUSHING
05. SPRING
06. SHIM
07. PISTON
08. SHOE
09. KEEPER PLATE
10. SHOE
11. VALVE PLATE
12. GUIDE RING
13. CASE
14. VALVE COVER
15. FRONT COVER
16. CAPSCREW
17. CAPSCREW
18. CAPSCREW
19. CAPSCREW
20. SNAP RING
21. SNAP RING
22. SNAP RING
23. ROLLER BEARING
24. ROLLER BEARING
25. INNER RACE
26. PIN
27. PLUG
28. PLUG
29. O-RING
30. O-RING
31. O-RING
32. O-RING
33. OIL SEAL
34. OIL SEAL
35. BRAKE COVER
36. BRAKE PISTON
37. COUPLING
38. SPACER
39. SPRIUNG
40. O-RING
41. O-RING
42. BACKUP RING
43. BACKUP RING
44. SHIM
45. SEPARATOR PLATE
46. FRICTION PLATE
47. PLUG
48. O-RING

Fig.2 MX250BO

3. OPERATION

3.1 MOTOR SECTION

When high pressure oil enters cylinder block (03) through inlet port (AM) on ball surface valve plate (11) which distributes oil coming in and out, hydraulic pressure actuates to piston (07) to generate axial force (F).
This force (F) is decomposed into vectors of vertical force (F1) against shoe plate (10) and right angle force (F2). Force (F2) is transmitted to cylinder block (03) through piston (07) and generates a rotating couple around the output shaft.
The cylinder block is arranged equally with nine pistons, and rotating torque of the pistons connected to the inlet port of high pressure oil is transmitted to the output shaft.
Reversing the direction of oil coming in and out reversesthe rotating direction of the output shaft.
Theoretical output torque T is given with the following formula.

$$T = q \times p / 2\pi \times 100$$

Here T ..... Output Torque (kg·m)
p ..... Efficient pressure (kgf/cm^2)
q ..... Displacement per one turn (cc/rev.)

Direction of Rotation

High pressure oil from the pump enters the motor to rotate the motor output shaft (drive shaft). Direction of the rotation is decided according to oil flow to the motor.

Table 3 Direction of Rotation

INLET	OUTLET	DILECTION (Viewed from Shaft)
AM	BM	Rotation to the left
BM	AM	Rotation to the right

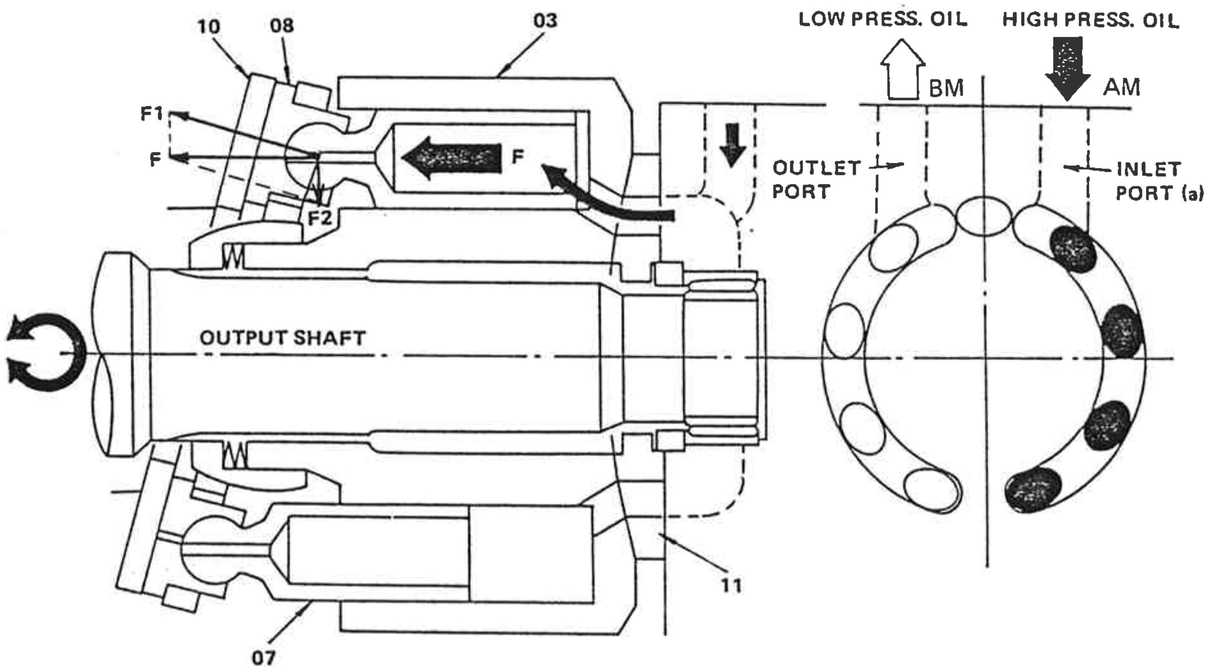


Fig.3 Motor Operation

3.2 BRAKE SECTION

Braking force is generated by friction between separator plates (45) connected to valve cover with splines and friction plate (46) connected to the output shaft through spline coupling (37).

When pressure does not actuate to brake piston (36) chamber, the brake piston is pushed with spring (39) against spacer (38) through friction plate (46) and separator plates (45), and friction force is generated by this pushing force. By this friction force the output shaft is restrained, and the brake is engaged.

The brake is released by the pressure sending to the brake chamber from outside.

The brake can be released manually by means of the following procedure.

Remove plug (27) from brake cover (35), and screw a capscrew into the tapped hole on brake piston (36) to draw the brake piston toward the brake cover.

Table 4

Model	Capscrew Size × Length (mm)	Amount
MX250B	M16 × 45 ~ 50	1
MX500B	M12 × 40 ~ 50	2
MX750B	M16 × 45 ~ 60	1

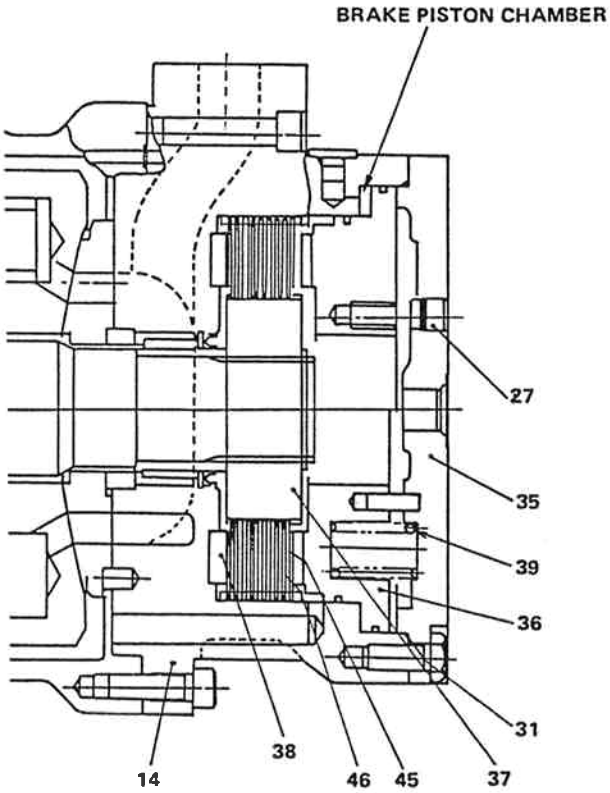


Fig.4 Negative Brake Operation

4. TROUBLESHOOTING

4.1 MOTOR SECTION

Table 5-1

Trouble	Cause	Remedy
1. The motor does not rotate.		
A. Pressure does not rise.	Relief valve in circuit is not set to correct value.	Set relief valve to correct value.
B. Pressure rises properly.	1) Overload.	1) Relieve load.
	2) Seizure of moving parts.	2) Check piston, shoe, cylinder or valve plate, etc. Repair or replace.
2. Direction of rotation is reverse.	1) Rotating direction of the motor is reverse.	1) Reassemble the motor correctly.
	2) Inlet and outlet of piping is reverse.	2) Correct piping.
3. Rotation does not reach preset value	1) Insufficient incoming oil flow.	1) Check for leakage through valves up to the motor. Check pump delivery quantity.
	2) Oil temperature is excessibly high.	2) Decrease oil temperature.
	3) Excessive leakage.	3) Repair or replace leaky components.
	4) Excessive wear on piston, cylinder block or valve plate.	4) Replace
4. Oil leakage.		
A. Oil leakage from oil seal.	1) Dirt in lip or damage of lip.	1) Replace oil seal.
	2) Shaft is worn or scratched.	2) Shift relative position of lip and shaft, or replace the shaft and oil seal.
	3) Casing inner pressure is extremely high.	3) Check and clean the drain tube as necessary.
	4) Rusty shaft.	4) Disassemble, repair and replace oil seal.
B. Oil leakage from joint.	1) O-ring not inserted.	1) Correctly insert and assemble.
	2) Scratched or cut O-ring.	2) Replace.
	3) Scratched seal surface.	3) Disassemble and repair.
	4) Loose or damaged bolt.	4) Tighten to the proper torque or replace.
5. Abnormal noise.	1) Damaged bearing.	1) Replace the bearing.
	2) Seizure of moving parts.	2) Replace the damaged parts.
	3) Loose mounting bolt or incorrect mounting.	3) Tighten to the correct torque.

4.2 BRAKE SECTION

Table 5-2

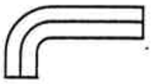
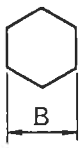
Trouble	Cause	Remedy
1. Pressure rises properly, but the motor does not rotate. (Brake is not released.)	1) Release pressure does not actuate to the brake. 2) Seizure of brake piston. 3) Seizure of separator plates and friction plates.	1) Check and repair circuit. 2) Disassemble, check and repair. 3) Disassemble and check. Replace seized parts.
2. Insufficient brake torque.	1) Worn friction plates and separator plates. 2) Weakened brake springs, and insufficient spring force. 3) Stuck brake pistons. 4) Brake releasing pressure is not removed. 5) Insufficient amount of brake shims. 6) Splines of friction plates and separator plates are damaged.	1) Disassemble and check. Replace parts which have worn more than serviceable limits. 2) Disassemble and check. Replace if weakened more than serviceable limit. 3) Disassemble and check. 4) Check circuit. 5) Disassemble and reset. 6) Disassemble and check. Replace damaged parts.
3. Oil leakage from match faces.	1) O-ring not inserted. 2) Scratched or cut O-ring. 3) Loose or damaged bolt.	1) Correctly insert and assemble. 2) Replace. 3) Tighten to the proper torque or replace.

5. REPAIRS

5.1 TOOLS

Tool required for disassembly and assembly are shown in the following table. As capscrews and plugs used on each model are different, tools should be prepared after making a check in advance.

Table 6

Tool Name & Size		Applicable Parts			Applicable Models								
					MX45	MX64	MX84	MX111	MX160	MX250	MX500	MX750	MX950
Name	B (Size)	Socket head Capscrew	PT Plug (PT Screw)	RO Plug (PF Screw)									
Allen Wrench	4	M5	BP-1/16	RO-1/8									
	5	M6	BP-1/8	–									
	6	M8	BP-1/4	RO-1/4						○	○		
	8	M10	BP-3/8	RO-3/8					○			○	○
	10	M12	BP-1/2	RO-1/2							○		
	12	M14	–	RO-3/4									
	14	M16 . M18	BP-3/4	RO-1	○	○	○	○				○	○
	17	M20 . M22	BP-1	RO-1 1/4, 1 1/2									
Ring Wrench Socket Wrench Both (Single) End Wrench	B (Size)	Hexagon head capscrew	Hexagon Nut	VP Plug (PF Screw)									
	10	M6	M6	–									
	13	M8	M8	–									
	17	M10	M10	–									
	19	M12	M12	VP-1/4									
	22	–	–	VP-3/8	○	○	○	○	○				
	24	M16	M16	–									
	27	M18	M18	VP-1/2						○			
	30	M20	M20	–									
	36	–	–	VP-3/4								○	○
Monkey Wrench	–	Medium Size 1			All models								
Screw Driver	–	Minus, Medium Size 2			All models								
Hammer	–	Plastic Hammer 1, Steel Hammer 1			All models								
Plier	–	For Stop Ring & Locking Ring			All models (Plier for locking ring is necessary for MX160 and under).								
Steel Bar	–	Carbon steel bar, Approx. 10 x 8 x 200			All models								
Torque Wrench	–	Those possible of tightening to prescribed torque.			All models								

5.2 DISASSEMBLY

1) Remove drain plug (28, Figure 2). Drain the oil from motor case (13).
2) Remove capscrews (19), and brake cover (35). Remove brake spring (39), and piston (36).

NOTE

At this step, mesure the dimention from the end surface of valve cover (14) to separator plate (45), and compare the measurerd dimention with standard value.

3) Remove snap ring (21), and remove spline coupling (37). Remove separator plate (45) and friction plate (46).
4) Remove capscrews (16 and 17), and valve cover (14) from case (13). When the capscrews are removed the valve cover will come out from the case by the force of spring (05).

CAUTION

1. When removing the valve cover, be careful not to allow valve plate (11) to fall out from the valve cover.
2. If necessary, measure the deflection of the spring at this time.
3. When separating mating surfaces with a screw driver, be careful not to damage the surfaces.

5) Place the motor holizontary, draw cylinder block (03) out straightly against drive shaft (01). At this time, remove pistons (07), keeper plates (09) and bushing (04).

CAUTION

Be careful not to damage the bushing and shoes (08).

6) Remove capscrews (18), and remove front cover (15) from case (14).

NOTE

When removing the front cover, use the tapped holes provided on the cover.

7) Lightly tapping the valve cover end face of drive shaft (01) with a plastic or wooden hammer, draw the drive shaft out from the case.
8) Remove valve plate (11) from valve cover (14).

NOTE

Proceed the following steps only when required.

9) Remove guide ring (12) from valve cover (14), and remove roller bearing (24).
10) Remove snap ring (20), and remove roller bearing (23) from drive shaft (01) by lightly tapping the inner race of the bearing.
11) Lightly tapping the back of oil seal (33), remove the oil seal from front cover (15).

5.3 INSPECTION

Prior to assembly, inspect the items listed in Table 7 to 9. Adjust or replace parts which exceed the allowable values or which show remarkable damage even if the parts do not exceed the allowable values.

5.3.1 Motor Section

Table 7-1

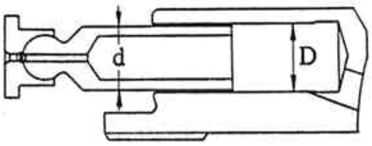
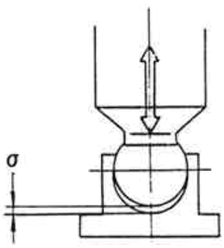
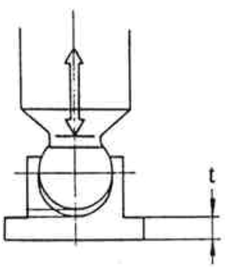
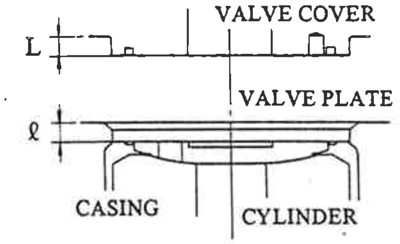
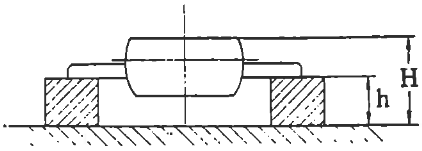
Item	Model		Standard Value (mm)	Allowable Value (mm)	Remedy
Clearance between piston and cylinder bore. (D – d) 	MX45	Swing	0.014	0.044	Replace piston or cylinder.
		General	0.024	0.048	
	MX64	Swing	0.015	0.045	
		General	0.026	0.052	
	MX84	Swing	0.016	0.046	
		General	0.028	0.056	
	MX111	Swing	0.017	0.047	
		General	0.030	0.060	
	MX160	Swing	0.018	0.048	
		General	0.034	0.068	
	MX250	Swing	0.020	0.050	
		General	0.037	0.074	
	MX500	Swing	0.023	0.053	
		General	0.045	0.090	
	MX750	Swing	0.026	0.056	
		General	0.051	0.102	
Play in caulked part of piston and shoe (δ) 	All models		0	0.3	Replace piston and shoe assembly.
Thickness of shoe (t) 	MX45		3.5	3.3	Replace piston and dhoe assembly.
	MX64		4.0	3.8	
	MX84		5.0	4.8	
	MX111		5.0	4.8	
	MX160		5.5	5.3	
	MX250		6.5	6.3	
	MX500		8.8	8.6	
	MX750		10.0	9.8	

Table 7-2

Item	Model	Standard Value (mm)	Allowable Value (mm)	Remedy
Deflected volume of disk spring (L – ℓ) 	MX45	1.5	1.2	Adjust disk spring shim and correct deflection volume to prescribed value.
	MX64	1.7	1.3	
	MX84	2.1	1.7	
	MX111	3.0	2.4	
	MX160	3.0	2.4	
	MX250	2.7	2.1	
	MX500	3.65	2.9	
	MX750	4.15	3.3	
Matched height of retainer plate and spherical bushing (H – h) 	MX45	16.5	16.2	Replace spherical bushing and set plate as a set.
	MX64	19.0	18.7	
	MX84	21.5	21.2	
	MX111	24.0	23.5	
	MX160	27.5	27.0	
	MX250	27.0	26.5	
	MX500	29.1	28.5	
	MX750	35.6	34.8	

Correction of Sliding Surface

Correct or replace, if roughness of sliding surface exceed the following value.

Table 8

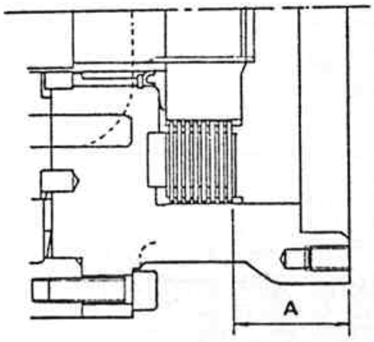
Surface Roughness of Shoe, Shoe Plate	Standard Surface Roughness	0.4-Z (Ra=0.1) (Lapping)
	Roughness requiring Correction	3-Z (Ra=0.8)

CAUTION

1. By lapping, make each sliding surface to a roughness below the standard roughness.
2. If the sliding surfaces of the cylinder, valve plate and retainer plate, bushing sphere are excessivery damaged or discolored, replace these parts as a set.

5.3.2 Brake Section

Table 9

Item	Model	Standard Value(mm)	Allowable Value(mm)	Remedy
Dimension from end face of valve cover to separator plate : (A) 	MX250B	48.8	48.3	Readjust brake shims.
	MX500B	53.8	53.3	
	MX750B	50.0	49.0	
Overall thickness of separator plates and friction plates	MX250B	※) 1.2×n+2.6×m	1.2×n+2.6×m -0.1×m ※)	Replace separator plates and friction plates.
	MX500B	※) 1.8×n+2.0×m	1.8×n+2.0×m -0.1×m ※)	
	MX750B	※) 1.5×n+2.9×m	1.5×n+2.9×m -0.1×m ※)	
Free length of brake spring	MX250B	55.9	55.4	Replace brake spring.
	MX500B	47.8	47.3	
	MX750B	62.7	62.2	

※) n : Quantity of separater plates.
m : Quantity of friction plates.

5.4 ASSEMBLY

NOTE

1. Be sure to repair parts damaged during disassembly, and to prepair necessary replacement parts beforehand.
2. Wash all parts, other than the seals, with clean hydraulic oil and dry them with compressed air. Place the assembly on a clean workbench.
3. Be sure to apply clean hydraulic oil to the sliding parts and bearing before assembling.
4. Do not reuse seal parts such as O-rings and oil seals once they are removed. Apply clean hydraulic oil to new seals before assembling.
5. When tightening the each mounting capscrews and plugs, use a torque wrench, and tighten them to the specified torque.

1) Install bearing (23) in place against the shoulder of drive shaft (01), and install spacer (02) and snap ring (20) on the shaft.
2) Tapping the outer race of bearing (23) with a hammer, insert drive shaft (01) with bearing (23) into case (13).

CAUTION

Do not tap the end of shaft (01) when inserting the shaft into the case.

3) Install oil seal (33) in the bore of front cover (15). Apply grease lightly to the lip section of the oil seal, and install the front cover with oil seal (33) on the case being careful not to damage the oil seal lip. Tighten capscrews (18) to the specified torque.
4) Insert shoe plate (10) into case (13) so that the largely chamfered side of the shoe plate faces the case.
5) Assemble piston (07), cylinder block (03), keeper plates (09), spherical bushing (04), spring (05) and shim (06) as shown in Figure 5. Aligning the phases of the cylinder spline teeth and of the spherical bushing, insert the cylinder block assembly into case (13) so as to align with the drive shaft spline.

CAUTION

1. When installing spring (05), be careful for the direction of the spring.
2. Shim (06) should be placed between spherical bushing (04) and the spring.

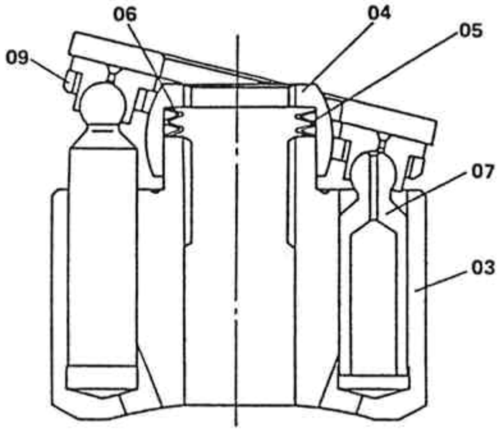


Fig.5 Cylinder Block Subassembly

6) Place the cylinder block subassembly with the front cover down. Place valve plate (11) on the cylinder block subassembly, and measure the dimension ℓ from the upper face of case (13) to the upper face of the valve plate (see Figure 6). Measure also the dimention L of the protrusion of valve cover (14). Then, confirm that dimention L-ℓ (amount of spring (05) deflection) is in the allowable value shown in Table 7-2. If the dimention is out of the specified value, adjust the spring shims.

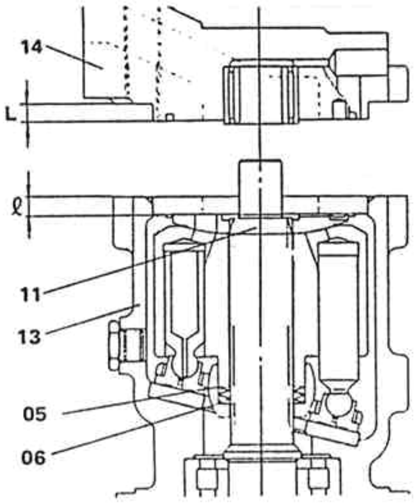


Fig.6 Checking Spring Deflection

7) Confirm that guide ring (12) is securely installed in valve cover (14). Paying attention to pin (26), install the valve plate on the valve cover.

NOTE

If a small hole is provided on the valve plate, install the valve plate so that the small hole comes to the lower dead point side of the pistons (see Figure 7).

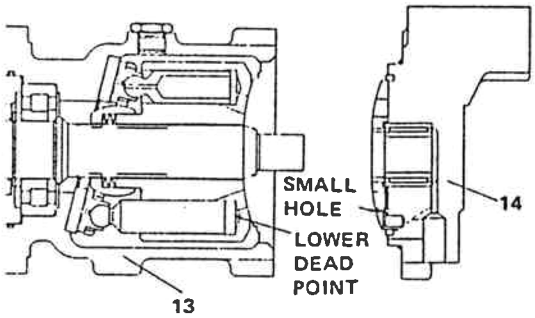


Fig.7 Small Hole of Valve Plate

8) Paying attention to the installation direction of the valve cover, install valve cover (14) on case (13), and secure it with capscrews (16 and 17).
9) Install coupling (37) on drive shaft (01), and secure it with snap ring (21).
10) Insert brake shims (44) to the spline section of coupling (37) and valve cover (14). Alternately insert separater plate (45) and friction plate (46). In this case, do not change order or the number of plates. Measure dimention A from the end face of the valve cover to the friction plate (see Figure 8), and adjust the brake brake shims so that dimention A becomes the specified value shown in Table 9.

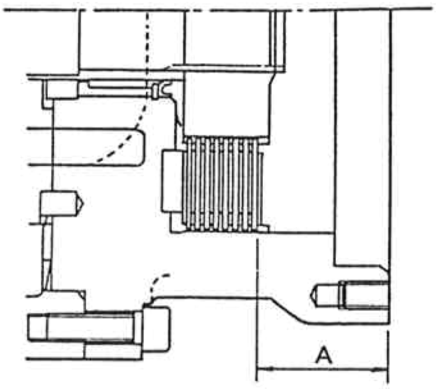


Fig.8 Checking Dimention A

11) Insert brake piston (36) into valve cover (14). Insert brake spring (39) into brake piston (36), and install brake cover (35) on valve cover (14) with capscrews (19).
12) Now, assembly of the motor is completed. Supply clean hydraulic oil to the suction port and piston shoe side, and comfirm that the drive shaft is turned smoothly by hand (see Figure 9).
If the drive shaft is too hard to be turned by hand or if the shaft cannot be turned smoothly, disassemble and determine the cause of difficulties.

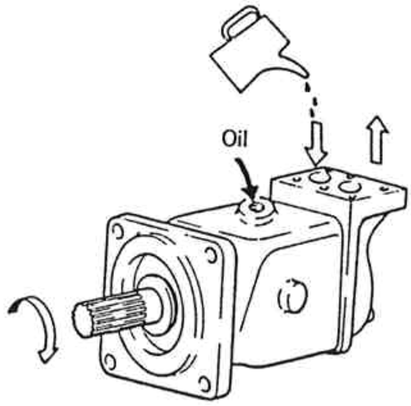


Fig.9 Supply of Hydraulic Oil

TIGHTENING TORQUE

Table 10

Screw Size	Tightenig Torque (kg・m)	Front Cover Capscrew	Valve Cover Capscrew	Brake Cover Capscrew	Drain Plug	Plug
M 8	3	MX250 MX500				
M10	5.8	MX750	MX111,160 MX250	MX250B		
M12	10		MX500	MX500B		
M16	24		MX45,64,84 MX750	MX750B		
PF1/4	3.7					MX250B MX500B
PF3/8	7				MX45,64,84 MX111,160	
PF1/2	10				MX250	
PF3/4	15				MX500 MX750	
PT3/8	4.5					MX750B
PT1/2	6.6					MX250B MX750B

1. GENERAL

1.1 GENERAL VIEW

This series are variabledisplacement type axial piston two speed motors. And these models include motors with negative brakes.

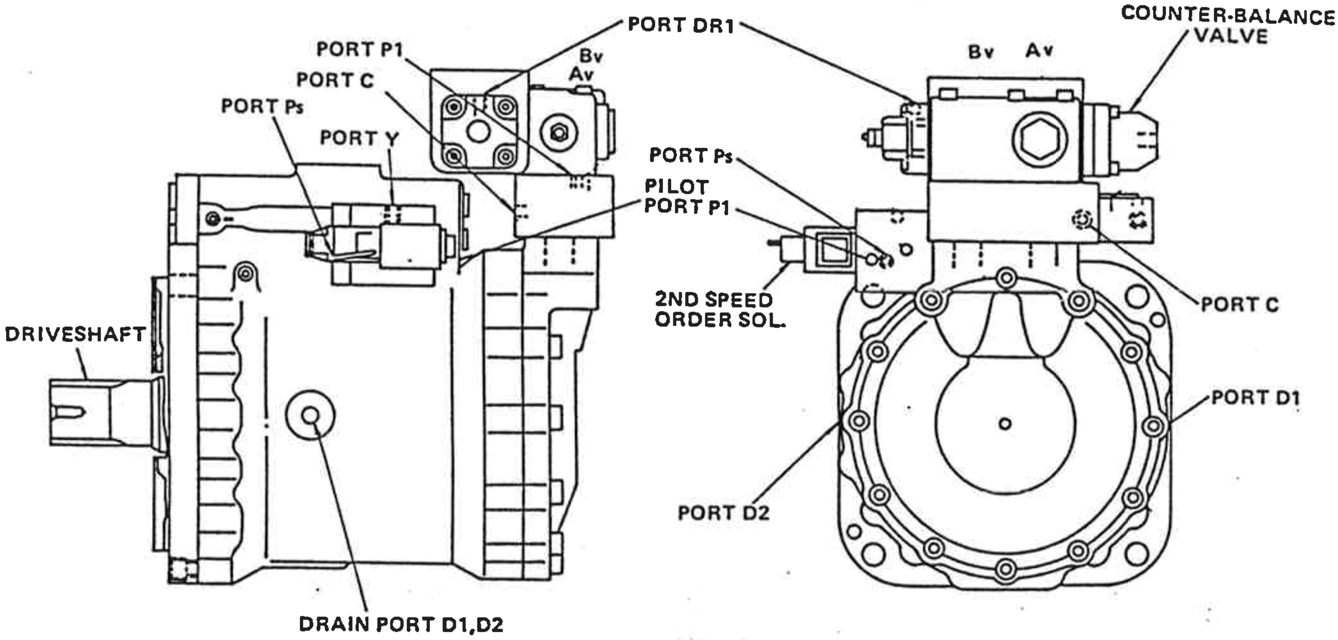


Fig.1 MB750AA

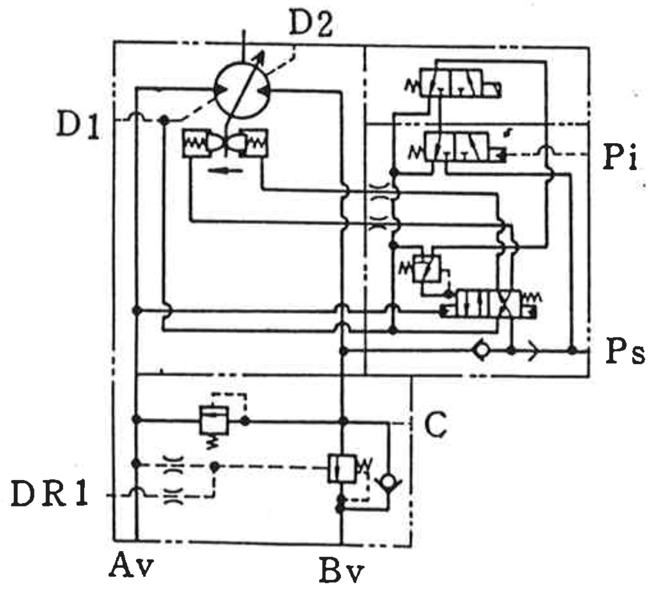


Fig.2 Symbol

1.2 MODEL INDICATION

M B 500 A O

- M — Motor Type: M : M Series Motor
- B — Fixed type or 2 speed type: X : Fixed Type; B : 2 Speed Type
- 500 — Displacement: 045: 45cc/rev. | | 950:947cc/rev.
- A — Valve Cover Type:
  - A : Standard
  - B : with Mechanical Brake
  - C : with Brake Valve (Cushion Function)
  - D : Flat Type

1.3 SPECIFICATION

1.3.1 Motor Section

Table 1

Model	Displacement Max./Min. (cc/rev.)	Pressure (kg/cm^2) Rating	Pressure (kg/cm^2) Max.	Rotation (rpm) ※4 Rating	Rotation (rpm) ※4 Max.	Output Torque (kg·m) ※1	Output Power (kw) ※2	Weight (kg) ※3
MB500	485 / 243	250	350	640 (960)	960 (1200)	193	190	185
MB750	737 / 369			560 (830)	830 (1050)	293	250	290

NOTE

※1) A theoretical value which does not include mechanical efficiency at rated pressure.

※2) A theoretical value at rated pressure and maximum rotation.

※3) A weight including mechanical brake.

※4) ( ) shows revolution at minimum displacement condition.

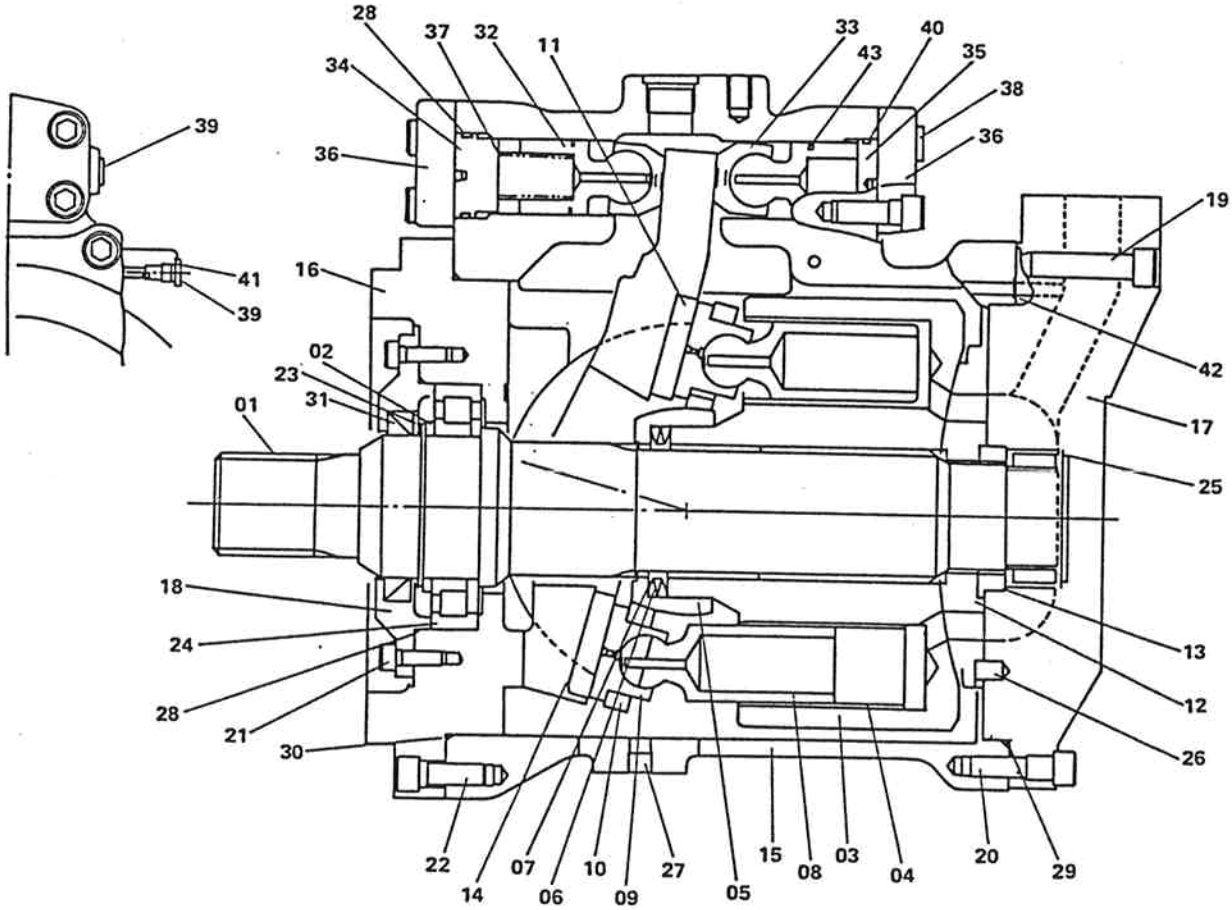
1.3.2 Brake Section (with Brake Type only)

Table 2

Model	Max. Brake Torque (kg·m)	Releasing Pressure (kg/cm^2)
MB500B	170	10
MB750B	293	10

2. CONSTRUCTION

Construction of the motor is shown in Figure 3. The item numbers in the following description in this manual correspond to the numbers in Figure 3.



01. DRIVE SHAFT	16. FRONT CASING	31. OIL SEAL
02. SPACER	17. VALVE COVER	32. PISTON
03. CYLIDER BLOCK	18. FRONT COVER	33. SHOE
04. BUSHING	19. CAPSCREW	34. STOPPER-F
05. BUSHING	20. CAPSCREW	35. STOPPER-R
06. SPRING	21. CAPSCREW	36. PISTON COVER
07. SHIM	22. CAPSCREW	37. SPRING
08. PISTON	23. SNAP RING	38. CAPSCREW
09. SHOE	24. ROLLER BEARING	39. PLUG
10. KEEPER PLATE	25. NEEDLE BEARING	40. O-RING
11. SHOE PLATE	26. PIN	41. O-RING
12. VALVE PLATE	27. PLUG	42. O-RING
13. GUIDE RING	28. O-RING	43. BACKUP RING
14. SWASH PLATE	29. O-RING	
15. CASING	30. O-RING	

Fig.3 MB750AA

3. OPERATION

3.1 MOTOR OPERATIN

When high pressure oil enters cylinder block (03) through inlet port (AM) on ball surface valve plate (12) which distributes oil coming in and out, hydraulic pressure actuates to piston (08) to generate axial force (F).
This force (F) is decomposed into vectors of vertical force (F1) against shoe plate (11) and right angle force (F2). Force (F2) is transmitted to cylinder block (03) through piston (08) and generates a rotating couple around the output shaft.
The cylinder block is arranged equally with nine pistons, and rotating torque of the pistons connected to the inlet port of high pressure oil is transmitted to the output shaft.
Reversing the direction of oil coming in and out reversesthe rotating direction of the output shaft.
Theoretical output torque T is given with the following formula.

$$T = q \times p / 2\pi \times 100$$

Here T ..... Output Torque (kg·m)
p ..... Efficient pressure (kgf/cm^2)
q ..... Displacement per one turn (cc/rev.)

<u>Direction of Rotation</u>

High pressure oil from the pump enters the motor to rotate the motor output shaft (drive shaft). Direction of the rotation is decided according to oil flow to the motor.

Table 3 Direction of Rotation

INLET	OUTLET	DILECTION (Viewed from Shaft)
AM	BM	Rotation to the left
BM	AM	Rotation to the right

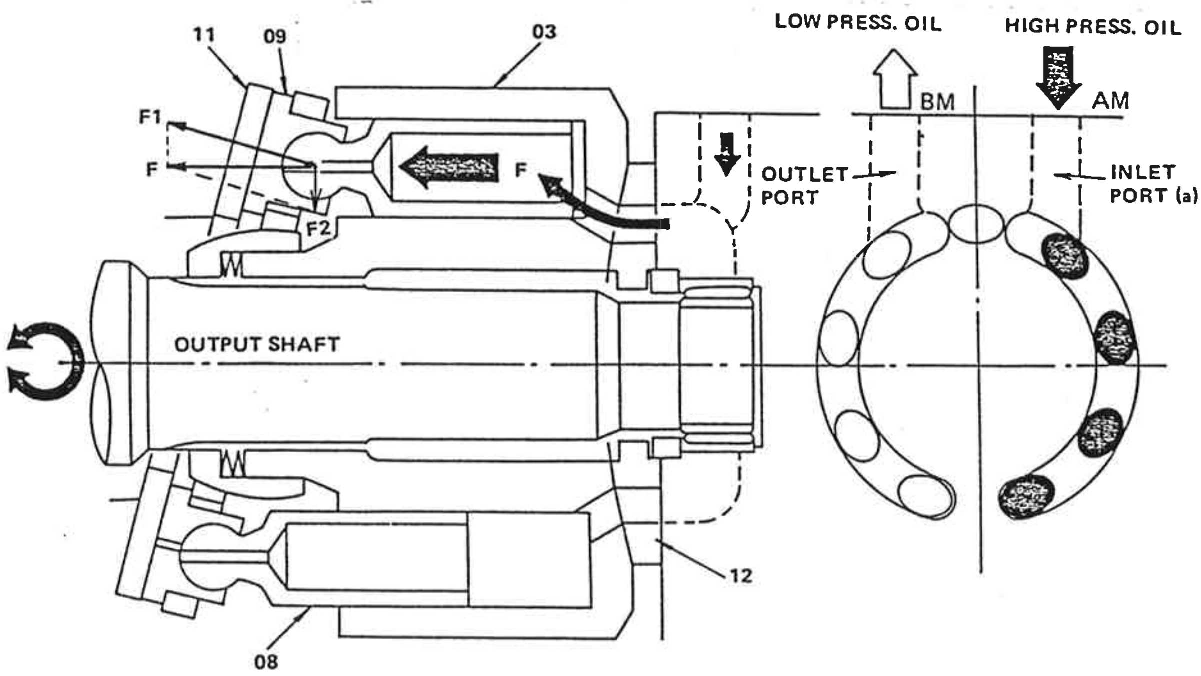


Fig.4 Motor Operation

3.2 VARIABLE DISPLACEMENT CONTROL

A piller type, which support loads with nealy semicircular cylindrical bushing (05), is applied for supporting swash plate (14), and variation of displacement is performed by varying the swash plate tilting angle. Two tilting pistons are provided in opposite positions against the swash plate. The swash plate is set to a required angle by controlling oil coming in and out to and fro the piston chambers. Various controls are possible by selecting the attached valves.

Tilting command valve : Shifting two large and small displacements by external command.

Sequence valve : Shifting automaticary large and small displacement according to largeness of loads.

Power fixing valve : Setting output power to a fixed value inspite of variation of loads.

Any control valve above can be connected directry to the hydraulic motor.

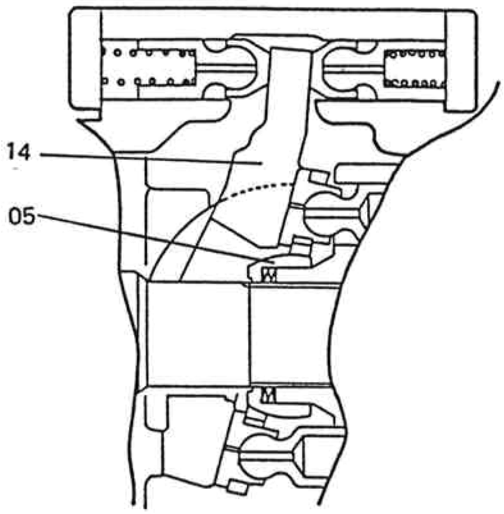


Fig.5 Mechanism of Variable Displacement

3.3 NEGATIVE BRAKE

Braking force is generated by friction between separator plates (45) connected to valve cover with splines and friction plate (46) connected to the output shaft through spline coupling (37).

When pressure does not actuate to brake piston (36) chamber, the brake piston is pushed with spring (39) against spacer (38) through friction plate (46) and separator plates (45), and friction force is generated by this pushing force. By this friction force the output shaft is restrained, and the brake is engaged.

The brake is released by the pressure sending to the brake chamber from outside.

The brake can be released manually by means of the following procedure.

Remove plug (27) from brake cover (35), and screw a capscrew into the tapped hole on brake piston (36) to draw the brake piston toward the brake cover.

Table 4

Model	Capscrew Size × Length (mm)	Amount
MB500B	M12 × 40 ~ 50	2
MB750B	M16 × 45 ~ 60	1

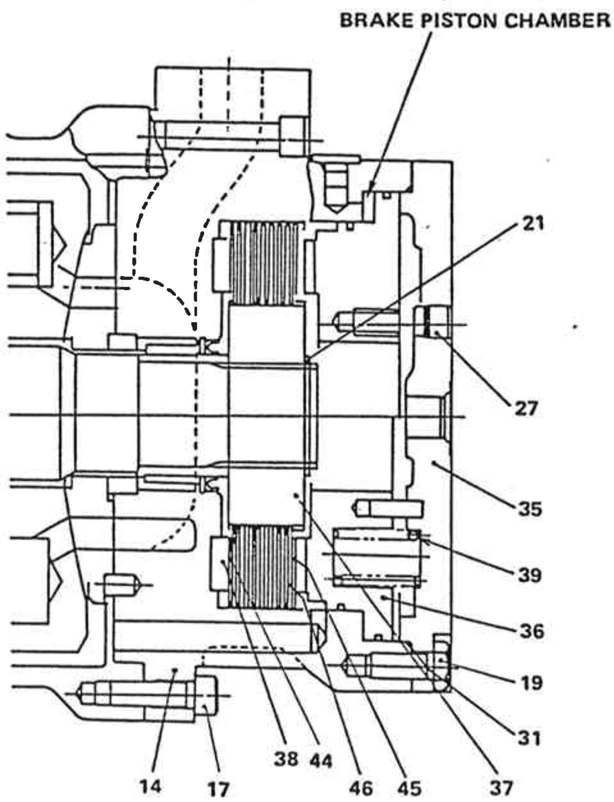


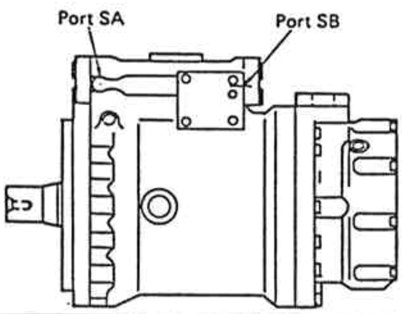
Fig.6 Negative Brake Operation

4. TROUBLESHOOTING

4.1 MOTOR SECTION

Table 5-1

Trouble	Cause	Remedy
1. The motor does not rotate.		
A. Pressure does not rise.	Safety valve in circuit is not set correctly.	Set safety valve to correct value.
B. Pressure rises properly.	1) Overload.	1) Relieve load.
	2) Releasing pressure does not actuate to brake.	2) Check and repair circuit.
	3) Friction plates seize on separator plates.	3) Check and replace friction plates and separator plates.
	4) Brake piston sticks.	4) Check and repair stuck parts.
	5) Seizure of moving parts.	5) Check and repair pistons/shoes, cylinder or valve plate, etc.
2. Direction of rotation is reverse.	Inlet and outlet of piping is reverse.	Correct piping.
3. Number of rotation does not reach preset value.	1) Insufficient incoming oil flow.	1) Check pump delivery and circuit to motor.
	2) Oil temperature is excessibly high, and oil leakage is also excessive.	2) Lower oil temperature.
	3) Excessive wear or damage of sliding parts.	3) Replace faulty parts.
	4) Tilting angle does not change.	4) See item 5 in this table.
4. Driving force does not reach preset value.	1) Setting of safety valve in circuit is low.	1) Set safety valve to correct value.
	2) Brake is not released.	2) Check and repair brake releasing pressure and inside of brake.
	3) Tilting angle is not changed.	3) See item 5 below.
5. Tilting angle is not changed.	1) Attached valve does not function properly.	1) Check and repair attached valve.
	2) Tilting piston (40) is seized.	2) Check and repair tilting piston.
	3) Sliding face of swash plate is seized.	3) Check and repair sliding face.
	NOTE: Tilting order pressures are as follows:	



	Port SA	Port SB
Large Tilting	High pressure	Low pressure
Small Tilting	Low pressure	High pressure

PF 1/8 thread of each port is plugged.

Table 5-2

Trouble	Cause	Remedy
6. Oil leakage		
A. Oil leakage from oil seal.	1) Dirt in lip or damage of lip.	1) Replace oil seal.
	2) Shaft is worn or scratched.	2) Shift relative position of lip and shaft, or replace the shaft and oil seal.
	3) Casing inner pressure is extremely high.	3) Check and clean the drain tube as necessary.
	4) Rusty shaft.	4) Disassemble, repair and replace oil seal.
B. Oil leakage from joint.	1) O-ring not inserted.	1) Correctly insert and assemble.
	2) Scratched or cut O-ring.	2) Replace.
	3) Scratched seal surface.	3) Disassemble and repair.
	4) Loose or damaged bolt.	4) Tighten to the proper torque or replace.

4.2 BRAKE SECTION

Table 5-3

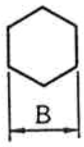
Trouble	Probable Cause	Remedy
1. Pressure rises properly, but the motor does not rotate. (Brake is not released.)	1) Release pressure does not actuate to the brake.	1) Check and repair circuit.
	2) Seizure of brake piston.	2) Disassemble, check and repair.
	3) Seizure of separator plates and friction plates.	3) Disassemble and check. Replace seized parts.
2. Insufficient brake torque.	1) Worn friction plates and separator plates.	1) Disassemble and check. Replace parts which have worn more than serviceable limits.
	2) Weakened brake springs, and insufficient spring force.	2) Disassemble and check. Replace if weakened more than serviceable limit.
	3) Stuck brake pistons.	3) Disassemble and check.
	4) Brake releasing pressure is not removed.	4) Check circuit.
	5) Insufficient amount of brake shims.	5) Disassemble and reset.
	6) Splines of friction plates and separator plates are damaged.	6) Disassemble and check. Replace damaged parts.
3. Oil leakage from match faces.	1) O-ring not inserted.	1) Correctly insert and assemble.
	2) Scratched or cut O-ring.	2) Replace.
	3) Loose or damaged bolt.	3) Tighten to the proper torque or replace.

5. REPAIRS

5.1 TOOLS

Tool required for disassembly and assembly are shown in the following table. As capscrews and plugs used on each model are different, tools should be prepared after making a check in advance.

Table 6

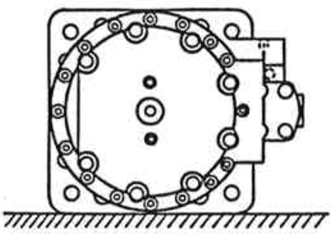
Tool Name & Size		Applicable Parts			Applicable Models
Name	B (Size)	Socket head Capscrew	PT Plug (PT Screw)	RO Plug (PF Screw)	
Allen Wrench	4	M 5	BP-1/16	RO-1/8	MB500,MB750
	6	M 8	BP-1/4	RO-1/4	MB500
	8	M10	BP-3/8	RO-3/8	MB500,MB750
	10	M12	BP-1/2	RO-1/2	MB500
	12	M14	—	RO-3/4	MB750
	14	M16,M18	BP-3/4	RO-1	MB750
Name	B (Size)	Hex. head Capscrew	Hex. Nut	VP Plug (PF Screw)	
Ring Wrench	19	M12	M12	VP-1/4	MB500
Socket Wrench	27	M18	M18	VP-1/2	MB500
Both (Single)	36	—	—	VP-3/4	MB500,MB750
End Wrench					
					
Monkey Wrench	—	Medium Size 1			All models
Screw Driver	—	Minus, Medium Size 2			All models
Hammer	—	Plastic Hammer 1, Steel Hammer 1			All models
Plier	—	For Snap Ring			All models
Steel Bar	—	Carbon steel bar, Approx.10×8×200			All models
Torque Wrench	—	Those possible of prescribed torque.			All models

5.2 DISASSEMBLY

NOTE

It is recommended that the complete motor be replaced if the motor is faulty. However, if disassembly are required proceed as follows.

1) Place the motor on the clean work bench, with the tilting piston assembly (32 to 43) side to prevent the cylindrical sliding part of the swash plate coming off.



2) Remove drain plug (27, Figure 3) from casing (15), and drain oil to a suitable container.

NOTE

Following steps 3 to 4 applied only when brake is equipped.

3) Remove capscrews (19,Figure 6), and brake cover (35). Remove brake spring (39), and piston(36), if brake is equipped.

NOTE

At this step, mesure the dimention from the end surface of valve cover (14) to separator plate (45), and compare the measurerd dimention with standard value.

4) Remove snap ring (21), and remove spline coupling (37). Remove separator plate (45) and friction plate (46).

5) Remove capscrews (19 and 20), and valve cover (17) from case (15). When the capscrews are removed the valve cover will come out from the case by the force of spring (06).

CAUTION

1. When removing the valve cover, be careful not to allow valve plate (12) to fall out from the valve cover.
2. If necessary, measure the deflection of the spring at this time.
3. When separating mating surfaces with a screw driver, be careful not to damage the surfaces.

6) Draw cylinder block (03) out straightly against drive shaft (01). At this time, remove pistons (08), keeper plates (10) and bushing (05).

CAUTION

Be careful not to damage the bushing and shoes (09).

7) Remove capscrews (38), and remove piston covers (36). Then, remove tilting stoppers (34 and 35), tilting springs (37), tilting pistons (32) and tilting shoes (33).

NOTE

When removing tilting stoppers (34 and 35), use the tapped holes on the stopper centers.
Be carefull also not to mix up F and R of stoppers.

8) Remove capscrews (21), and remove front cover (18) from casing (16).

NOTE

When removing the front cover, use the tapped holes provided on the cover.

9) Lightly tapping the valve cover end face of drive shaft (01) with a plastic or wooden hammer, draw the drive shaft out from the front casing.

10) Remove capscrew (22), and remove front casing (16) from casing (15).

NOTE

Casing (15) may be drawn out if casing is placed to the bottom.

11) Draw swash plate (14) out from casing.

12) Remove valve plate (12) from valve cover (17). Valve plate may be removed at step 5.

NOTE

Proceed the following steps only when required.

13) Remove guide ring (13) from valve cover (17), and remove roller bearing (25).
14) Remove snap ring (23), and remove roller bearing (24) from drive shaft (01) by lightly tapping the inner race of the bearing.
15) Lightly tapping the back of oil seal (31), remove the oil seal from front cover (18).

5.3 INSPECTION

Prior to assembly, inspect the items listed in Table 7 to 9. Adjust or replace parts which exceed the allowable values or which show remarkable damage even if the parts do not exceed the allowable values.

5.3.1 Motor Section

Table 7-1 Maintenance Standard (unit : mm)

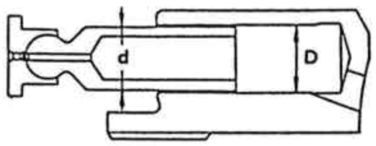
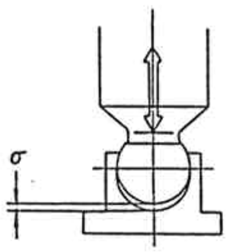
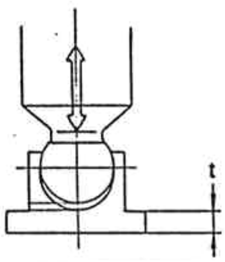
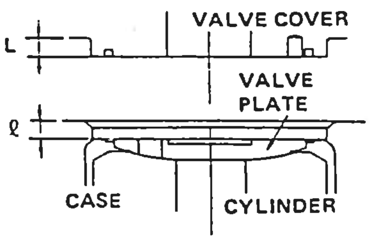
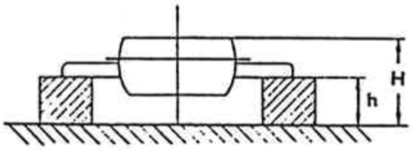
Item	Model	Standard Value	Allowable Value	Remedy
Clearance between piston and cylinder bore : (D-d) 	MB500 MB750	0.045 0.051	0.090 0.102	Replace piston or cylinder block
Play between piston and calking part of shoe : (δ) 	All	0.0	0.3	Replace piston and shoe assembly
Thickness of shoe : (t) 	MB500 MB750	8.8 10.0	8.6 9.8	Replace piston and shoe assembly
Deflected volume of disk spring : (L-l) 	MB500 MB750	3.65 4.15	2.9 3.3	Adjust spring shims so that amount of spring bending becomes the specified value.

Table 7-2 Maintenance Standard (continued) (unit : mm)

Item	Model	Standard Value	Allowable Value	Remedy
Assemble height of keeper plate and spherical bushing : (H-h) 	MB500 MB750	29.1 35.6	28.5 34.8	Replace spherical bushing and keeper plate assembly

Correction of Sliding Surface

Correct or replace, if roughness of sliding surface exceed the following value.

Table 8

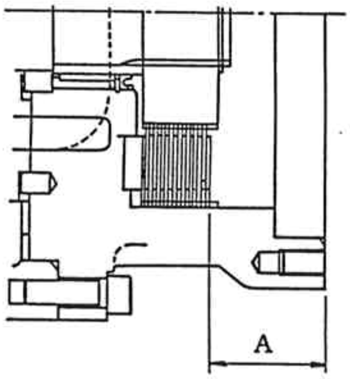
Surface Roughness of Shoe, Shoe Plate	Standard Surface Roughness	0.4-Z (Ra=0.1) (Lapping)
	Roughness requiring Correction	3-Z (Ra=0.8)

CAUTION

1. By lapping, make each sliding surface to a roughness below the standard roughness.
2. If the sliding surfaces of the cylinder, valve plate and retainer plate, bushing sphere are excessivery damaged or discolored, replace these parts as a set.

5.3.2 Brake Section

Table 9 Maintenance Standard (unit : mm)

Item	Model	Standard Value(mm)	Allowable Value(mm)	Remedy
Dimension from end face of valve cover to separator plate : (A)  	MB500B MB750B	53.8 50.0	53.3 49.0	Readjust brake shims.
Overall thickness of separator plates and friction plates	MB500B MB750B	※) 1.8×n+2.0×m ※) 1.5×n+2.9×m	1.8×n+2.0×m -0.1×m ※) 1.5×n+2.9×m -0.1×m ※)	Replace separator plates and friction plates.
Free length of brake spring	MB500B MB750B	47.8 62.7	47.3 62.2	Replace brake spring.

※) n : Quantity of separater plates.
m : Quantity of friction plates.

5.4 ASSEMBLY

NOTE

1. Be sure to repair parts damaged during disassembly, and to prepair necessary replacement parts beforehand.
2. Wash all parts, other than the seals, with clean hydraulic oil and dry them with compressed air. Place the assembly on a clean workbench.
3. Be sure to apply clean hydraulic oil to the sliding parts and bearing before assembling.
4. Do not reuse seal parts such as O-rings and oil seals once they are removed. Apply clean hydraulic oil to new seals before assembling.
5. When tightening the each mounting capscrews and plugs, use a torque wrench, and tighten them to the specified torque.

1) Install bearing (24) in place against the shoulder of drive shaft (01), and install spacer (02) and snap ring (23) on the shaft.
2) Tapping the outer race of bearing (24) with a hammer, insert drive shaft (01) with bearing (24) into case (16).

CAUTION

Do not tap the end of shaft (01) when inserting the shaft into the case.

3) Install oil seal (31) in the bore of front cover (18). Apply grease lightly to the lip section of the oil seal, and install the front cover with oil seal (31) on the case being careful not to damage the oil seal lip. Tighten capscrews (21) to the specified torque.
4) Place swash plate (14) on front casing (16), on which place casing (15) paying attention to the arm of the swash plate. Secure the casing to the front casing with capscrews (22).

CAUTION

When assembling the parts in the valve cover side be careful not to allow the cylindrical sliding part of the swash plate to go off.

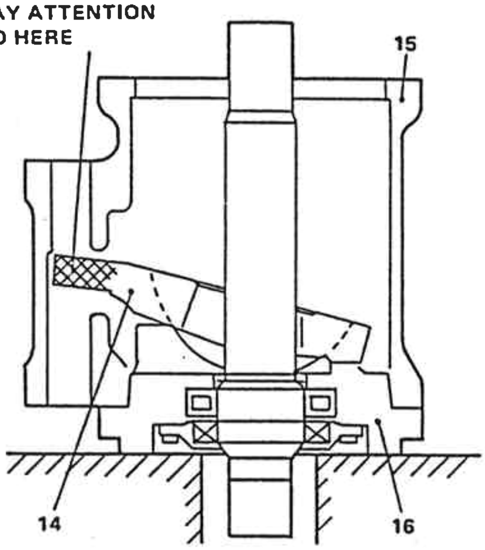


Fig.7 Installing Casing on Front Casing

5) Insert tilting pistons (32), tilting springs (37) and tilting stoppers (34 and 35) into casing (15) being careful not to mix up stopper F (34) and stopper R (35). Install piston covers (36) on casing (15) with capscrews (38).
6) Place the subassembly assembled in step 5 as shown in Figure 8.

NOTE

Paying attention not to allow the swash plate to go off.

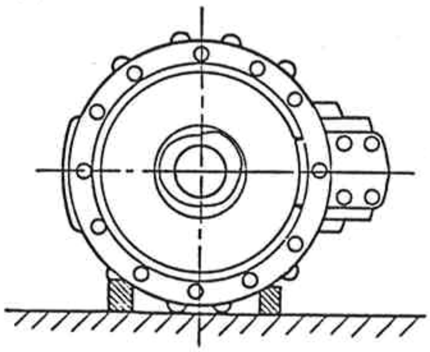


Fig.8 Placing Subassembly

7) Insert shoe plate (11) into swash plate (14) so that the largely chamfered side of the shoe plate faces the swash plate.

8) Assemble piston (08), cylinder block (03), keeper plates (10), spherical bushing (05), spring (06) and shim (07) as shown in Figure 9. Aligning the phases of the cylinder spline teeth and of the spherical bushing, insert the cylinder block assembly into case (15) so as to align with the drive shaft spline.

CAUTION

1. When installing spring (06), be careful for the direction of the spring.
2. Shim (07) should be placed between spherical bushing (05) and the spring.

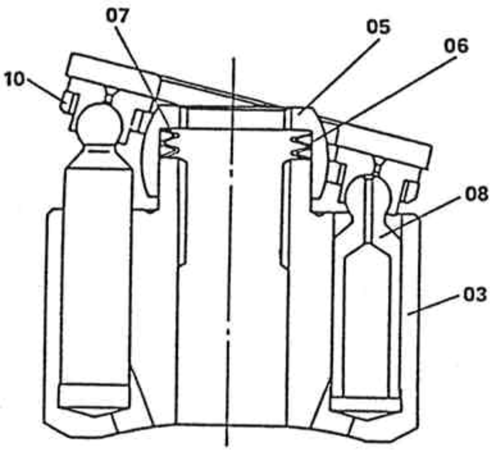


Fig.9 Cylinder Block Subassembly

9) Place the cylinder block subassembly with the front cover down. Place valve plate (12) on the cylinder block subassembly, and measure the dimension ℓ from the upper face of casing (15) to the upper face of the valve plate (see Figure 10). Measure also the dimention L of the protrusion of valve cover (17). Then, confirm that dimention L-ℓ (amount of spring (06) deflection) is in the allowable value shown in Table 7-1. If the dimention is out of the specified value, adjust the spring shims.

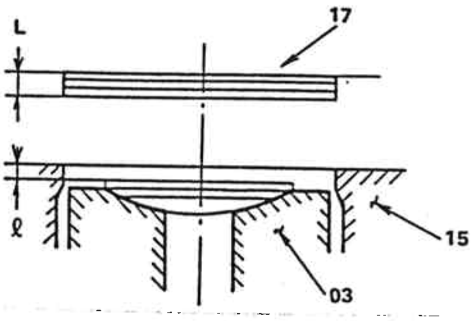


Fig.10 Checking Spring Deflection

10) Confirm that guide ring (13) is securely installed in valve cover (17). Paying attention to pin (26), install the valve plate on the valve cover.

NOTE

If a small hole is provided on the valve plate, install the valve plate so that the small hole comes to the lower dead point side of the pistons

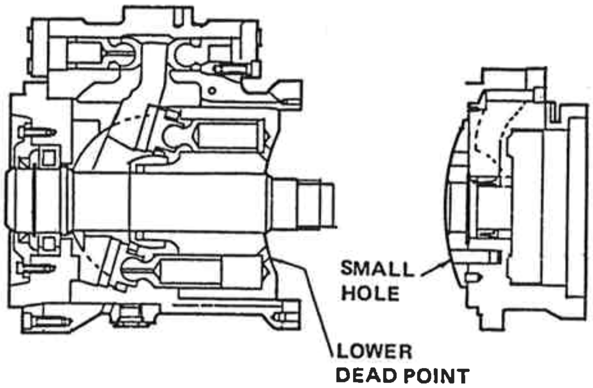


Fig.11 Small Hole of Valve Plate

11) After greasing between valve plate (12) and valve cover (17) to prevent the valve plate from falling, paying attention to the installation direction of the valve cover, install the valve cover on casing (15), and secure it with capscrews (19 and 20).

NOTE

Following steps 12 to 14 applied only when brake is equipped. (see Figure 6)

12) Install coupling (37,Figure 6) on drive shaft (01), and secure it with snap ring (21).

13) Insert brake shims (44) to the spline section of coupling (37) and valve cover

(14). Alternately insert separater plate (45) and friction plate (46). In this case, do not change order or the number of plates. Measure dimention A from the end face of the valve cover to the friction plate (see Figure 12), and adjust the brake brake shims so that dimention A becomes the specified value shown in Table 9.

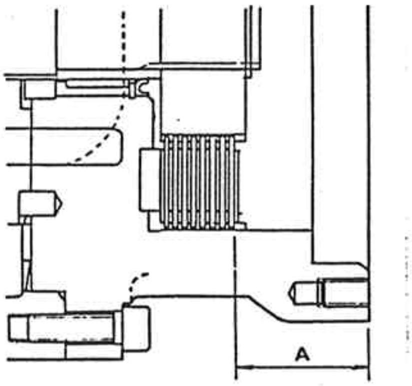


Fig.12 Checking Dimention A

14) Insert brake piston (36) into valve cover (14). Insert brake spring (39) into brake piston (36), and install brake cover (35) on valve cover (14) with capscrews (19).
15) Now, assembly of the motor is completed. Supply clean hydraulic oil to the suction port and piston shoe side, and comfirm that the drive shaft is turned smoothly by hand (see Figure 13).
If the drive shaft is too hard to be turned by hand or if the shaft cannot be turned smoothly, disassemble and determine the cause of difficulties.

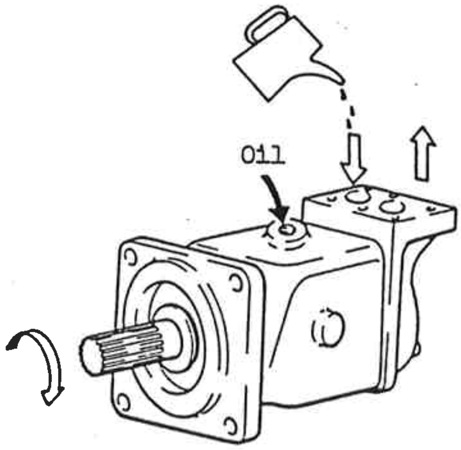


Fig.13 Supply of Hydraulic Oil

5.5 TIGHTENING TORQUE

Table 10

Screw Size	Tightenig Torque(kg·m)	Front Cover Capscrew	Front Casing Capscrew	Valve Cover Capscrew	Brake Cover Capscrew	Piston Cover Capscrew	Plug
M 8	3	MB500					
M10	5.8	MB750					
M12	10		MB500	MB500	MB500	MB500	
M14	16		MB750				
M16	24			MB750	MB750	MB750	
PF1/8	2						MB500 MB750
PF1/4	4						MB500
PF1/2	10						MB500
PF3/4	15						MB500 MB750
PT3/8	4						MB500
PT1/2	5						MB750