

Service Guide

Crawler Excavator



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| .Specification Comparisions

R140LC-7

	Unit	Hyundai	Komastu	CAT	Hitachi
		R140-7	PC130-6	312C	ZX120
Oper. Weight	Kg	13980	13050	12200	12200
Power, SAE net	HP/rpm	102/2100	86/2200		
DIN net	PS	103/2100	87/2200	91/1950	85/2100
Bucket PCSA	cu m	0.58		0.5	0.5
CECE	cu m	0.5		0.45	0.45
Engine		Cummins	Komatsu	CAT	Isuzu
Model		B3.9-C	S4D102E	3064-E1T	CC-4BG1TC
Cyl*Bore*Stroke	mm	4*102*120	4*102*120		
Displacement	cc	3920	3920	4250	4329
Max. torque	Kgf.m/rpm	46.2/1500			
Hydraulic pump	LPM	2*130	1*226		
Oper. Pressure					
Attachment	Kg/cm2	330	325	305	350
Power boost		360	-	-	-
Travel		330	325	350	
Swing		240	275		
Swing speed	rpm	13.6	12.0	12.9	13.7
Travel speed	Km/h	3.3/5.5	2.7/3.6/5.5	3.8/5.5	3.4/5.5
Standard machine					
Boom	m	4600	4600	4650	
Arm	m	2500	2500	2500	2000
Track shoe width	mm	600	500	500	500
Track gauge	mm	2000	1960	1990	1990
Tumbler distance	mm	3000	2750	2780	
Ground pressure	kg/cm2	0.36	0.41	0.4	0.38
Max traction force	ton	13.3	10.2	11.0	
Bucket digging force,SAE	ton	9.27	8.5		
Arm crawd force,SAE	ton	9.27	8.5		
Fuel tank	liter	270	230	250	250

R160LC-7

	Unit	Hyundai	Komastu	CAT	Hitachi
		R160LC-7	PC160-6	315C	ZX160LC
Oper. Weight	Kg	17400	16530	16000	15600
Power, SAE net	HP/rpm	116/2100	104.5/2100	-	-
DIN net	PS	118/2100	106/2100	111/2150	100/1950
Bucket PCSA	cu m	0.70	0.58	0.65	0.6
CECE	cu m	0.60	0.53	0.55	0.55
Engine		Mitsubishi	Komatsu	CAT	Isuzu
Model		S6S-DT	SA4D102E	3046-E3DT	A-4BG1TC
Cyl*Bore*Stroke	mm	4*94*1200	4*102*120	-	-
Displacement	cc	4996	3920	4990	4329
Max. torque	Kgf.m/rpm	42.5/1500	-	-	-
Hydraulic pump	LPM	2*168	276		
Oper. Pressure					
Attachment	Kg/cm2	330	325	350	350
Power boost		360	355	-	-
Travel		330	355	350	
Swing		240	325		
Swing speed	rpm	12.1	12.0	10.2	13.6
Travel speed	Km/h	3.7/5.6	2.7/4.0/5.5	3.4/5.6	3.1/5.3
Standard machine					
Boom	m	5100	5150	5100	5100
Arm	m	2600	2600	2600	2580
Track shoe width	mm	600	600	500	500
Track gauge	mm	1990	1990	1990	1990
Tumbler distance	mm	3190	2880	2880	3100
Ground pressure	kg/cm2	0.42	0.44	0.51	0.46
Max traction force	ton	15.7	13.8	-	-
Bucket digging force,SAE	ton	12.08	12.54	-	9.2
Arm crawd force,SAE	ton	8.35	8.393	-	8.1
Fuel tank	liter	260	250	285	280

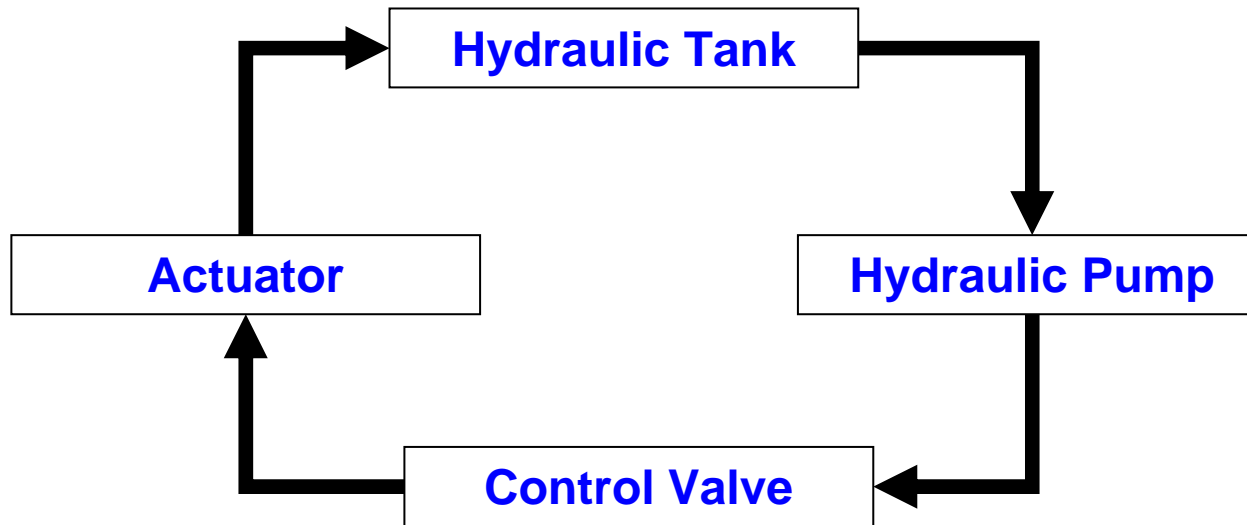
R210LC-7

	Unit	Hyundai	Komastu	CAT	Hitachi
		R210LC-7	PC210-6	320B	EX200-5
Oper. Weight	Kg	21700	21570	20518	18800
Power, SAE net	HP/rpm	143/2100	133/2200	128/1800	133/1950
DIN net	PS	145/2100		130/1800	135/1950
Bucket PCSA	cu m	0.92	0.86	0.80	0.80
CECE	cu m	0.8		0.70	0.70
Engine		Cummins	Komatsu	CAT	Isuzu
Model		B5.9-C	S6D102E	3116T	A-6BG1T
Cyl*Bore*Stroke	mm	6*102*120	6*102*120	6*105*127	6*105*125
Displacement	cc	5880	5880	6600	6494
Max. torque	Kgf.m/rpm	62.0/1600			47/1600
Hydraulic pump	LPM	2*220	2*206	2*180	2*185
Oper. Pressure					
Attachment		330	325	350	350
Power boost	Kg/cm2	360	355	-	370
Travel		330	355	350	350
Swing		240	280	235	
Swing speed	rpm	12.5	12.4	10.7	13.9
Travel speed	Km/h	3.4/5.3	3.2/4.5/5.5	3.4/5.5	3.8/5.5
Standard machine					
Boom	m	5880	5700	5680	5680
Arm	m	2920	2930	2900	2910
Track shoe width	mm	600	600	600	600
Track gauge	mm	2390	2380	2200	2200
Tumbler distance	mm	3650	3640	3265	3370
Ground pressure	kg/cm2	0.46	0.45	0.48	0.43
Max traction force	ton	21.1	17.7	18.1	17.3
Bucket digging force,SAE	ton	14.84	15.0	13.5	12.2
Arm crawd force,SAE	ton	10.8	10.1	10.1	
Fuel tank	liter	320	340	340	310

II .Hydraulic System

1. Outline of Hyd. System: the equipment to transmit the power by oil flow

-Characteristic of hydraulic oil : incompressible, automatic lubrication, less friction loss, higher cooling efficiency, more safety for overload, silent operation, precise control



-Hydraulic Tank : Oil Storage

-Hyd. Pump : Create oil flow to transmit the power


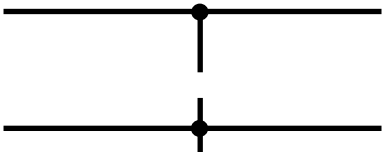
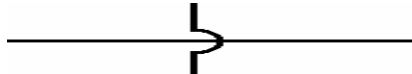
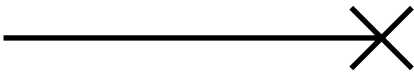
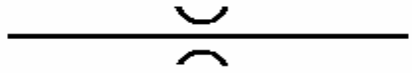

-Control Valve : Direction control of actuator

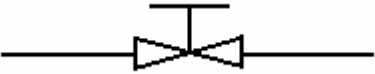
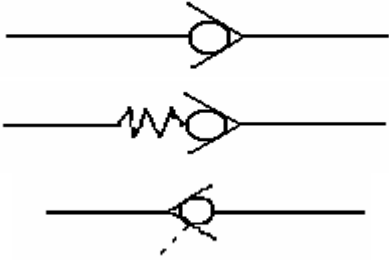

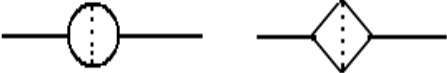

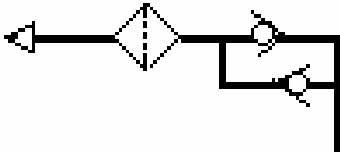
-Actuator : Working device such as cylinder, motor and etc

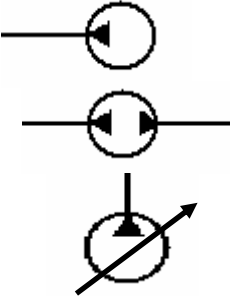

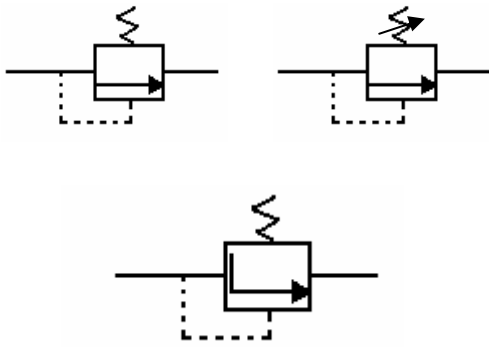
Cylinder - Inline movement

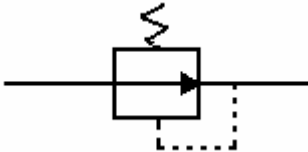
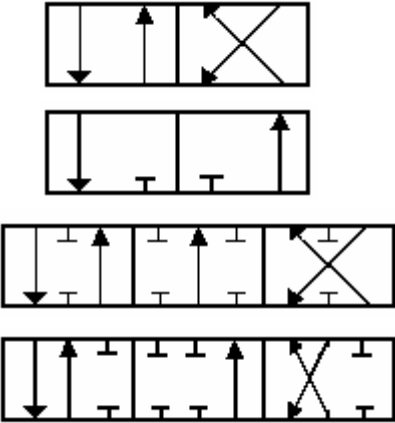
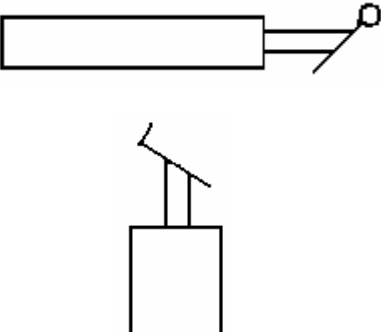
Motor – Rotating movement

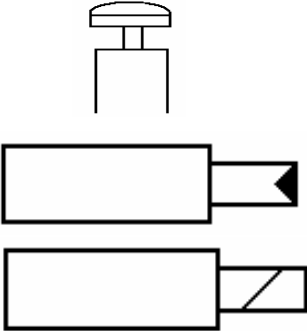
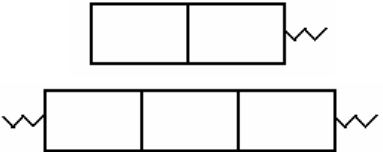
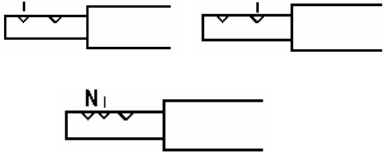
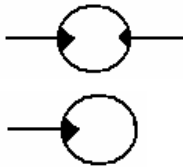

2. Hydraulic Symbol

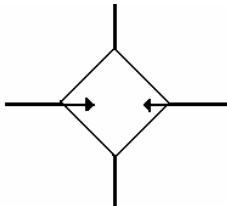
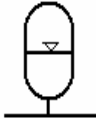
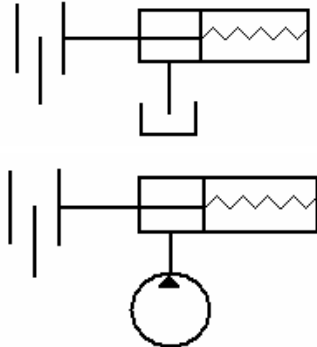

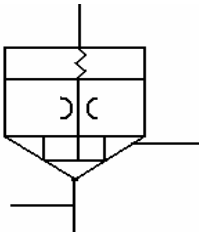
Component	Symbol	Explanation
Pipe or hose -Main line -Pilot line -Drain or internal leakage		Color code -Supply line : red -Return line : blue -Suction line : green -Pilot line : brown -Drain or internal leakage line : green
		Line connected each other : Tee joint or drilled hole
		Line cross over without connection
		Line closed or plugged for future usage or special purpose
Orifice		Reduced diameter of oil passage to reduce oil flow
Adjustable orifice		Adjustable(or variable)

Component	Symbol	Explanation
Shut off valve		
Check valve -Without spring -With spring -Pilot check valve		Direction controlling device to prevent reverse flow One check valve & pilot line in one block
Hyd. tank		Hyd. oil storage
Filter		Filtering all the dirt in hydraulic system
Cooler		Exhaust the heat of hyd. oil
Breather		Maintain the pressure inside of hydraulic tank same as atmospheric pressure

Component	Symbol	Explanation
Hydraulic pump -fixed flow pump -Variable flow pump		-One direction -Both direction, depending on rotation of pump Discharge amount of pump are flexible depending on the pressure at actuator such as cylinder and motor
Cylinder		-Double acting : retract and extend by direction of oil supply -Single acting : retract by weight and extend by oil supply
Pressure control valve -Relief valve -Regulating valve		Safety device to protect hyd. component such as hose, pipe, cylinder and etc When the hyd. system overloaded, relief valve is open and circuit oil go to the tank through opened passage Maintain the required pressure all the time to activate system for transmission clutch and etc. by increasing decreasing the size of overflow passage

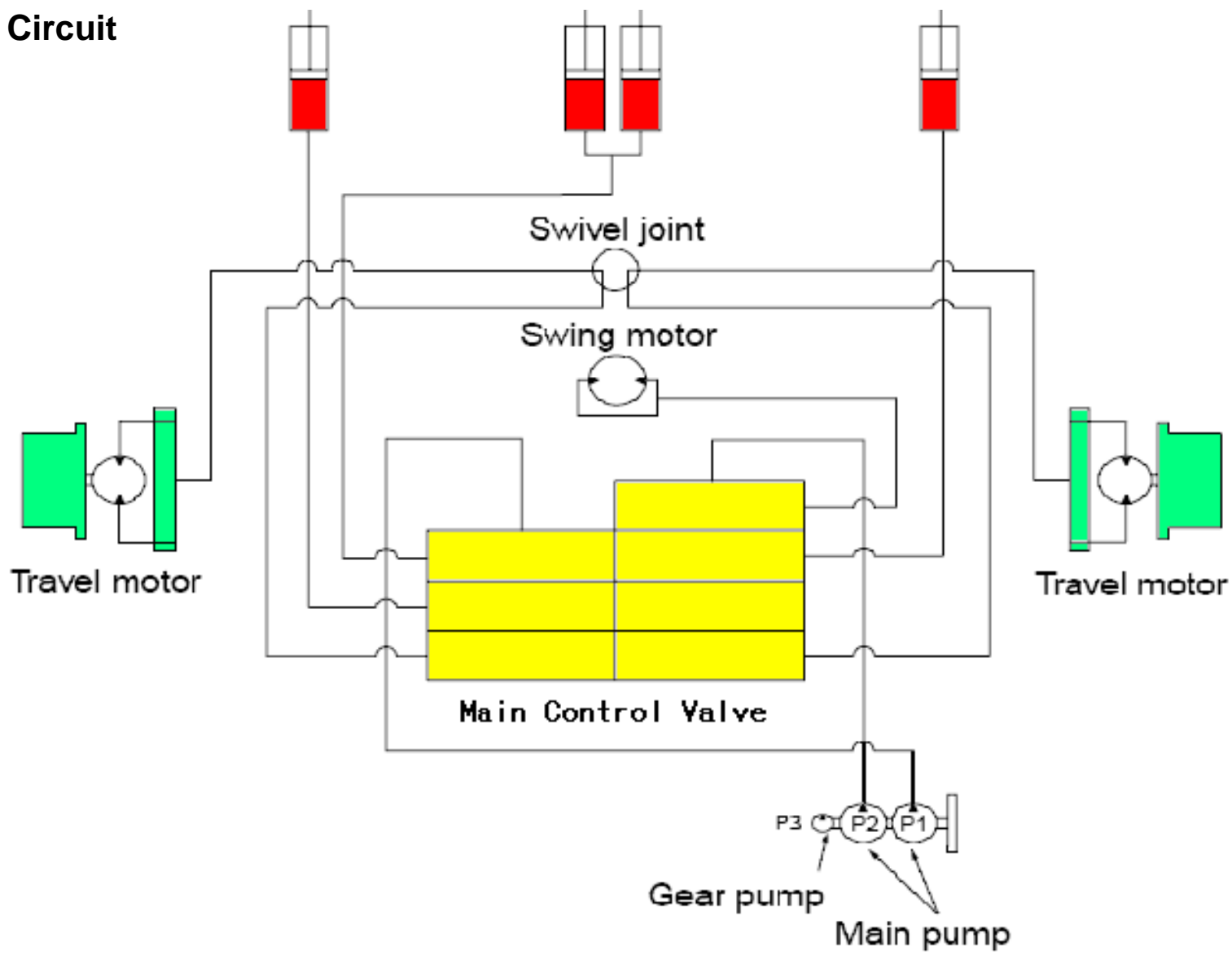
Component	Symbol	Explanation
-Reducing vave		<p>It is used for low pressure circuit.</p> <p>When the supplied pressure reach to required value, supplied oil is cut off</p>
Direction valve -2 way -3 way		<p>For double acting</p> <p>For single acting</p> <p>Double acting</p>
		<p>Controlling method of direction control valve</p> <p>Hand control lever</p> <p>Foot control pedal</p>

Component	Symbol	Explanation
		<p>Button control</p> <p>Hydraulic control by pilot pressure</p> <p>Electro-magnet control by electricity</p>
		<p>Automatic return control by spring tension</p>
		<p>Control valve is fixed with selected direction</p> <p>N : neutral position</p>
Motor		<p>Rotating device</p> <ul style="list-style-type: none"> -Reversible motor -Irreversible motor : rotate one direction only
Pressure switch		

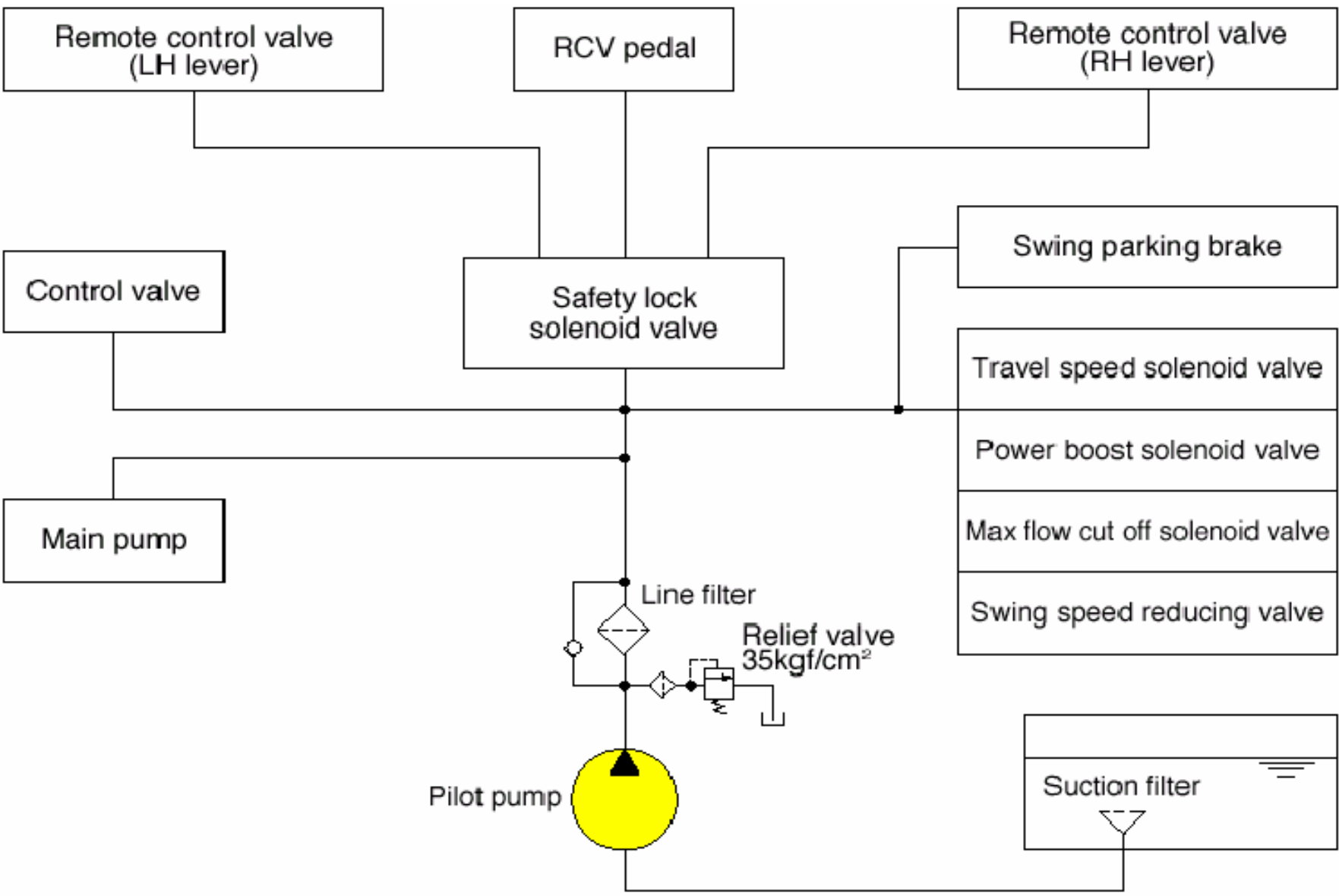
Component	Symbol	Explanation
Heater		
Accumulator		
Brake and clutch		<p>Applied by spring force</p> <p>Released by hydraulic pressure</p>
Shuttle valve		<p>Two check valve in one block</p> <p>Oil flow achieved by pressure difference between left & right hand side</p>
Logic valve		<p>Is combined with piston and orifice</p> <p>Area difference operates direction control valve</p>

3. Hydraulic Circuit

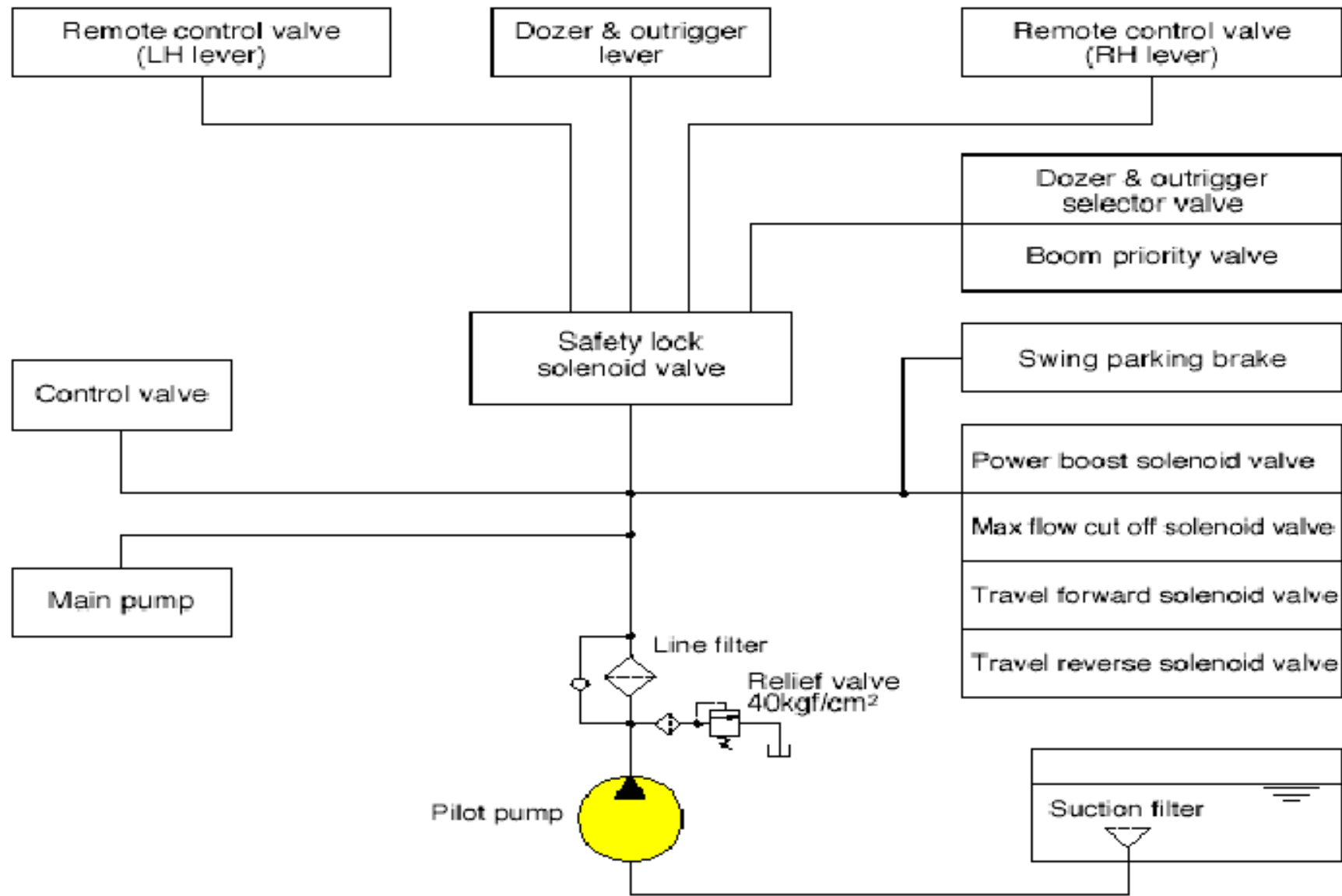
3-1. Main Circuit



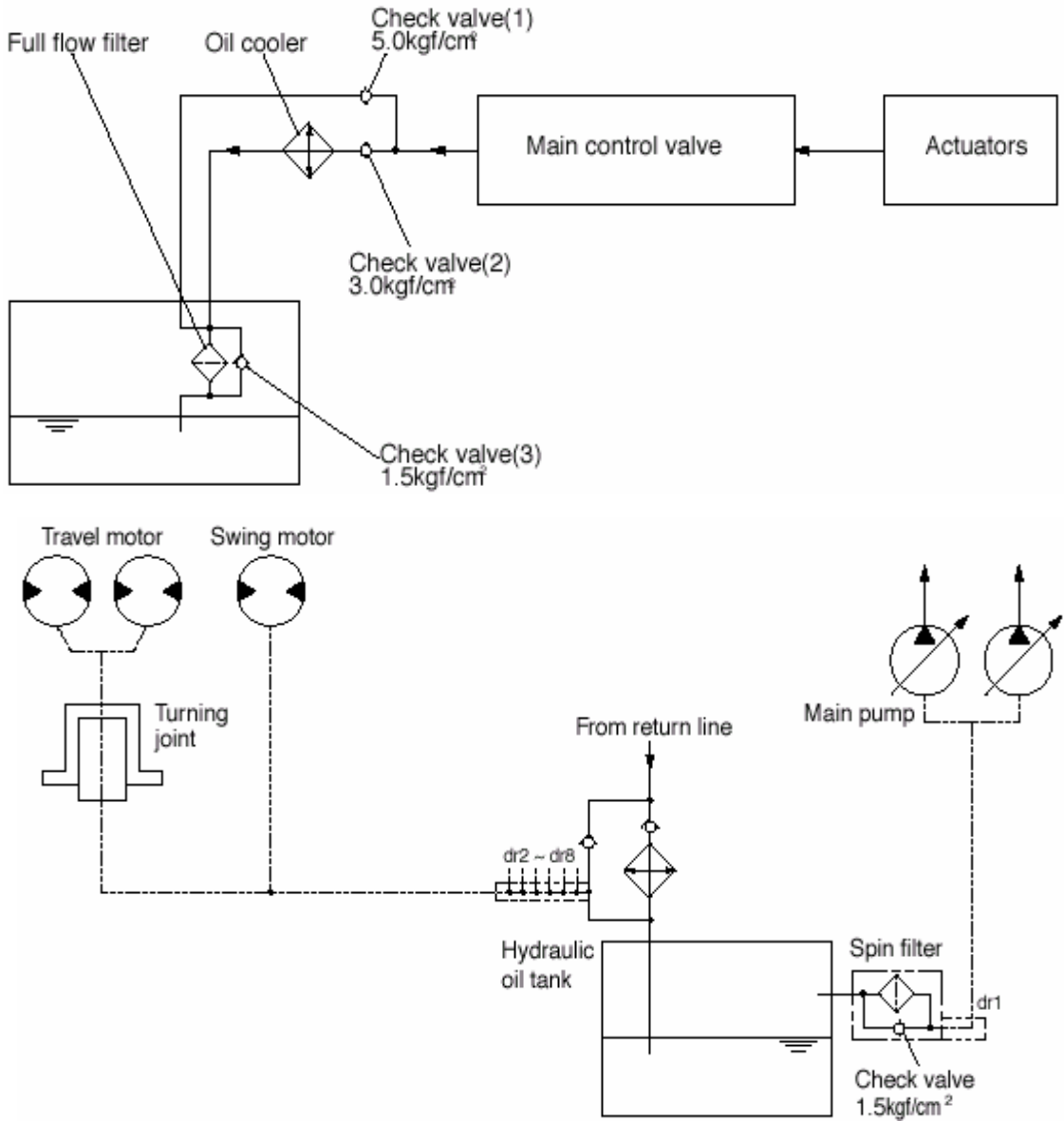
3-2.Pilot Circuit (Crawler Type)



3-3.Pilot Circuit (Wheel Type)



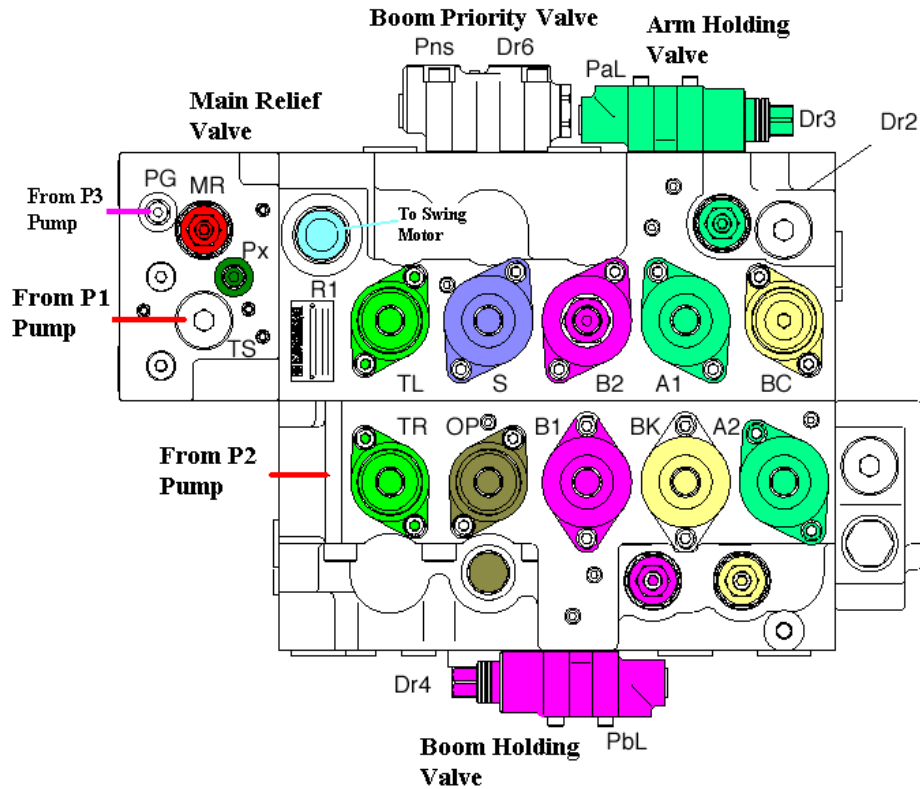
3-4.Oil Return Circuit

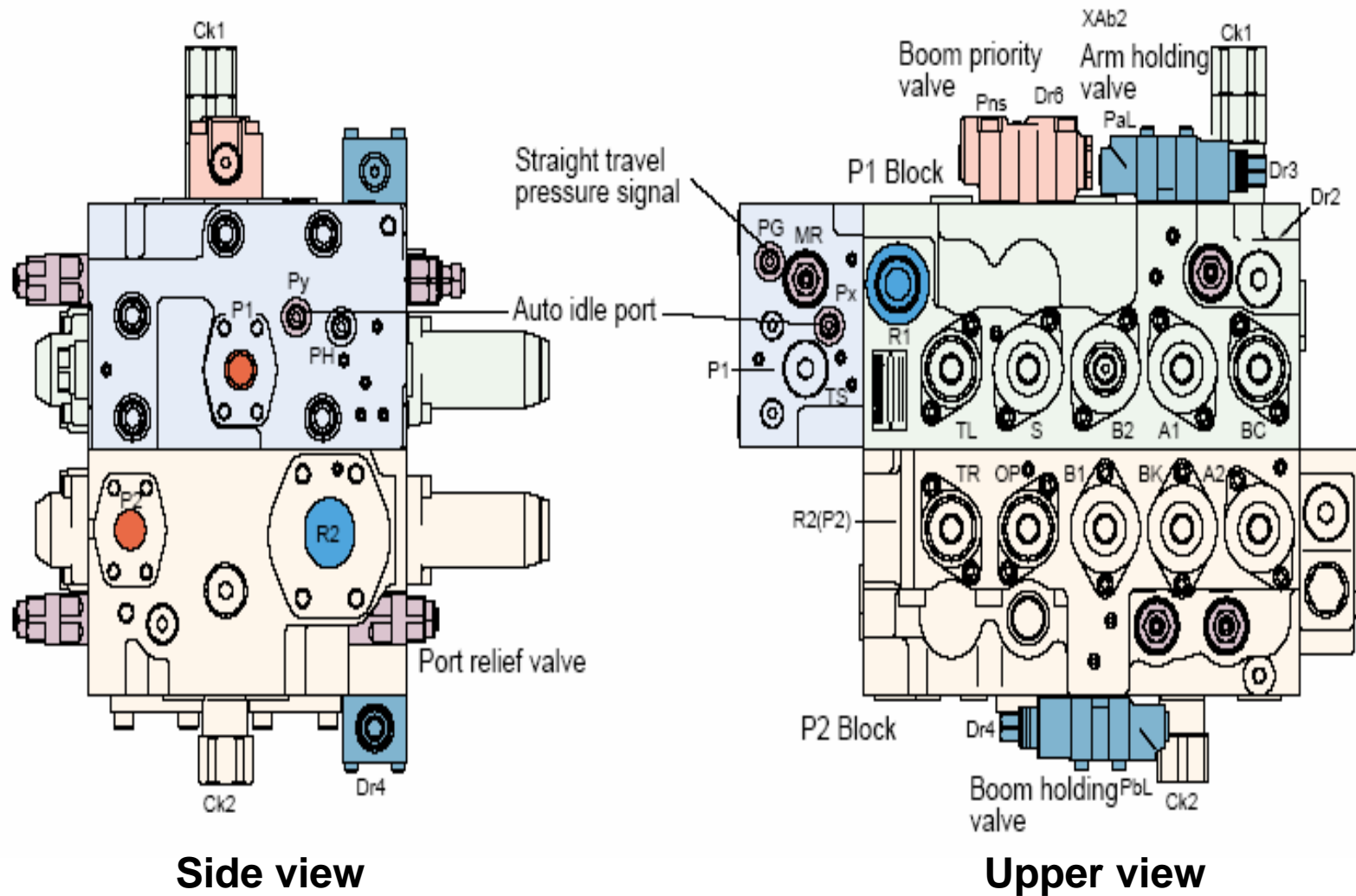


Model	Return Pressure (Bar)	
	Oil Cooler	By-pass
R450LC-7	3	5
R360LC-7	3	5
R320LC-7 R200W-7	3	5
R290LC-7A	1.5	3
R210LC-7	3	5
R180LC-7	1.5	3
R140LC-7	1.5	3

4. Main Components

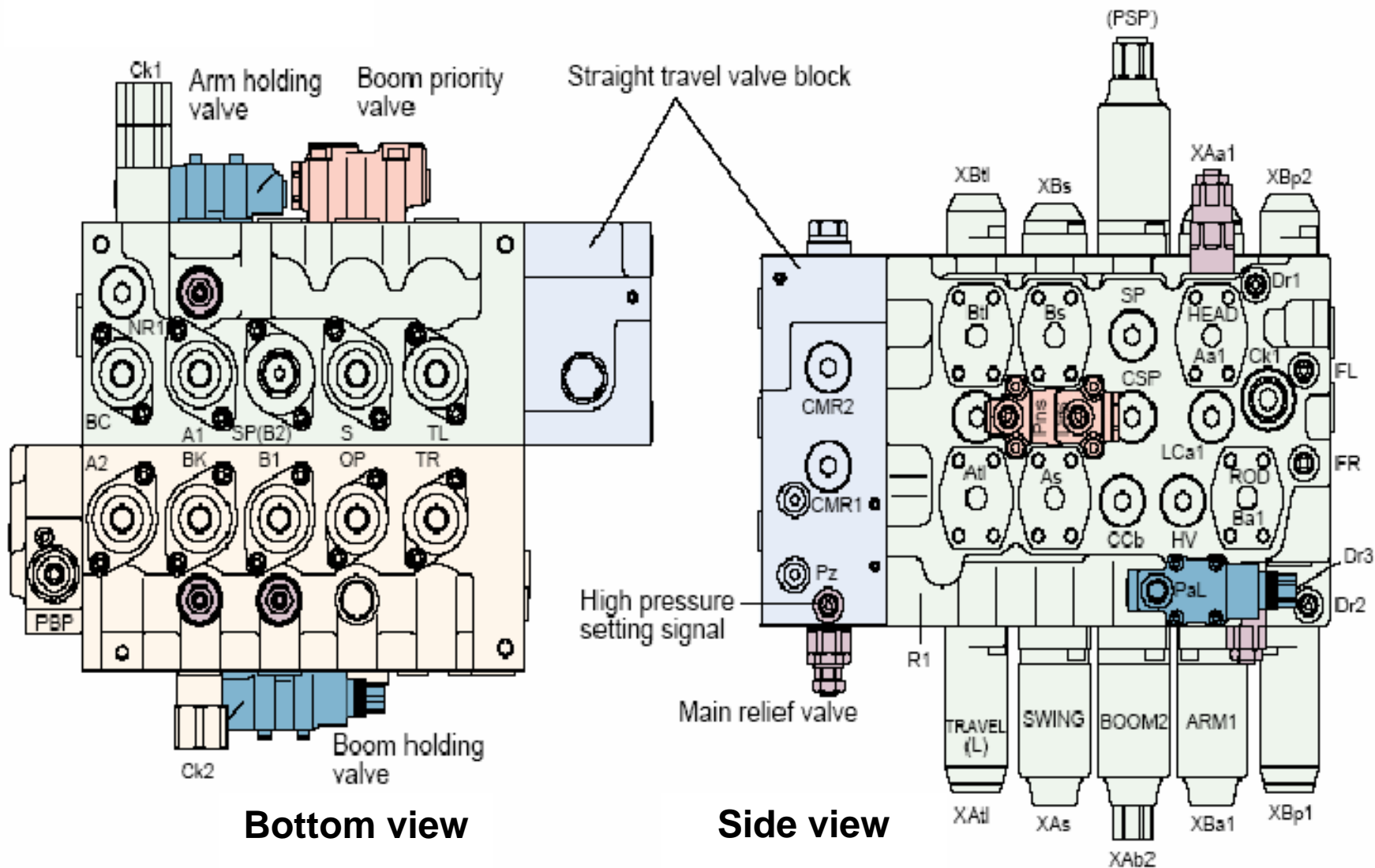
4-1A. Main Control Valve (Kawasaki)



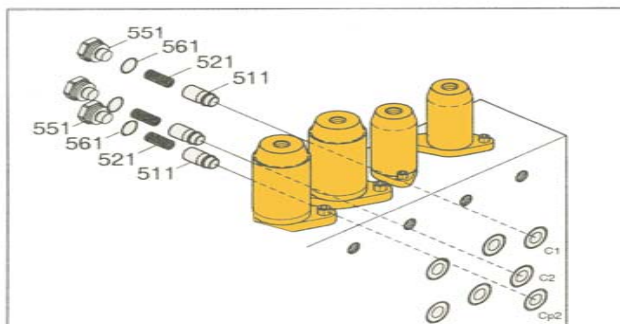


Side view

Upper view

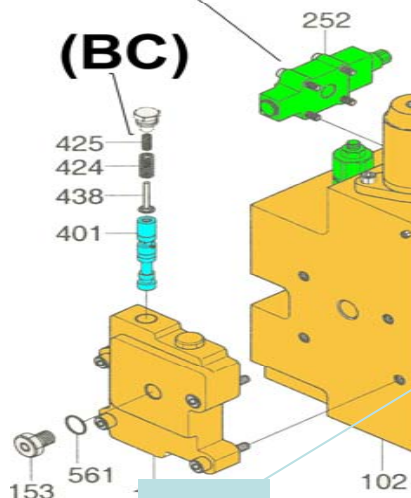


Streight Travel Valve



Boom Holding Valve

(BC)

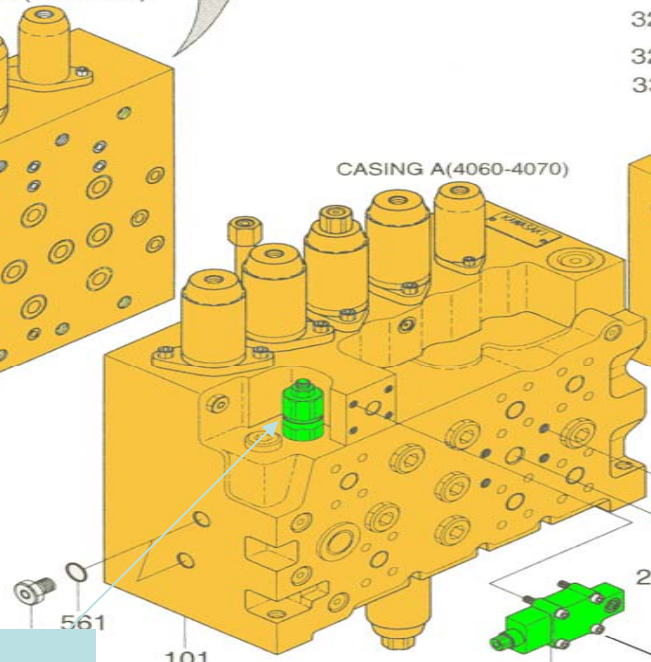


RH

CASING B(4080-4090)

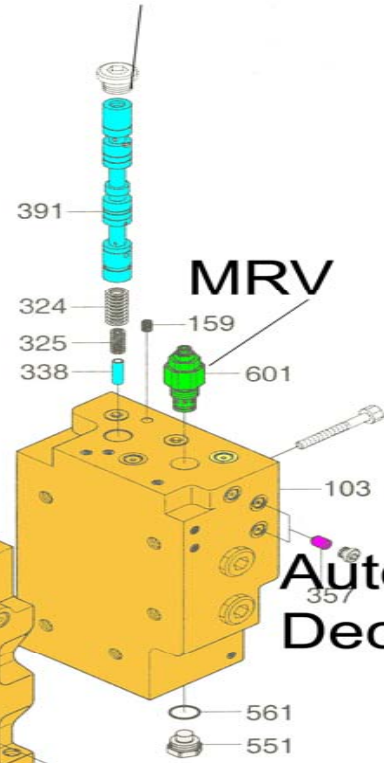
CASING A(4060-4070)

LH



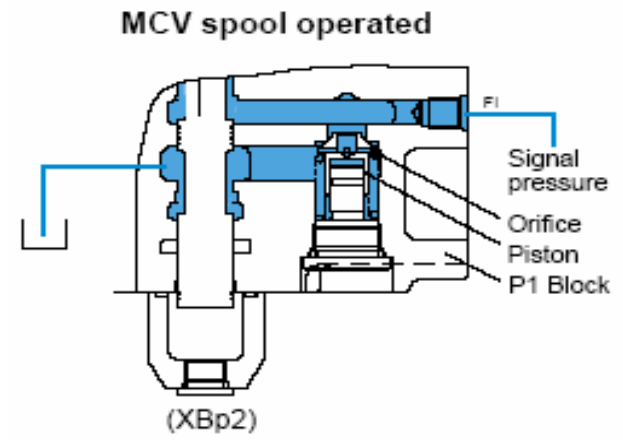
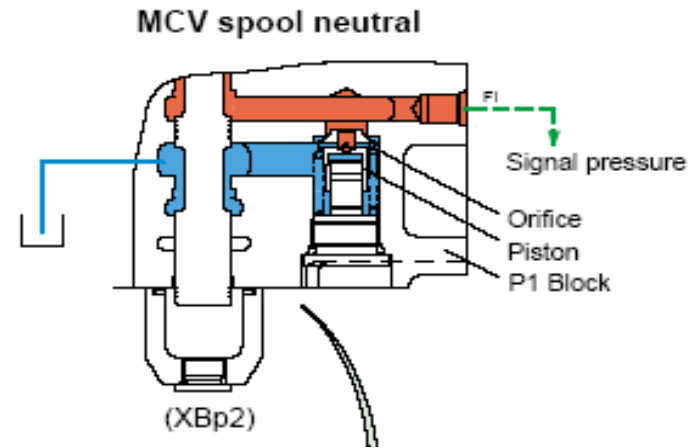
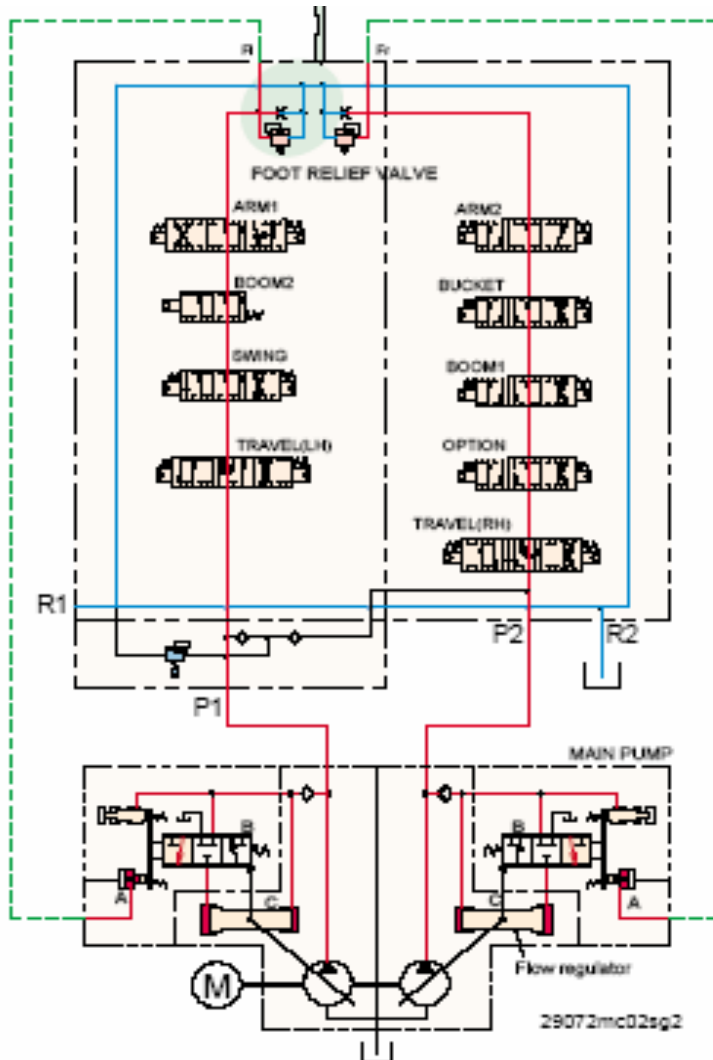
Arm Holding V/V

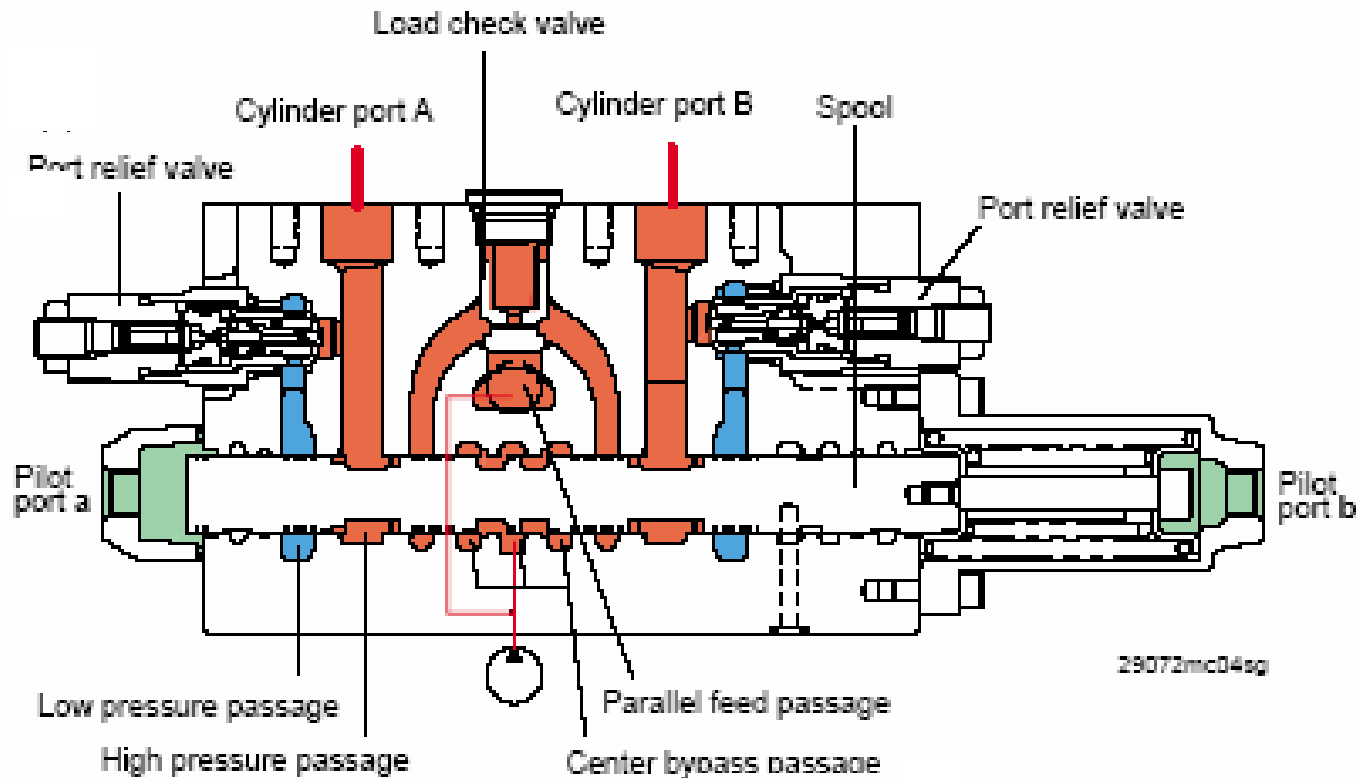
MRV



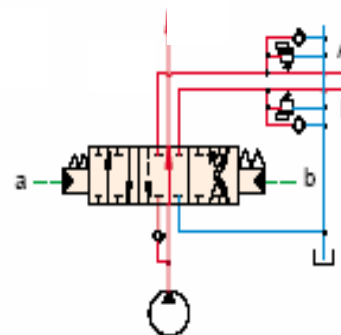
Auto Decel

Swing Priority V/V





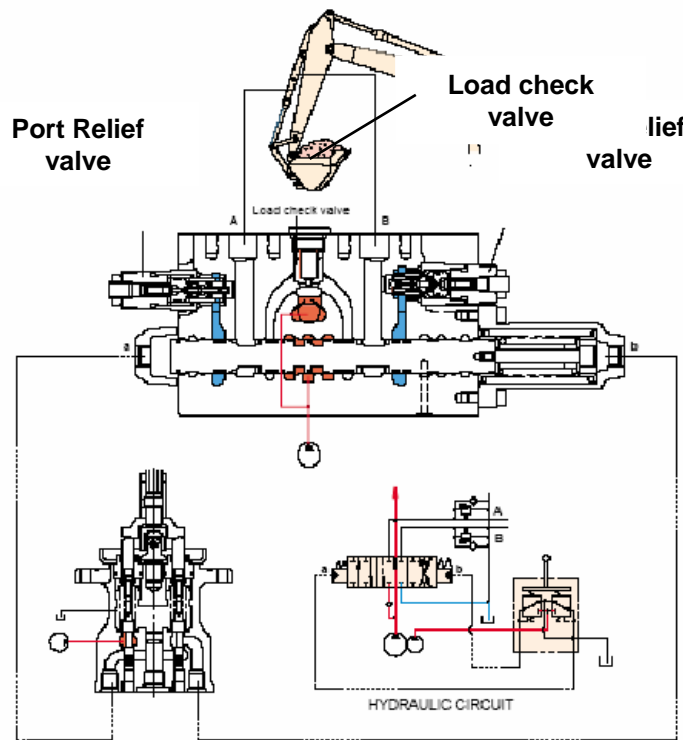
Section view of MCV(Buck)



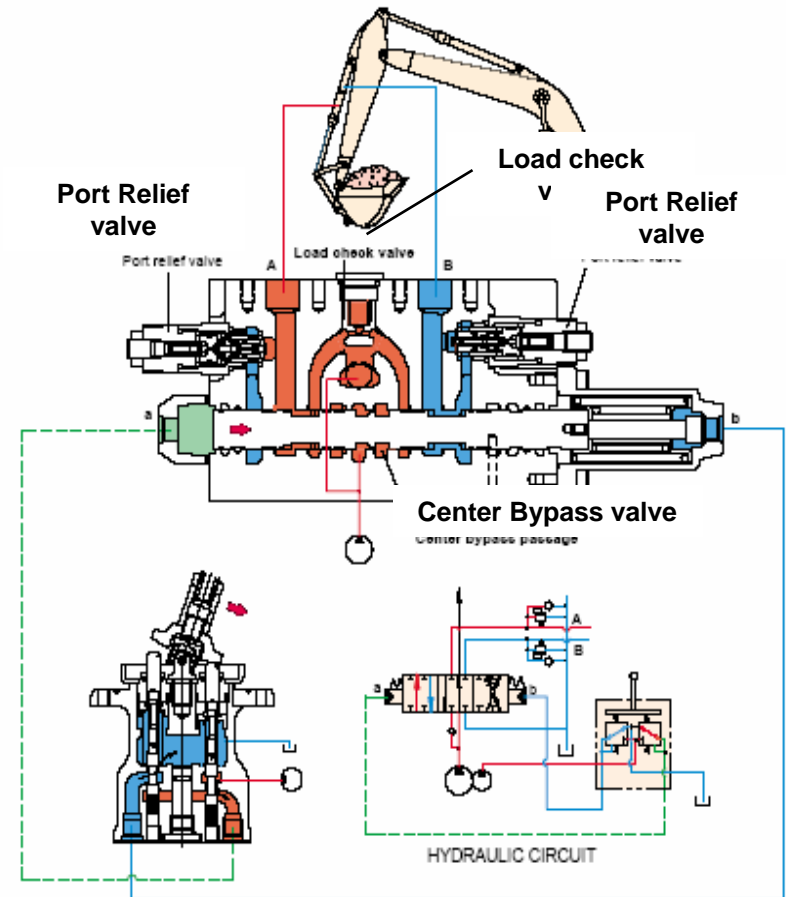
- Direction control by spool.
- Load holding by load check valve.
- Protection of hyd system component by relief valve.
- In neutral, spring set the plunger at neutral position;
- * The high pressure feed passage is shut off by plunger.
- * Oil from the pump flow through the center bypass.

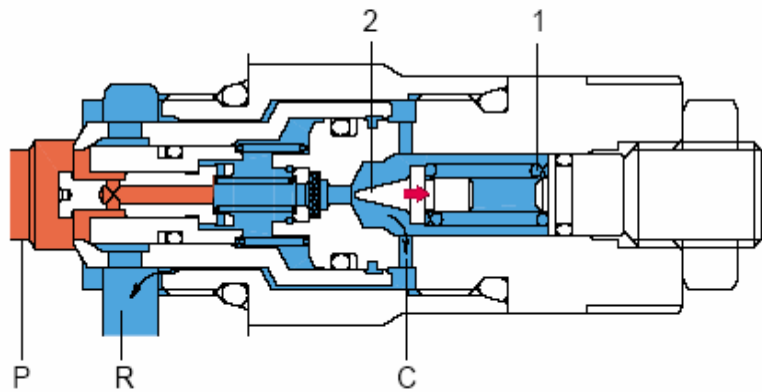
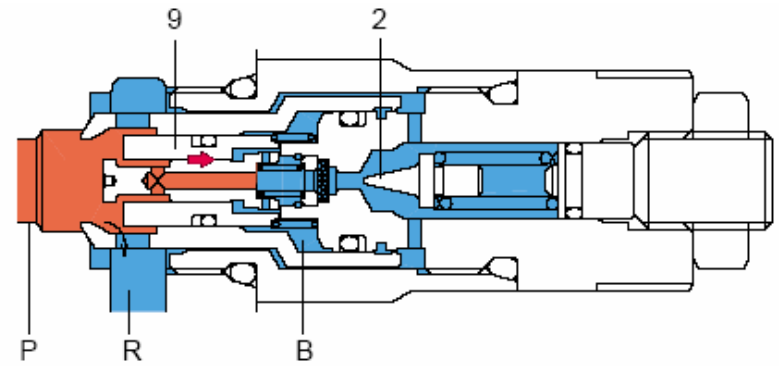
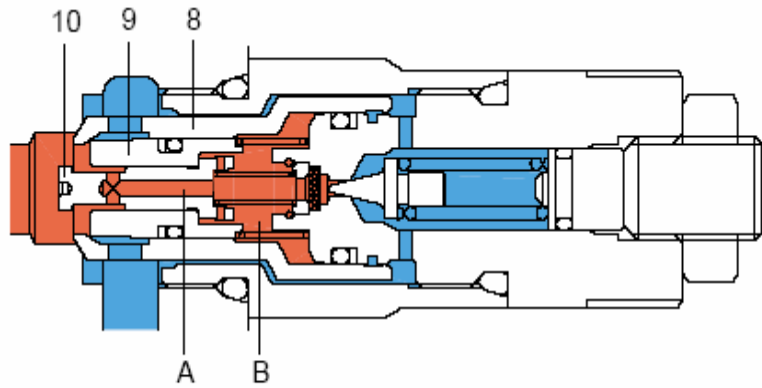
HYDRAULIC SYSTEM

Neutral Position

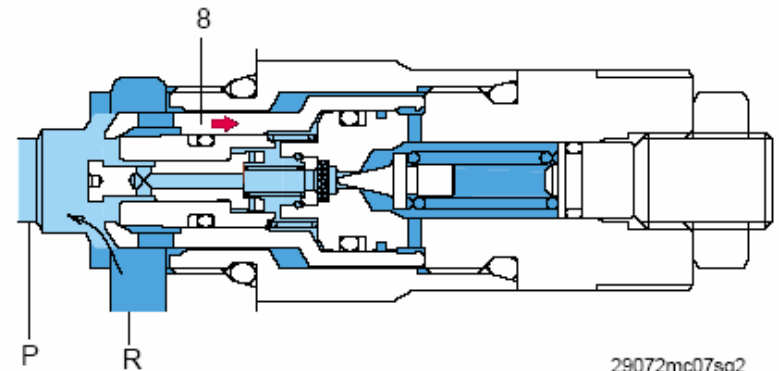


Operation Position

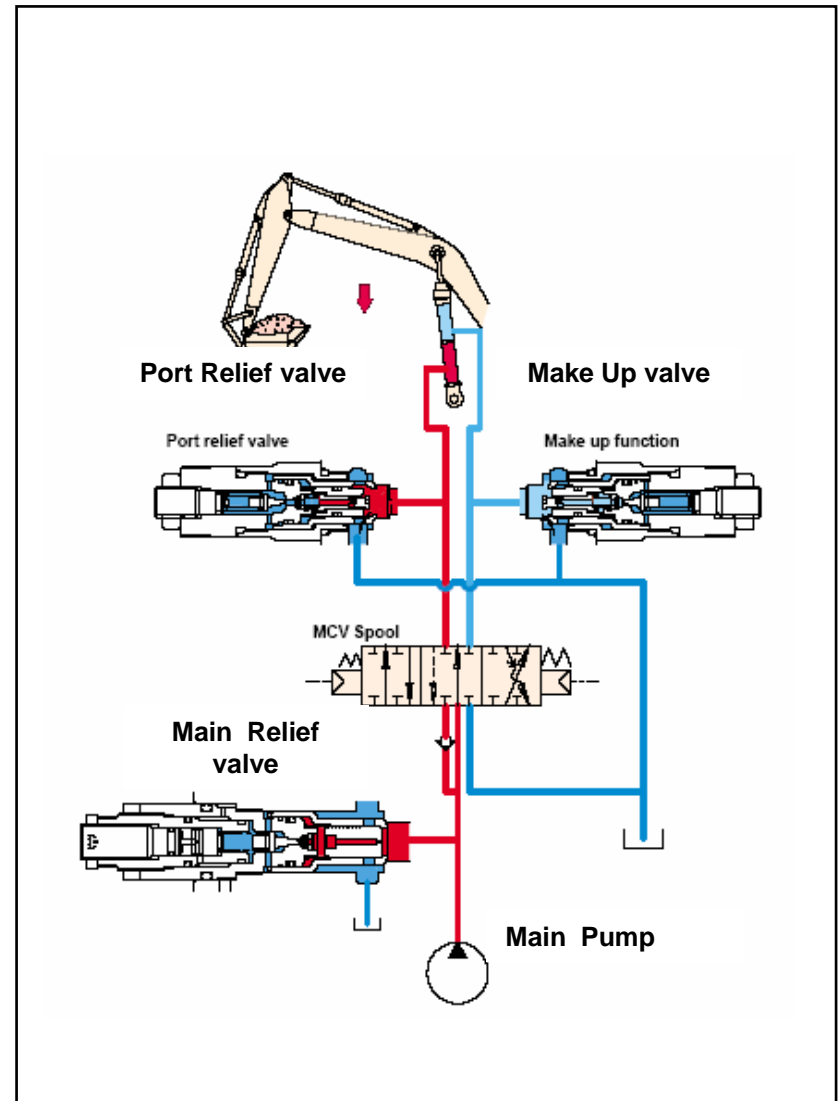
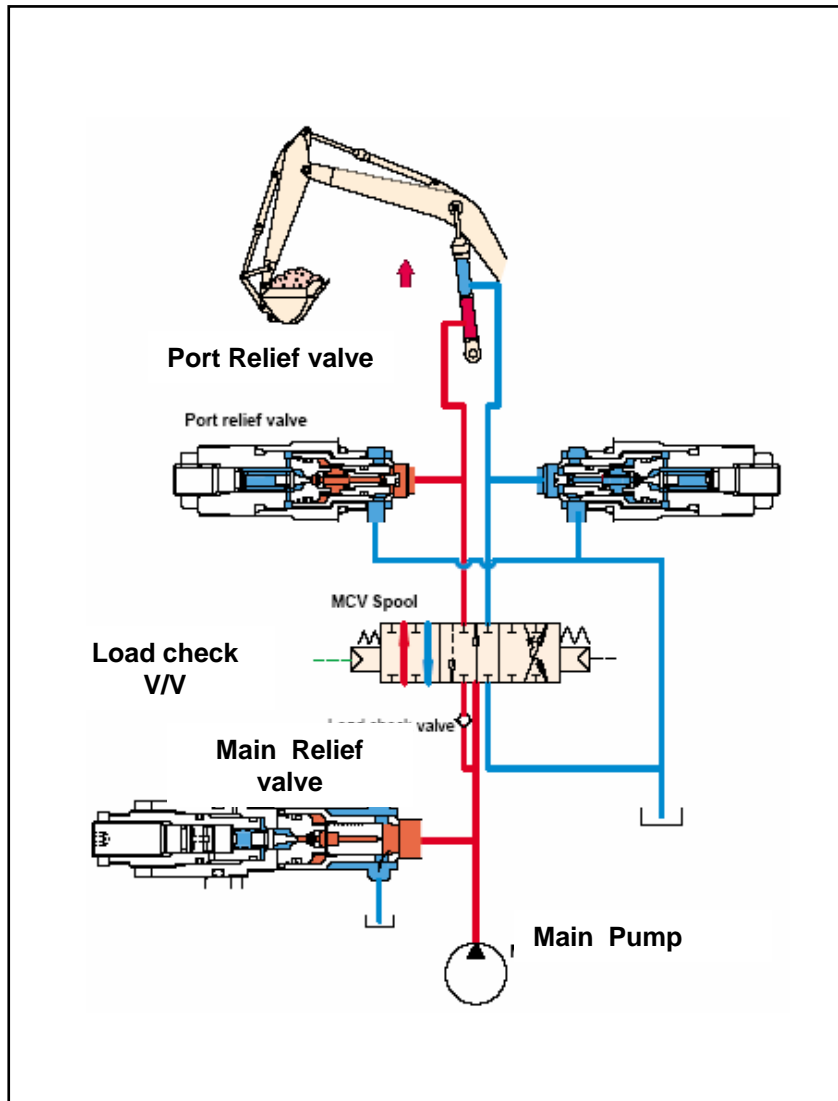


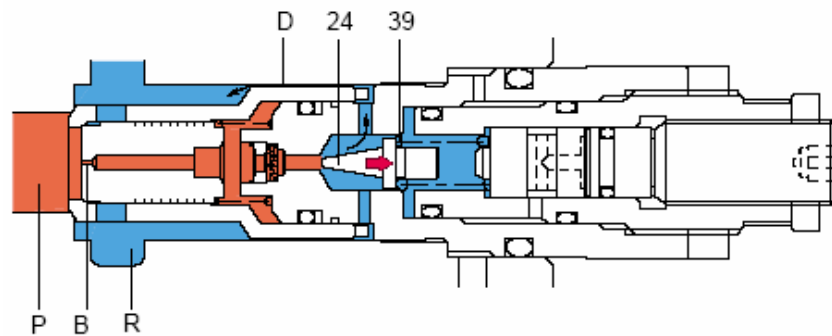
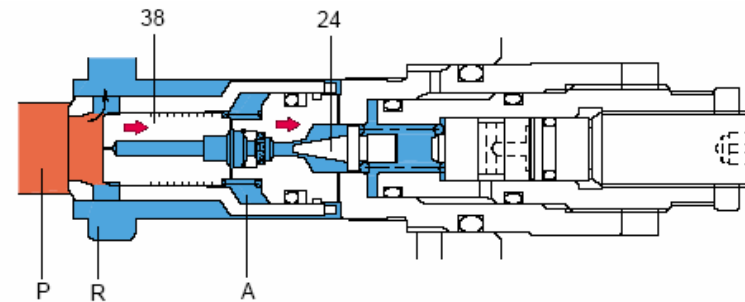
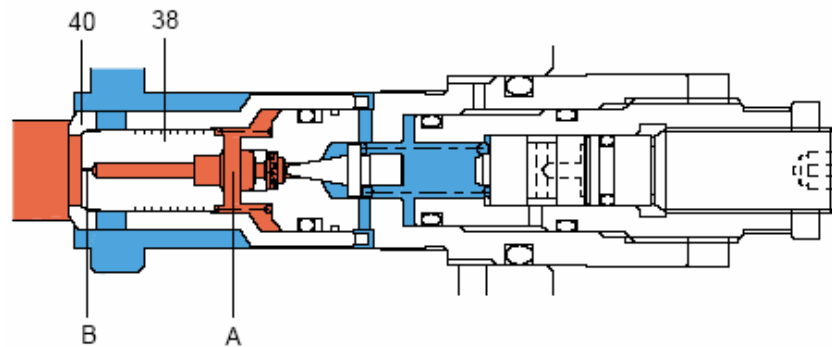


- Function as make up valve

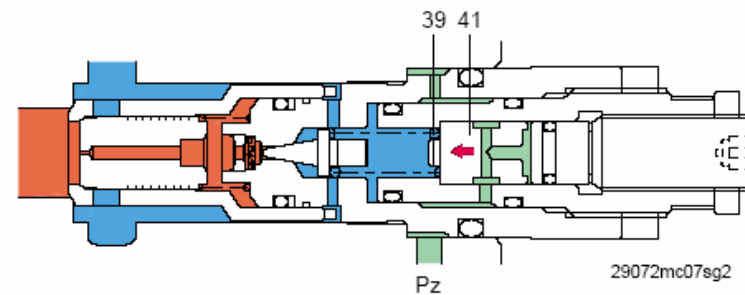


29072mc07sg2





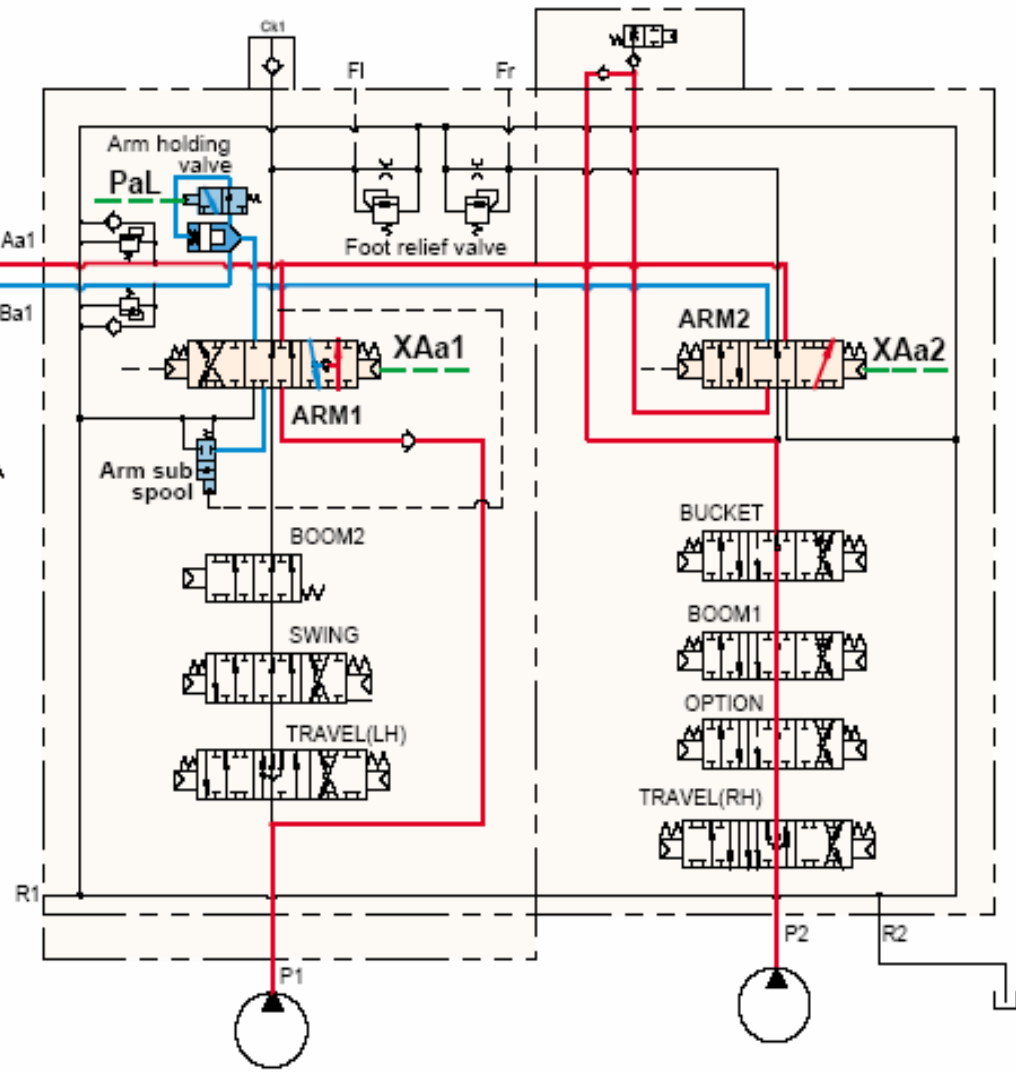
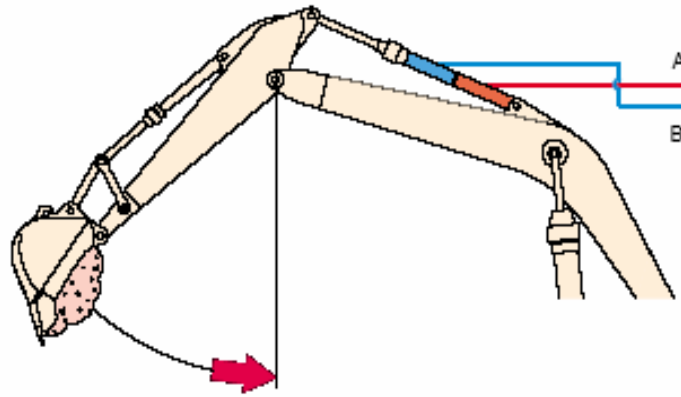
- High pressure setting signal(Pz) : ON

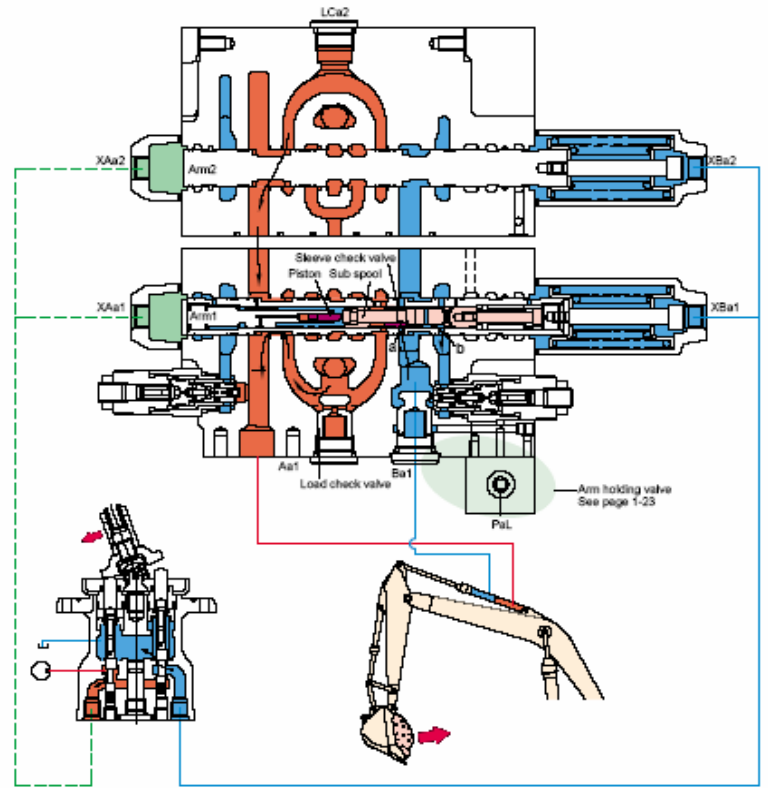
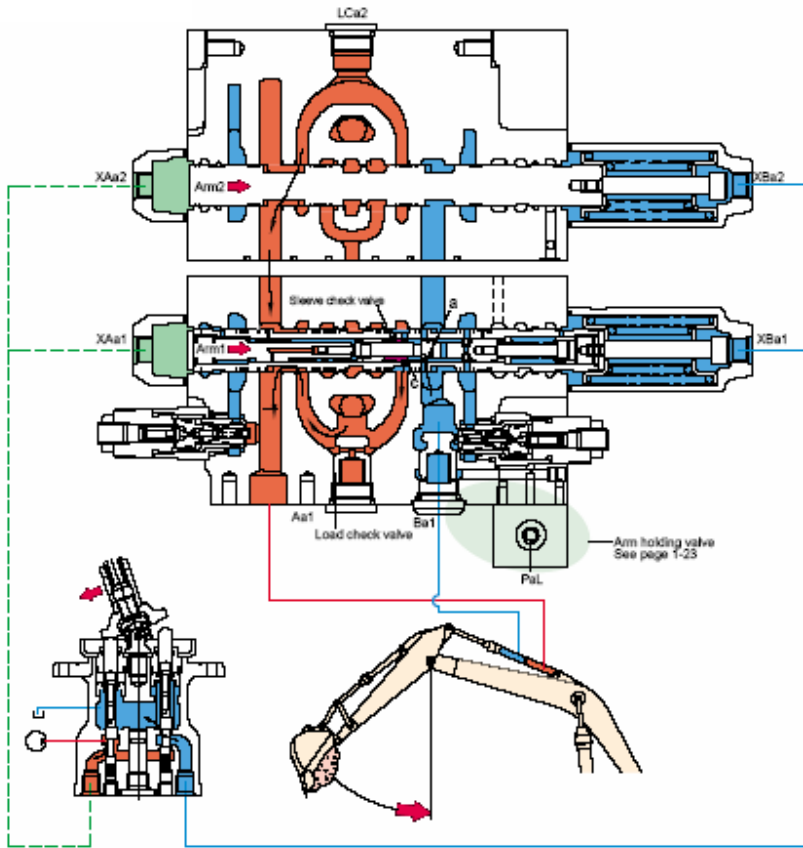


29072mc07sg2

5) Arm-In Operation (Regeneration)

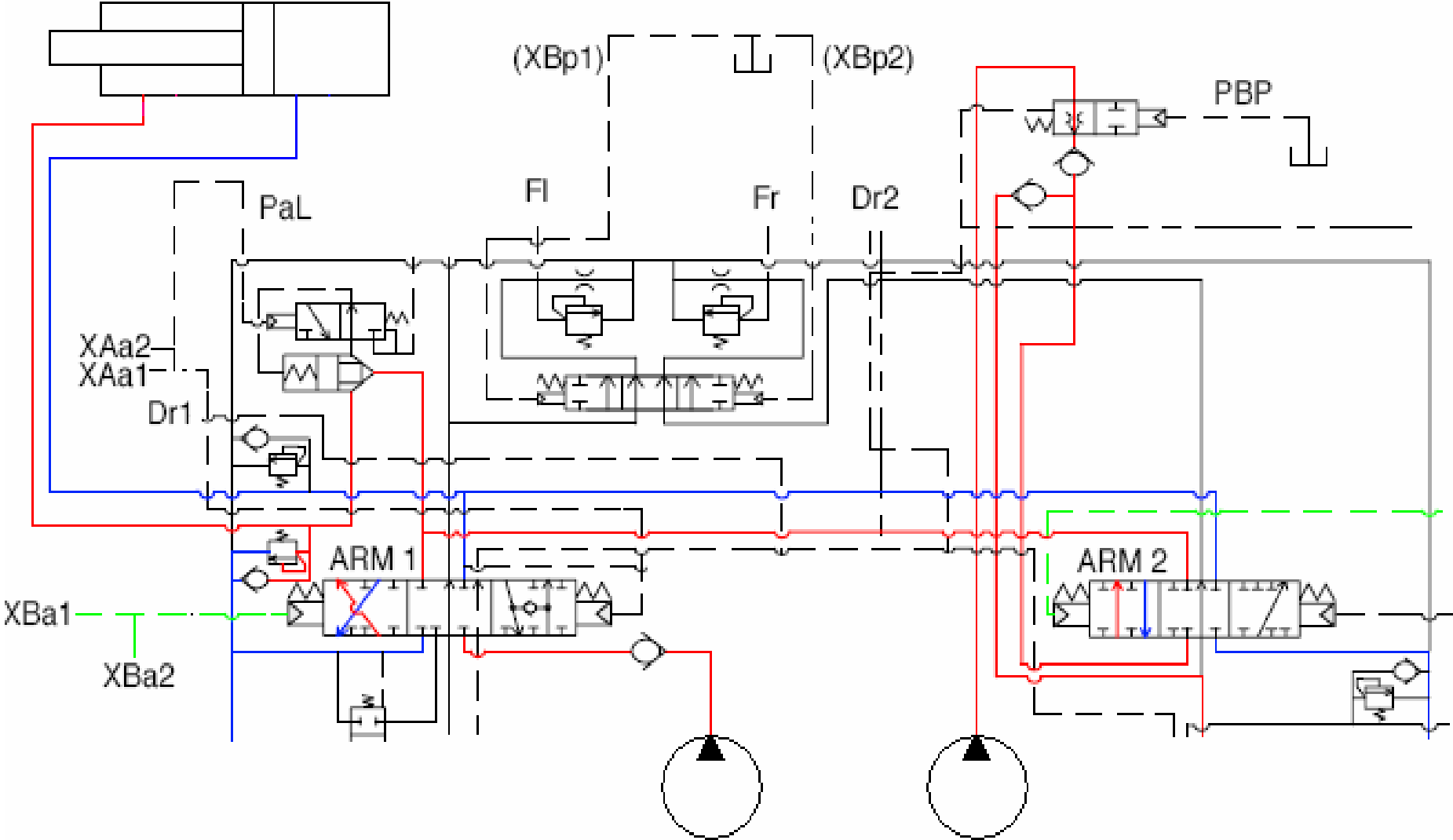
- Improve arm-in speed
- Prevent arm cylinder cavitation



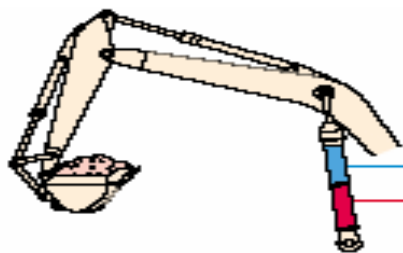


29072mc09eg2

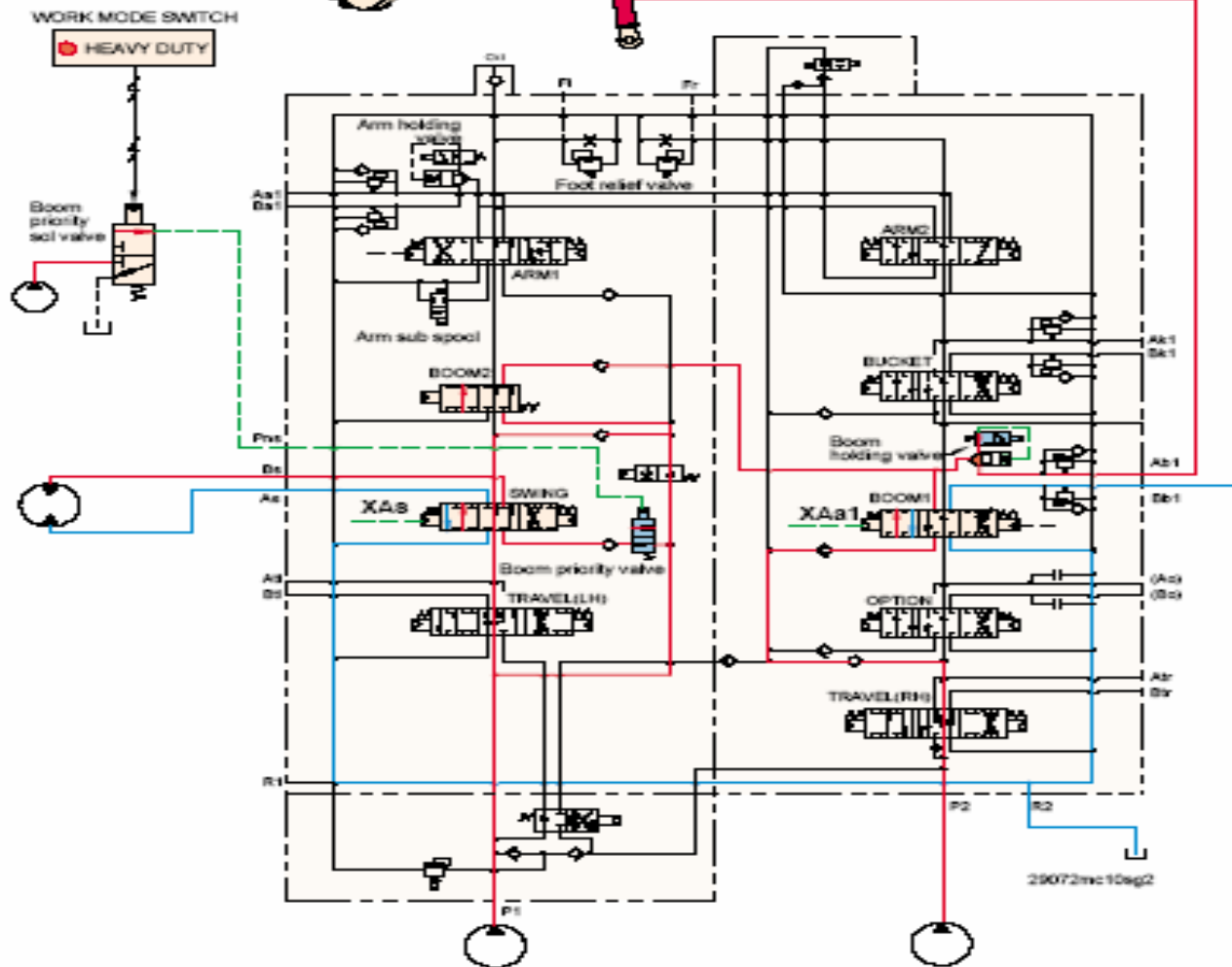
Arm Roll Out



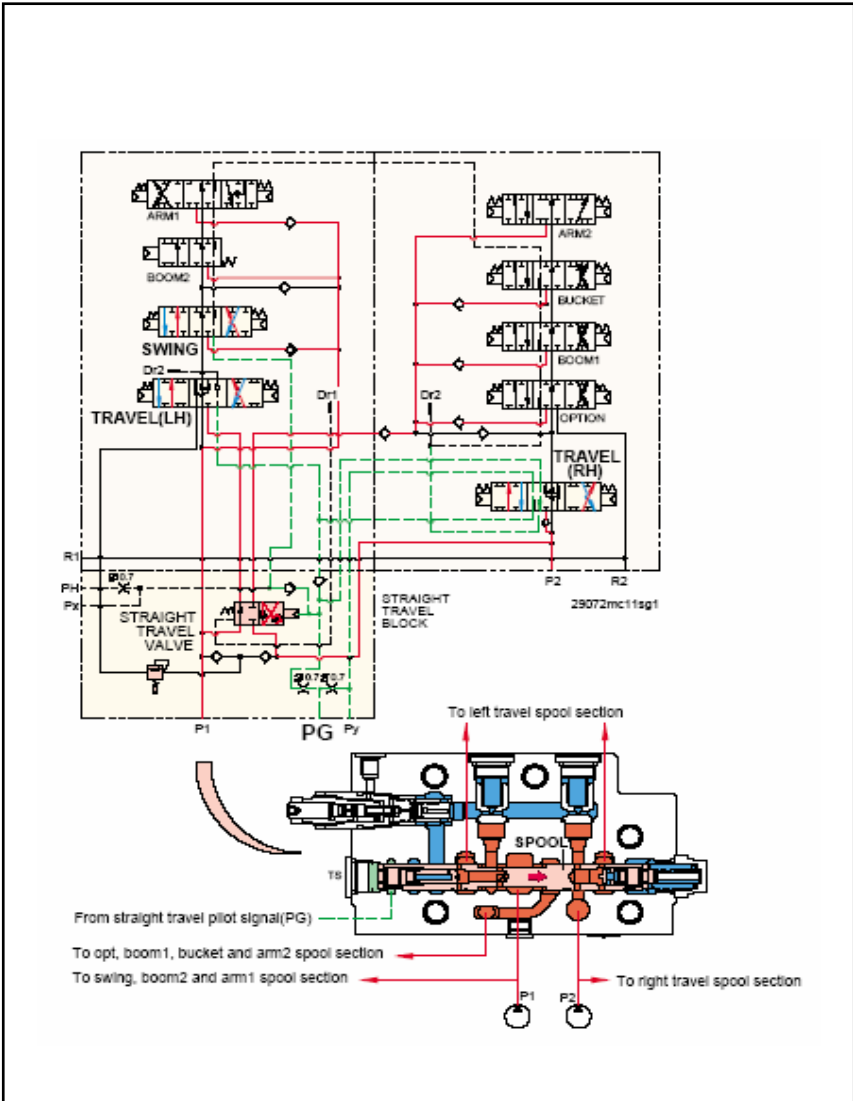
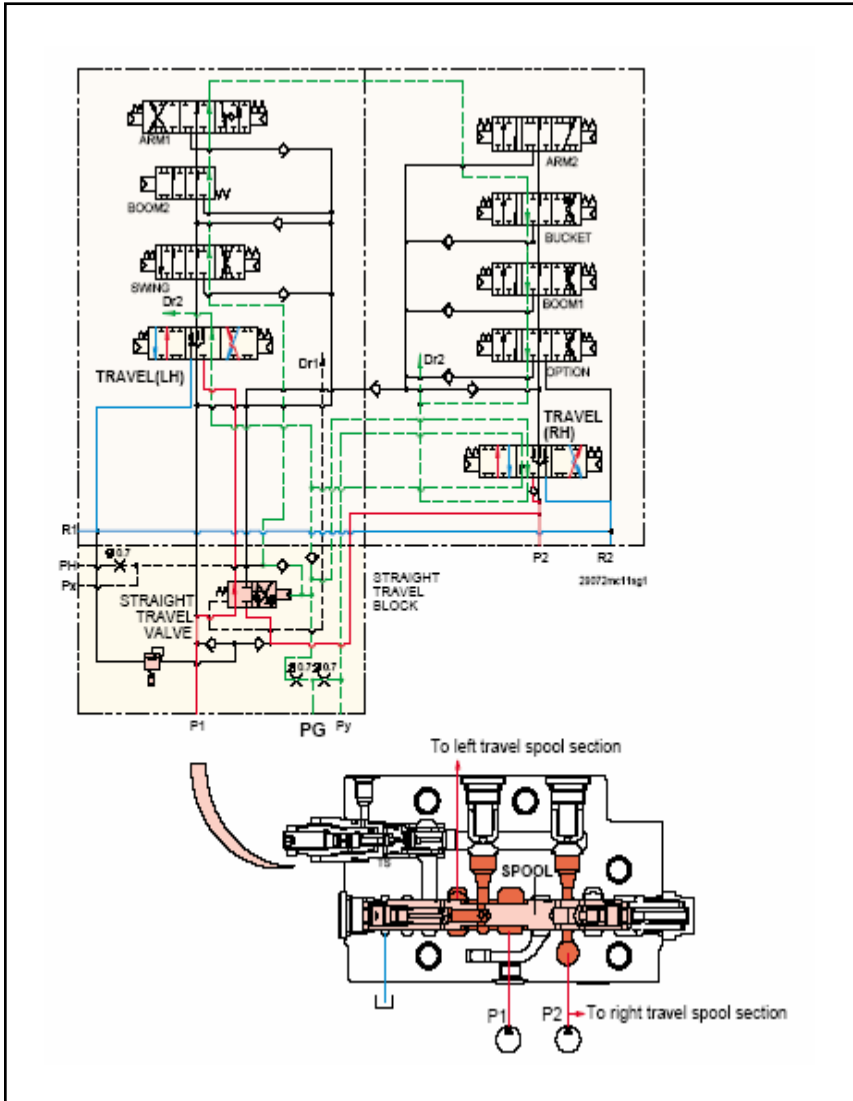
6) Boom Priority System (Boom & Swing Operation)



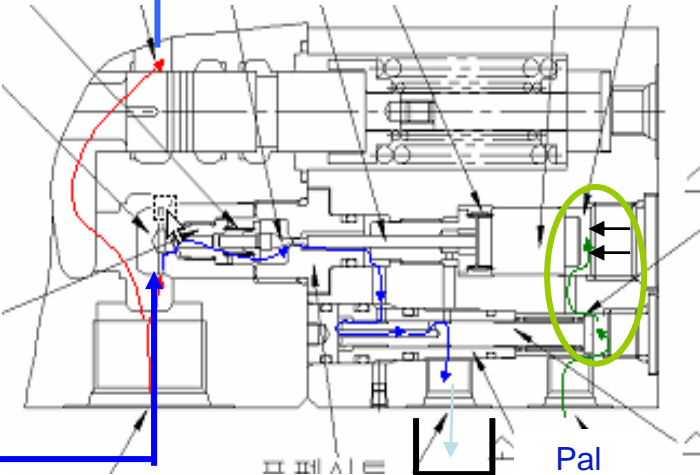
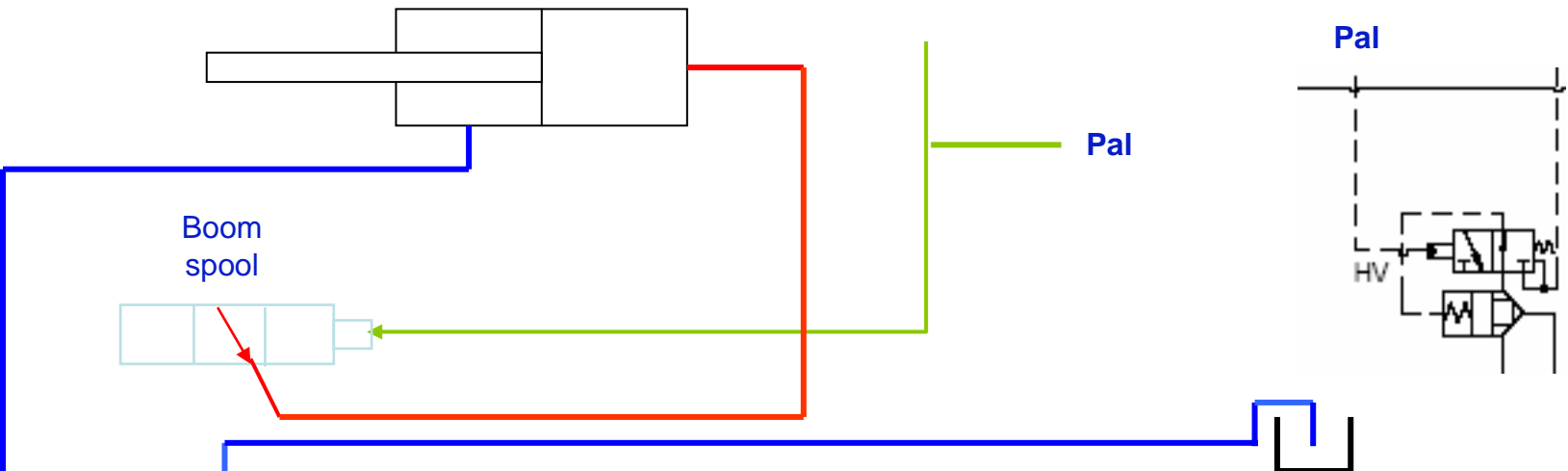
When carrying out the combined operation of swing and boom or arm.



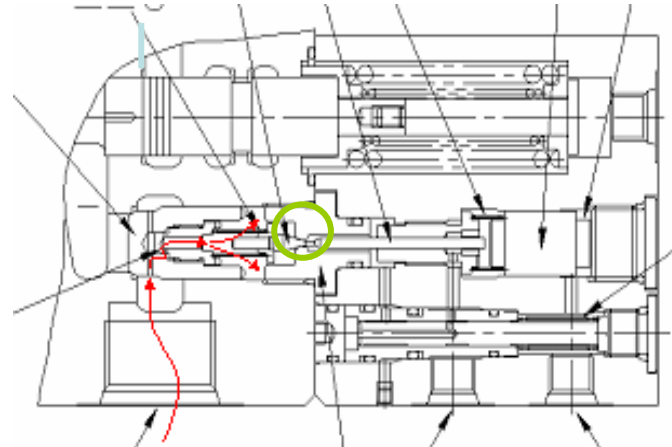
7) Straight Travel Valve



8) Boom & Arm Holding Valve



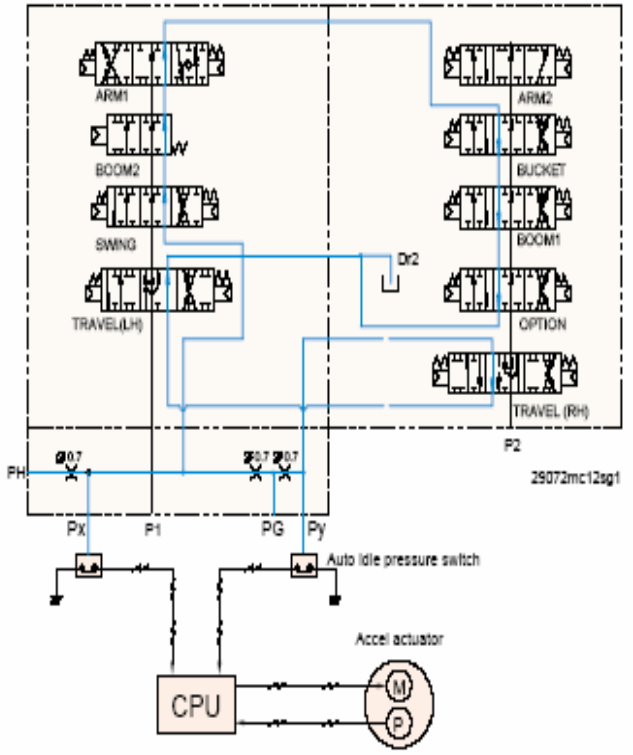
Boom Holding valve open



Boom Holding valve closed

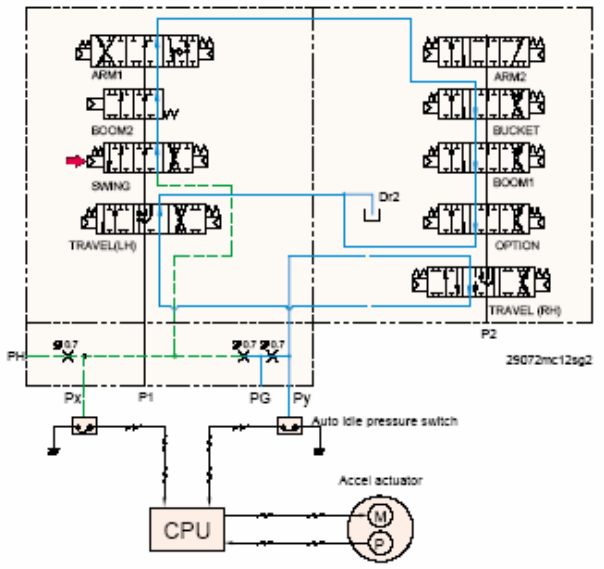
9)Auto Idling Control System

Neutral Position



- PG : Pilot oil supply from pilot ump.

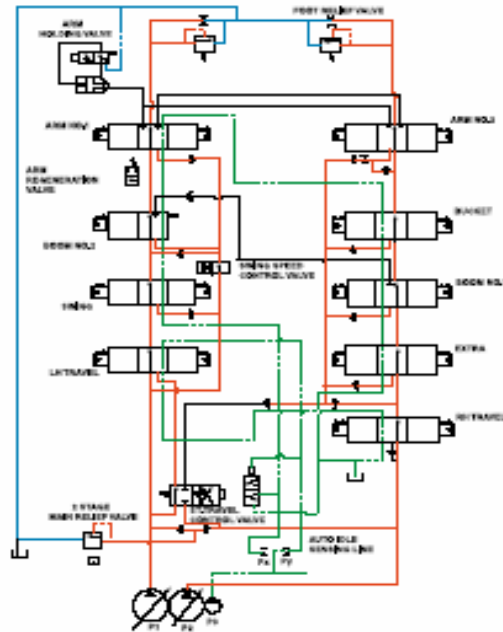
Operated Position



Operating pressure of pressure switch(Px, Py)
 -10 ± 1 bar below : Close (idling)
 -10 ± 1 bar over : Open (rpm with selected mode)

Leadtime
 - Deceleration : 5.5 sec
 - Recovery : 1.5 sec

10) Straight Travel Valve at Neutral position



- Neutral position

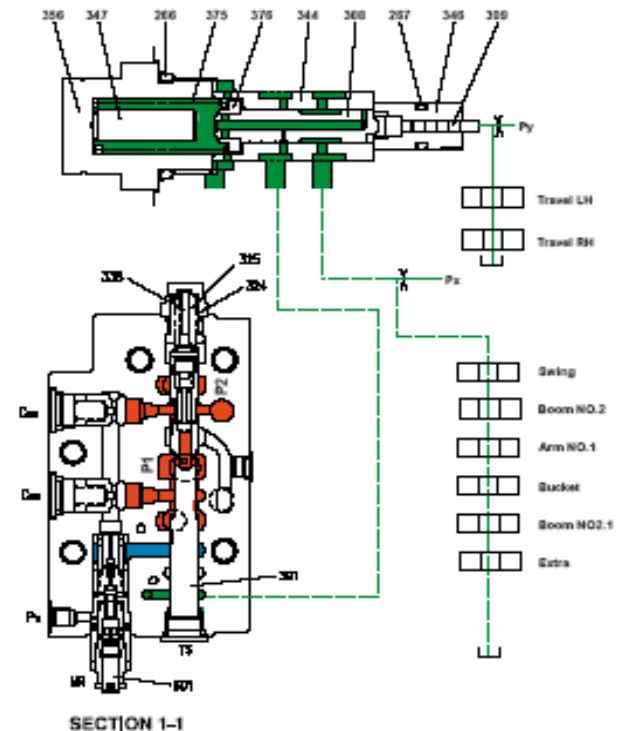
P1 oil → LH Travel → Swing → Boom No. 2 → Arm No. 1 → Tank
 P2 oil → RH Travel → Extra → Boom No. 1 → Bucket → Tank

- Travel only forward or reverse

P1 oil → LH Travel motor → Tank
 P2 oil → RH Travel motor → Tank

- Pilot line

PX oil : Swing → Boom 2 → Boom No. 2 → Boom No. 1 → Bucket → Boom No. 1 → EXTRA → TANK
 PY oil : LH Travel → RH Travel → TANK

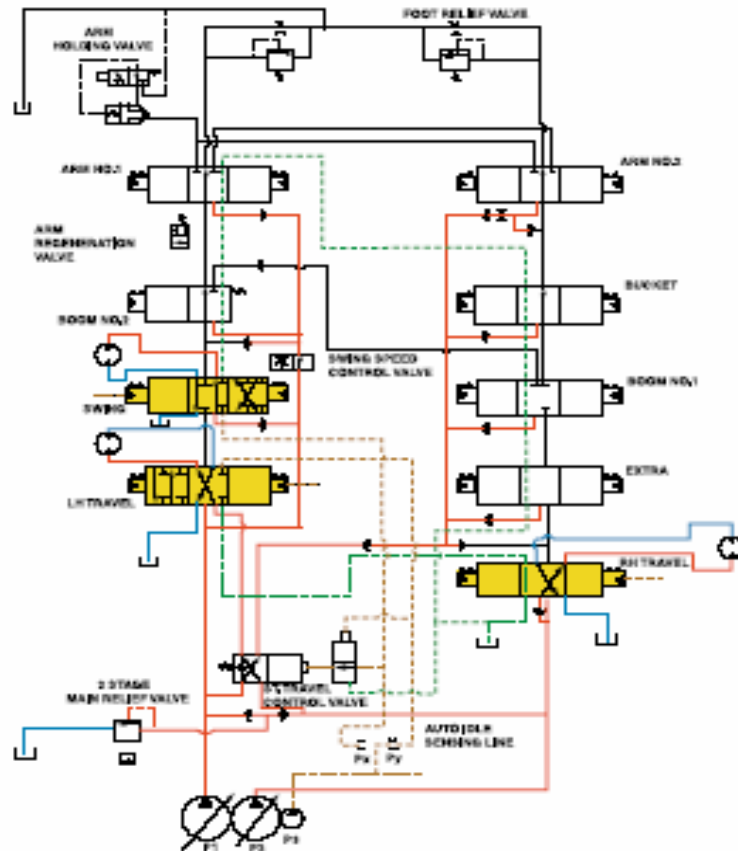


- Pilot line Fx and Py oil return to tank through oil passage of the spools.

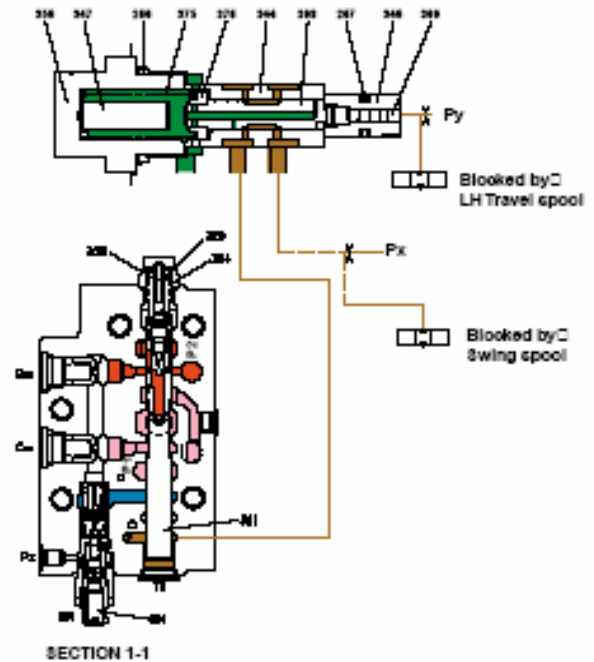
- Oil passage between P1 & P2 is blocked by piston (391).

11) Travel and Swing Simultaneously

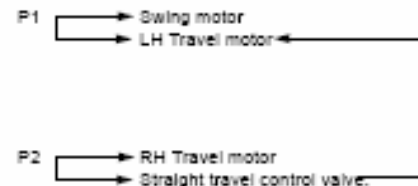
Example : travel and swing simultaneously.



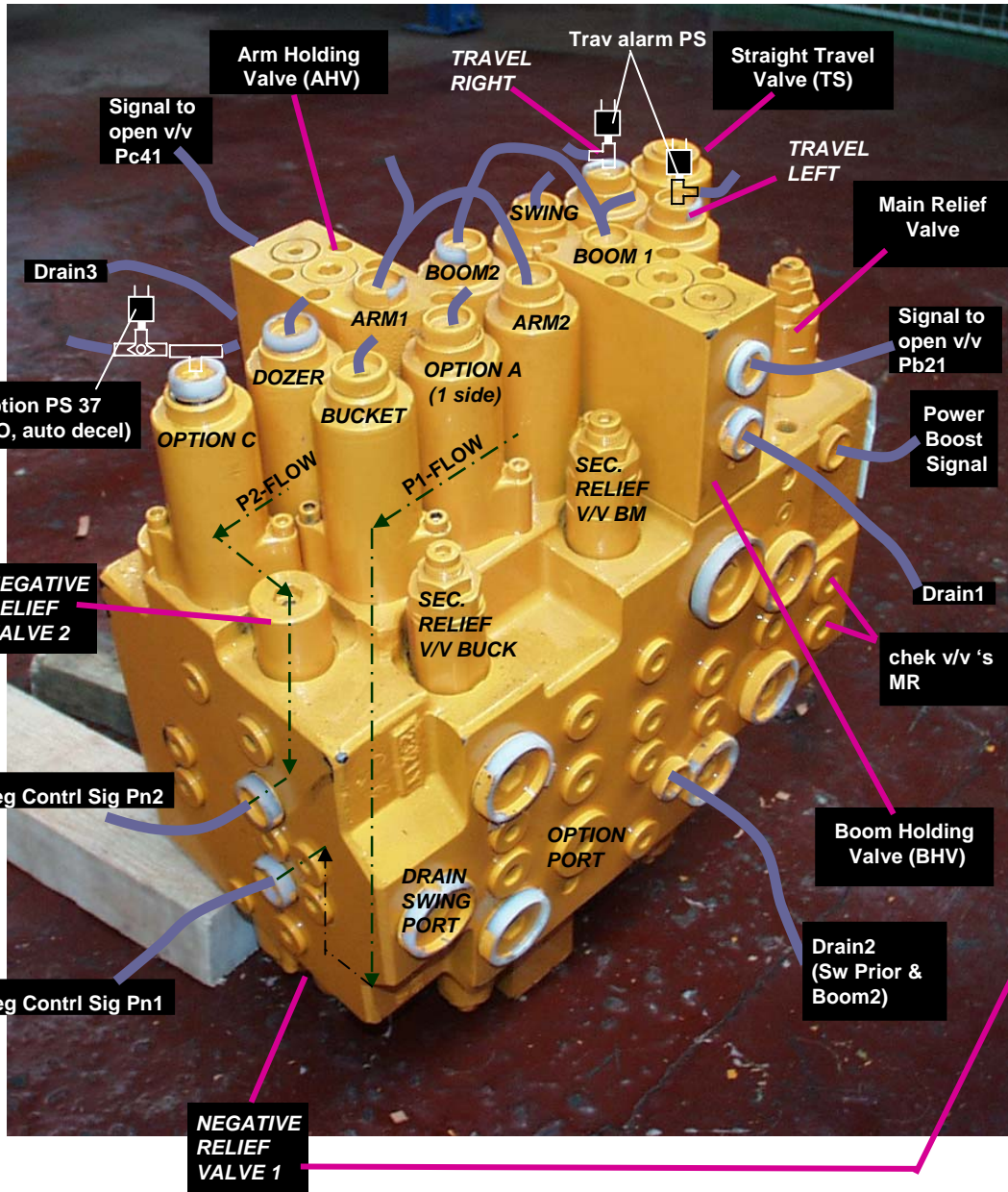
- When machine is operated travelling with swing (or other function) simultaneously, Px or Py line is blocked by operated spools.
- So Px or Py line pressure are increased, and operate straight travel control valve.



- Py line :
 - Oil passage is blocked by LH travel spool and pressure is increased.
 - Py pressure moves pistons (309, 308).
- Px line :
 - Oil enters the passage at piston (308) and moves piston (351) to open the oil passage between P1 and P2 because pressure in Px line is increased by swing spool.



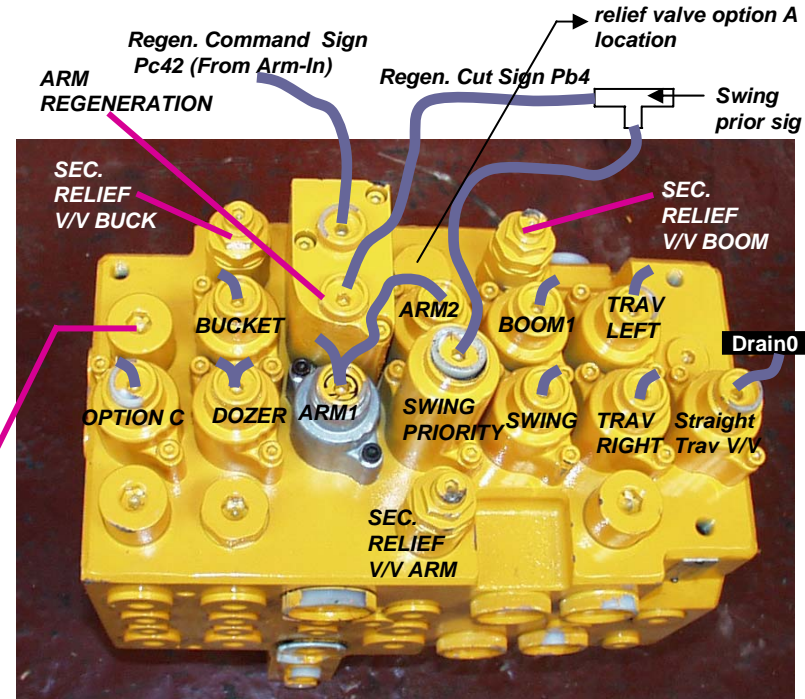
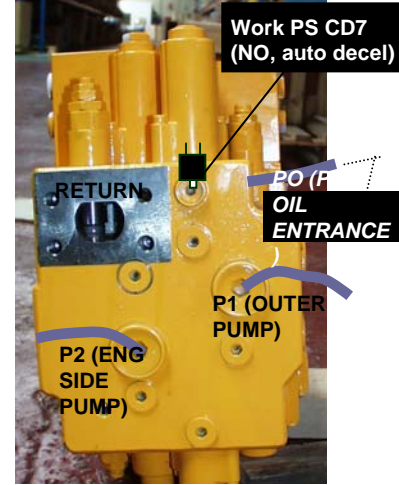
Compensation for shortage of oil which is used for swing.



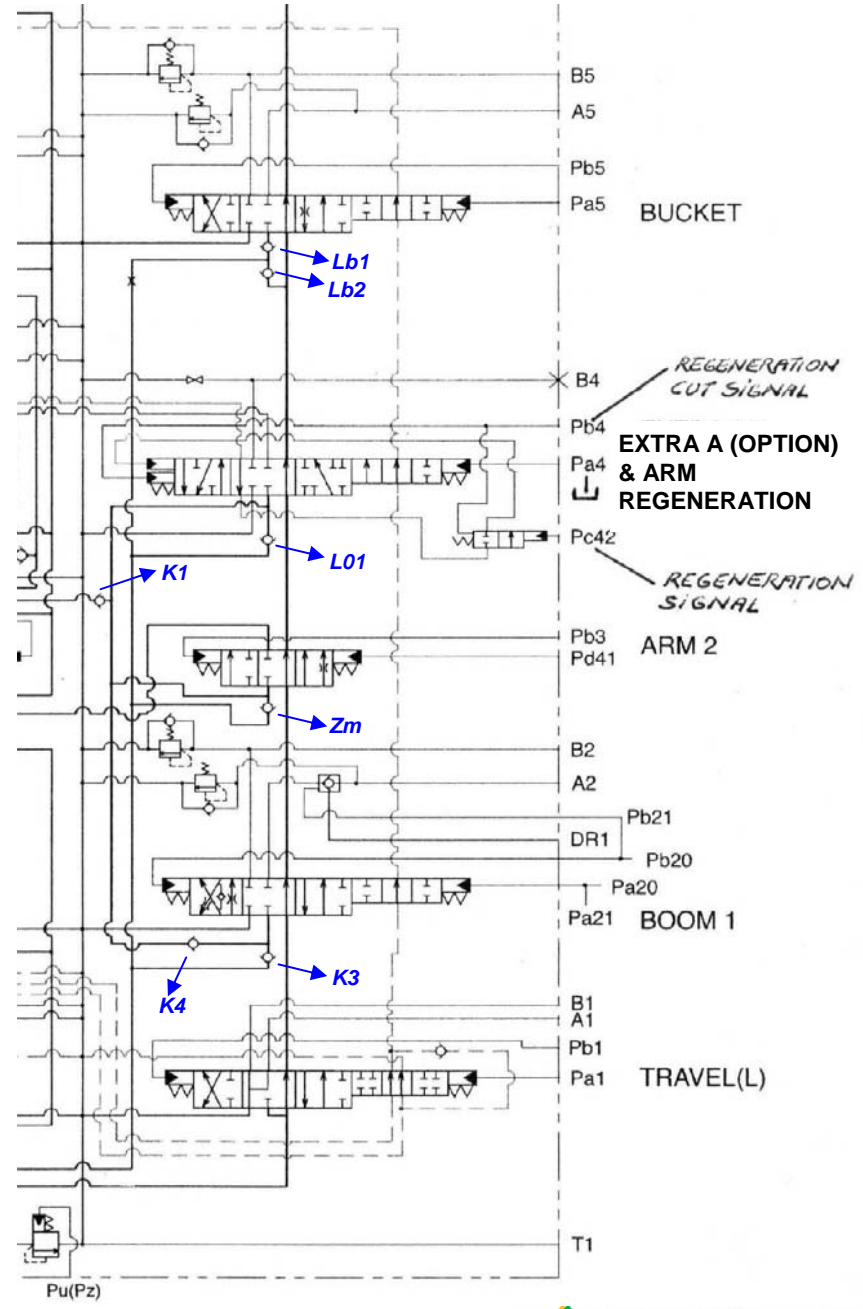
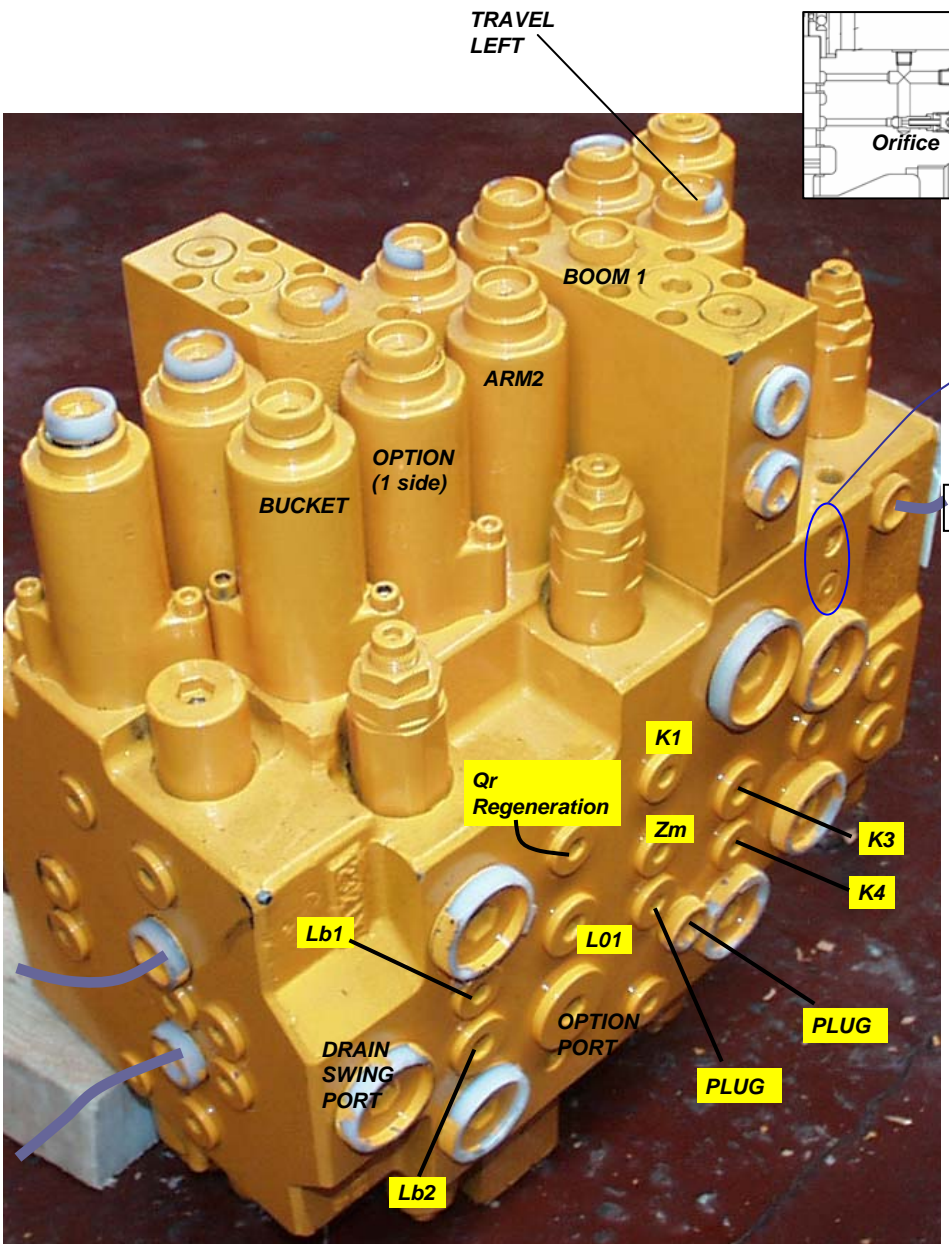
FRONT VIEW

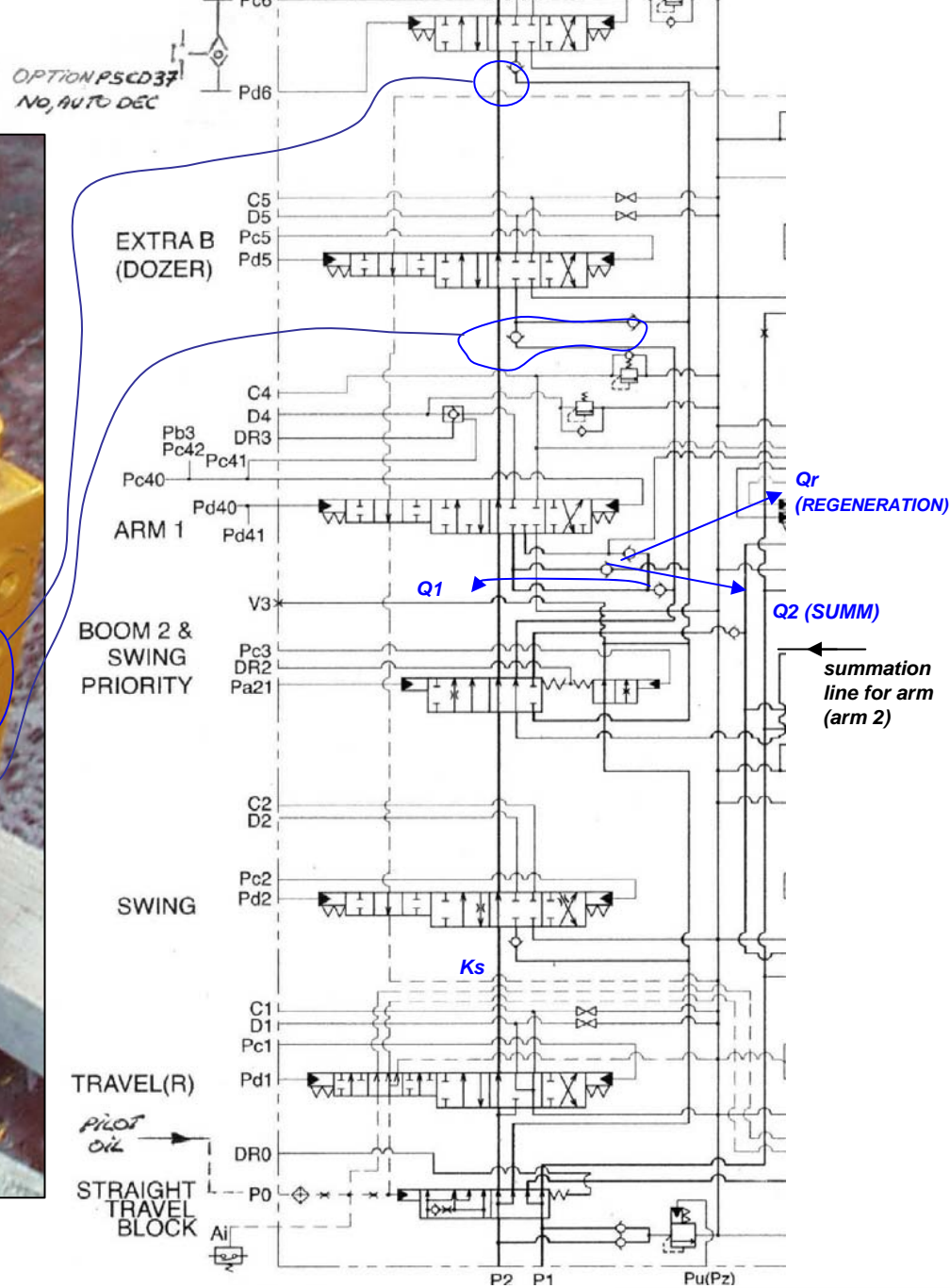
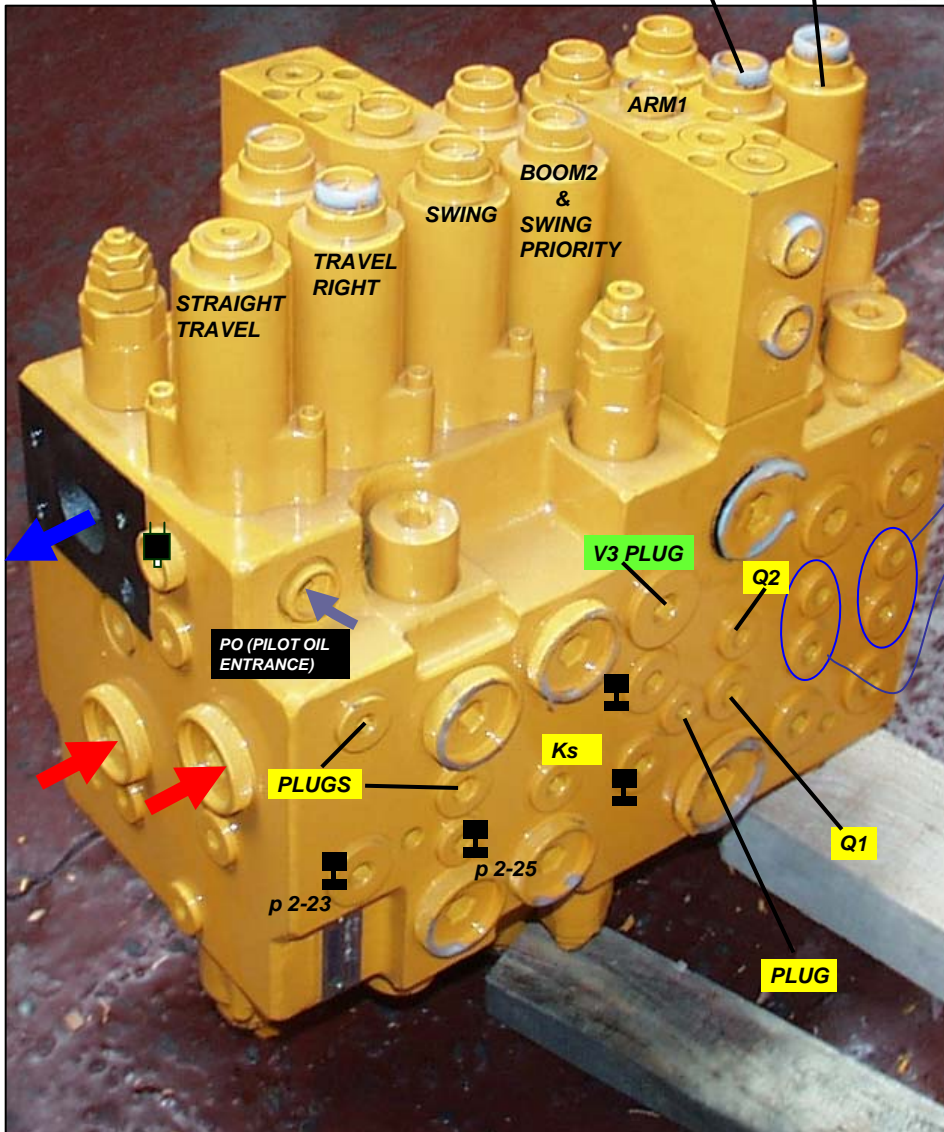


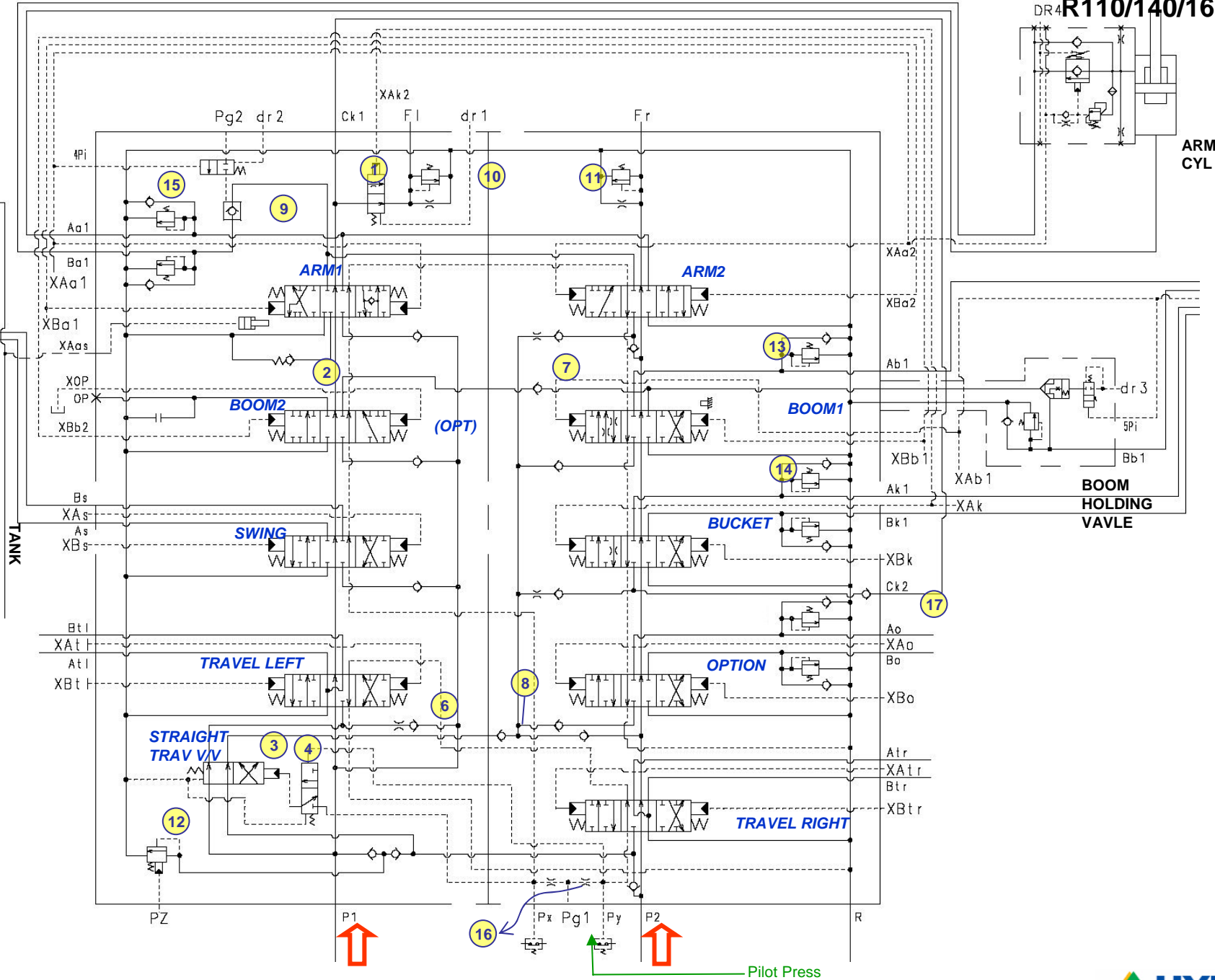
BACK VIEW

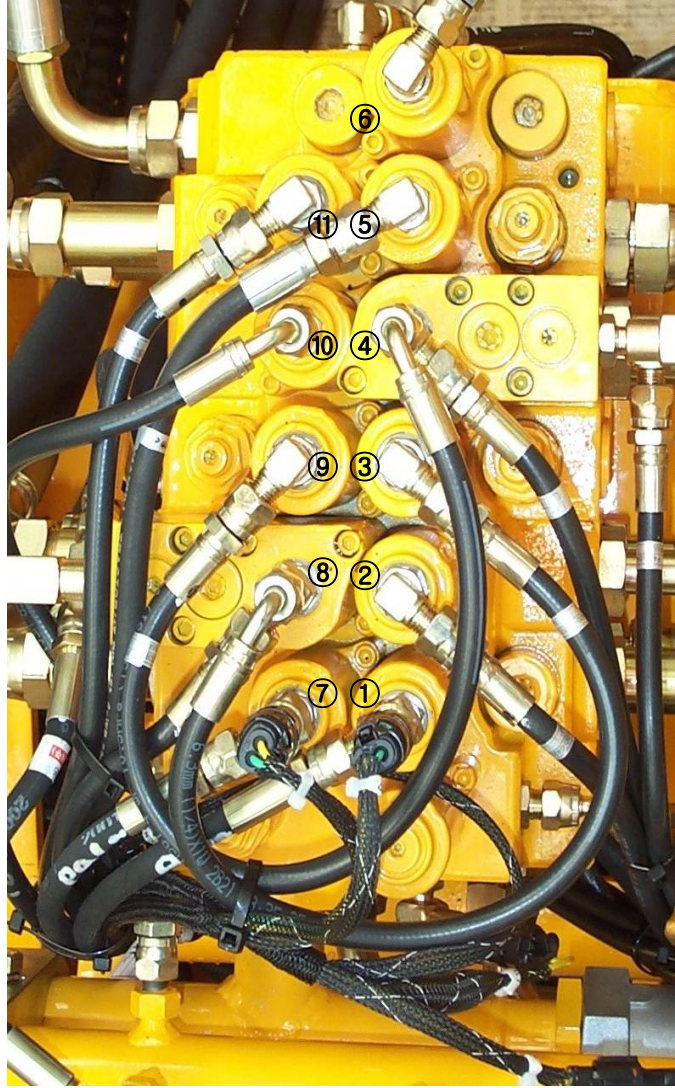
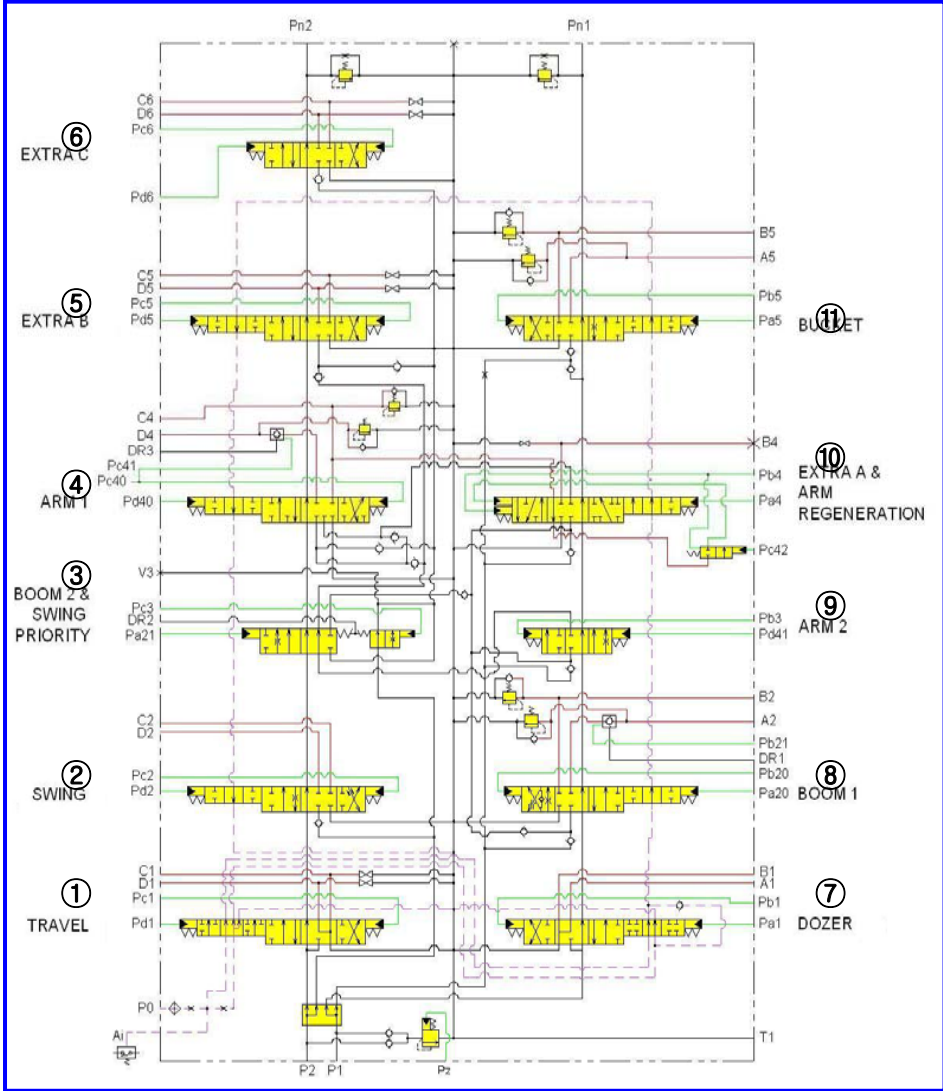


BOTTOM VIEW

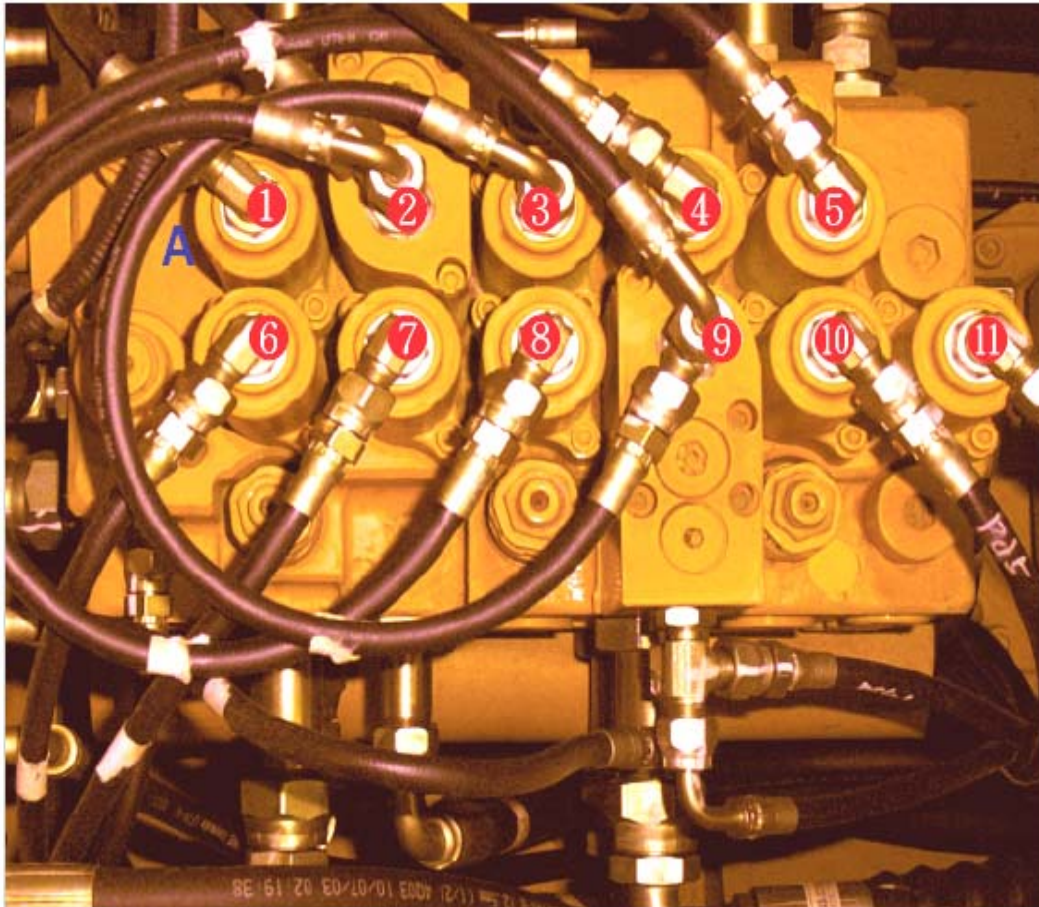






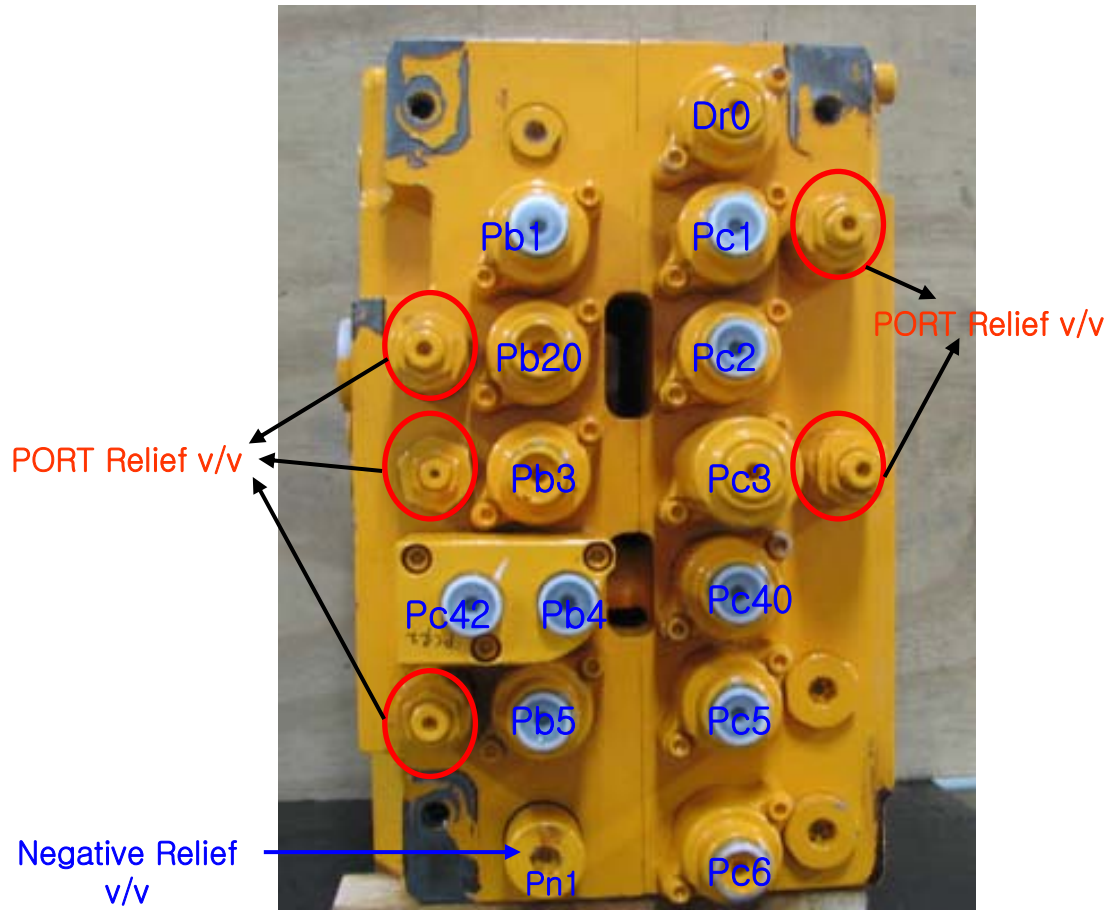


1) SPOOLS



- ① OPTION (Dozer for Wheel excavator)
- ② BOOM1
- ③ ARM2
- ④ ARM REGENERATION
- ⑤ BUCKET
- ⑥ TRAVEL
- ⑦ SWING
- ⑧ BOOM2
- ⑨ ARM1
- ⑩ OPTION
- ⑪ OPTION

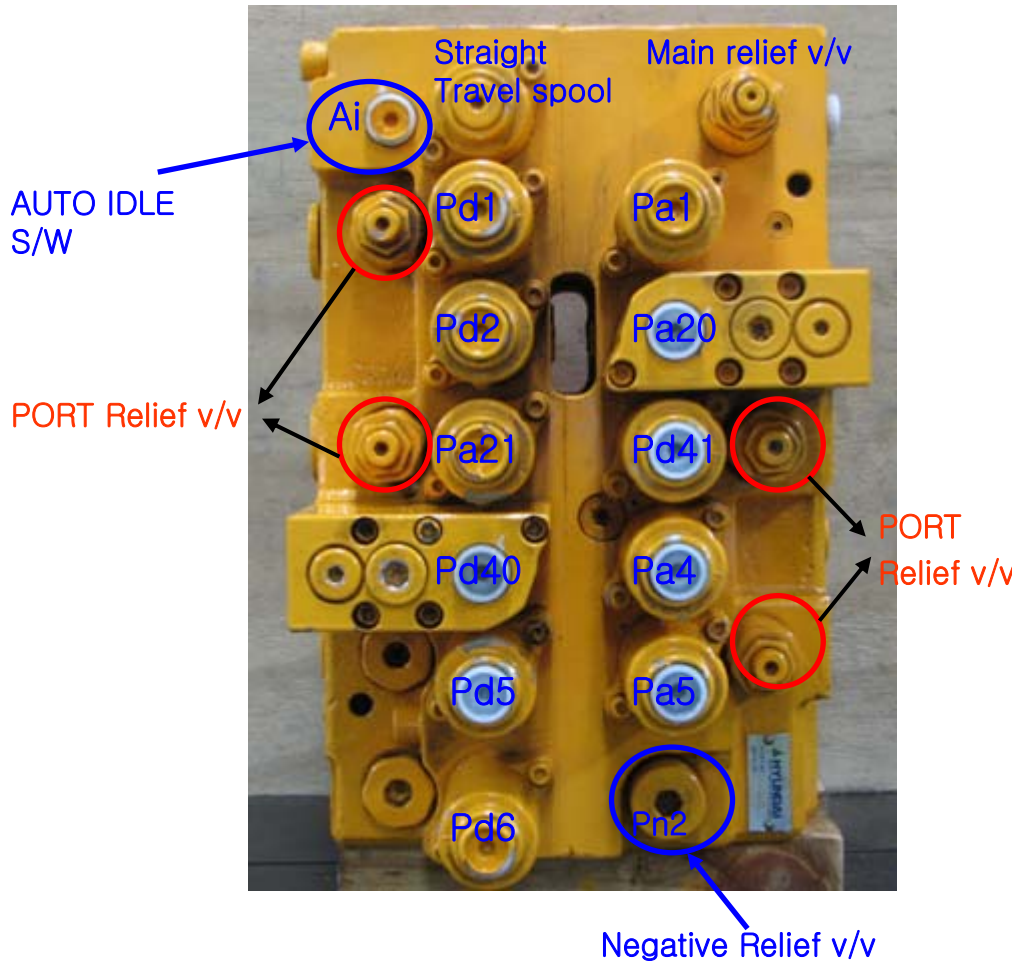
2) SPOOL Location-1



- Pb1 Dozer up
- Pb20 Boom down
- Pb3 ARM-In confluence
- Pc42 ARM Regeneration
- Pb4 ARM Regeneration cut
- Pb5 BUCKET Out

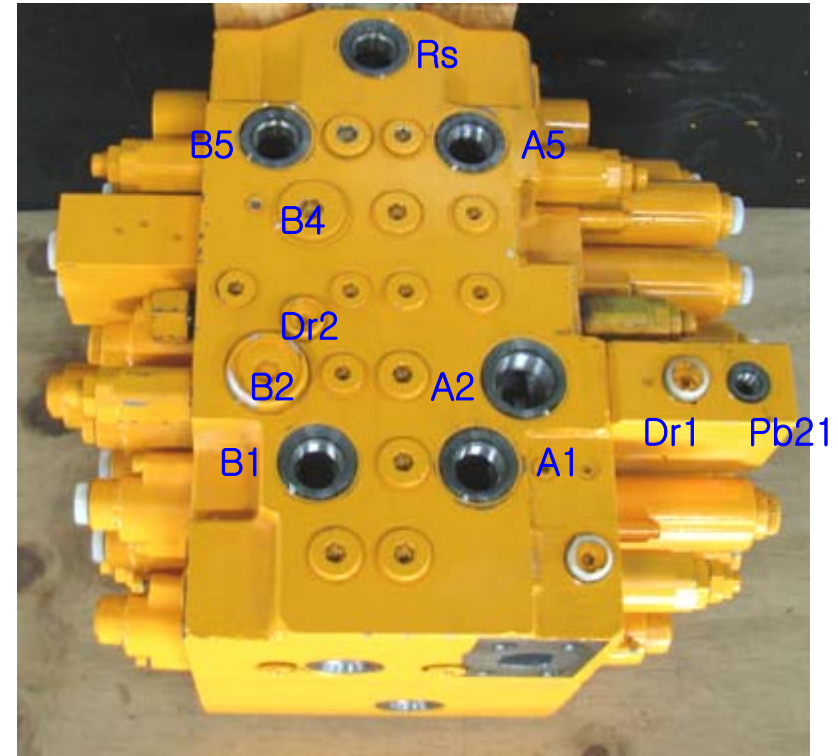
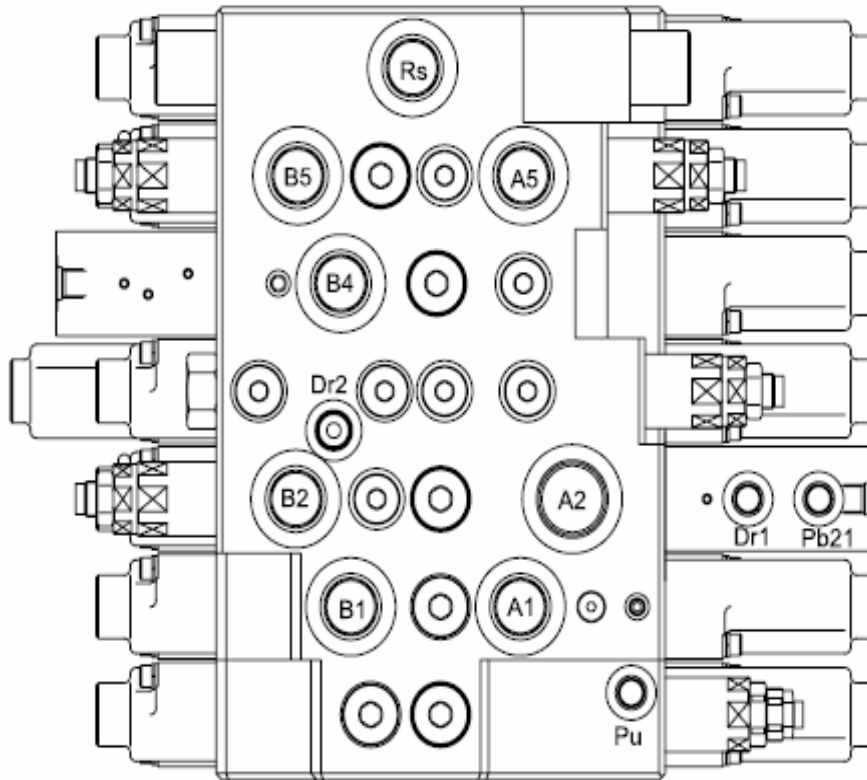
- Dr0 Drain
- Pc1 TRAVEL Reverse
- Pc2 RH SWING
- Pc3 SWING Priority
- Pc40 ARM-In
- Pc5 OPTION B
- Pc6 OPTION C

3) SPOOL Location-2



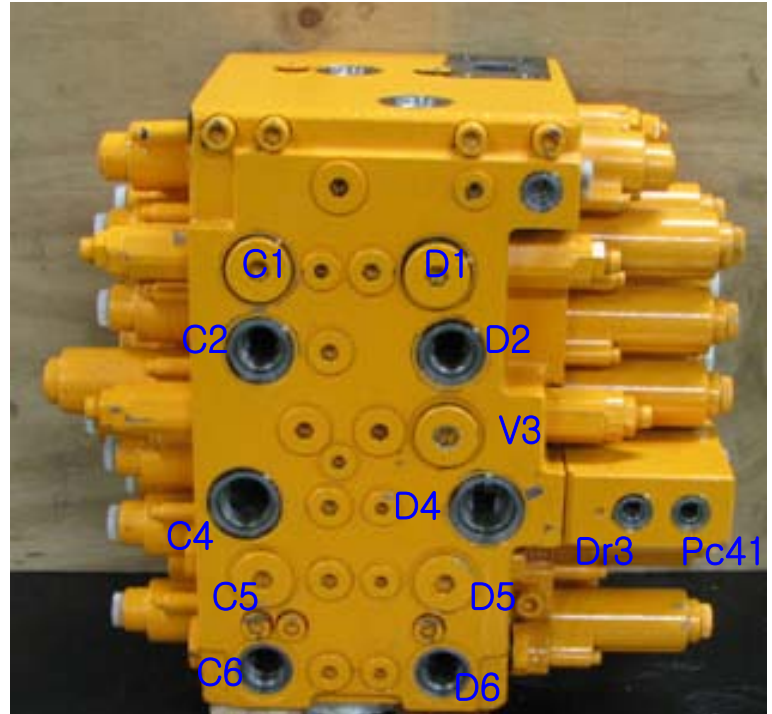
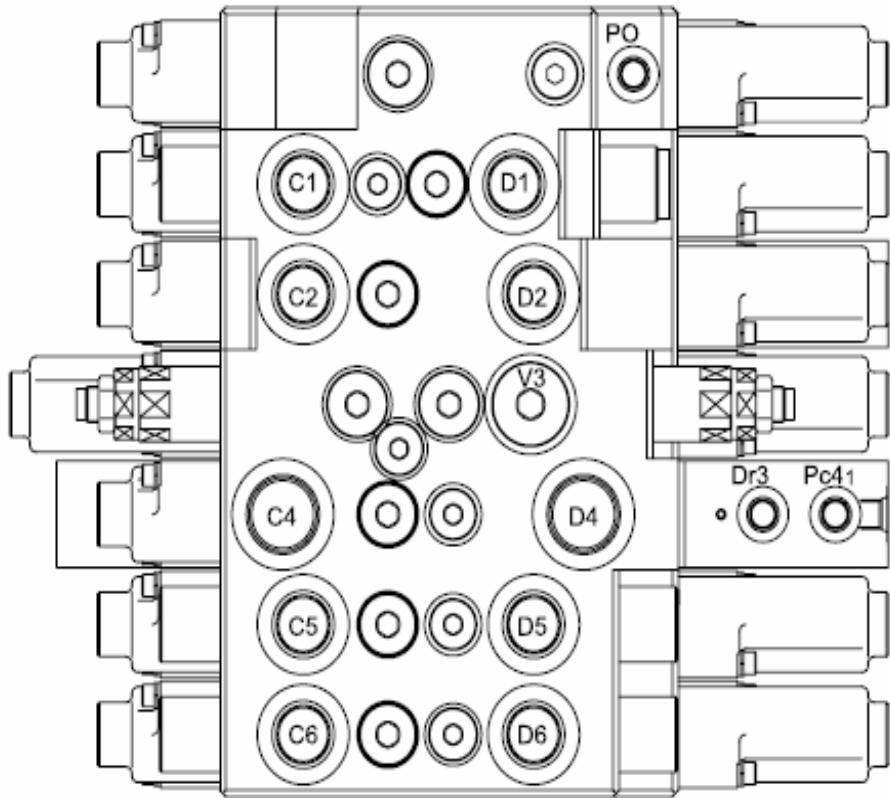
- Pd1 TRAVEL Reverse
- Pd2 SWING(LH)
- Pa21 BOOM RAISE confluence(BOOM2)
- Pd40 ARM Out
- Pd5 OPTION B
- Pd6 OPTION C
- Pa1 DOZER Down
- Pa20 BOOM Raise
- Pd41 ARM Out confluence(ARM2)
- Pc40 OPTION(Breaker)
- Pc6 BUCKET In

4) ATTACHMENT Supply port-1



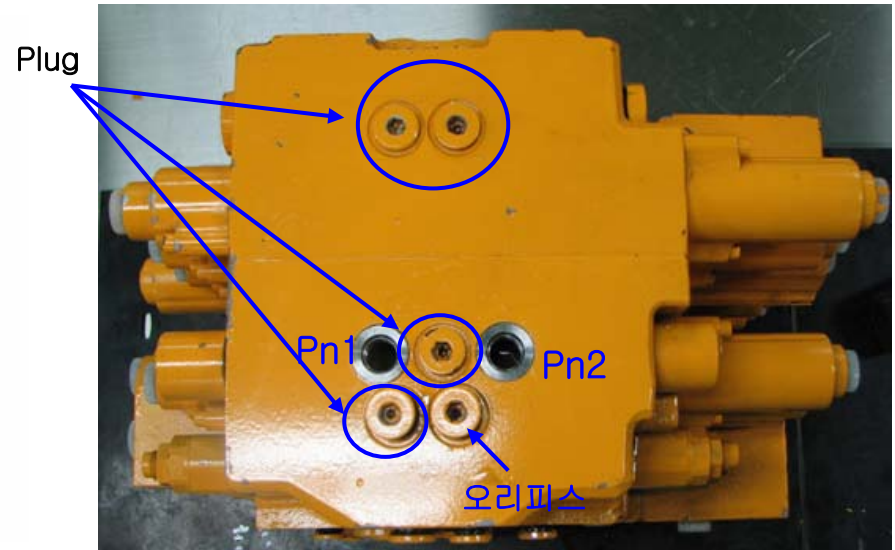
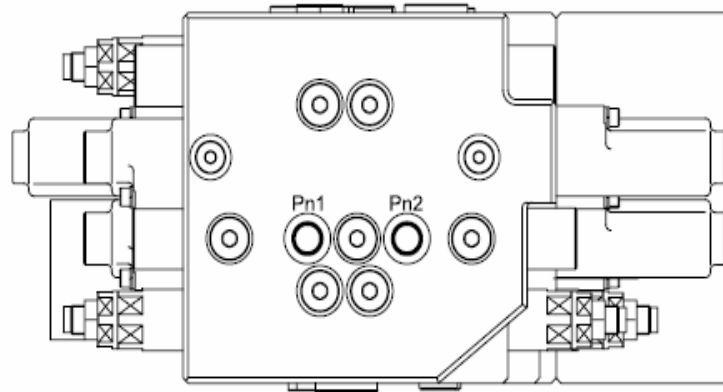
Rs	SWING Make-up	A5	BUCKET In
B5	BUCKET Out	A2	BOOM Raise
B4	OPTION A(BREAKER)	A1	OPTION(DOZER Down)
B2	BOOM Down	Dr1	Drain
Dr2	Drain	Pb21	BOOM Holding release
B1	OPTION(DOZER Raise)		

5) ATTACHMENT SUPPLY port-2

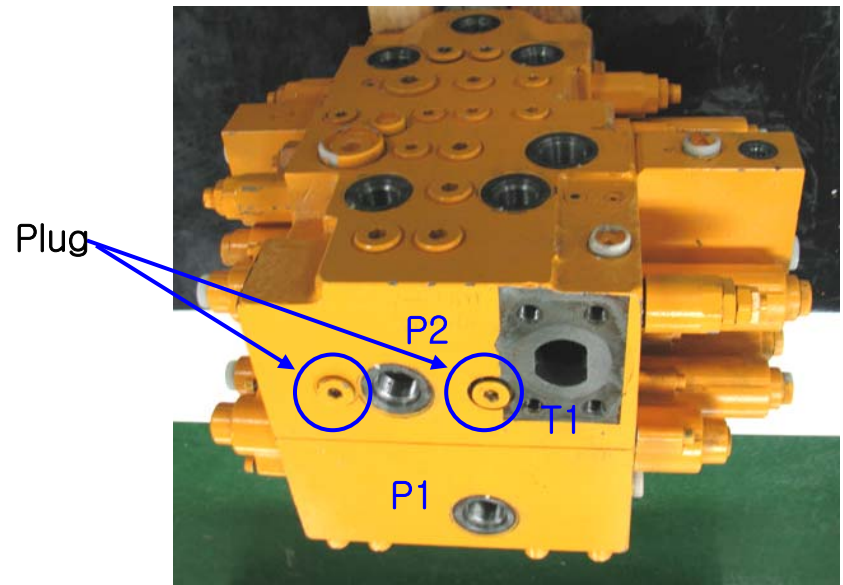
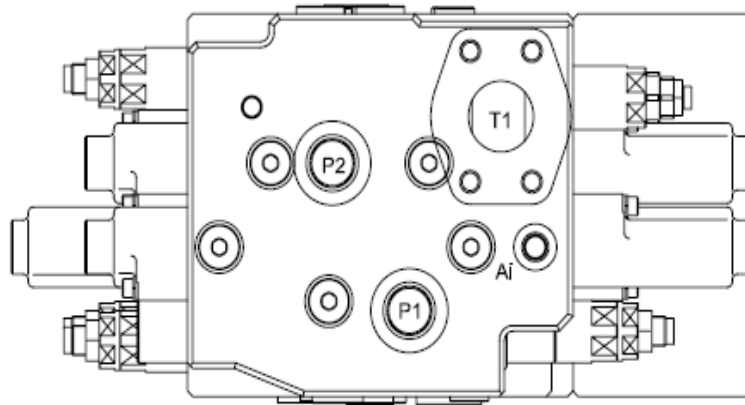


C1	TRAVEL Reverse	D1	TRAVEL Forward
C2	SWING(LH)	D2	SWING(RH)
C4	ARM In	D4	ARM Out
C5	OPTION B	D5	OPTION B
C6	OPTION C	D6	OPTION C
		Dr3	Drain
		Pc41	ARM Holding release


6) NEGATIVE Control port

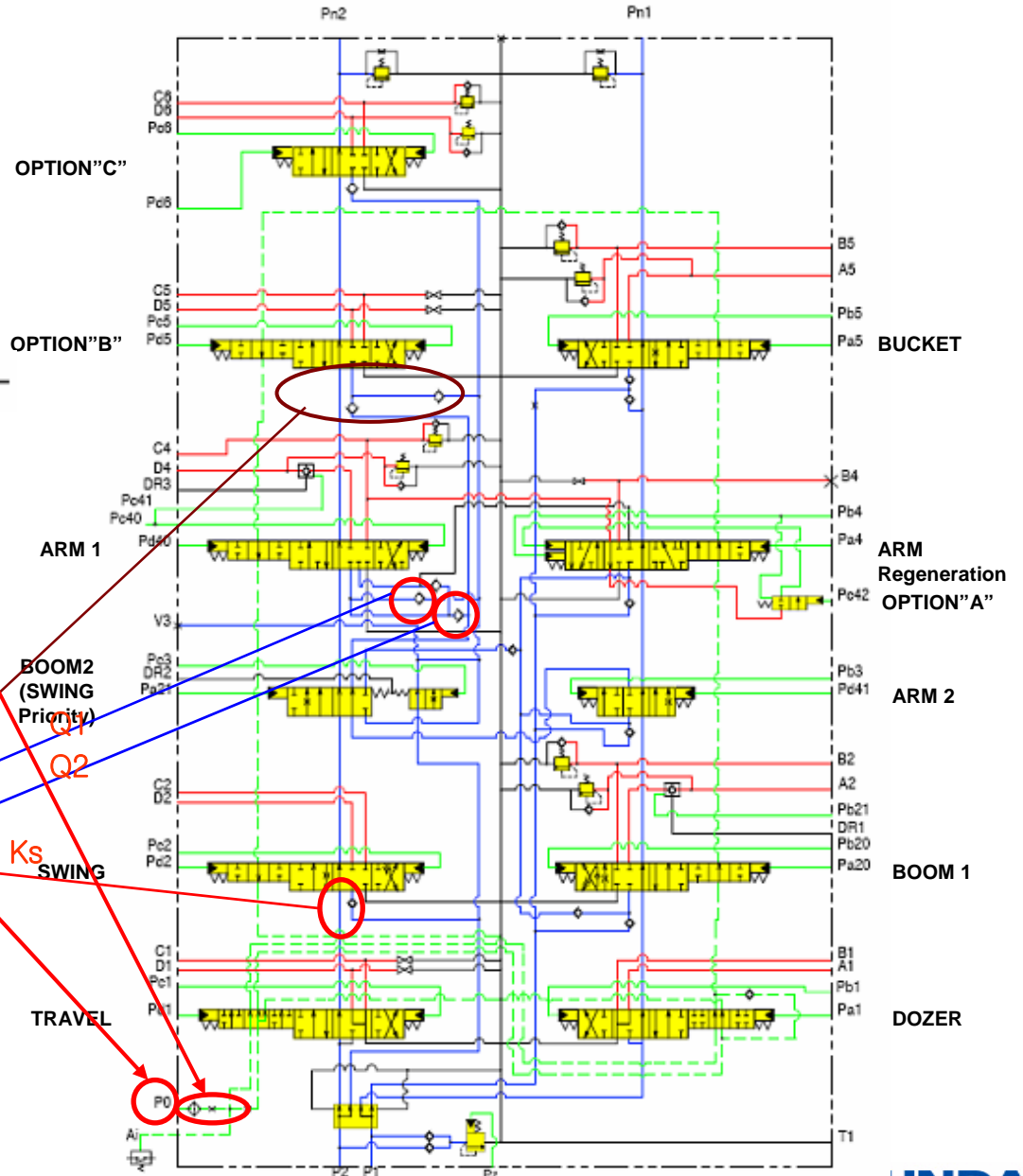
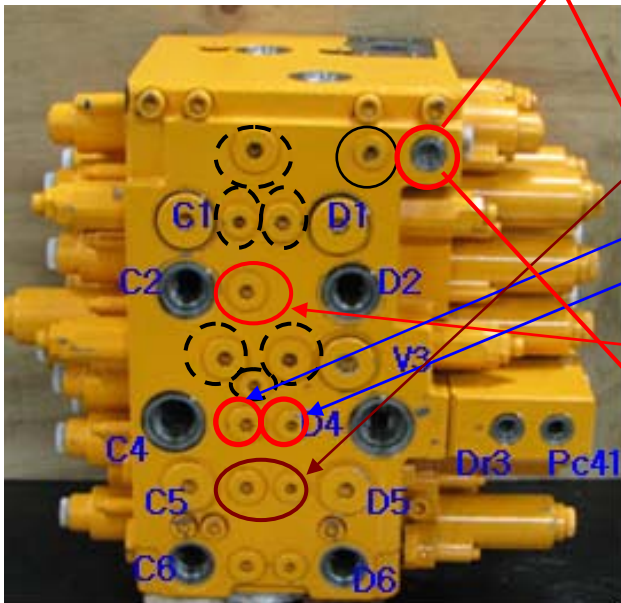


2-8. P1, P2 Port



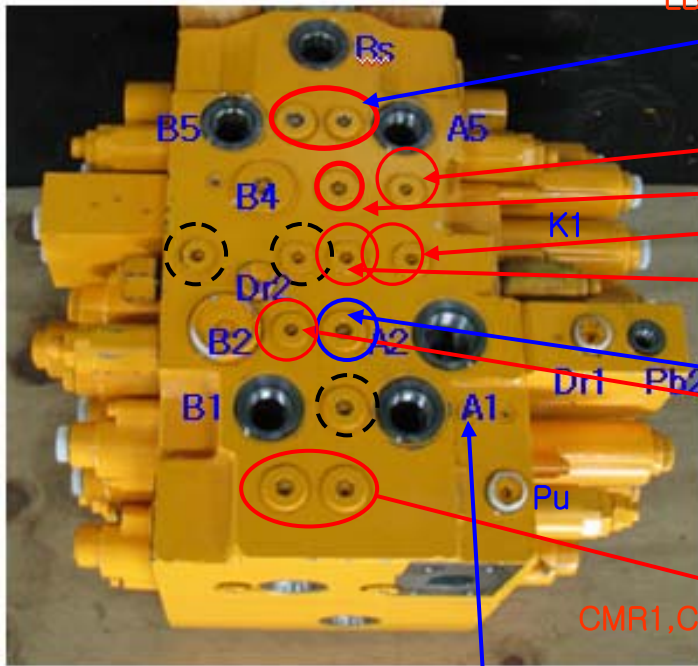
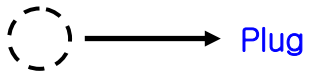
7) CHECK Valves -1

 → Plug



8) CHECK Valves -2

- Rs SWING Make-up
- B5 BUCKET Out
- B4 OPTION A(BREAKER)
- B2 BOOM Down
- Dr2 Drain
- B1 OPTION(DOZER Raise)
- A5 BUCKET In
- A2 BOOM Raise
- A1 OPTION(DOZER Down)
- Dr1 Drain
- Pb21 BOOM Holding release



LB1, LB2

OPTION "C"

OPTION "B"

ARM 1

Qr

L01

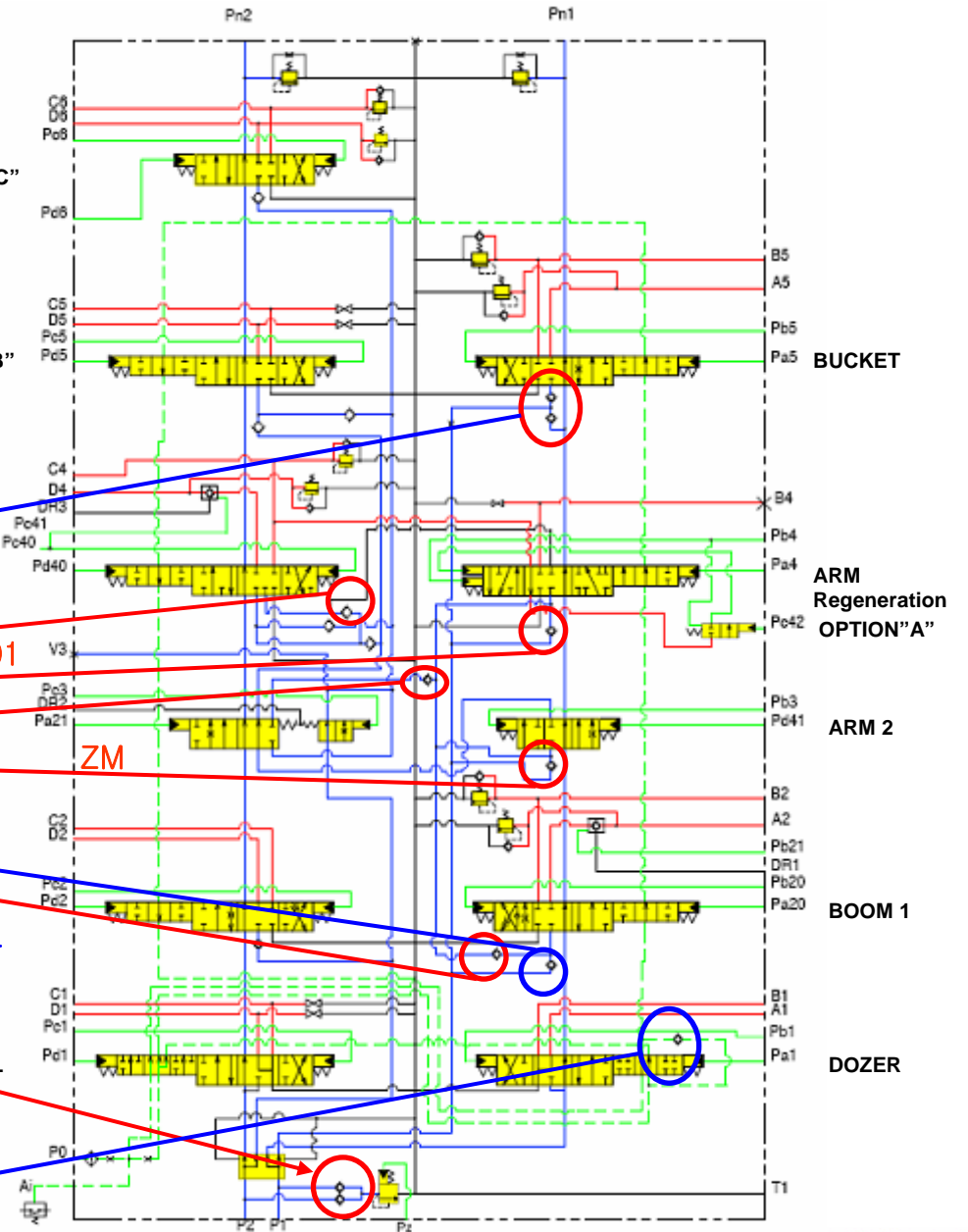
BOOM2
(SWING
Priority)

K3

SWING
K4

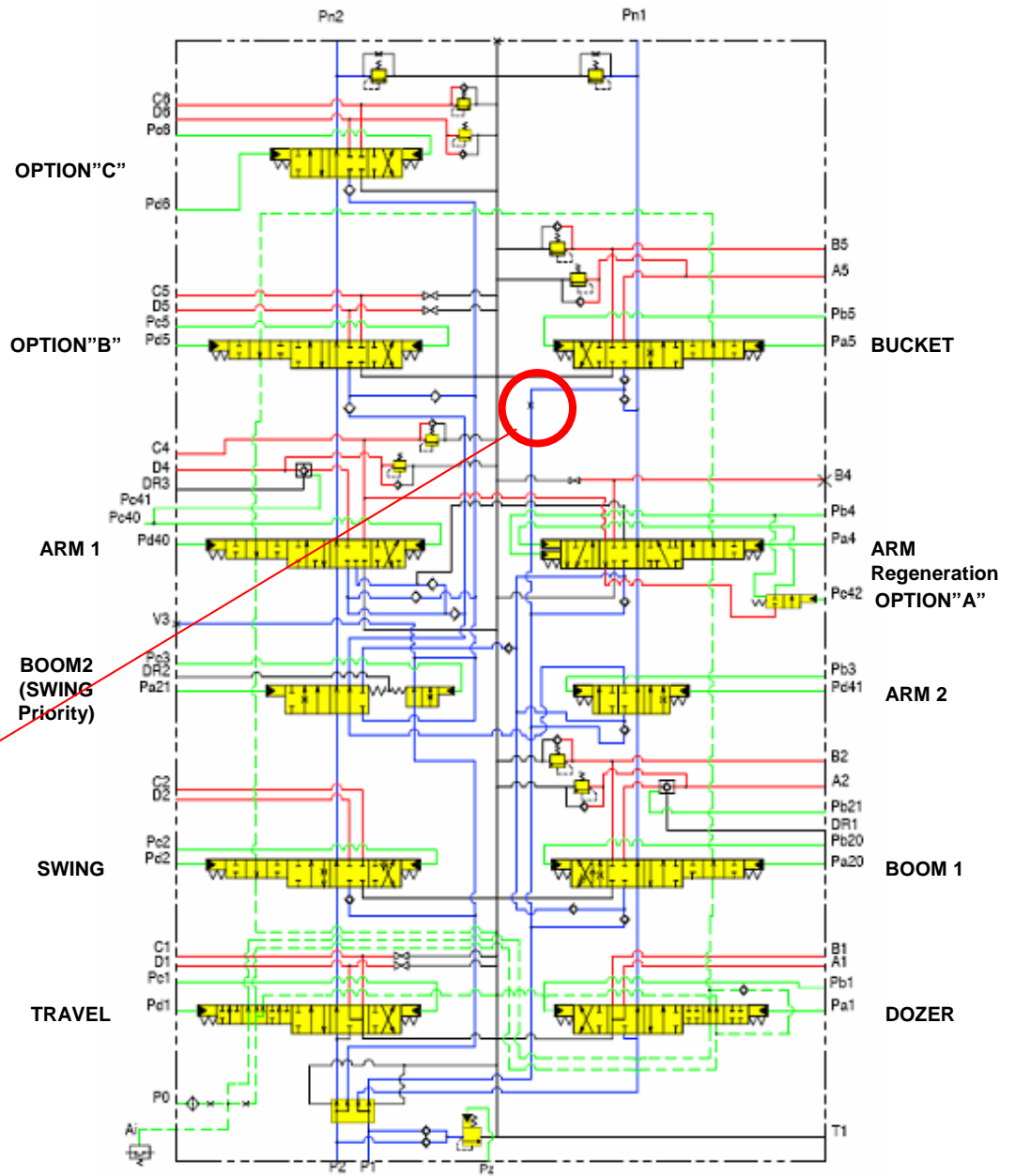
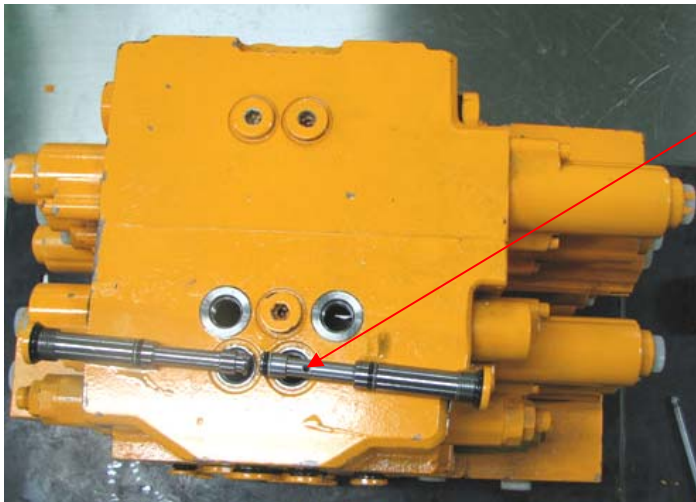
TRAVEL

CMR1, CMR2



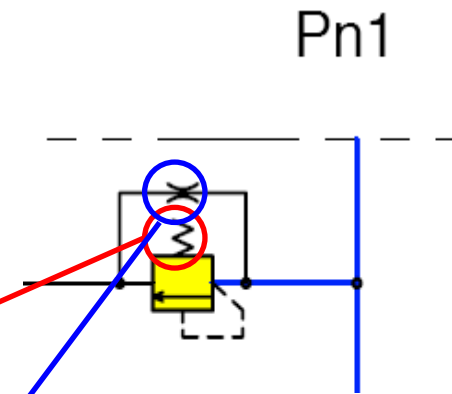
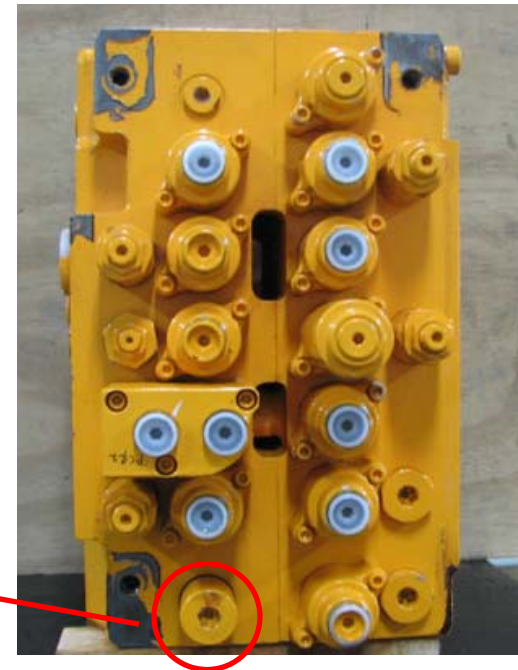
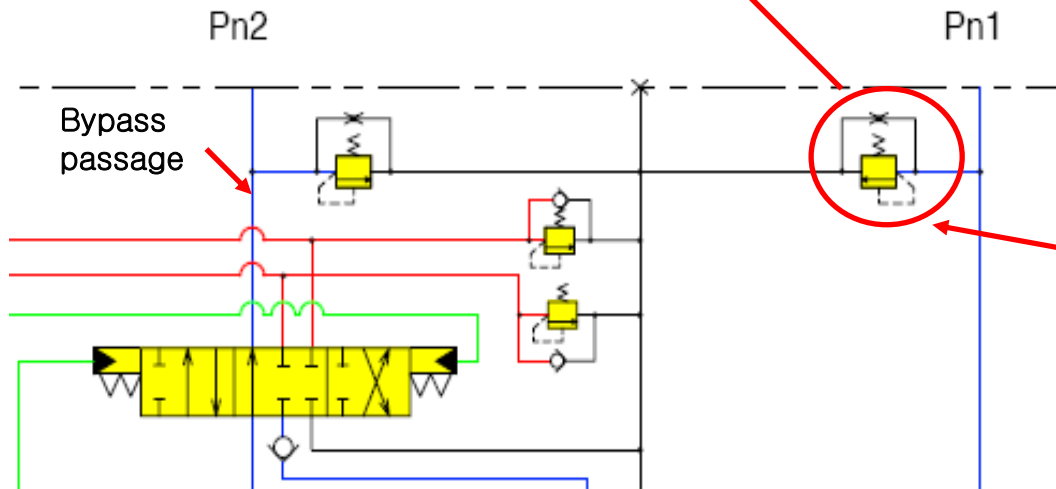
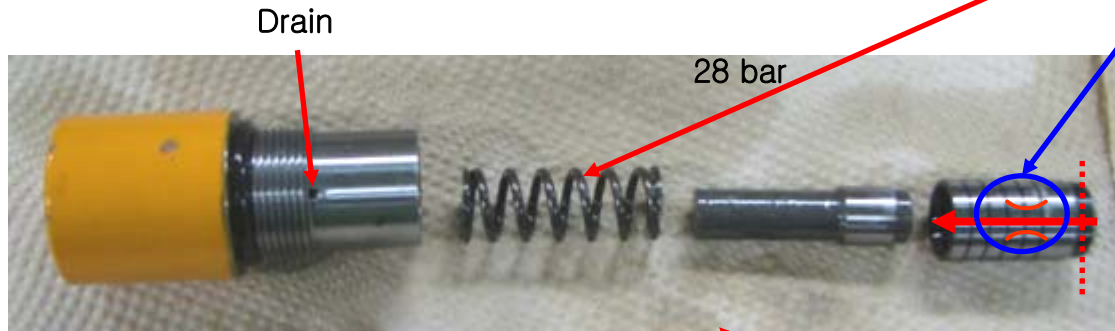
9) BUCKET Orifice

; When combined operation with BUCKET,
it allow to supply much oil to ARM/BOOM.



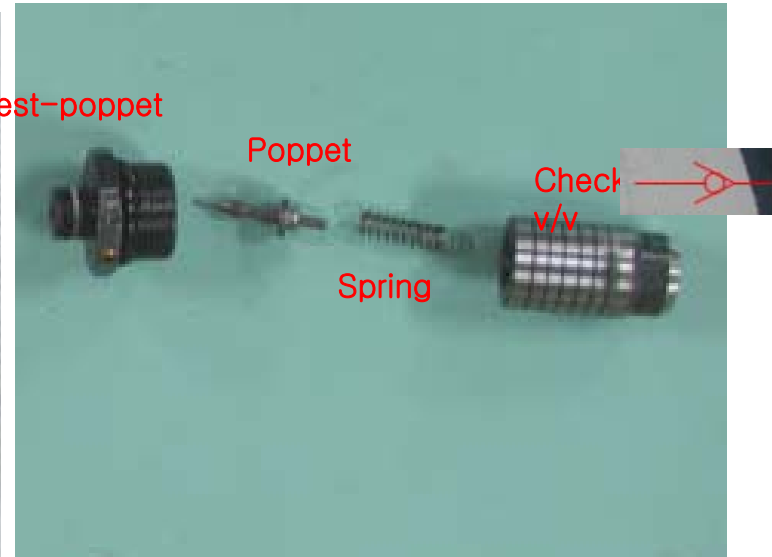
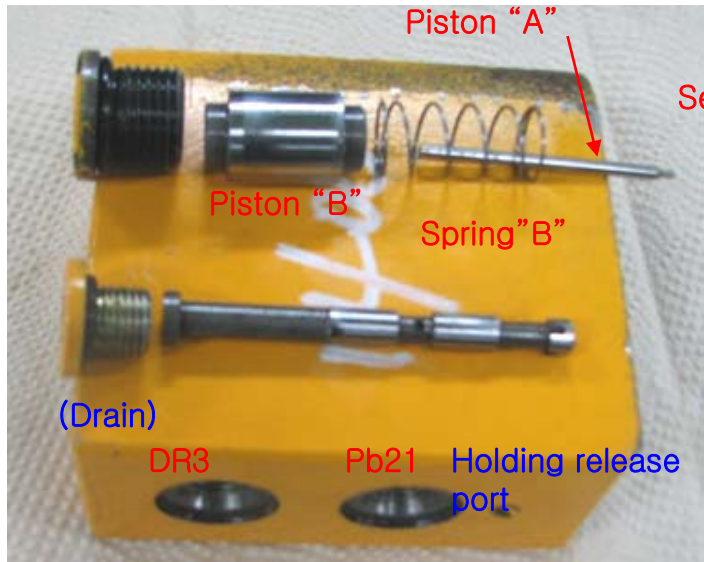
10) NEGATIVE Relief Valve

- RCV Neutral : Bypass pressure up–Pump flow decrease
- RCV Operation : Bypass pressure down–Pump flow increase

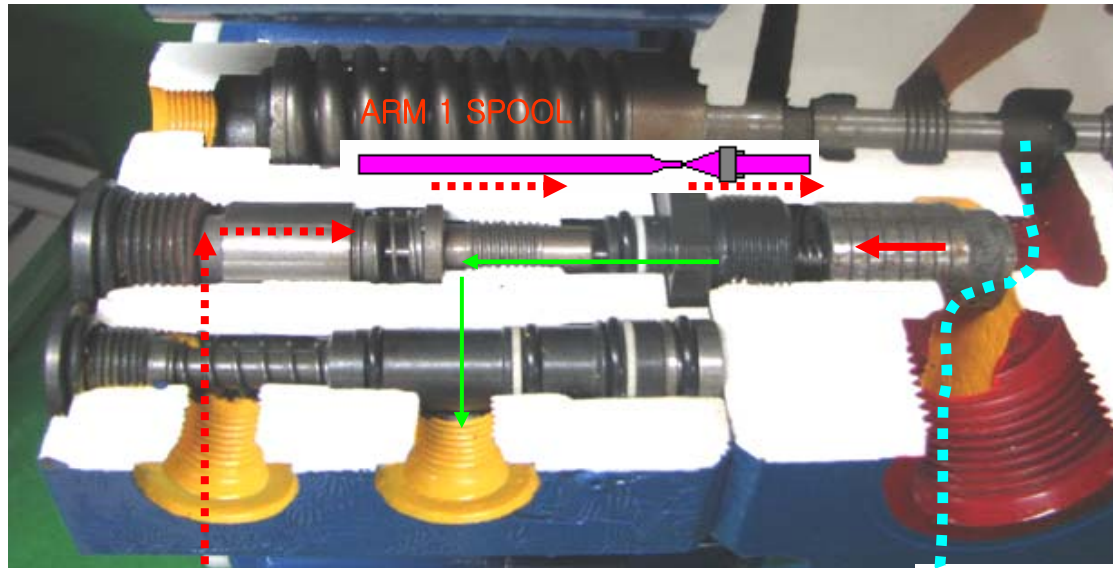


11) Holding valve

11-1) Composition

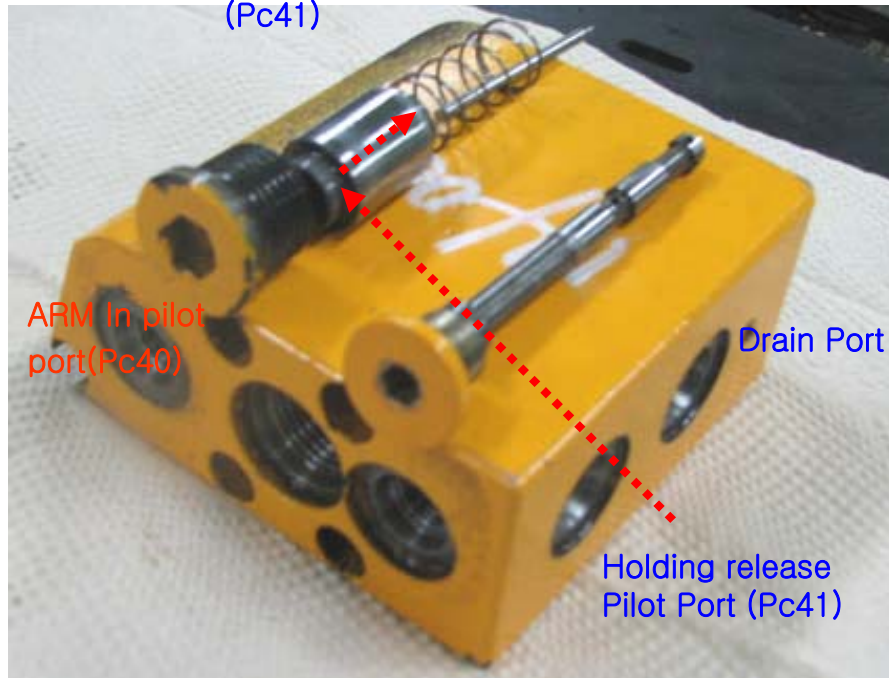
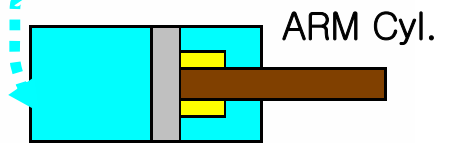


11-2) ARM Holding release



Holding release Pilot port (Pc41)

Drain Port



ARM In pilot port (Pc40)

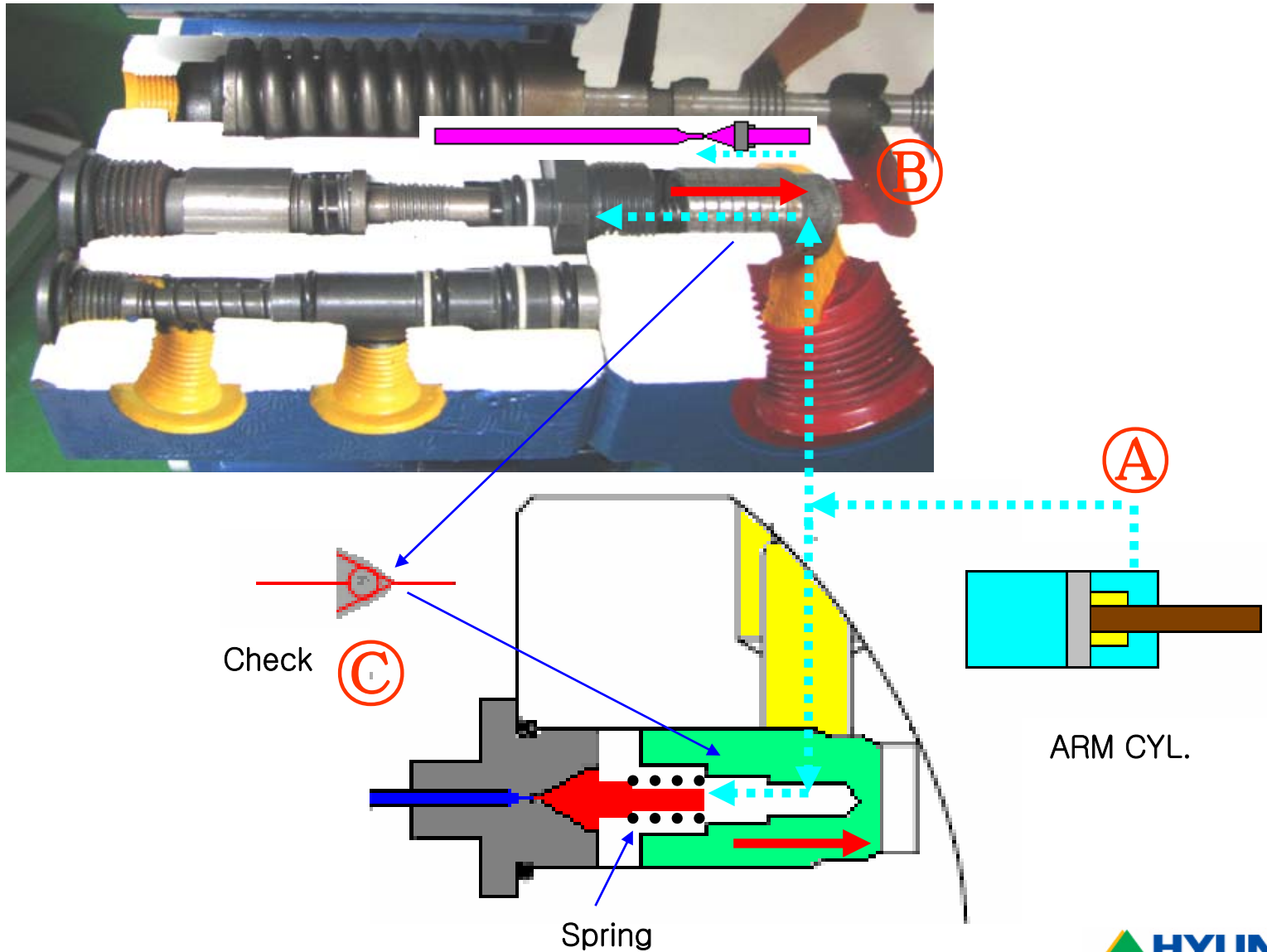
Drain Port

Holding release Pilot Port (Pc41)

When ARM In operation, PILOT pressure can act on Pc40 (ARM 1 Spool), Pc41 (Holding release port) and ARM will be lower down.

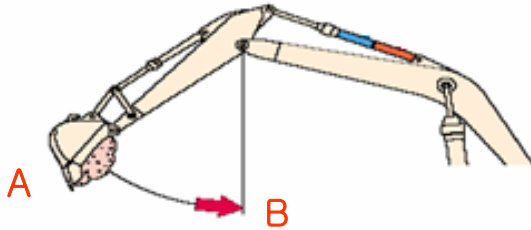
11-3) ARM Holding

The Return oil from ARM CYL.(A) is blocked by the Check valve(C) and so it can not flow to the ARM Spool section(B).



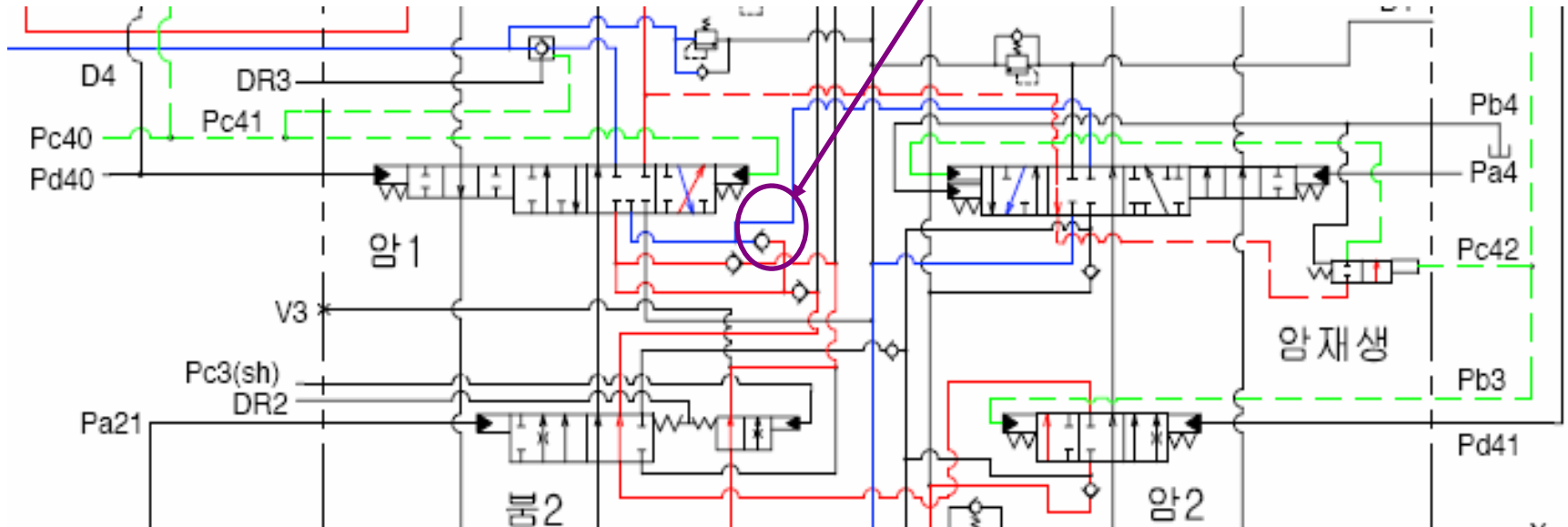
12) ARM Regeneration

12-1) Concept

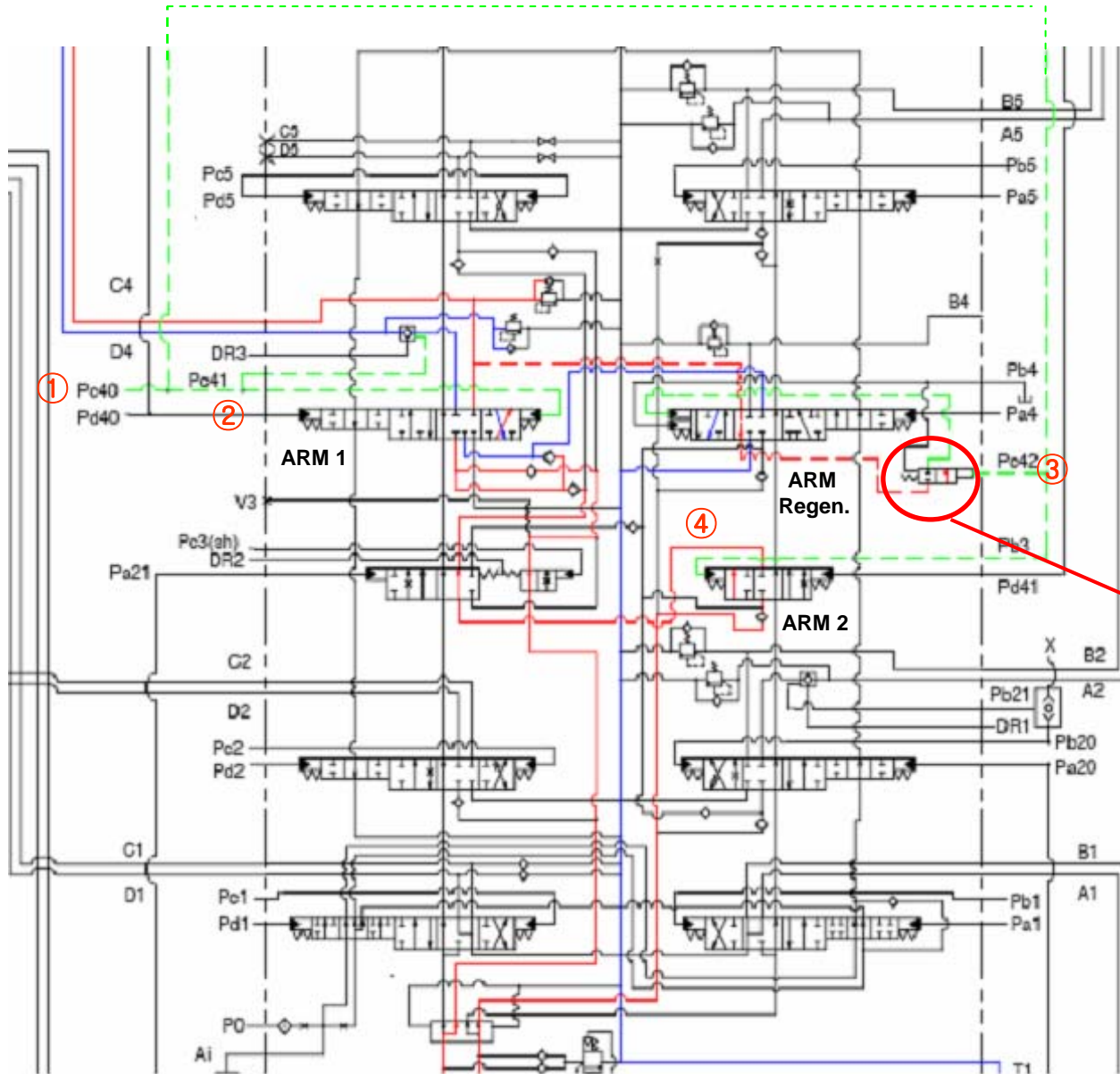


While the ARM moves down from “A” to “B” position as the figure, Return oil quantity will exceed the supply oil amount cause of the ARM gravity. It can make a Cavitation.

To make stop Cavitation, Return oil from (ARM Regeneration-Check v/v) cylinder flow to the supply line.



12-2) ARM Regeneration circuit

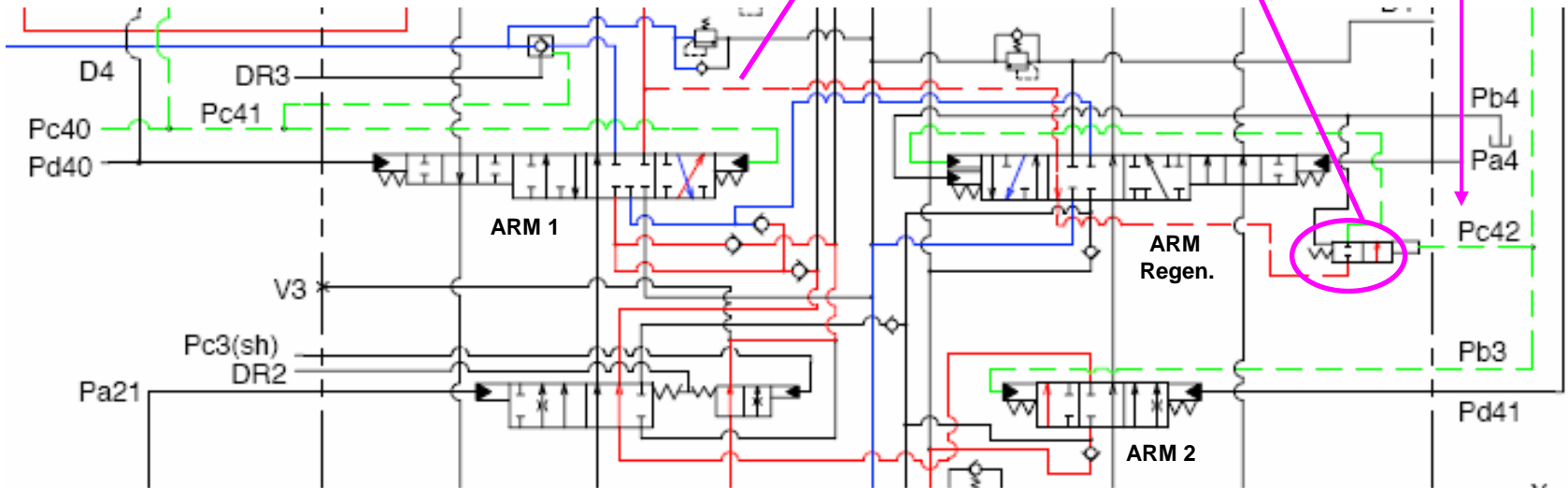
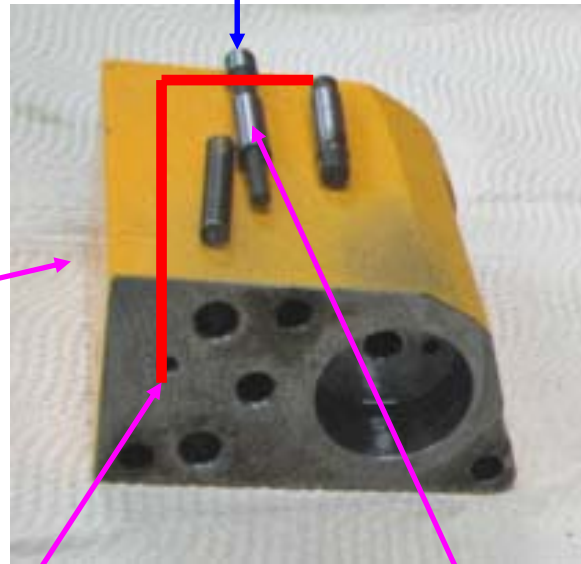
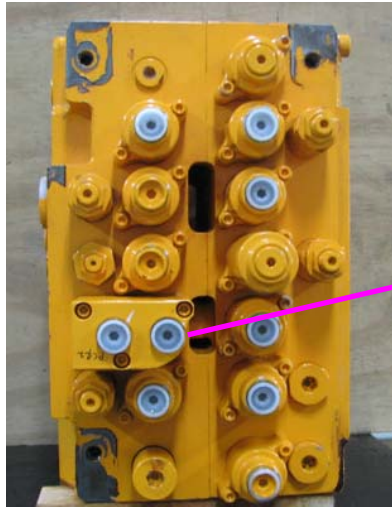


* PILOT Supply port
when ARM in operation

- ① Pc40 ARM 1 Spool
- ② Pc41 ARM Holding release
- ③ Pc42 Selection v/v
- ④ Pb3 ARM 2 Spool

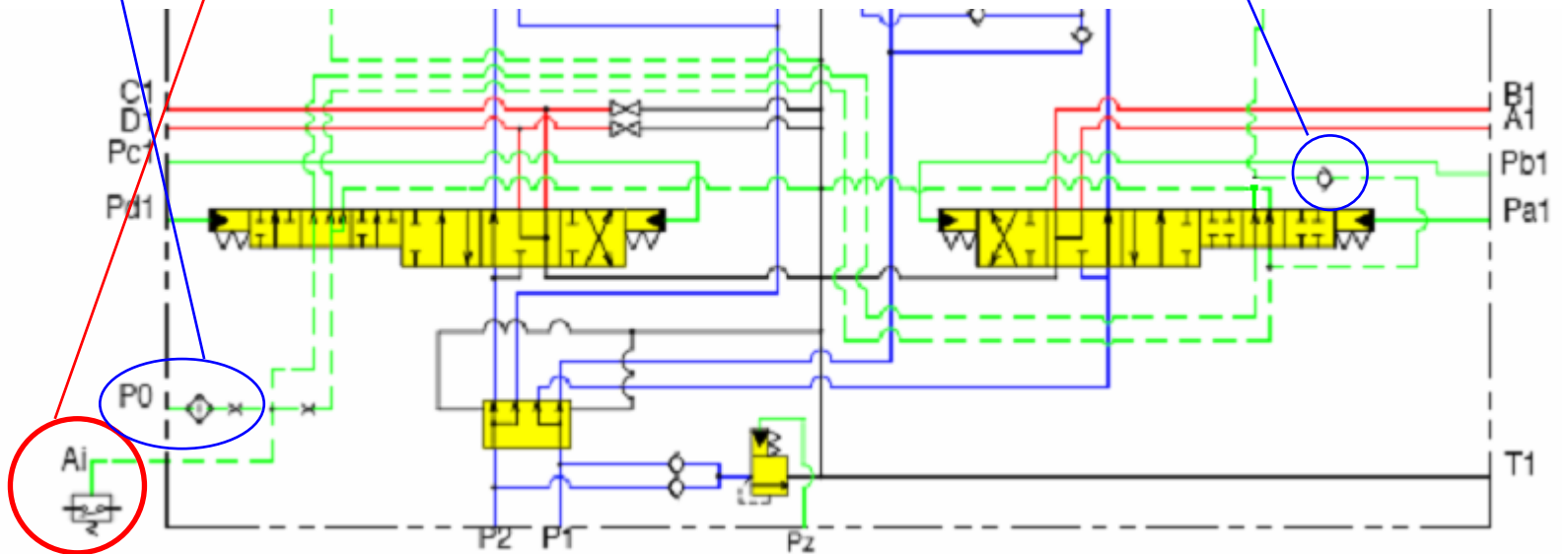
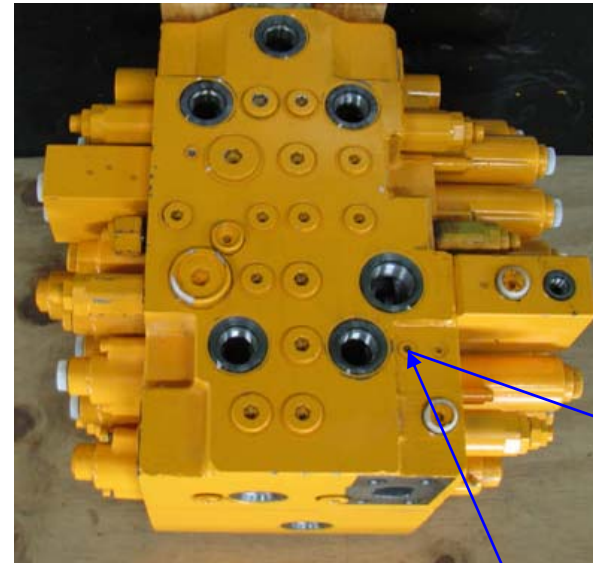
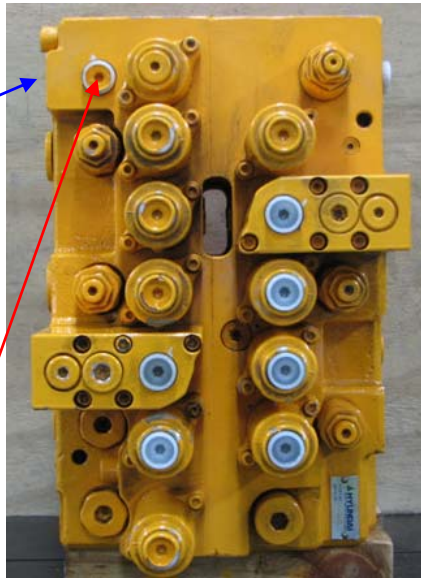


12-3) ARM Regeneration - Action



13) AUTO IDLE

; One for Attachment, the other one for travel operation check.



4-1C. Pressure Settings

UNIT: BAR

		110LC-7	140LC-7	160LC-7	180LC-7	210LC-7	250LC-7	290LC-7	320LC-7	360LC-7	450LC-7 *500LC-7
MAIN CONTROL VALVE	MAIN RELIEF	330	330	330	330	330	330	330	330	330	330
	POWER BOOST	360	360	360	360	360	360	360	360	360	360
	PORT RELIEF (arm, boom, bucket)	380	380	380	380	390	390	390	390	390	*380
SWING MOTOR	RELIEF PRESS (measured on swing motor)	240	240	240	240	240	275	265	265	260	285
	BRAKE RELEASE	33~50	30~50	20	20	33~50	33~50	29~32	26	30	20~50
TRAVEL MOTOR	RELIEF PRESS	330	330	330	330	365	365	375	330	335	345
	BRAKE RELEASE	< 9	6	6	6	6	6	16	16	9	17~50
PILOT PUMP	RELIEF PRESS	35	35	35	35	35	35	35	35	35	33 - *35

OVERLOAD RELIEF PRESSURES FOR LONG REACH MODELS:

MODEL	ARM IN & OUT	BUCKET IN & OUT
R210LC/LR-7	300 bar	280 bar
R290LC/LR-7	230 bar	270 bar

Subject 1 : Only one attachment speed is slow

1.Problem : attachment speed is slow

2.Check & Measure : Only one attachment speed is slow

1) Condition : S Mode, max rpm

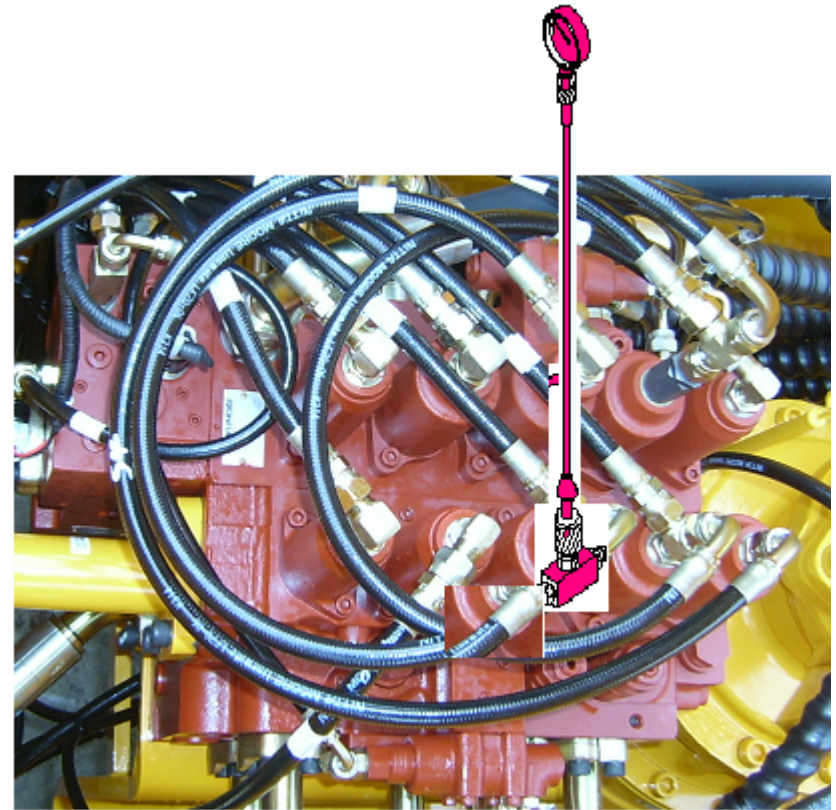
2) Test Items and Specifications

Measuring Point	Pressure		Test result (Kg/cm ²)	Remedy (If not)
	Pilot	Main		
Boom	40Kg/cm ²	330Kg/cm ²		
Arm	40Kg/cm ²	330Kg/cm ²		
Travel	40Kg/cm ²	330Kg/cm ²		
Deviation	40Kg/cm ²	330Kg/cm ²		

3) Measuring point for pilot pressure

※ How to measure

- (1) disconnect Pilot Hose
- (2) connect the disconnect hose to Gauge "T" fitting
- (3) start the engine



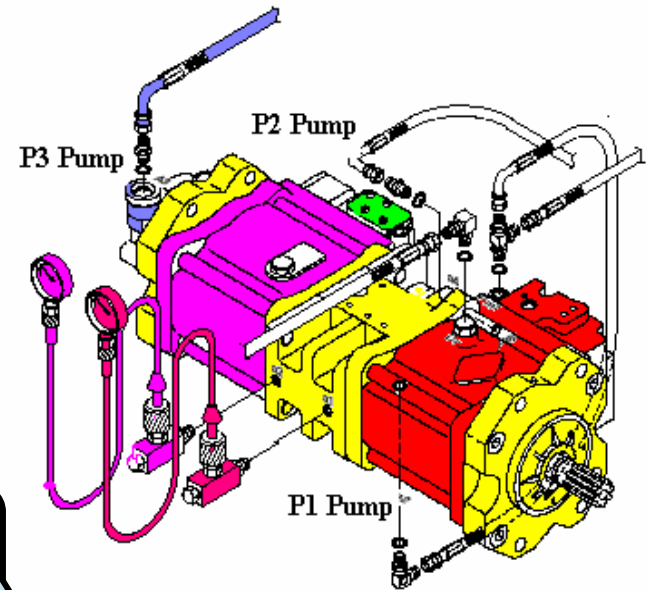
※ Test Items and Specifications

Attachment	Pilot Pressure		Test result (Kg/cm ²)	Remarks (If Not)
	In Neutral	Full		
Boom	0Kg/cm ²	40Kg/cm ²		See RCV
Arm				See RCV
Bucket				See RCV

4) Measuring point for main pressure

※ How to measure

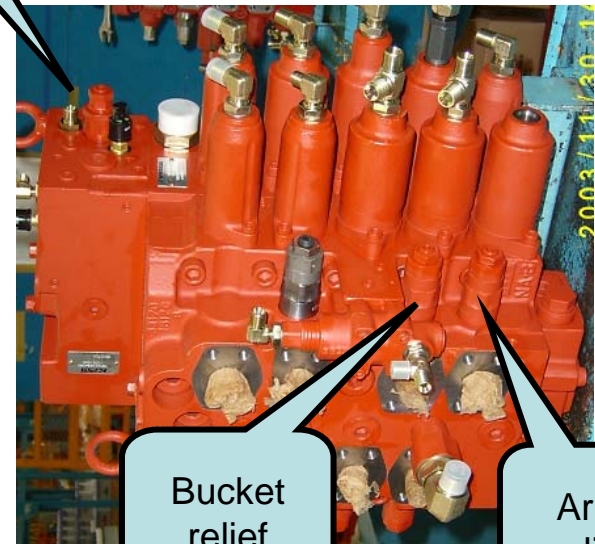
- 1) disconnect pilot hose
- 2) connect the disconnect hose to gauge "T" fitting
- 3) start the engine



Main relief

※ Test Items and specifications

Relief Valve	Pressure (Kg/cm ²)	Remarks
Main	330/360Kg/cm ²	Adjust if need
Boom	330/360Kg/cm ²	
Arm	330/360Kg/cm ²	
Bucket	330/360Kg/cm ²	



Bucket relief

Arm relief

Subject 2 : All attachment speeds are slow

1.Problem : All attachment speeds(boom,arm,bucket) are slow

2.Check & Measure :

1) Condition : H Mode, max rpm

2) Pressure check of attachment

Kgf/cm²

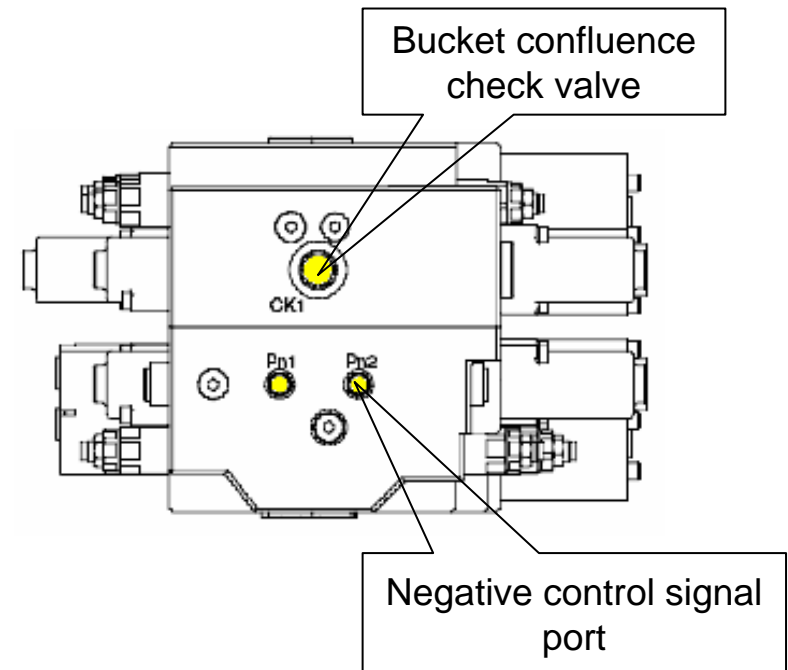
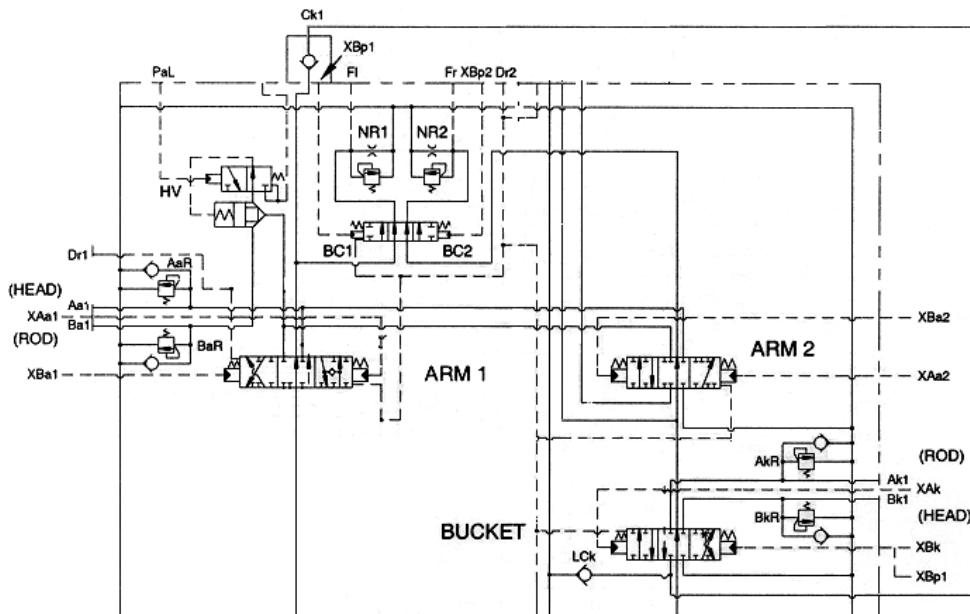
	R/H Travel	L/H Travel	Swing	Bucket out	Bucket In	Arm In/Out	Boom Up	Swing + L/H Travel
P1	330	150	250	170	330	320	320	220
fr	30/35	-	-	150/35	3/35	70/35	70/35	150
P2	30	280	30	240	360	180	180	200
fl	-	-	-	0/35	0/35	0/35	0/35	2

3.Cause

- 1) Abnormal result of pressure check : L/H travel, bucket out, arm in, boom up
- 2) Check the pressure for swing and L/H relief to find if the pump 2 oil flows to pump1.
As a result, it was found that pump 2 oil flows to pump1 side of main control valve
-bucket confluence check valve broken

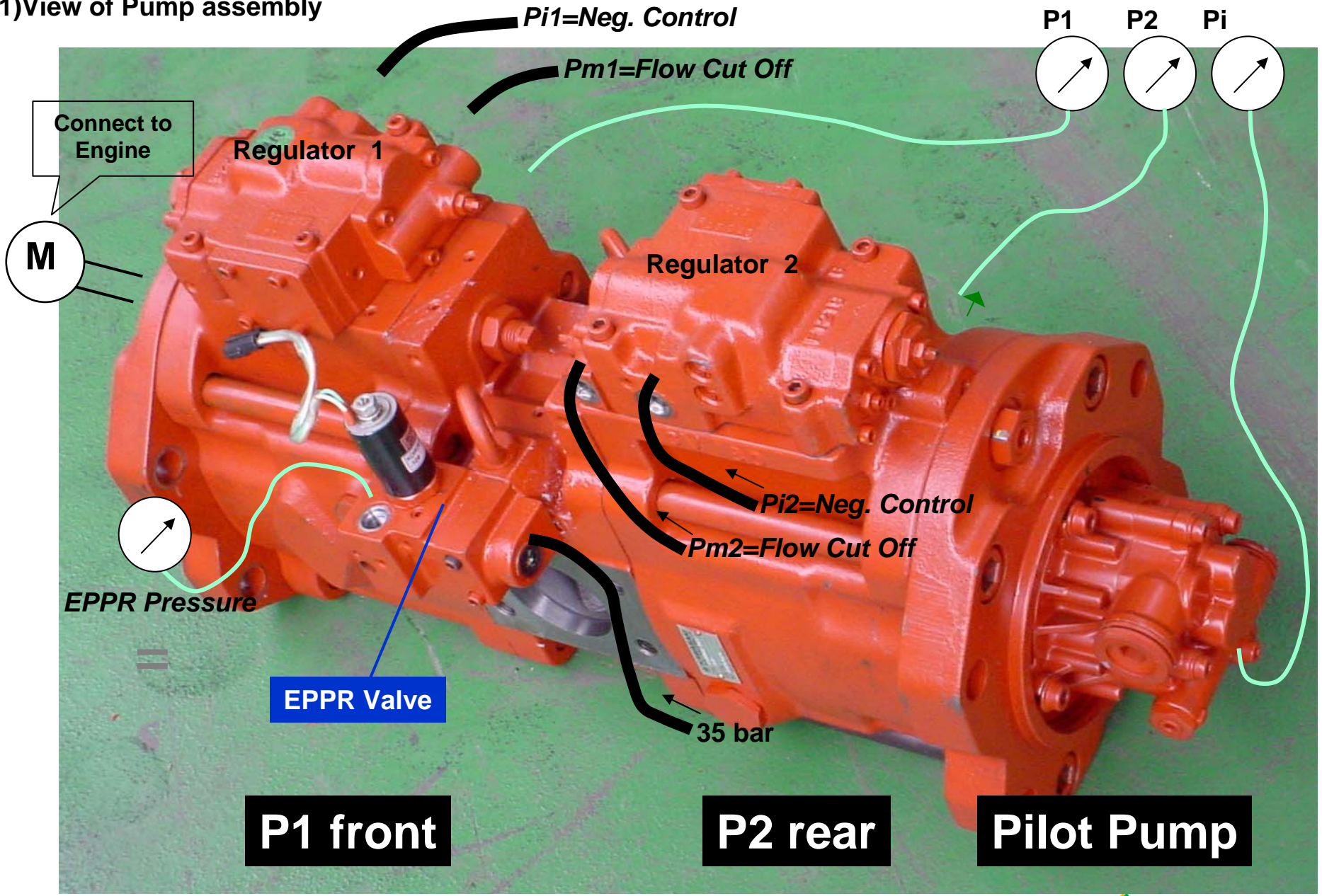
4.Remedy

Replaced bucket confluence check valve

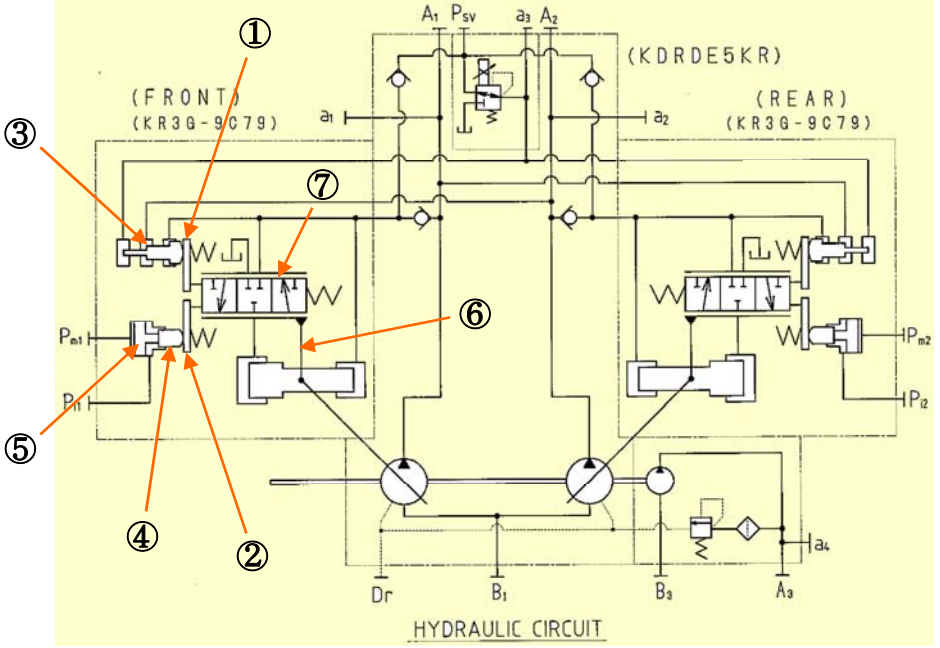
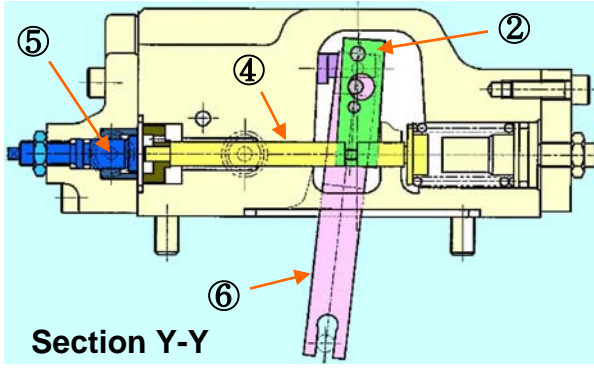
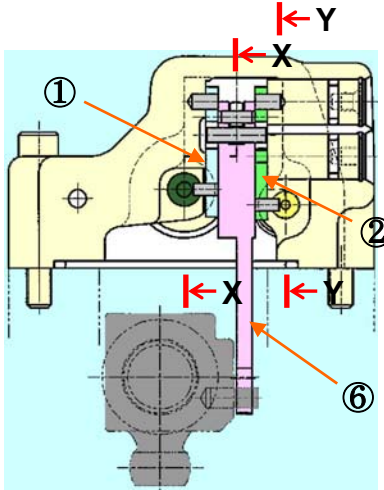
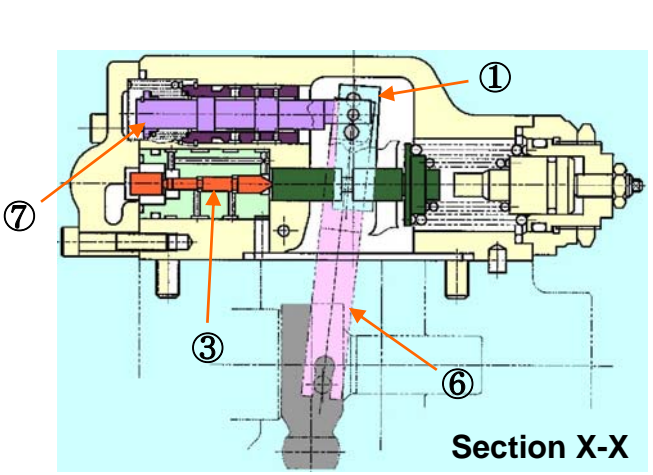


4-2.Pump assembly

1)View of Pump assembly

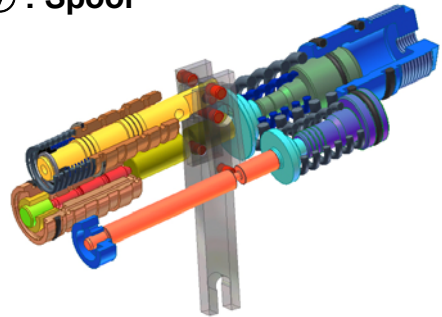


2) The Type and circuit of regulator



**** ①~⑦ Regulator Parts Name ****

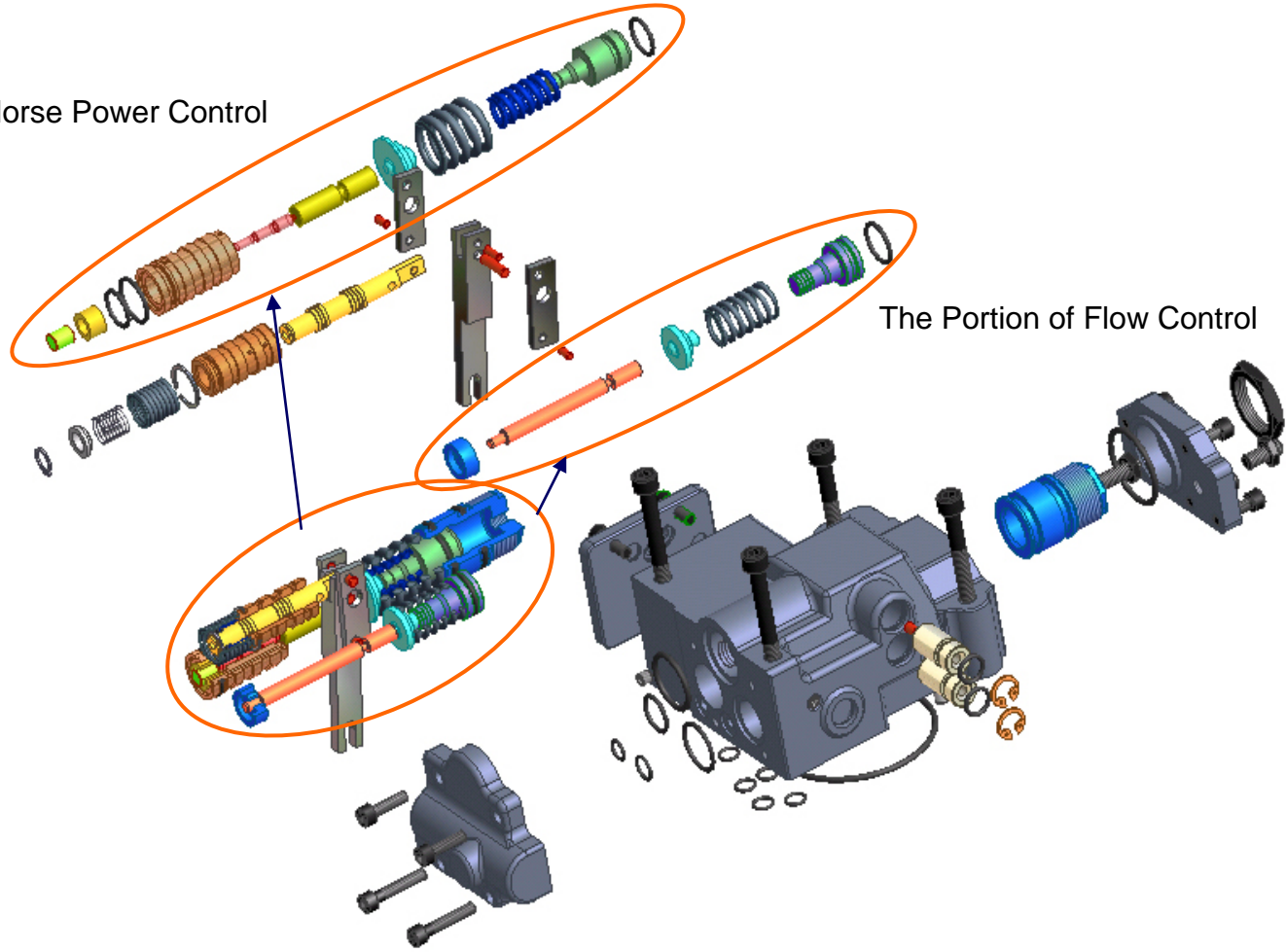
- ① : Lever 1
- ② : Lever 2
- ③ : Compensator Piston
- ④ : Pilot Piston
- ⑤ : Adjust Screw(QMC)
- ⑥ : Feed Back Lever
- ⑦ : Spool



3)View of regulator

The Portion of Horse Power Control

The Portion of Flow Control

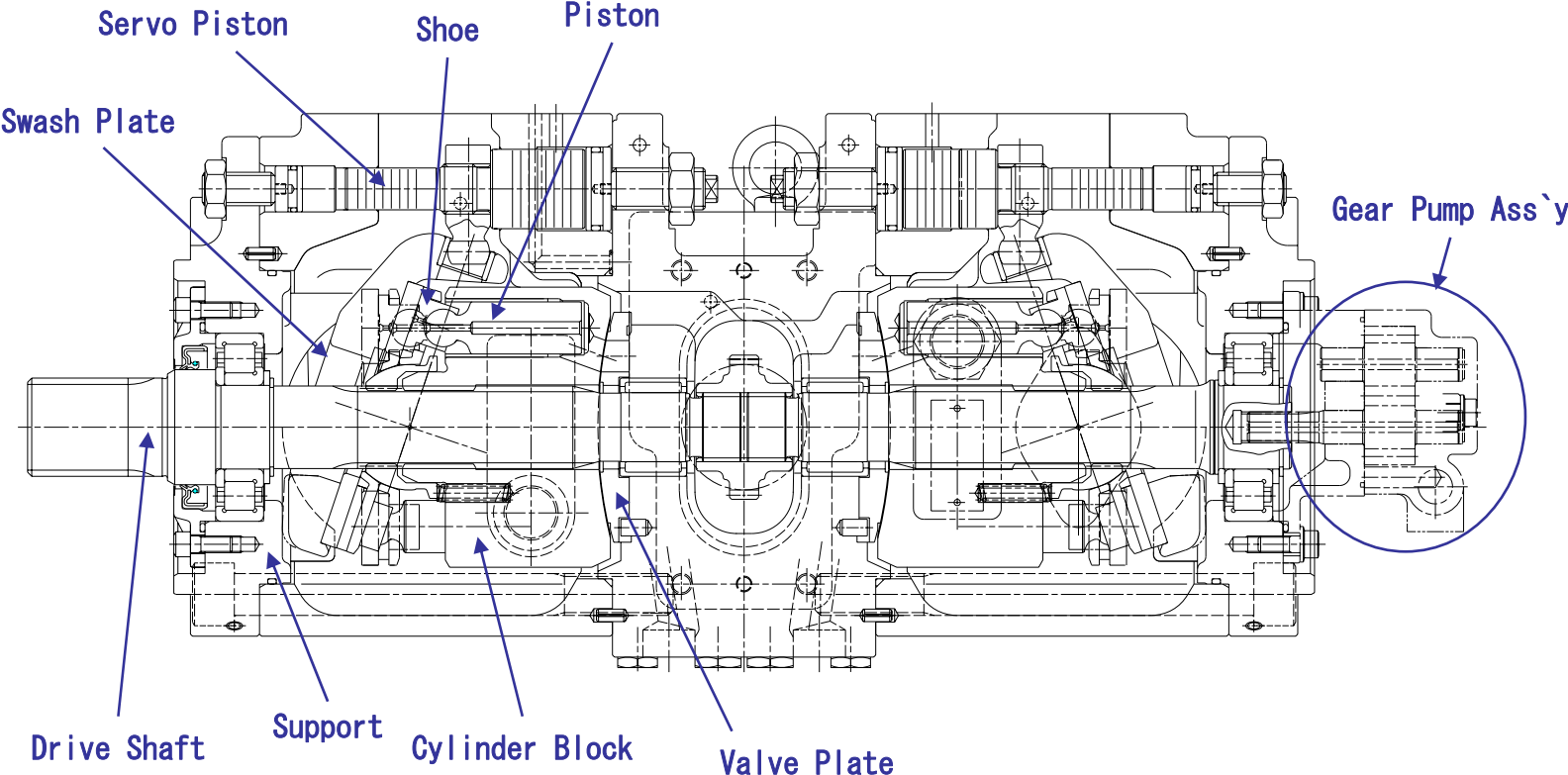


4) HHI Pump-regulator adjustment

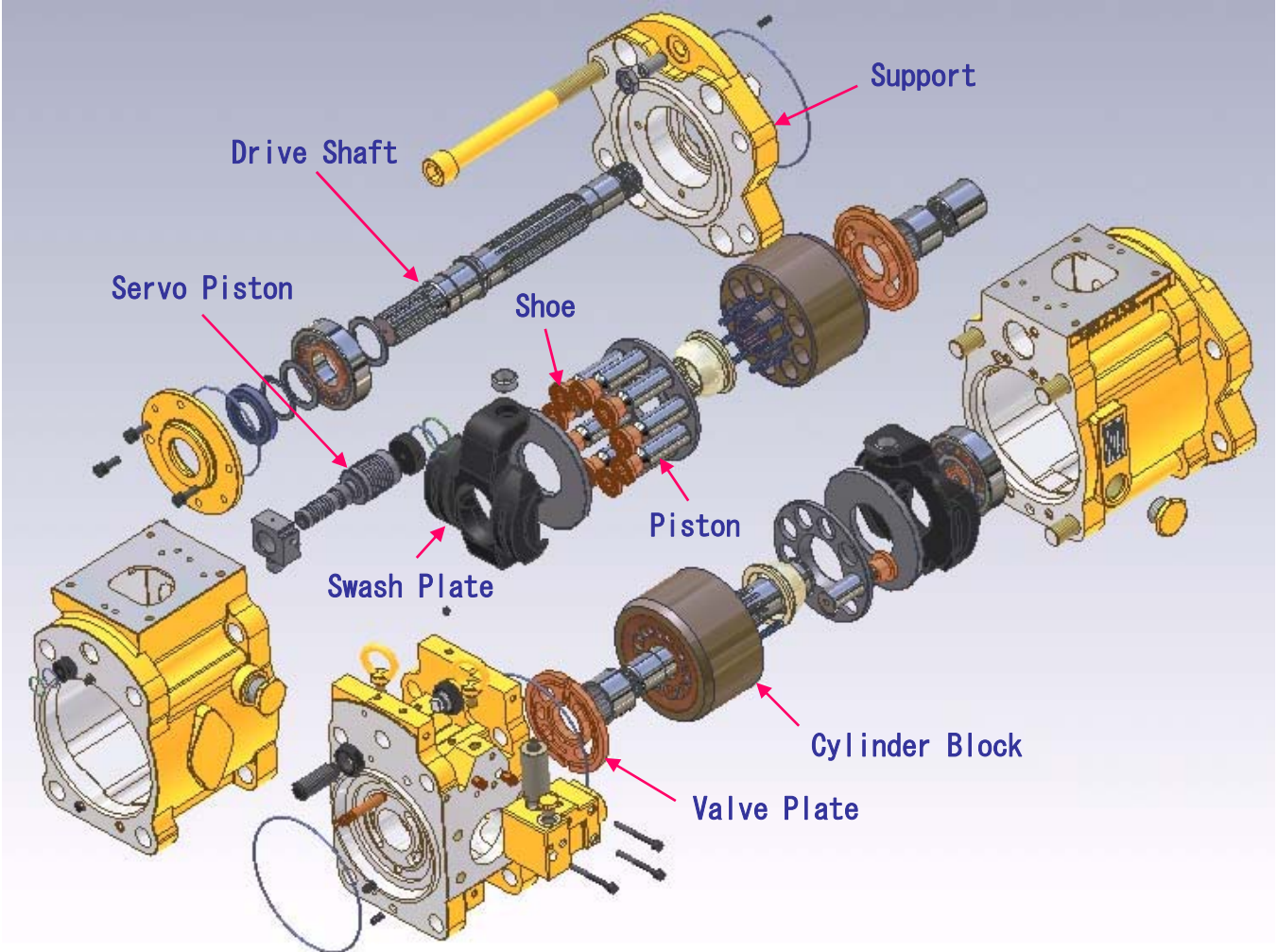
Model/type	rpm	Adjustment of max. flow control		Adjustment of min. flow control		Adjustment of outer spring			
		Tightening amount of adjusting screw (954)	Flow change amount	Tightening amount of adjusting screw (953)	Flow change amount	Tightening amount of adjusting screw (628)	Compensating control starting pressure change amount	Input torque change amount	A
		Turn	L/min	Turn	L/min	Turn	MPa	N · m	
R140LC-7A K5V80DT-1LCR-9C01	2,000	+1/4	-3.2	+1/4	+3.2	+1/4	+1.88	+32.7	1.44
R140W-7A K5V80DTP1LHR-9C01	2,000	+1/4	-3.2	+1/4	+3.2	+1/4	+1.88	+35.1	1.44
R160/180LC-7A K5V80DT-1LCR-9C05	2,100	+1/4	-3.4	+1/4	+3.4	+1/4	+1.74	+34.7	1.54
R170W-7A K5V80DTP1LHR-9C05	2,100	+1/4	-3.4	+1/4	+3.4	+1/4	+1.74	+34.7	1.54
R210LC-7A K3V112DT-1LHR-9C32	1,900	+1/4	-5.5	+1/4	+4.4	+1/4	+1.56	+39.1	1.48
R250LC-7A K3V112DT-1LHR-9C52	1,900	+1/4	-5.5	+1/4	+4.4	+1/4	+1.56	50.5	1.48

Model/type	Adjustment of inner spring				Adjustment of flow control characteristic		
	rpm	Tightening amount of adjusting screw (627)	Flow change amount	Input torque change amount	Tightening amount of adjusting screw (924)	Flow control starting pressure change amount	Flow change amount
	min-1	Turn	L/min	N · m	Turn	MPa	L/min
R140LC-7A K5V80DT-1LCR-9C01	2,000	+1/4	+9	+40.1	+1/4	+0.17	+9.5(-9.5)
R140W-7A K5V80DTP1LHR-9C01	2,000	+1/4	+9	+43.0	+1/4	+0.17	+9.5(-9.5)
R160/180LC-7A K5V80DT-1LCR-9C05	2,100	+1/4	+8.9	+37.0	+1/4	+0.15	+10.0(-10.0)
R170W-7A K5V80DTP1LHR-9C05	2,100	+1/4	+8.9	+37.0	+1/4	+0.15	+10.0(-10.0)
R210LC-7A K3V112DT-1LHR-9C32	1,900	+1/4	+11.3	+45.5	+1/4	+0.15	+12.3(-12.3)
R250LC-7A K3V112DT-1LHR-9C52	1,900	+1/4	+10.7	+57.9	+1/4	+0.13	+12.3(-12.3)

5) Structure of pump



6) View & main components of pump



注記
 図中 ㉔㉕㉖㉗㉘㉙㉚ および ㉛㉜㉝㉞ はレギュレータ取付位置を示す

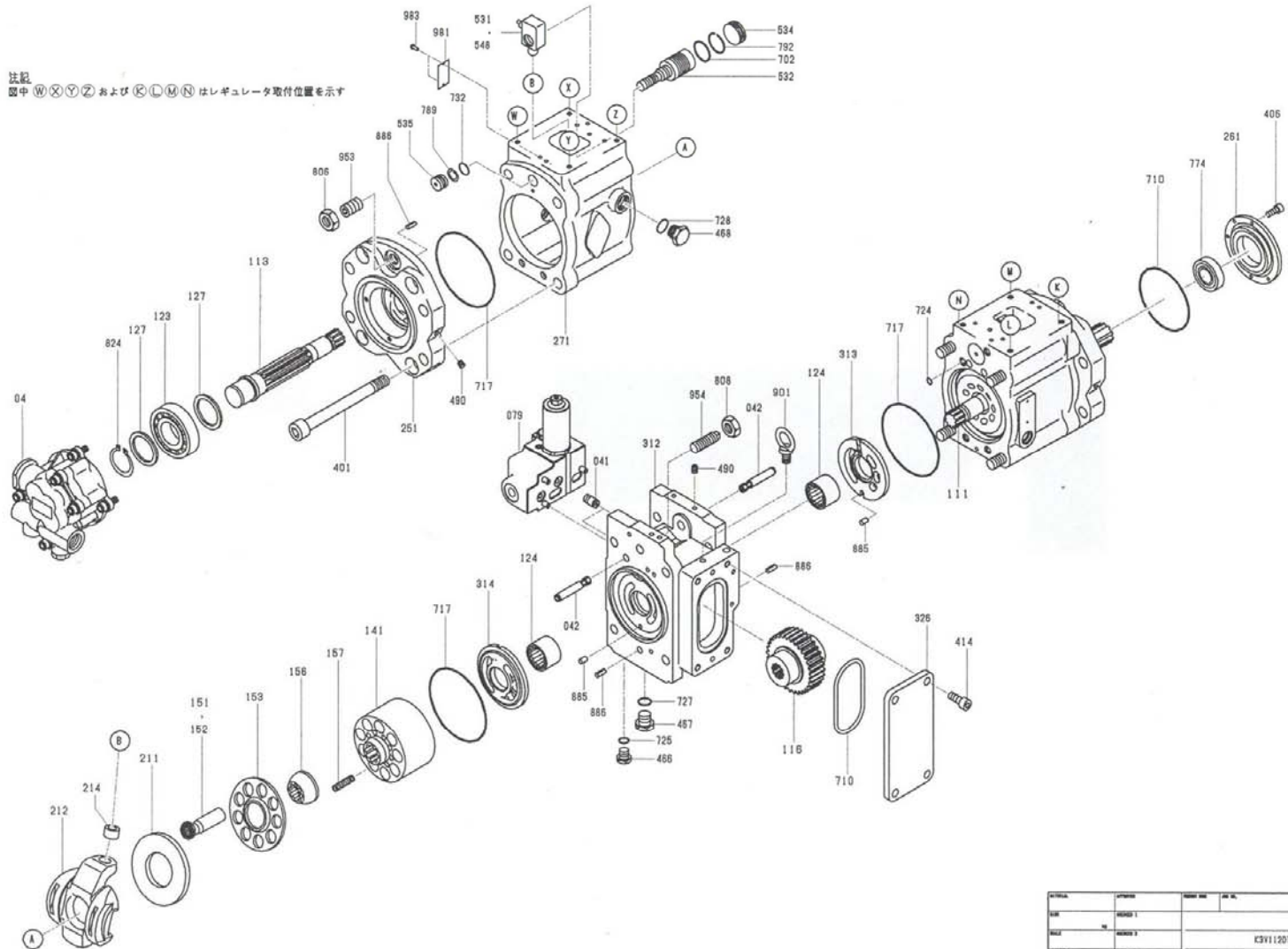
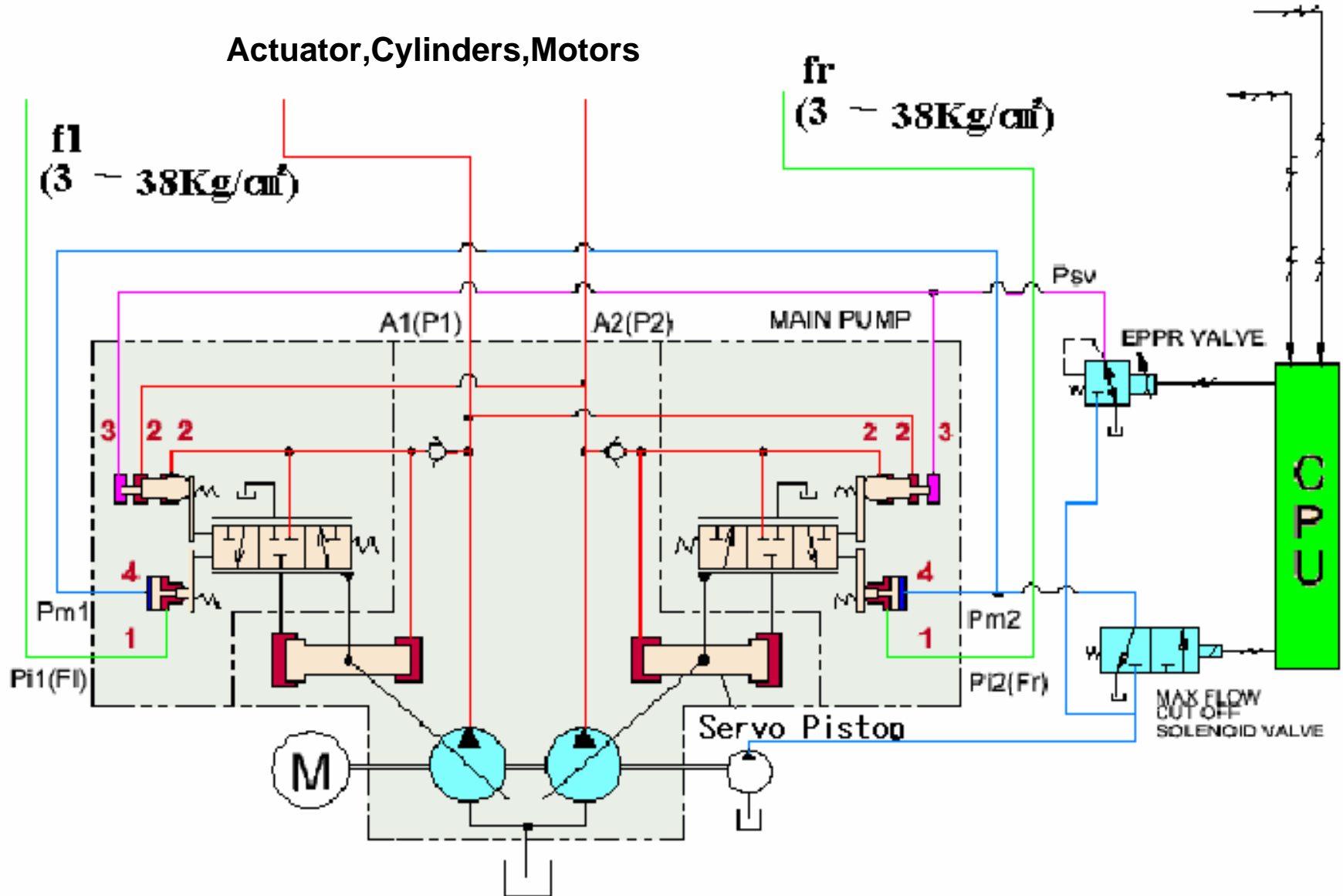
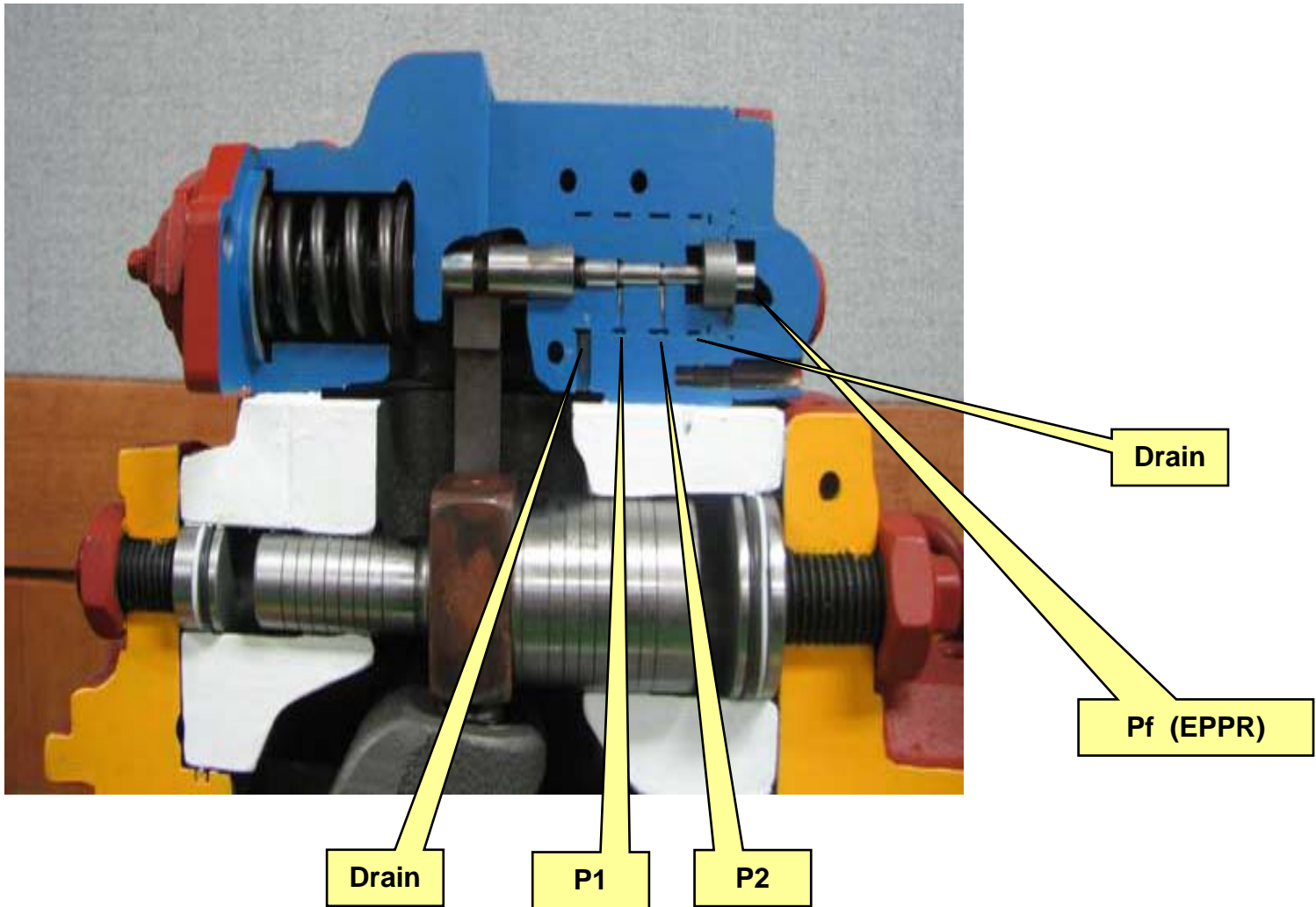


FIGURE	REVISED	REVISION NO.	REV. DATE	REV.
04	01			
K3V1120TF				
Exploded view of Pump				
DATE	SCALE	FIG. NO.	REV. NO.	SCALE
03/05/04	1:1	03850478		1:1

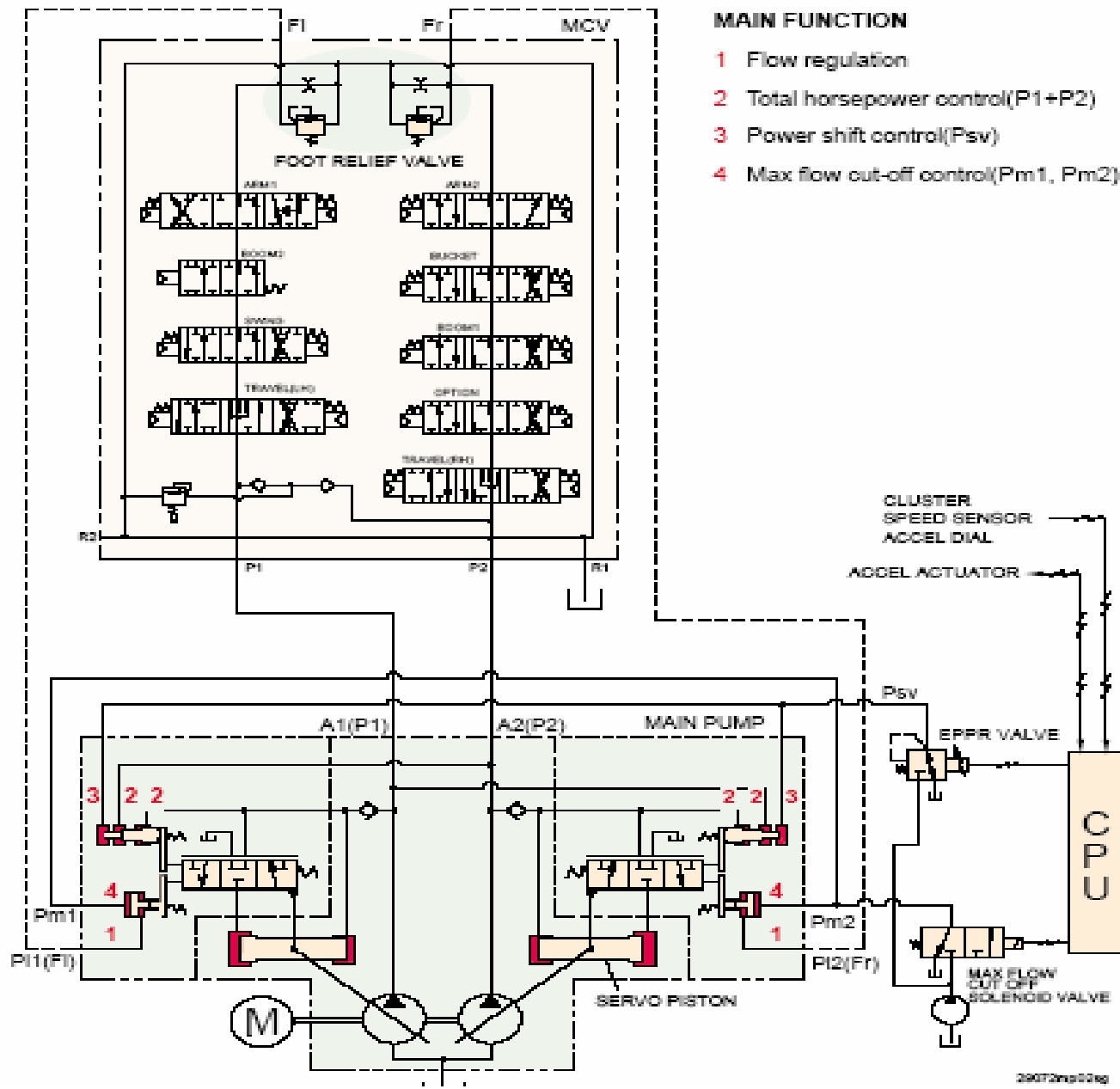
KCP-078 Kawasaki Precision Machinery Ltd.

Actuator,Cylinders,Motors





8) Pump Regulation Schematic



9) Pump Regulating System

- A. Opening of a spool in the Main Control Valve results in flow increase of the pump, which supplies oil to the relevant spool. This **flow increase** is accomplished by **pressure decrease** in front of the foot relief valve.



= **NEGATIVE CONTROL SYSTEM** signals: F1 & F2

- B. The pump power changes, according to the selected mode on the cluster (H, S, M, U) and work condition of the machine. Therefore the CPU sets relevant currents towards the Electric Proportional Pressure Reducing Valve (EPPR valve), which establishes the pump power for P1 and P2.



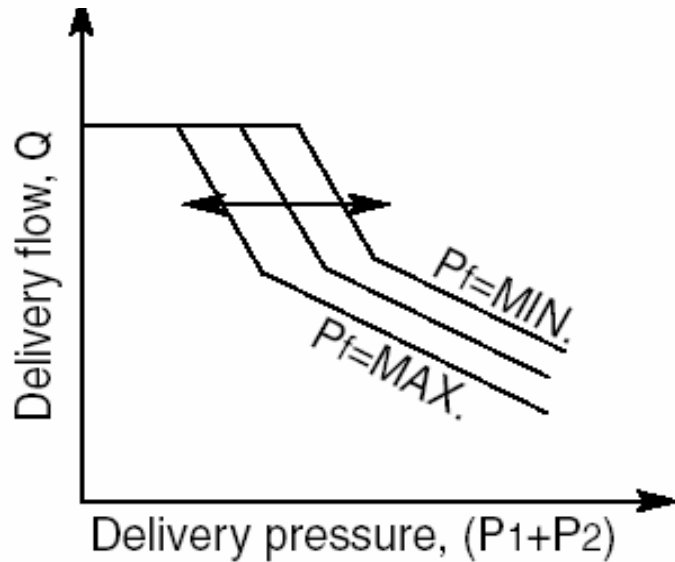
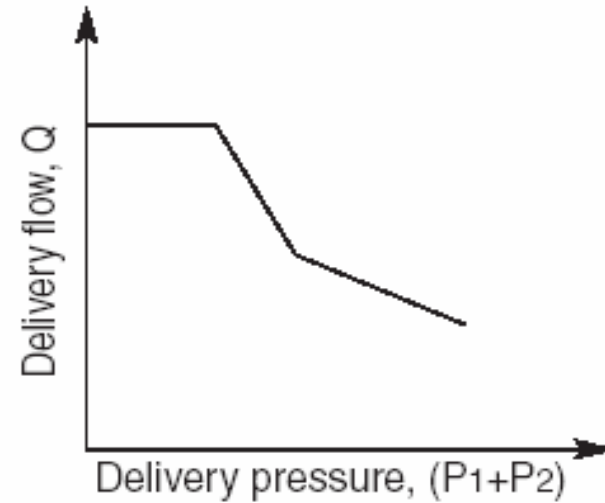
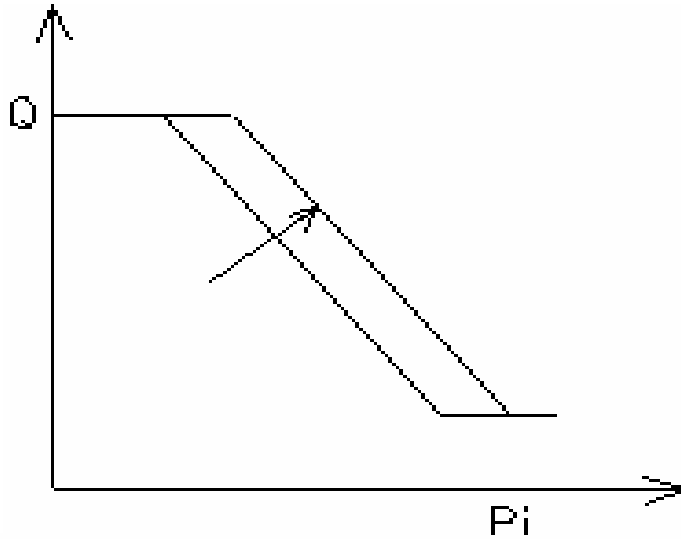
= **POWER SHIFT SYSTEM** signal: PEPPR

- C. If P1 or P2 pressure rises significantly, both pump flows will be reduced, according to the Pressure-Flow diagram.

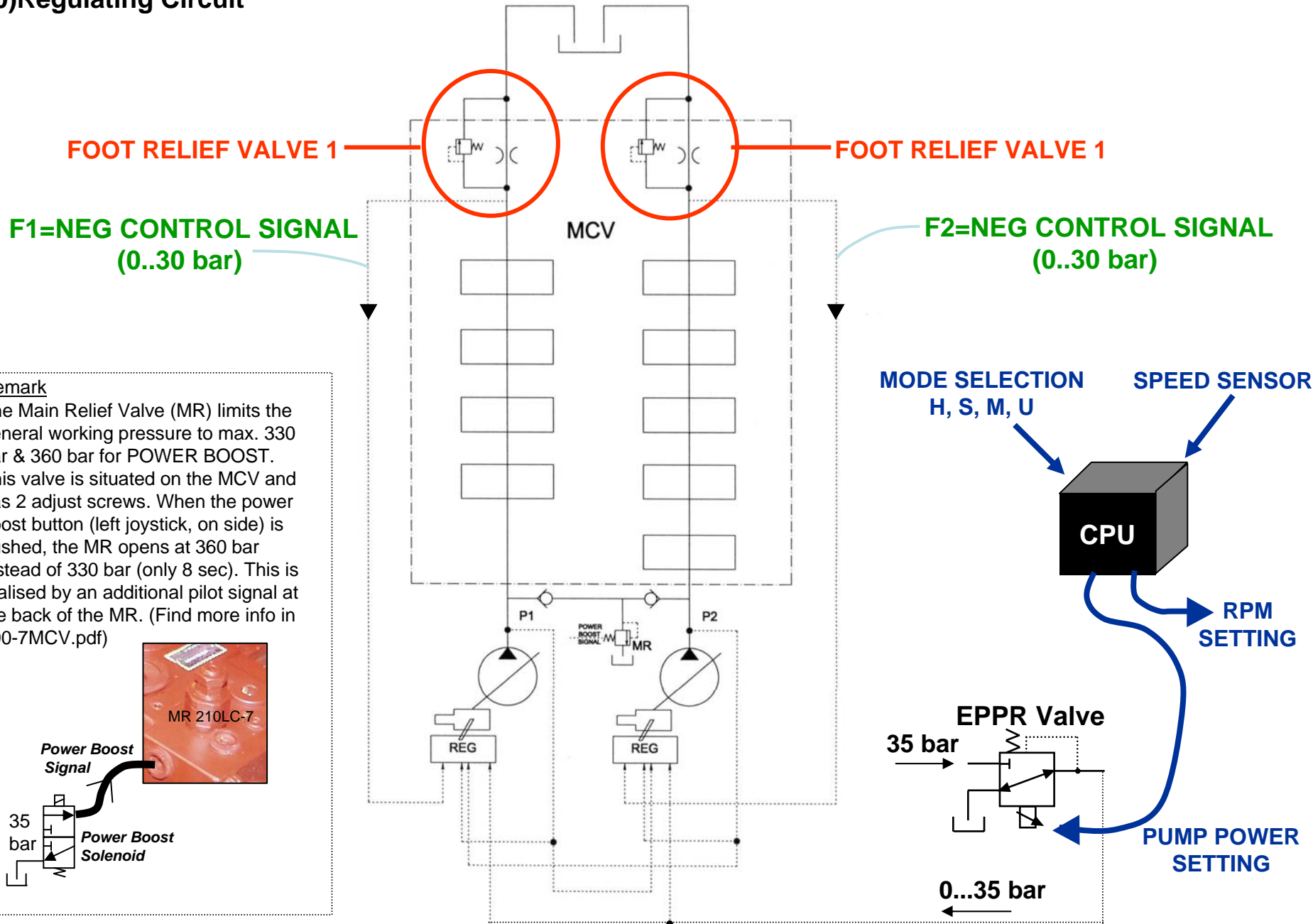


= **TOTAL POWER CONTROL** signal: P1 & P2

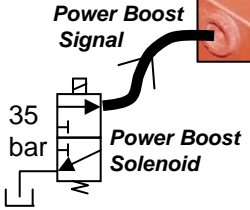
Regulator consists of the negative flow control, total horse power control and power shift control(EPPR)



10)Regulating Circuit

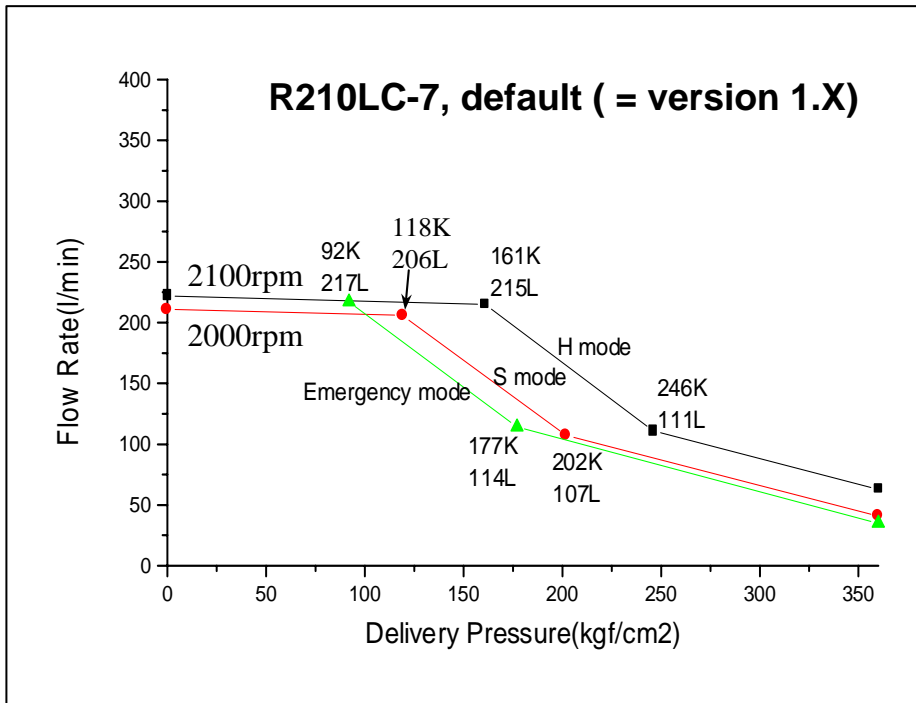


Remark
 The Main Relief Valve (MR) limits the general working pressure to max. 330 bar & 360 bar for POWER BOOST. This valve is situated on the MCV and has 2 adjust screws. When the power boost button (left joystick, on side) is pushed, the MR opens at 360 bar instead of 330 bar (only 8 sec). This is realised by an additional pilot signal at the back of the MR. (Find more info in 290-7MCV.pdf)

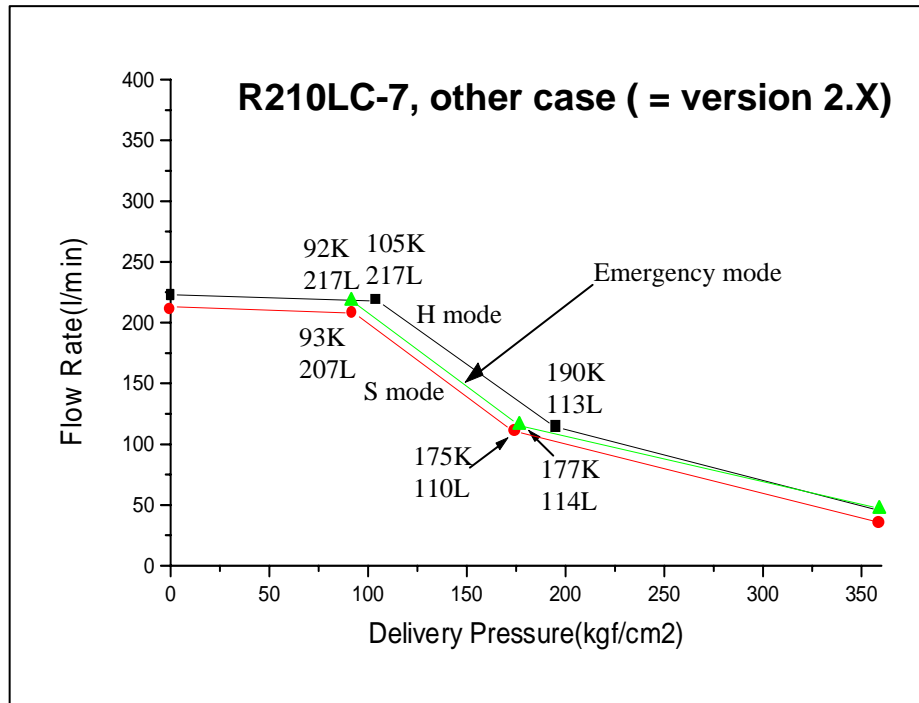


11) Flow Pressure Chart R210LC-7

The flow pressure chart of the pump depends on the active program version of the cluster.



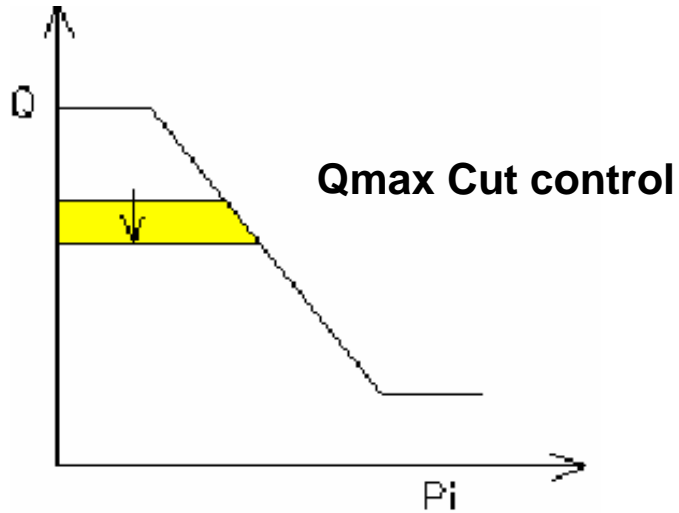
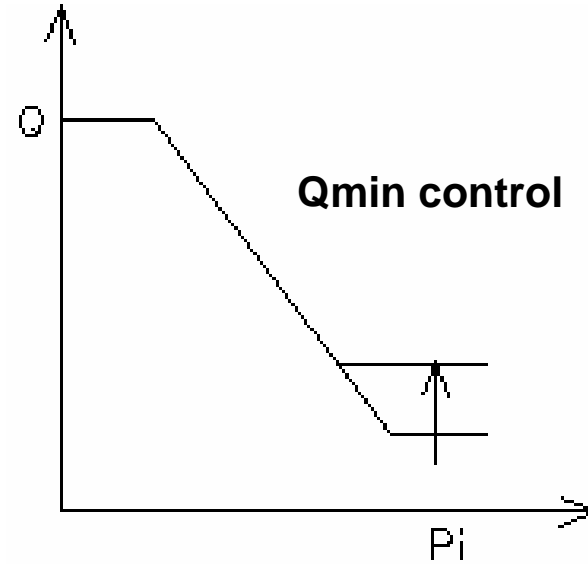
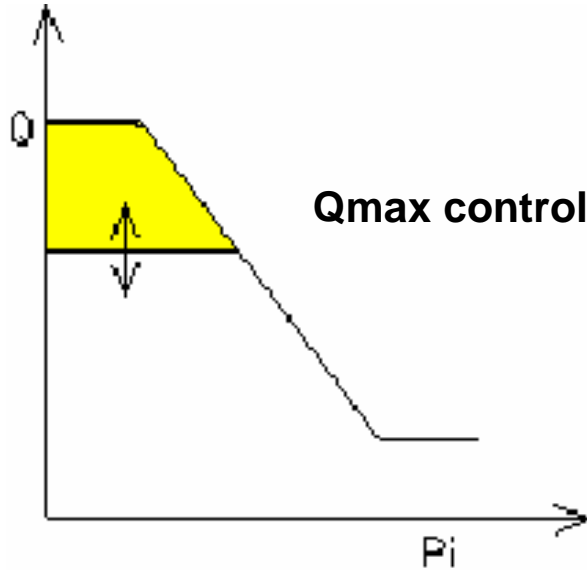
EPPR (bar)	
H	0
S	13
Emergency	15



EPPR (bar)	
H	18
S	22
Emergency	15

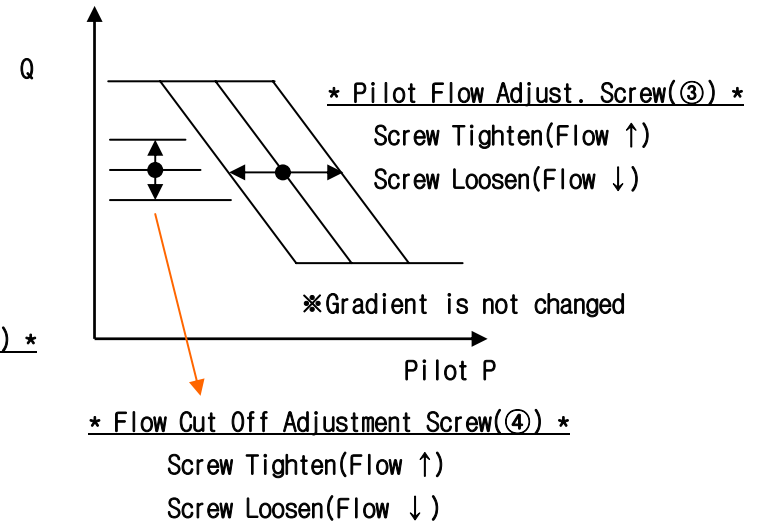
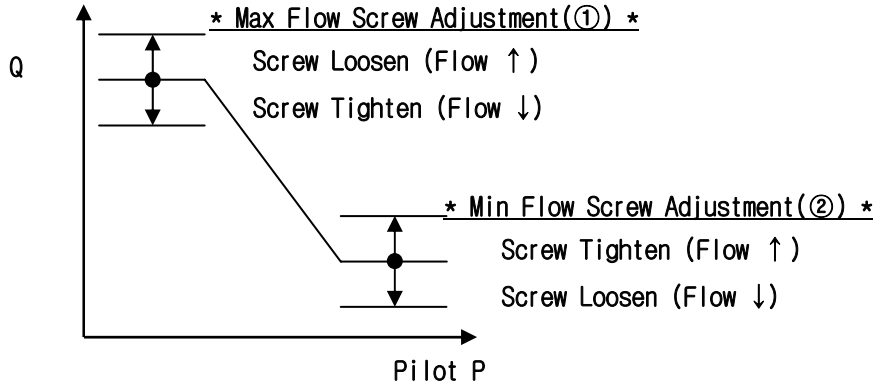
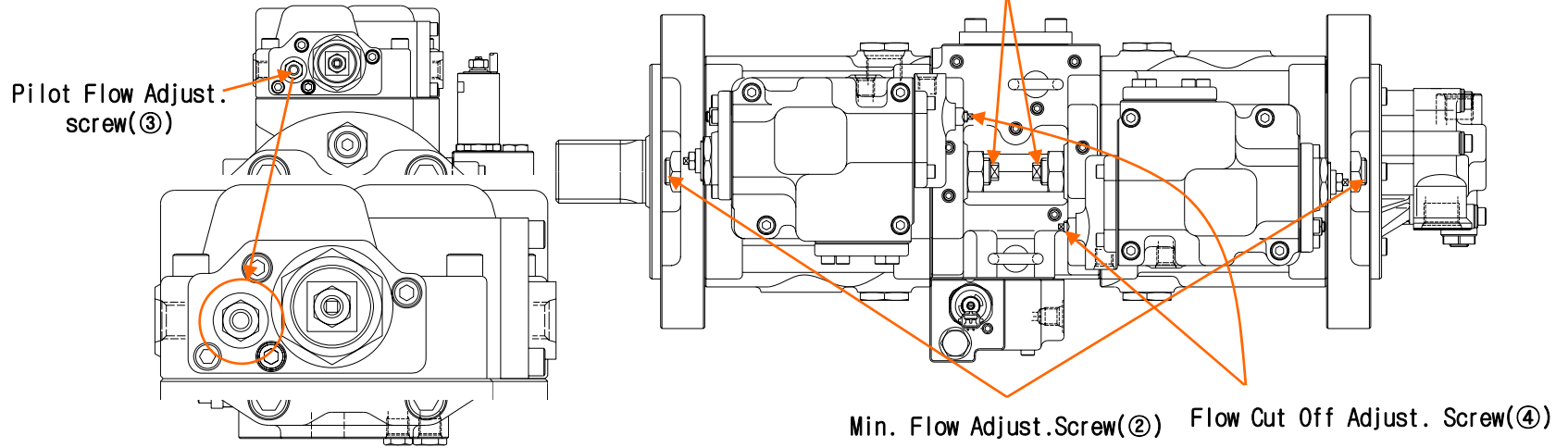
12) Pump Regulator

Qmax control, Qmin control, Qmax Cut control



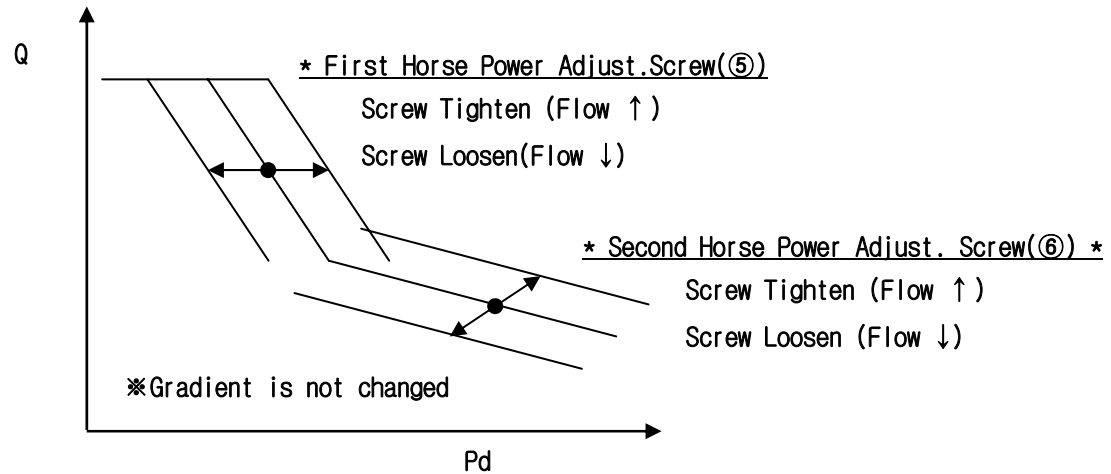
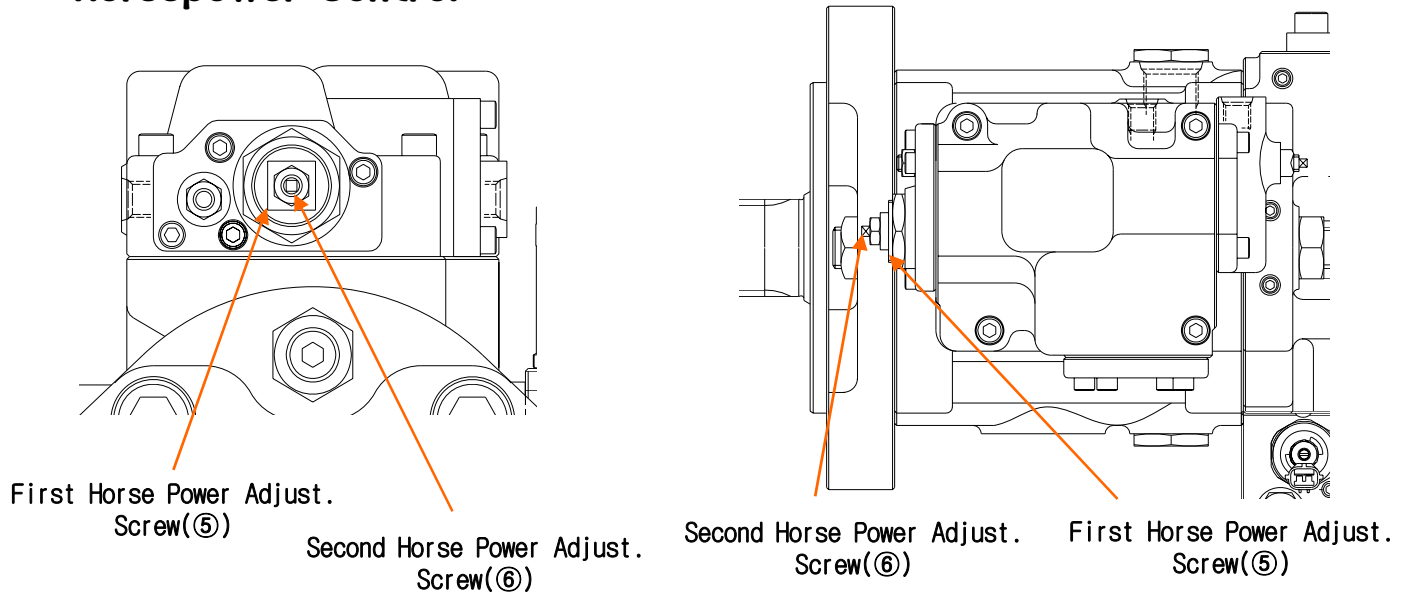
13)Control and Adjustment of Regulator

- Flow Control

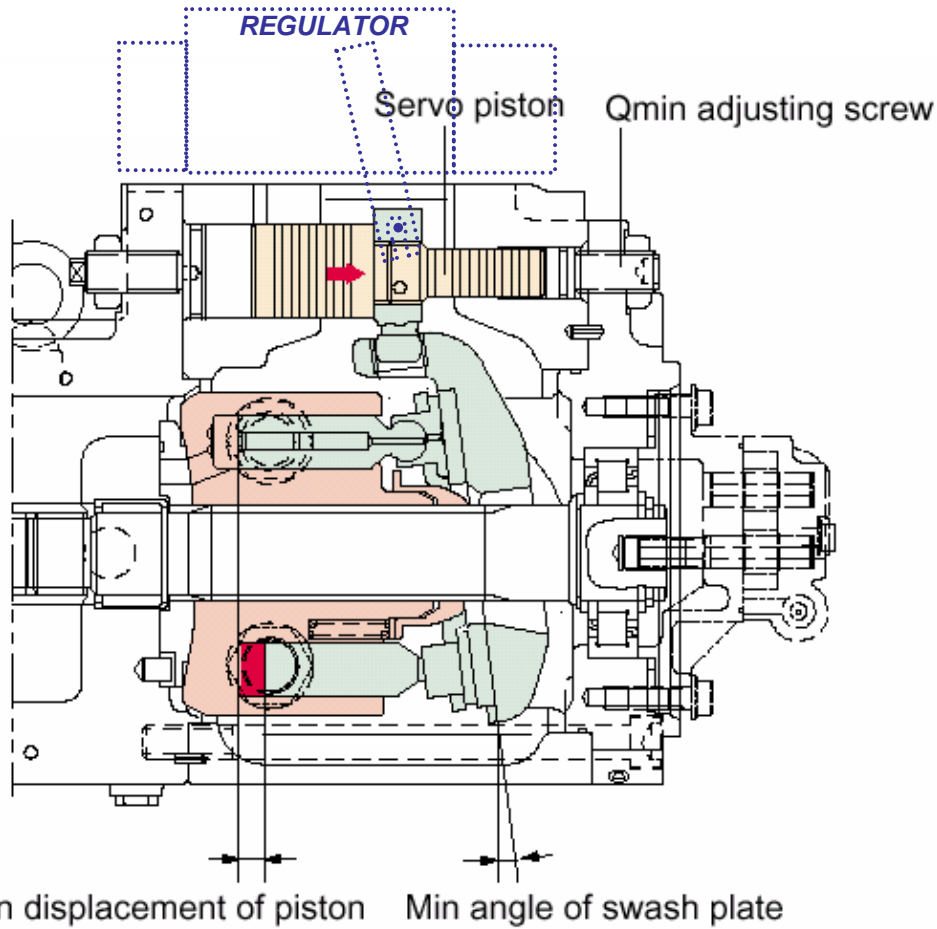


14) Control & adjustment of regulator

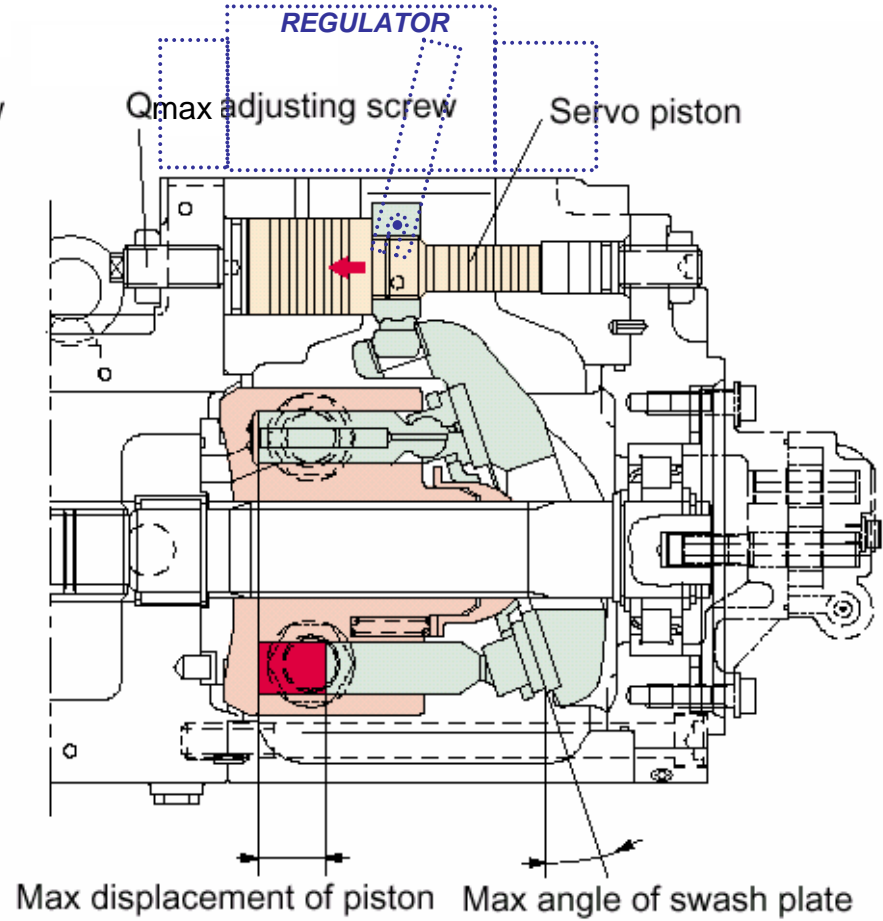
- Horsepower Control



Minimum flow

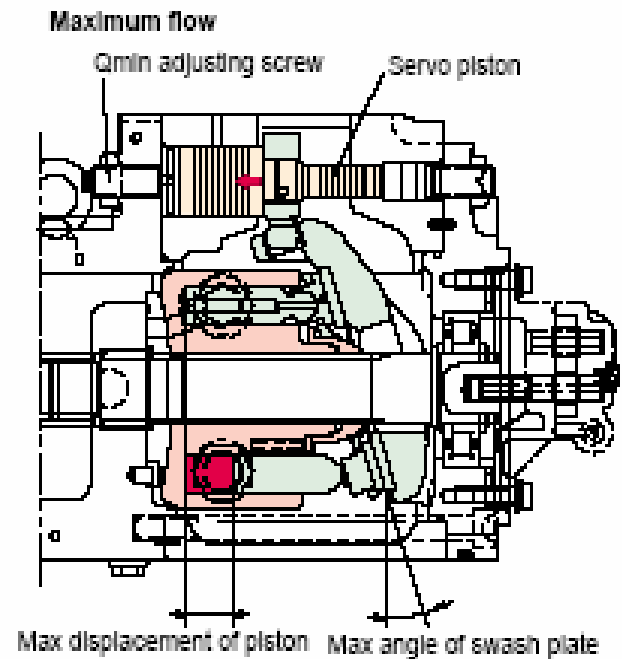
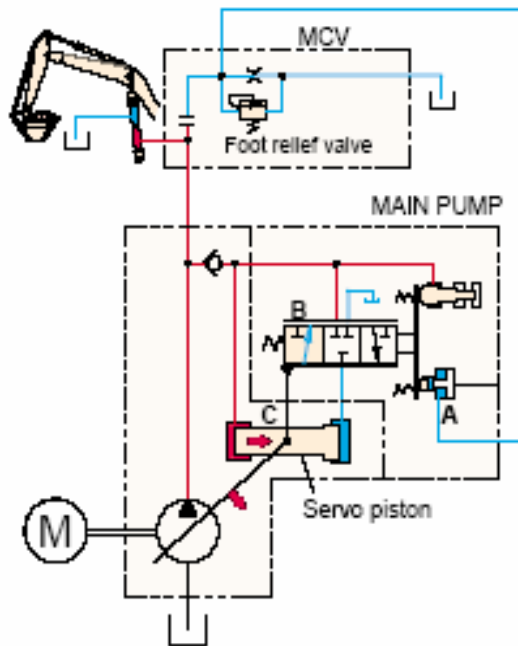


Maximum flow

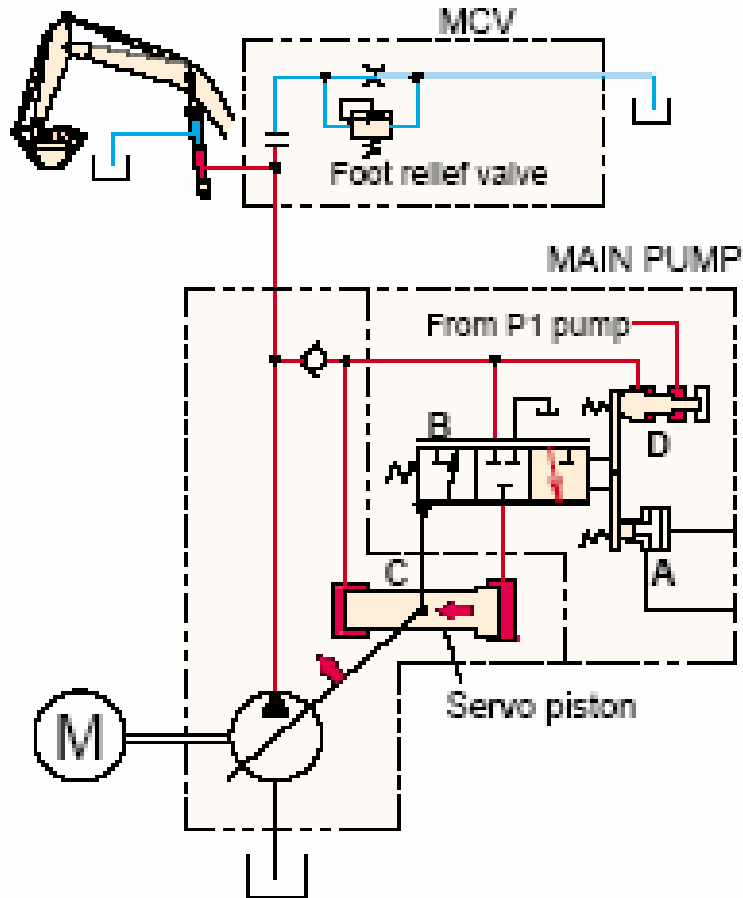


15) Maximum flow

- When a machine is operating, oil is supplied to the actuator(cylinder or motors) so that no oil pressure reaches piston A.
- Then, the piston B goes back to the neutral position by the spring and the oil in the large chamber of the piston C is returned to the tank
- Now the oil is supplied to LH side of the cylinder C.
- That pressure moves the piston C to RH side, therefore the swash plate is positioned at maximum flow angle during operation



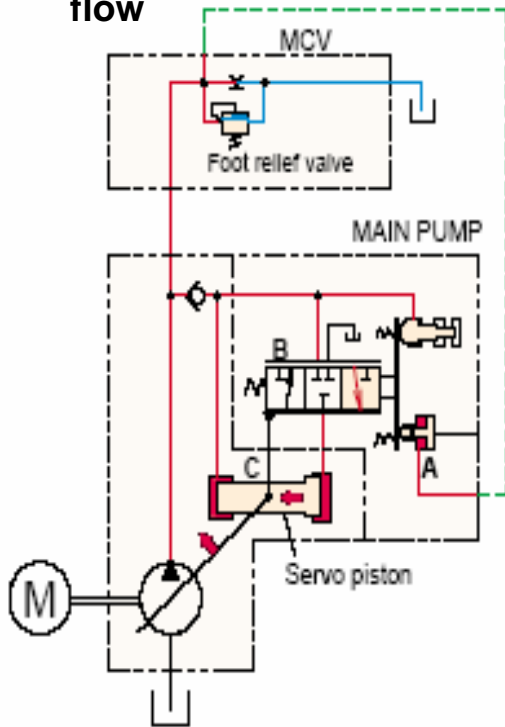
16)Over Load Preventing Function (Minimazing)



- When a machine is under load or the cylinder arrives at the end of stroke, the pressure is increased
Cylinder pressure > spring pressure (B + D)
The pressure is applied at the piston D and compresses the spring D and B
So, the valve B moves to LH side and the oil enters the piston C through the passage at piston B
The piston C moves the swash plate to reduce the angle upon the angle upon the load of cylinder.

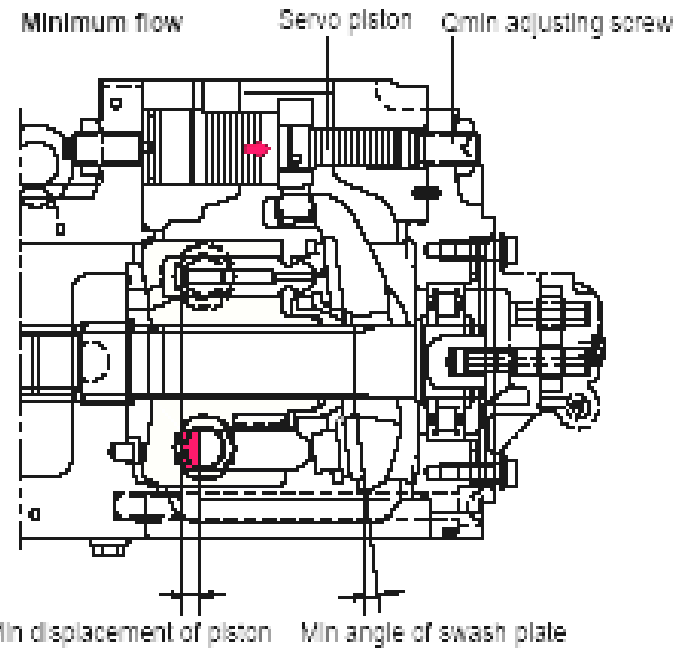
17)Flow Control

Minimum flow

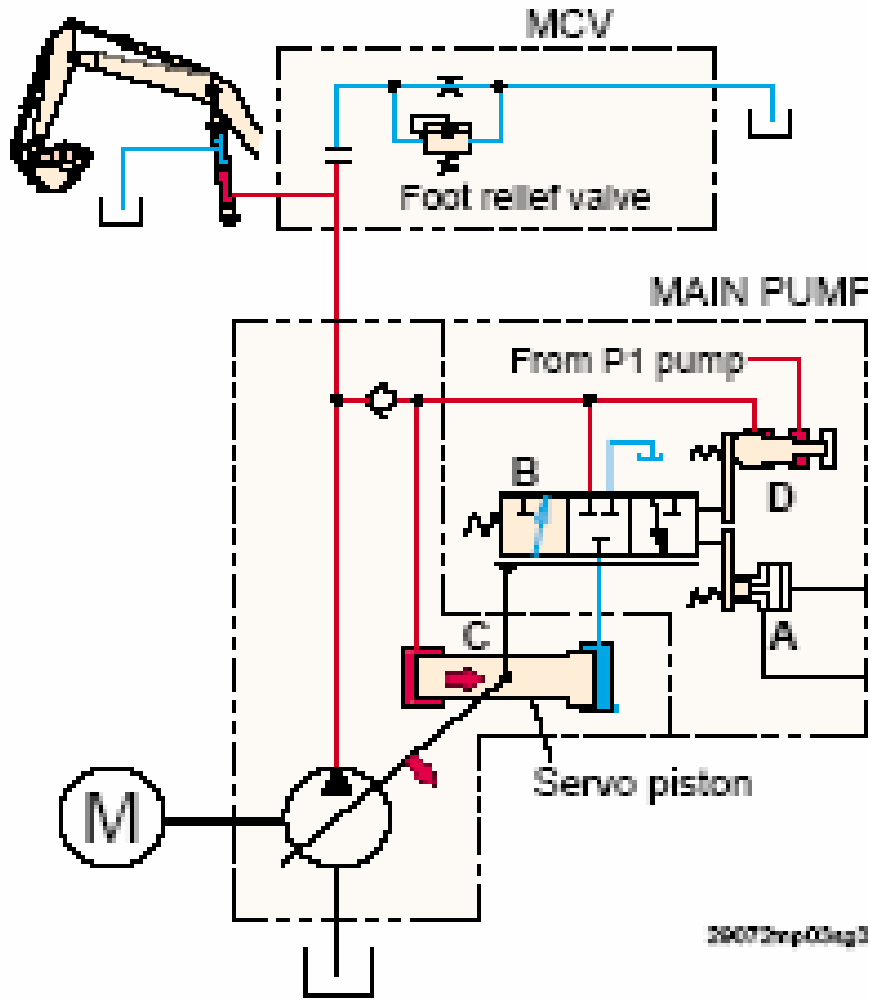


-When the engine is running, the swash plate moves to minimum angle position as per the following steps

- 1.the pressure is created by restriction of the foot relief valve
- 2.the pressure apply to the piston A
- 3.the piston A is moved to LH side
- 4.the valve B is opened
- 5.the pressure flows to the piston C
- 6.the piston C is moved to LH side. Therefore the swash plate is positioned at minimum flow angle



18) Flow Reset Function (Maximizing)



-When the load at the cylinder is gone, the pressure in

the cylinder and in the position D is decreased

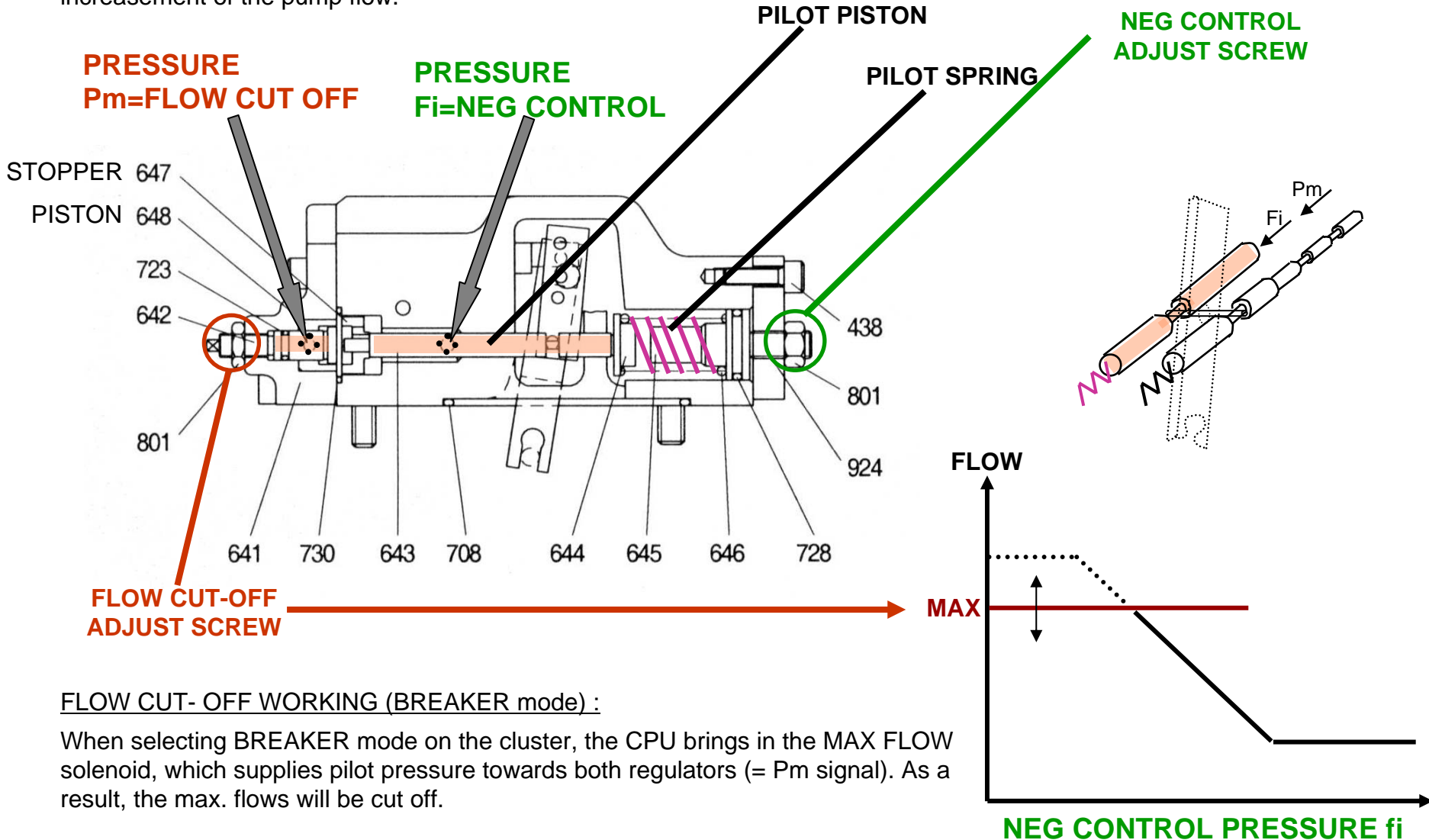
Cylinder pressure < spring force (B+D)

Then, the oil in the cylinder C returns to the tank as shown in figure, and the swash plate angle is increased

to give maximum flow

19)Regulator: “Flow” Control System

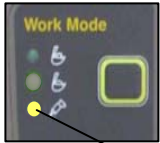
When operating the excavator equipment, the negative control pressure F_i inside regulator 1 or 2, drops, which results in displacement of the pilot piston and increasement of the pump flow.



FLOW CUT- OFF WORKING (BREAKER mode) :

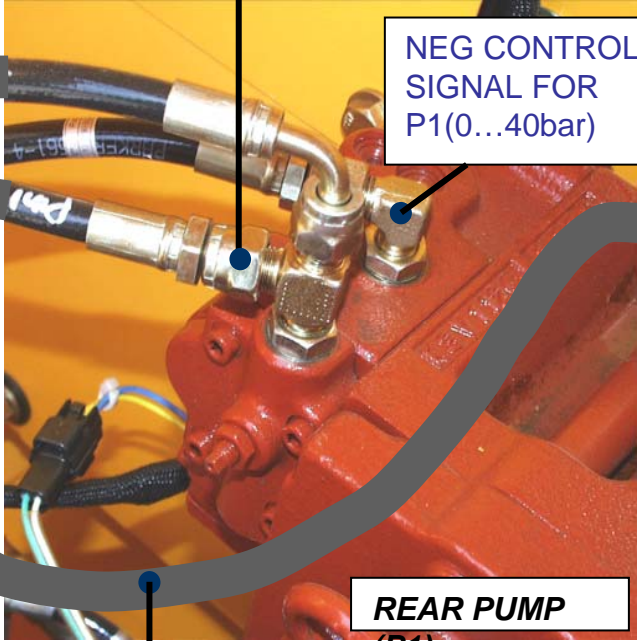
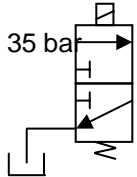
When selecting BREAKER mode on the cluster, the CPU brings in the MAX FLOW solenoid, which supplies pilot pressure towards both regulators (= P_m signal). As a result, the max. flows will be cut off.

Flow Control Signals



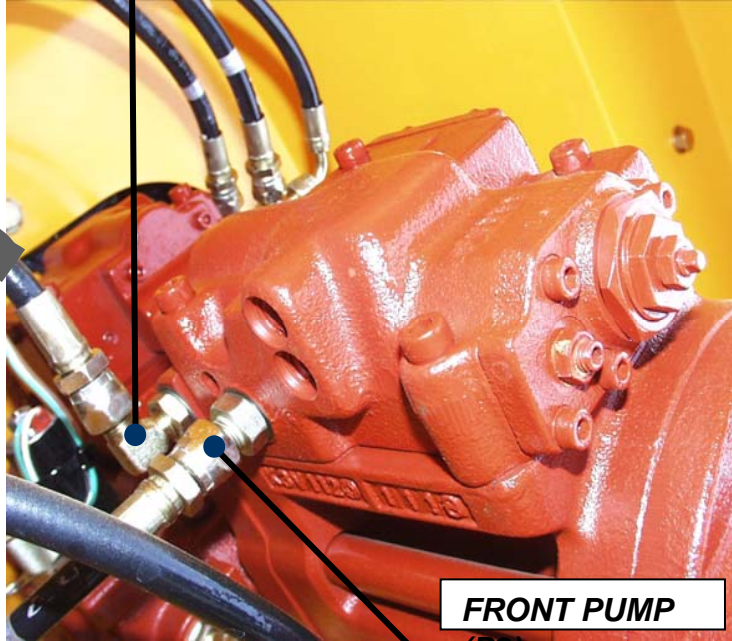
MAX FLOW CUT-OFF SIGNAL for P1
(35 bar ON / 0 bar OFF)

MAX FLOW CUT-OFF SIGNAL for P2
(35 bar ON / 0 bar OFF)



NEG CONTROL SIGNAL FOR P1(0...40bar)

REAR PUMP (P1)



NEG CONTROL SIGNAL FOR P2 (0...40bar)

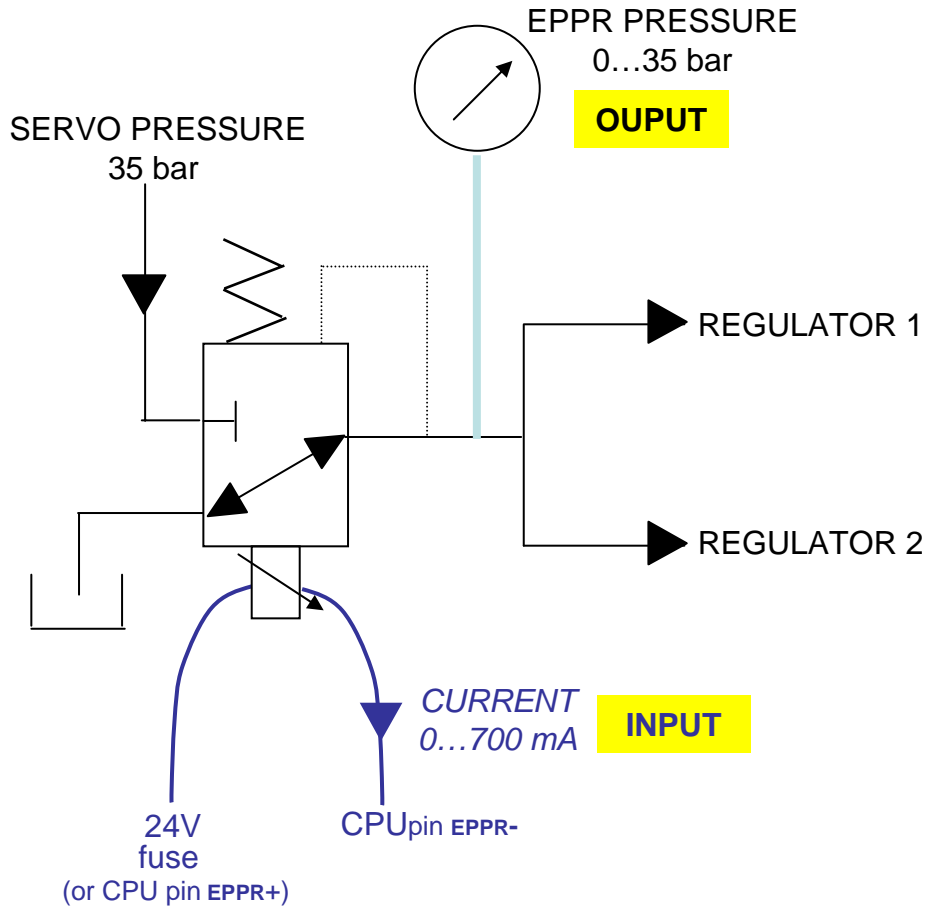
FRONT PUMP (P2)

On -7 models: Max flow cut off Sig is "ON" after selecting BREAKER OPERATION MODE
On R210/250LC-3: Max flow cut off Sig automatically "ON" in L mode

20)Regulator: “Power” Control System

By changing the mode (H,S,M,U) the CPU varies the current towards the EPPR valve (Electric Proportional Pressure Reducing Valve). This results in varying EPPR pressures, which work (together with P1 & P2 pressure) on the power piston inside each regulator. The power piston & pilot piston are situated near each other and control the swash plate angle.

In case of significant drop of engine speed, the CPU will automatically increase the current, in order to lower the pump power and it will do this until the engine speed reaches the set-value again



In case of faulty CPU: put machine in emergency

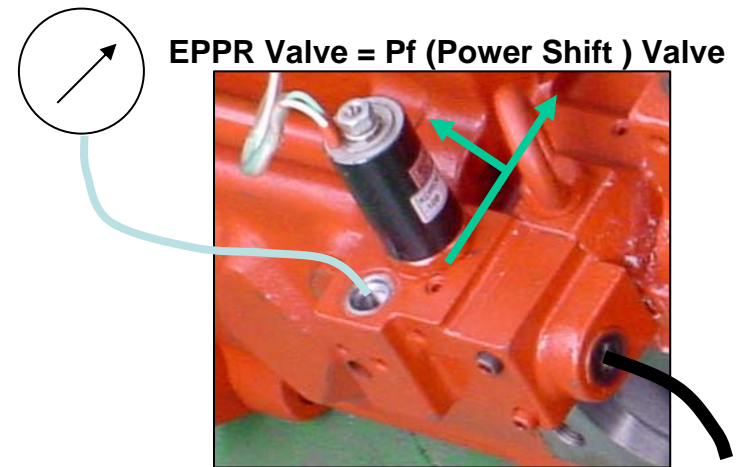
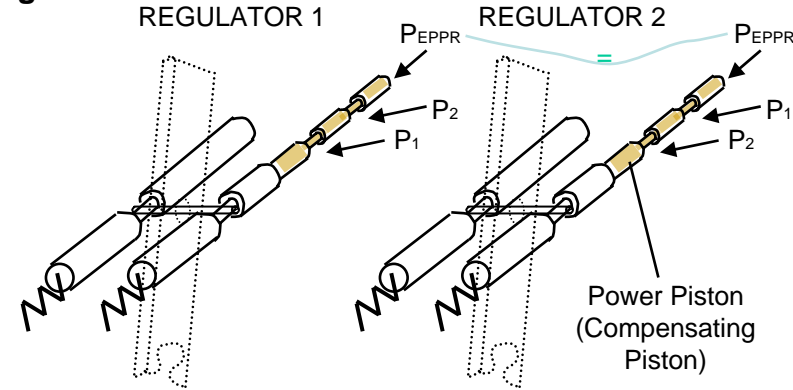
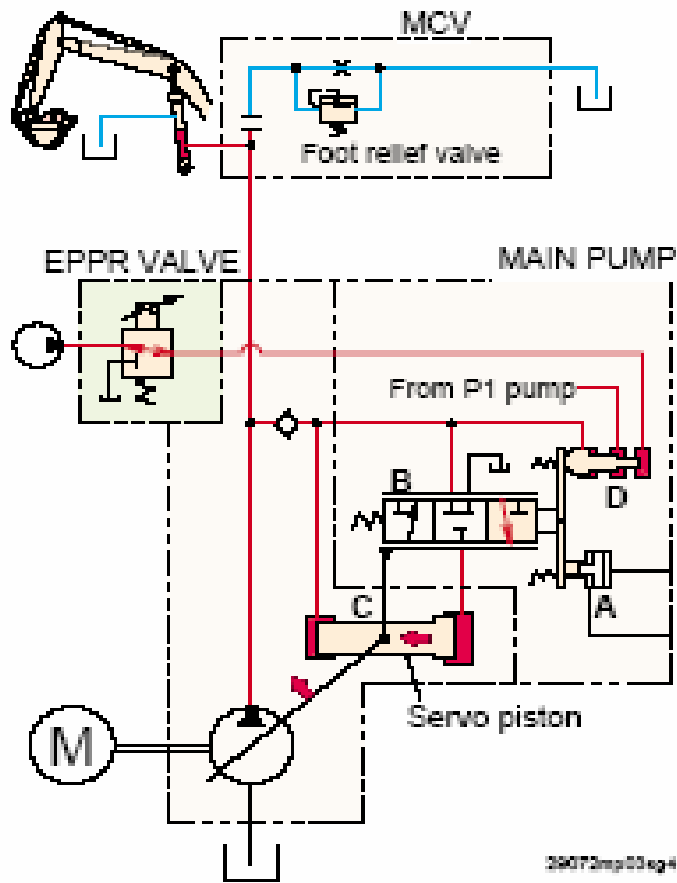


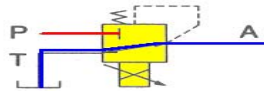
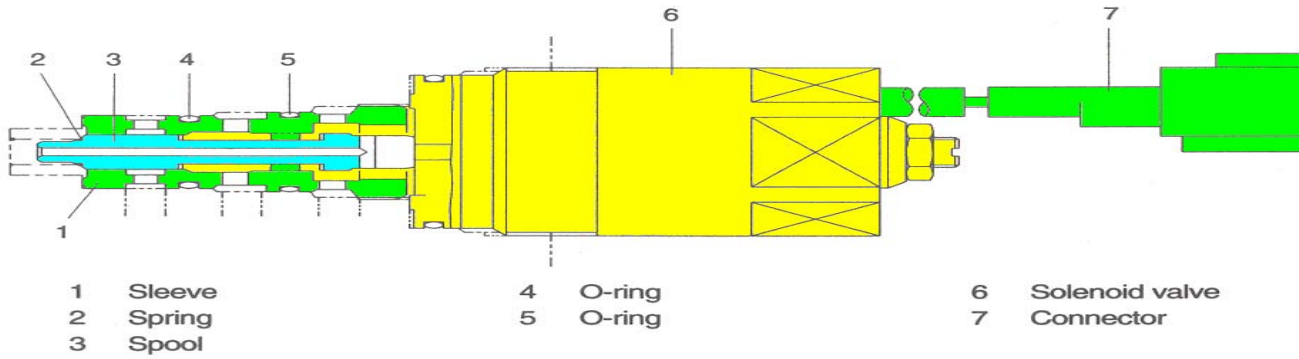
TABLE EPPR CURRENTS & PRESSURES



-When one of the power modes is selected during operation, the EPPR valve pressure is applied at the piston D. The piston D compresses the spring and moves the valve B to the LH side. Therefore, the pump oil enters to the piston C and reduces the angle of swash plate. So, oil delivery of the pump is reduced.

2. OPERATING PRINCIPLE

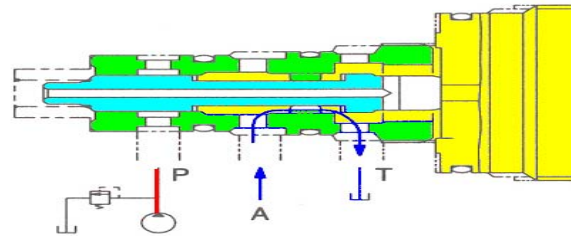
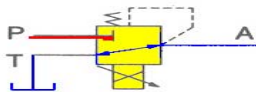
1) STRUCTURE



P Pilot oil supply line(Pilot pressure)
 T Return to tank
 A Secondary pressure to flow regulator at hydraulic pump

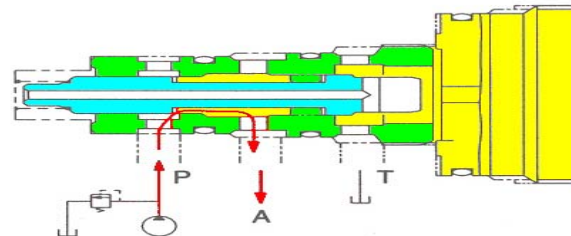
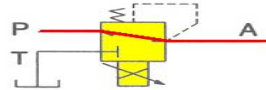
2) AT H MODE

Pressure line is blocked and A oil returns to tank.

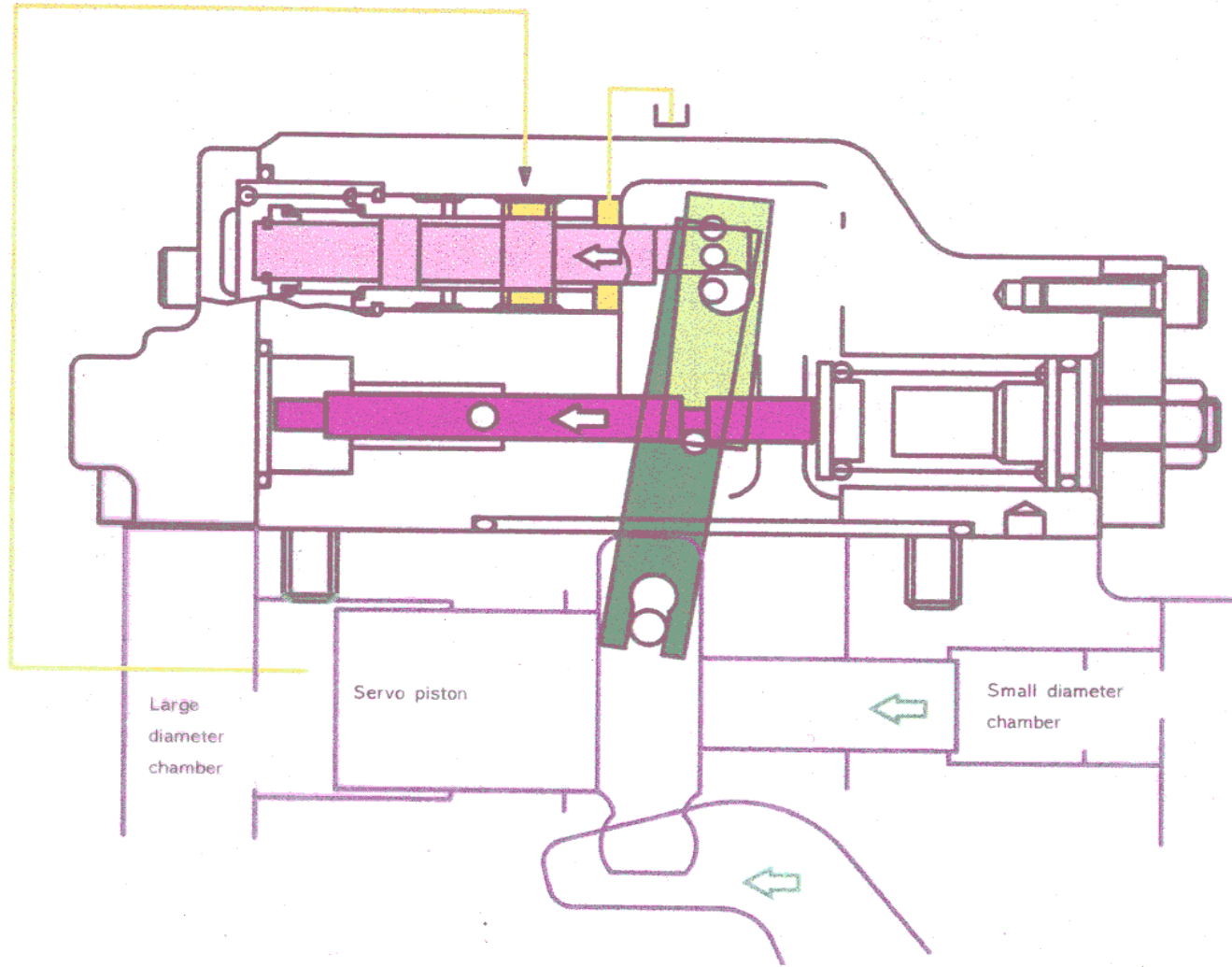


3) AT S, L, F MODE

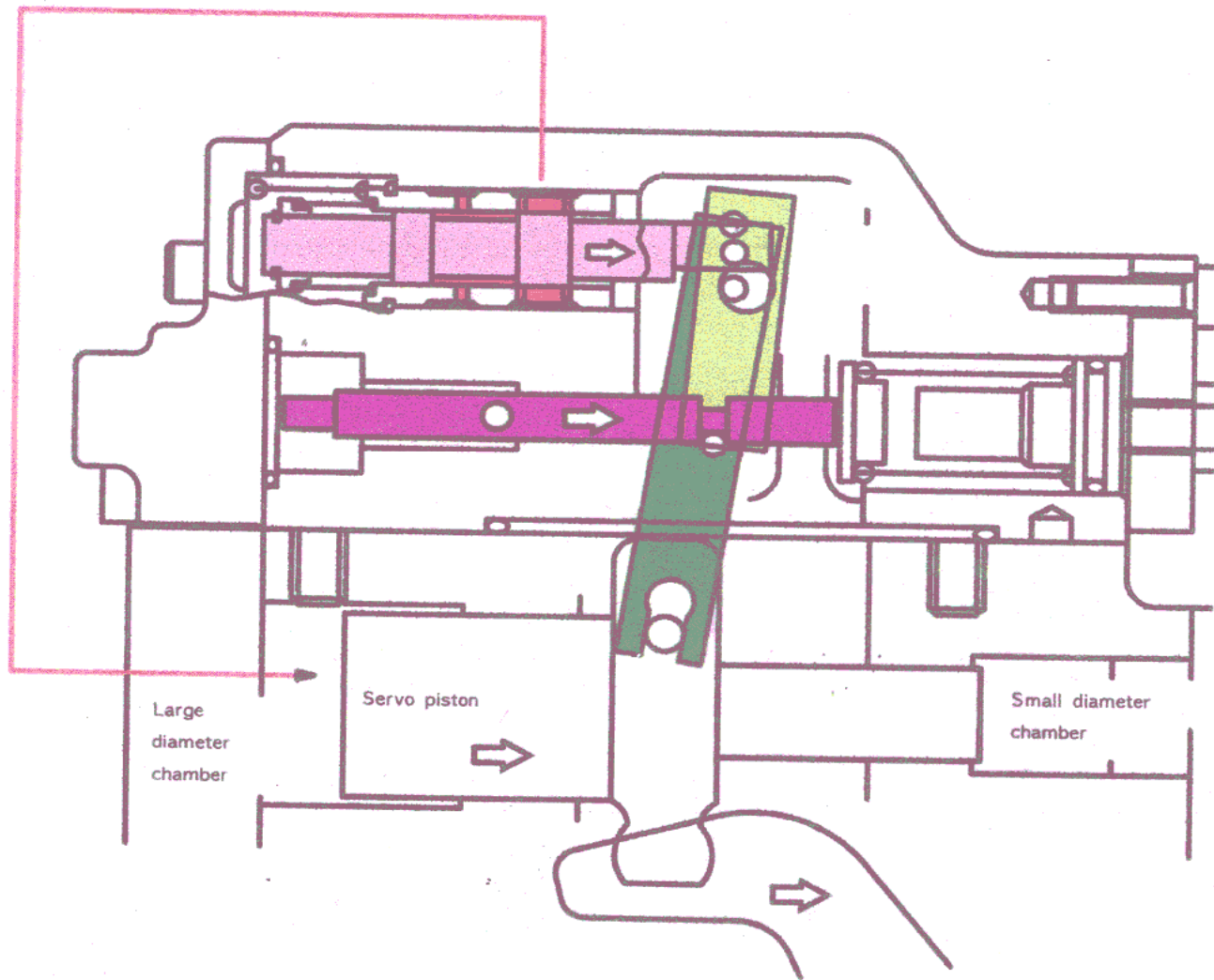
Secondary pressure enters into A.



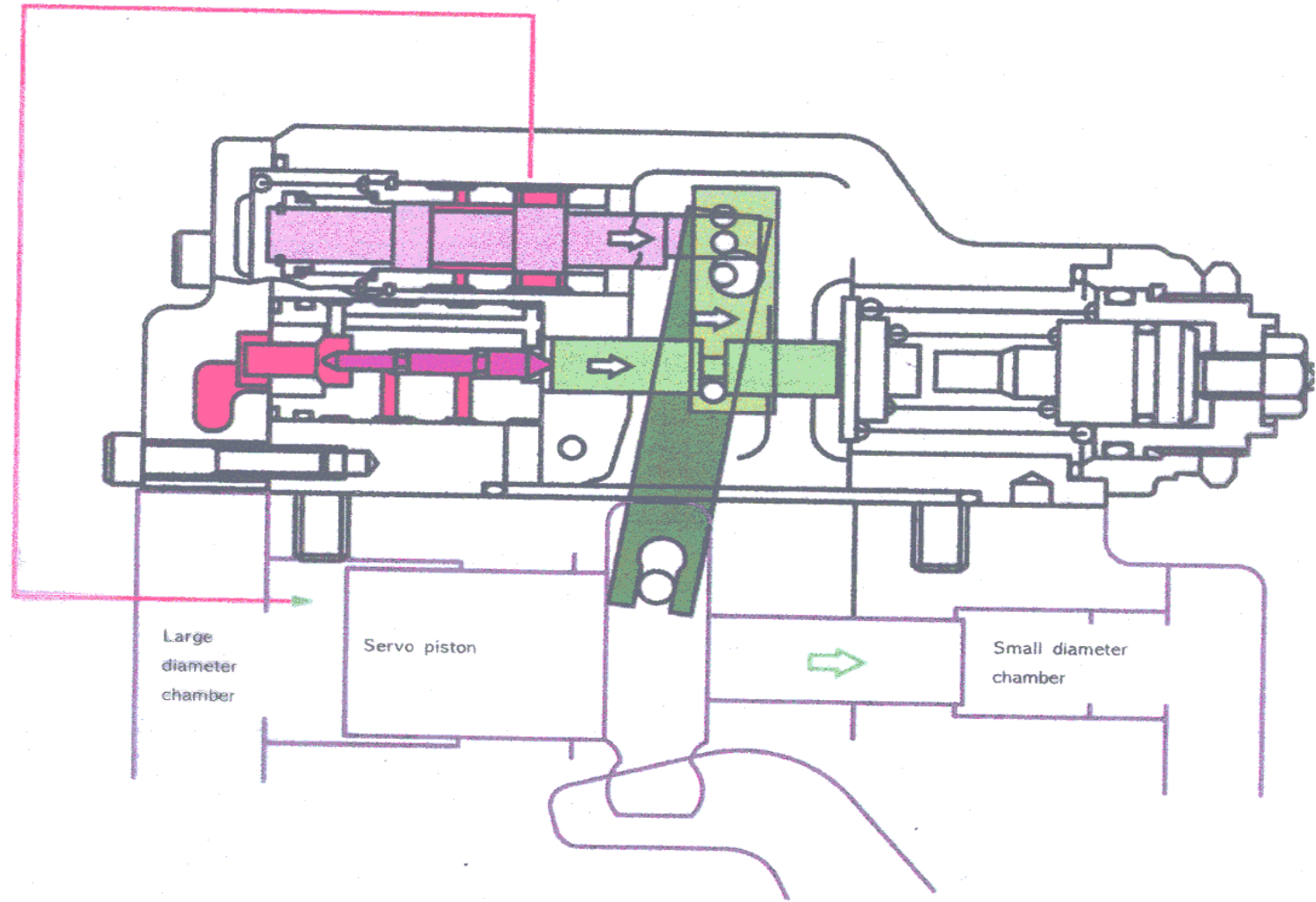
21) Flow Increasing Function

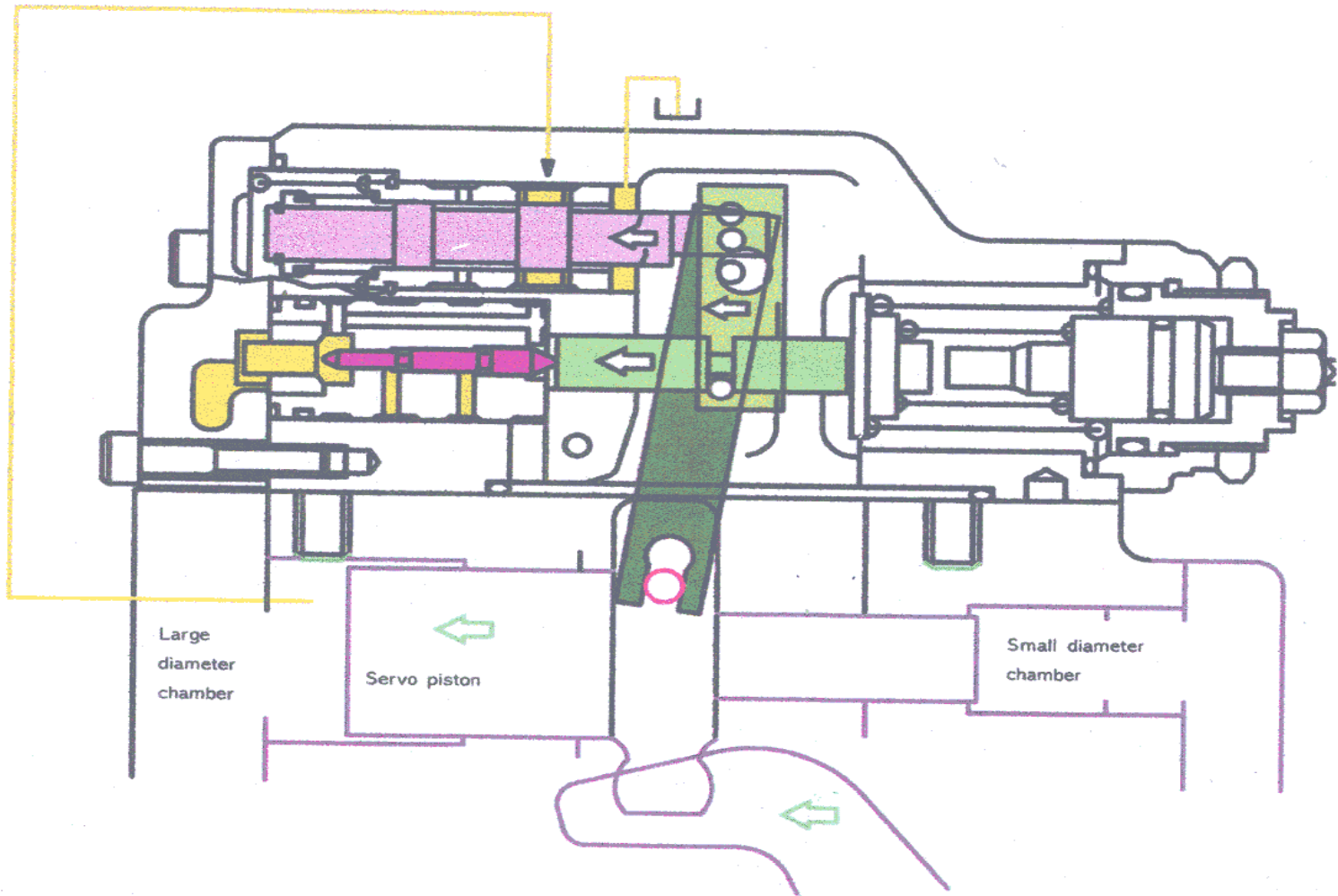


22) Flow Reducing Function



23)Overload Prevention Function





1.Negative flow control

2.Total horsepower control

3.Adjustment of input horsepower

① Adjustment of outer spring

② Adjustment of inner spring

4.Power shift control

5.Qmax cut control

6.Adjustment of maximum and minimum flows

Subject 1 : Attachment operating speed for R290LC-7A is slow

1.Problem : All attachment speed is slow

2.Check & Measure

1)Test condition : S Mode, max rpm

2) Test Items and Specifications

Measuring Point	Condition	Test Result	Spec'	Remedy (If not)
EPPR Valve	Unload		1750rpm	
	Full		1700rpm	
Engine RPM	Unload		1850rpm	
	Full		1800rpm	
Main Relief V/V			330Kg/cm ²	
Pilot pressure			40Kg/cm ²	Adjust pilot relief V/V
Fr & Fl pressure	In neutral		38Kg/cm ²	
	In full		5Kg/cm ²	

3) Specification for EPPR Valve

Mode	Eng' RPM		Pump EPPR	
	Unload	Load	Current (mA)	Pressure (Kg/cm ²)
M	1950	1900	160	0
H	1850	1800	225	4.0
S	1750	1700	225	4.0
Auto Idle	1200	-	670	38

4) Measuring Method of EPPR Pressure

By Cluster



By Pressure Gauge



Gauge Port

5) Specification of Accel' and ECM signal

※ Specification Table

Accel' Dial (dL)		Signal to ECM (Po)		
Step	Signal	M /rpm	H /rpm	S /rpm
1	1.9	0V/950	0V/950	0V/950
2	2.1	0.6/1120	0.6/1120	0.6/1120
3	2.2	0.8/1200	0.8/1200	0.8/1200
4	2.4	1.8/1500	1.6/1450	1.6/1450
5	2.6	2.1/1600	2.0/1560	1.8/1490
6	2.8	2.4/1700	2.1/1600	2.0/1560
7	2.9	2.6/1750	2.3/1650	2.1/1600
8	3.1	2.8/1810	2.4/1700	2.3/1650
9	3.2	3.0/1880	2.6/1750	2.4/1700
10	3.4	3.2/1950	2.9/1850	2.6/1750

※ How to find out

By cluster



•Notices

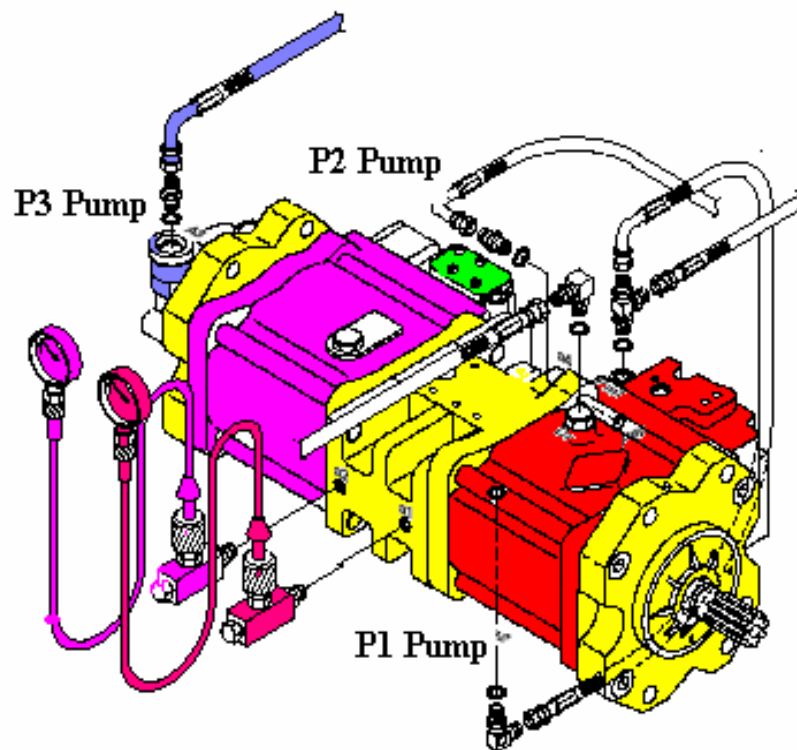
1) The engine rpm is below than desired engine rpm, the CPU controller will increase the EPPR pressure to recover the engine rpm until reach to desired engine rpm so it is one of the reason all speed is able to be slow

6) Measuring Point for Main Pressure

※ Specification Table

Unit : Kg/cm²

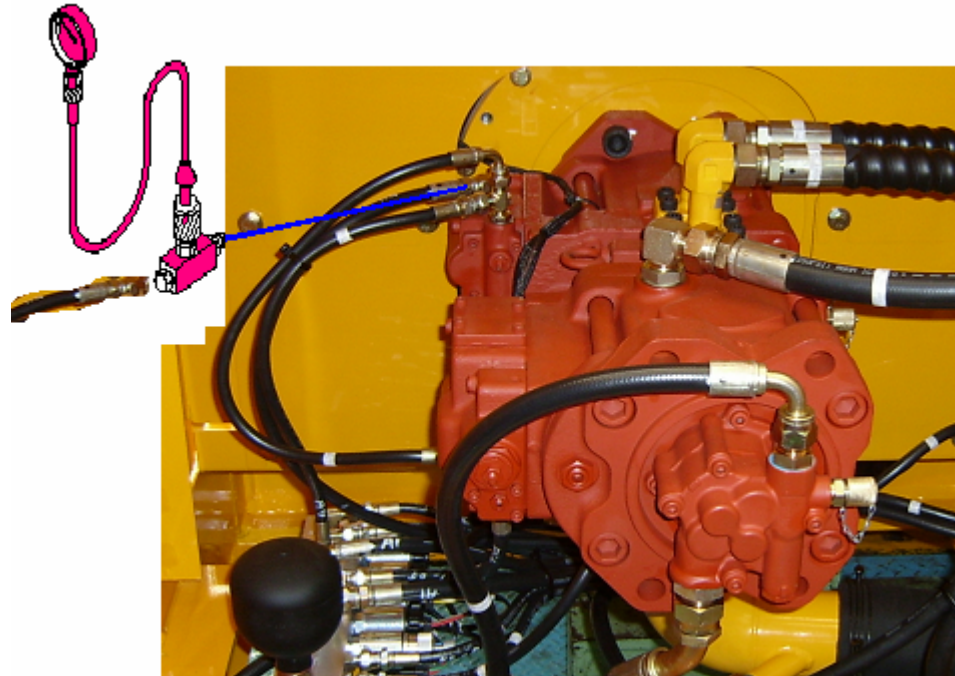
Attachment	Pressure	Remarks
Main Relief	330/360±10	
Boom, Arm, Bucket	330/360±10	
Travel	360±10	
Swing	265±10	



7) Fr & FI pressure

※ How to measure

- (1) disconnect Fr or FI hose
- (2) connect the disconnect hose to gauge "T" Fitting
- (3) start the engine



※ Specification Table

RCV Lever	Test result	Spec'	Remarks
In Neutral		Below 38Kg/cm ²	
In Full		Below 5Kg/cm ²	

Subject 2: Deviation for R290LC-7 travel

1.Problem : deviation for travel

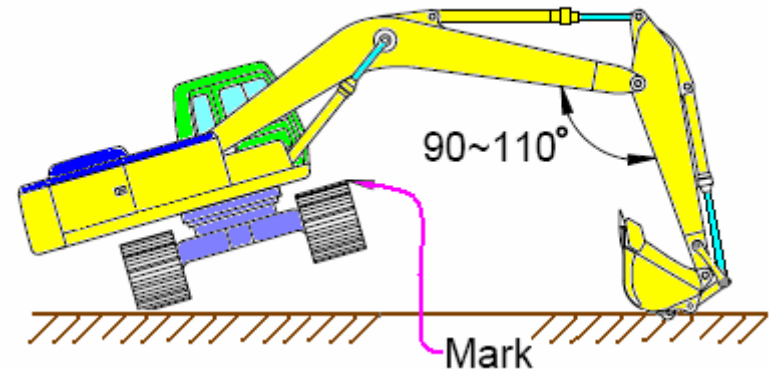
2.Check & measure

1)Preparation

- Hyd' Temp' : above 50°C
- H Mode, Max rpm

2)How to measure

Rotate 1 turn and then measure time taken for next 3 revolution



3)Specifications

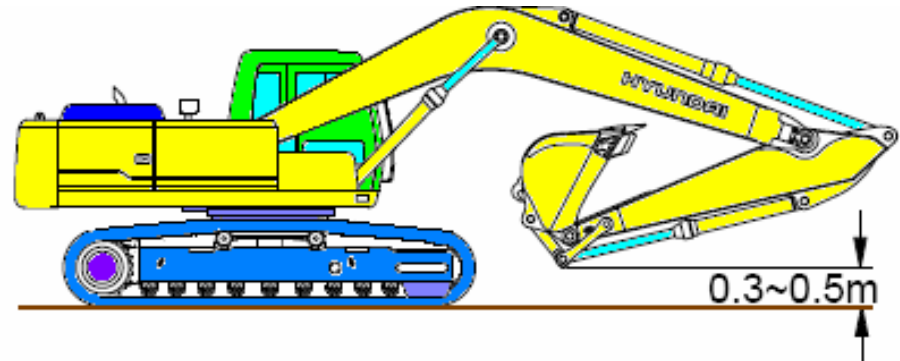
Attachment	Test result		Spec' (Second)	Remedy (If not)
	RH	LH		
1 speed			35±2.0	
2 speed			20±2.0	

※ You can decide which one is slower and faster than spec'

3. Remedy

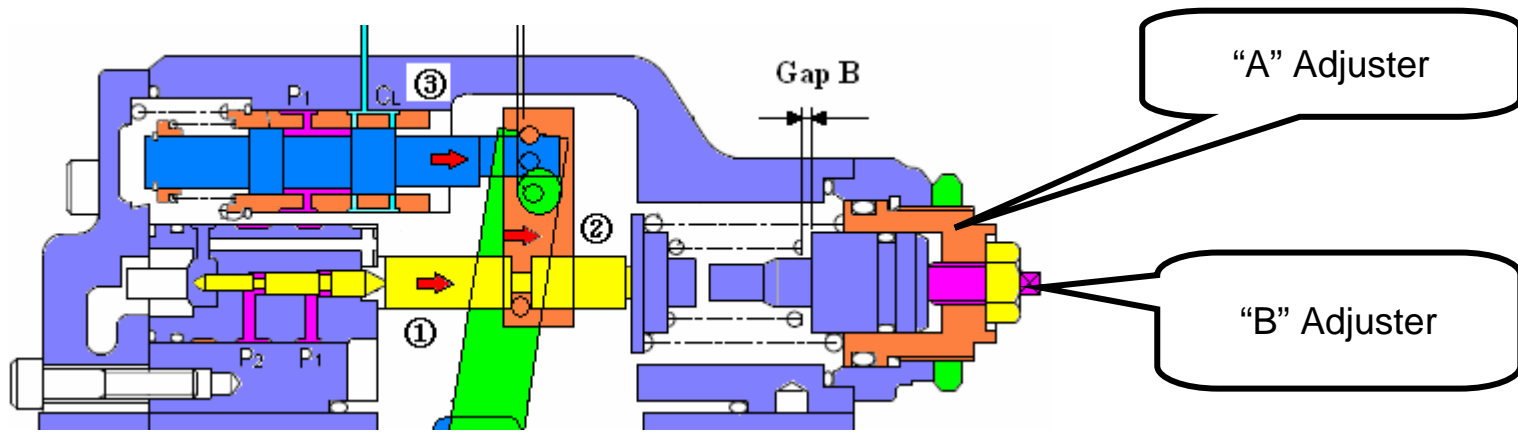
1) How to measure the Pressure

- Pull Travel lever fully
- Measure the travel pressure



2) Remedy according to the test result

Travel Pressure	Remedy
Below 210Kg/cm ²	A adjuster should be adjusted
Above 210Kg/cm ²	B adjuster should be adjusted

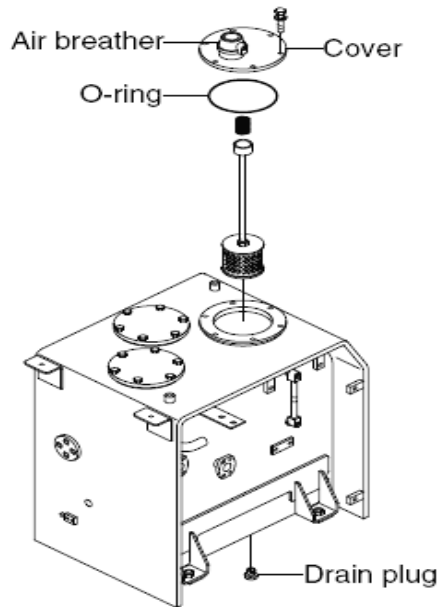


Subject 3 : Pump cavitation

1.Problem :Cavitation occurs with pump

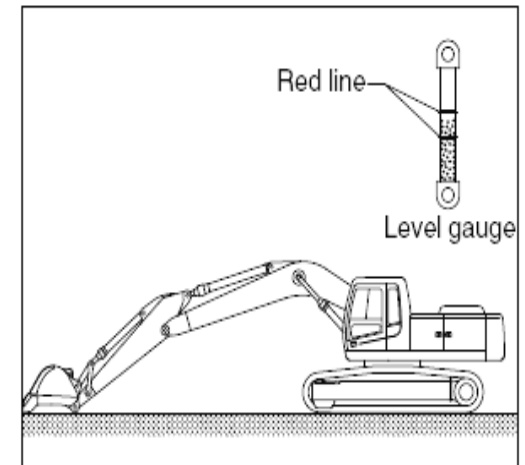
2.Check & Remedy:

- 1)Check if hydraulic volume proper =>Replenish specified oil to the standard level
- 2)Check if viscosity of hydraulic oil is too high =>Replace oil with one of proper viscosity
- 3)Check if suction strainer clogged =>Clean suction strainer
- 4) Air is intruding from pump suction line =>Retighten or replace parts
- 5)Check if reservoir breather is clogged =>Clean or replace reservoir breather
- 6)Check if the hose on pump inlet line collapsed or restricted=> adjust the problem

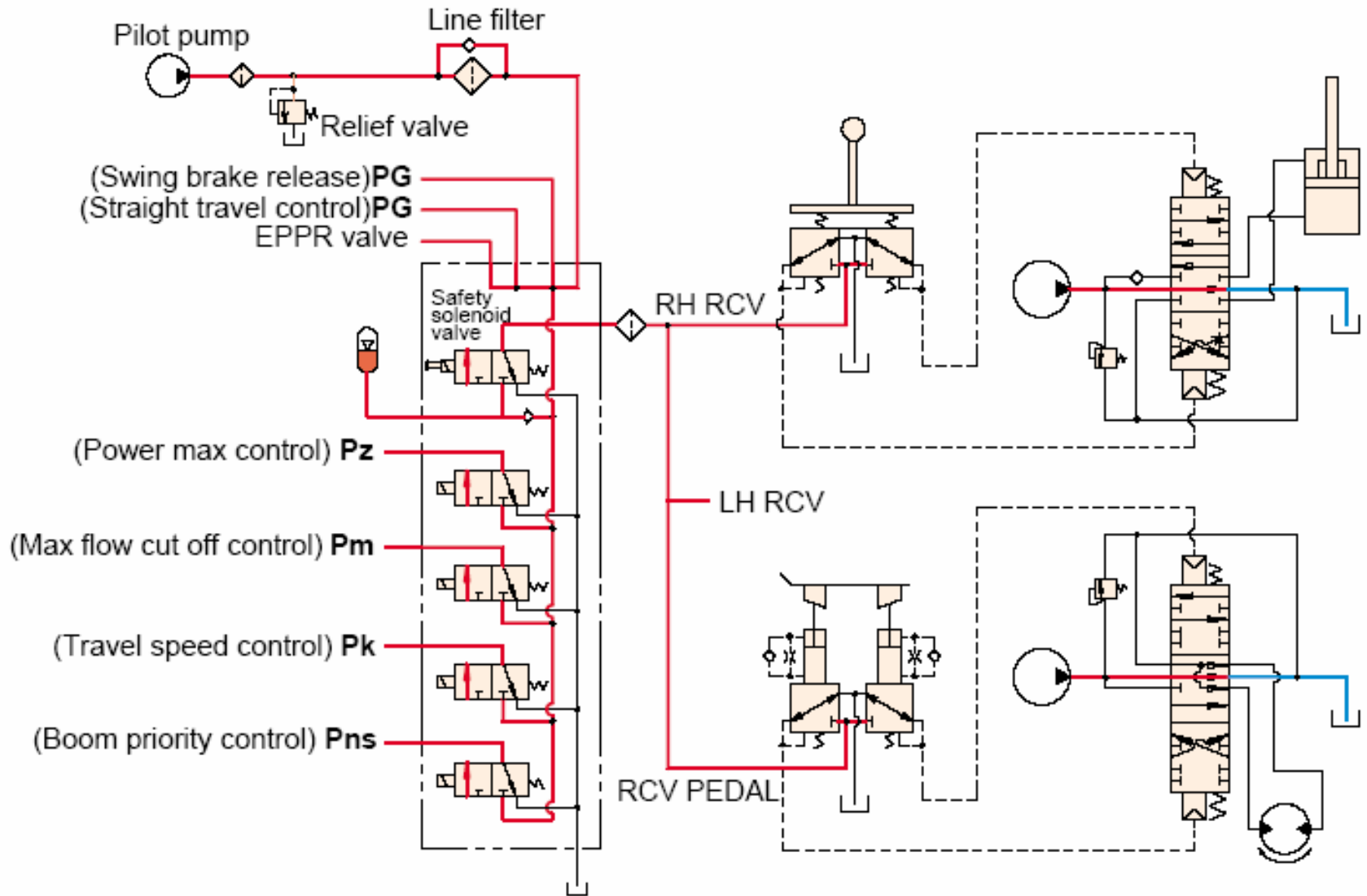


HYDRAULIC OIL CHECK

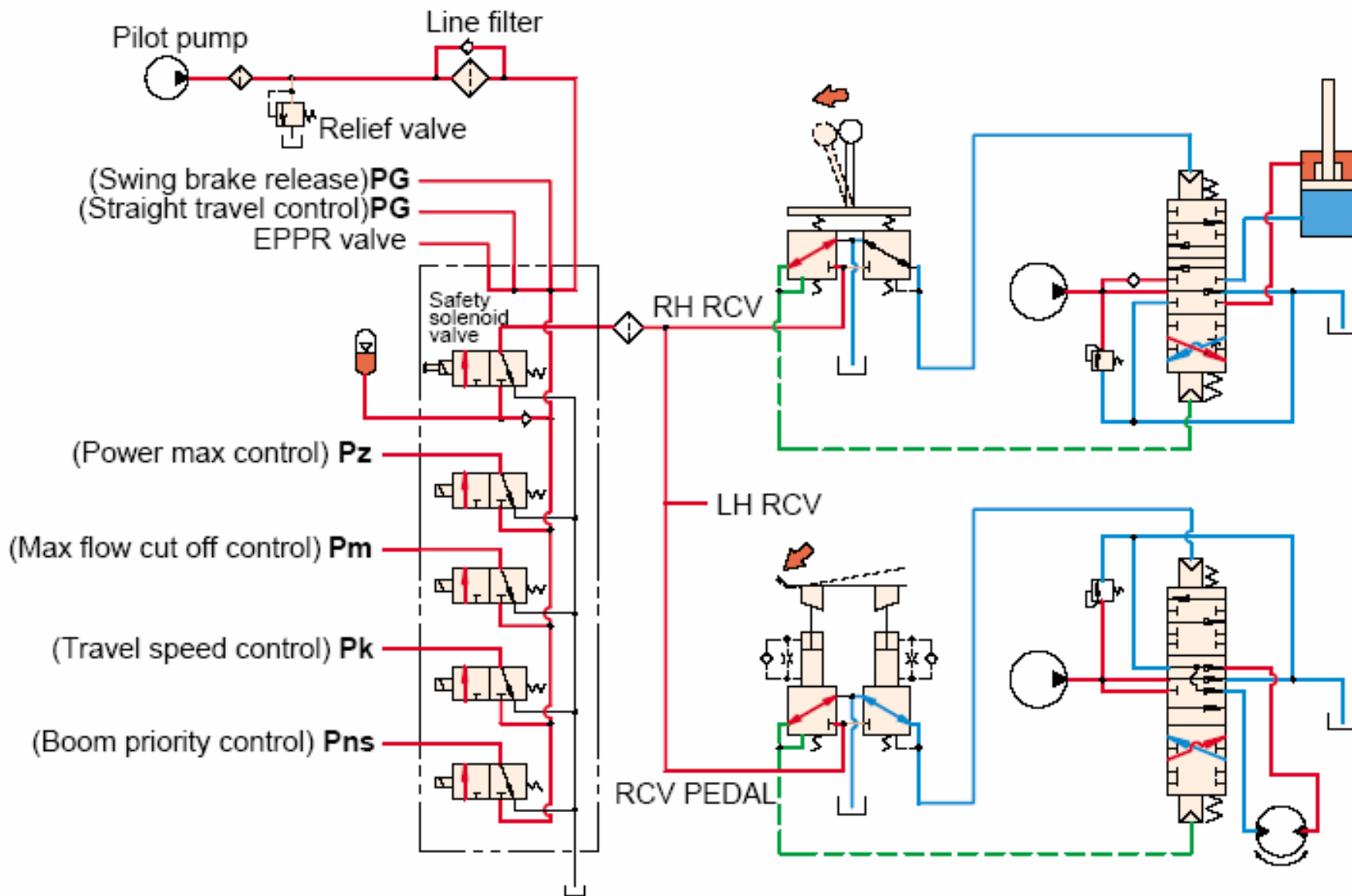
- 1) Stop the engine after retract the arm and bucket cylinders, then lower the boom and set the bucket on the ground at a flat location as in the illustration.
- 2) Check the oil level at the level gauge of hydraulic oil tank.
- 3) The oil level is normal if between the red lines.



4-3.Pilot Circuit



Operated Position

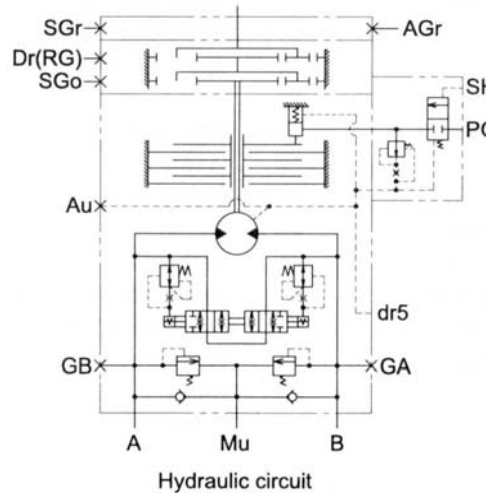
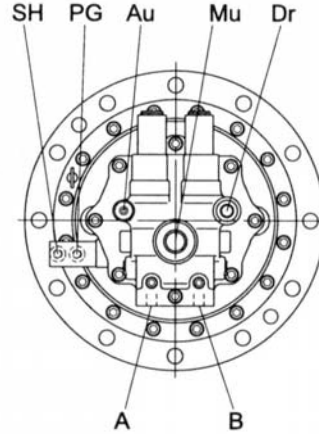
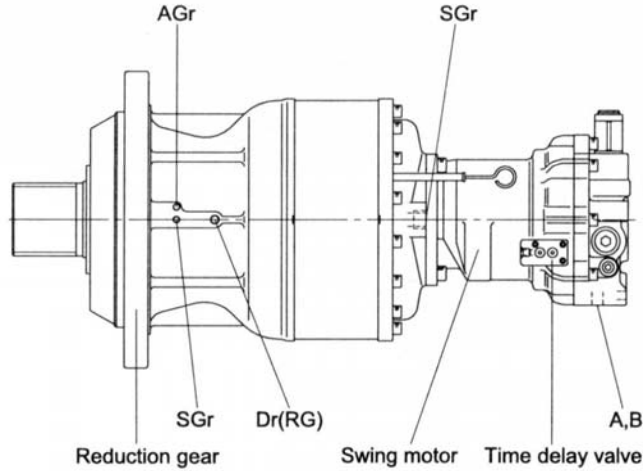


4-4.Swing Motor

1)View of Swing Motor

Swing device consists swing motor, swing reduction gear.

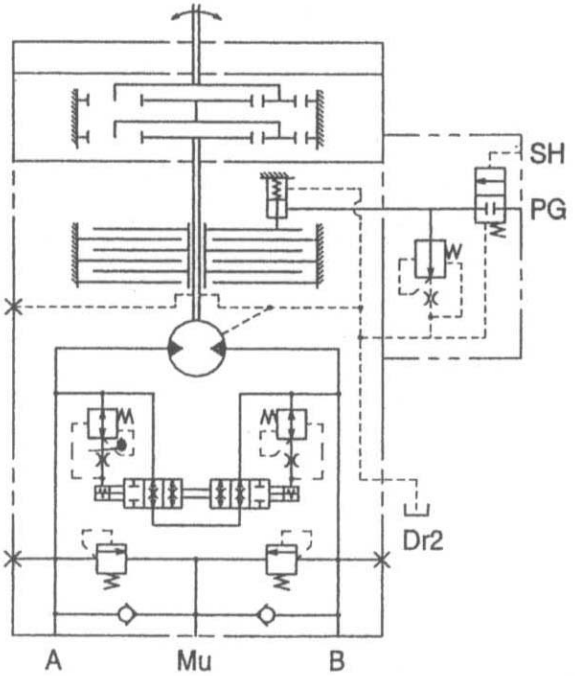
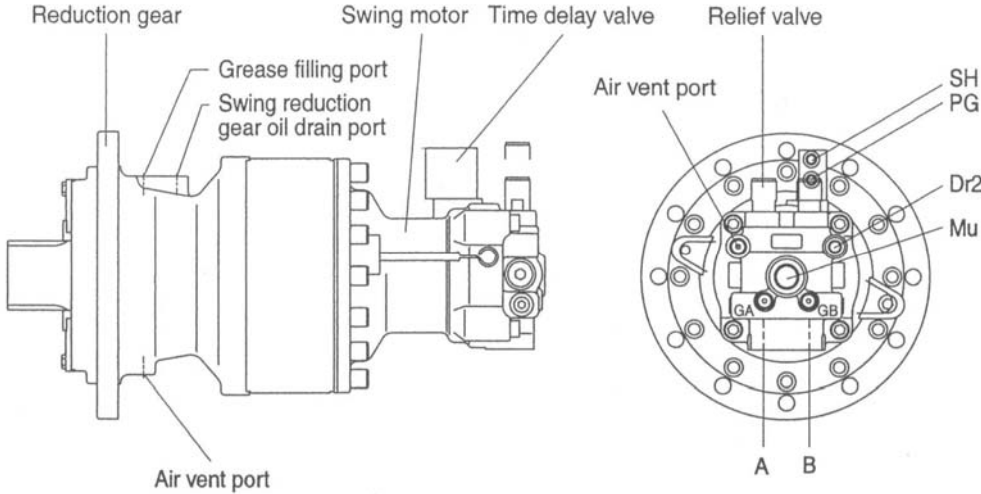
Swing motor include mechanical parking valve, relief valve, make up valve and time delay valve.



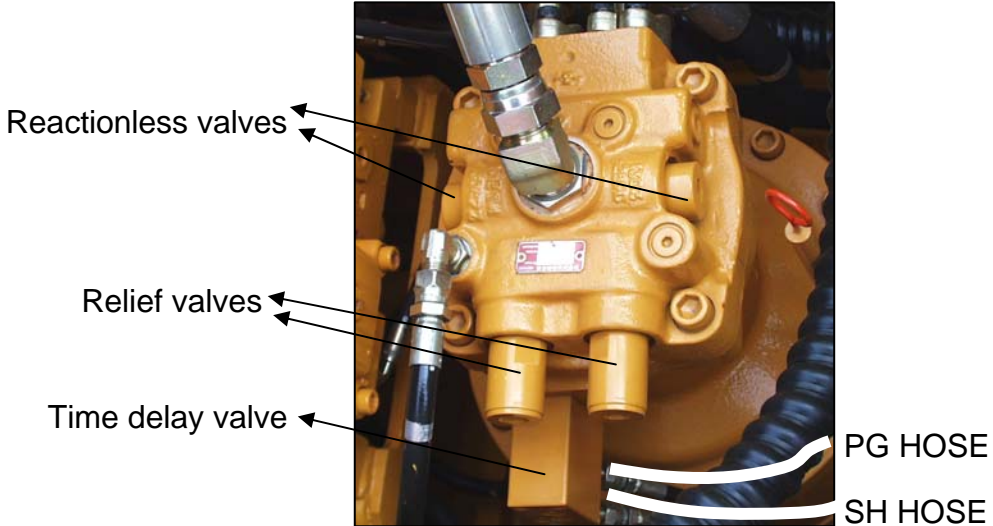
Port	Port name	Port size
A	Main port	SAE 1"
B	Main port	SAE 1"
Dr	Drain port	PF 1/2
MU	Make up port	PF 1 1/4
SH	Brake release port	PF 1/4
PG	Stand by port	PF 1/4
GA, GB	Gauge port	PF 1/4
Au	Motor air bleed port	PF 1/2
AGr	R/G air bleed port	PT 1/8
SGr	Grease filling port	PT 1/8
Dr(R/G)	Drain port	PT 3/8
SGo	Gear oil filling port	PT 3/4

All excavators have a similar swing device
 Swing device consists swing motor, swing reduction gear.
 Swing motor include mechanical parking valve, relief valve, make up valve and time delay valve.

SWING MOTOR R210LC-7
 (ser. nr below E1938)

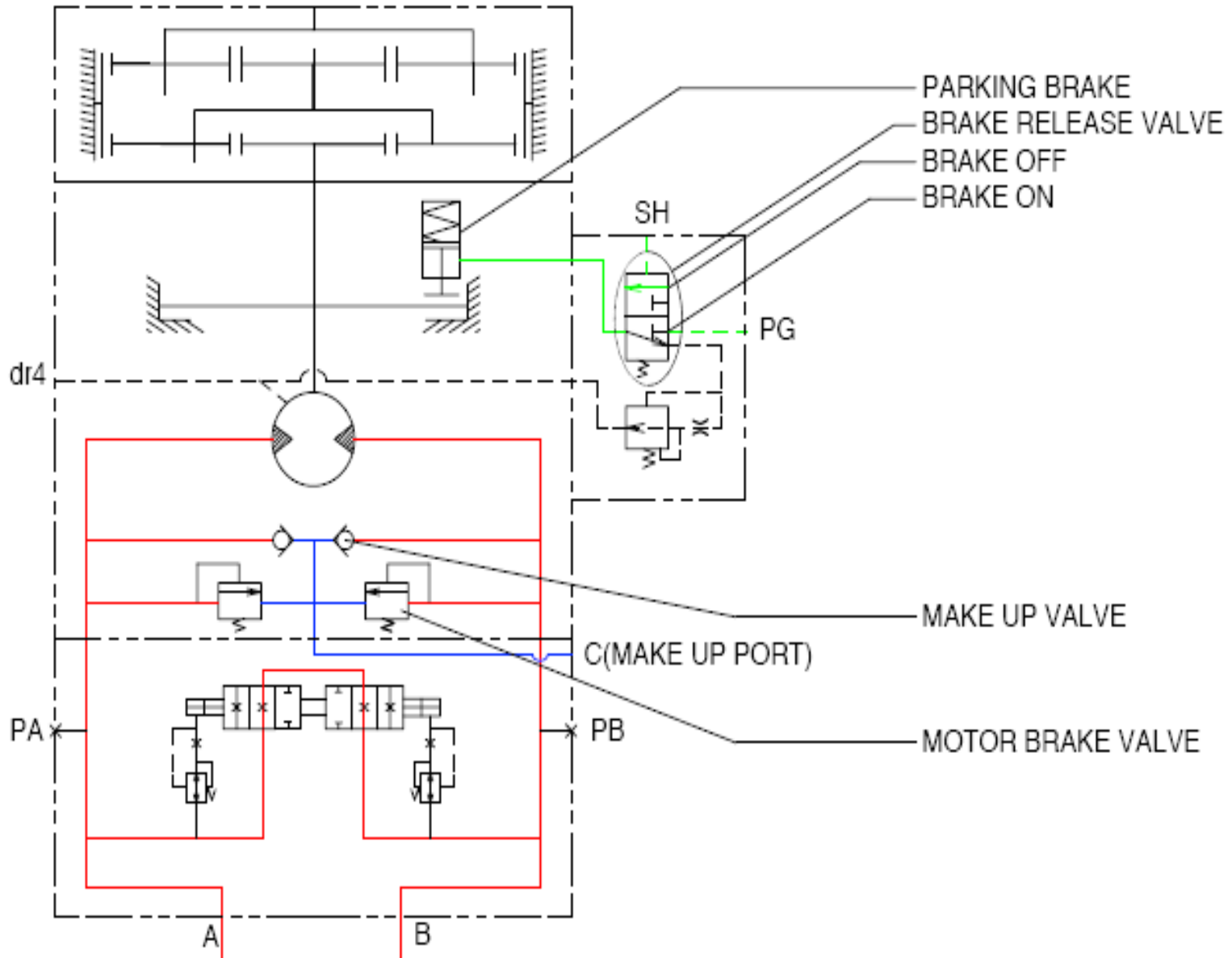


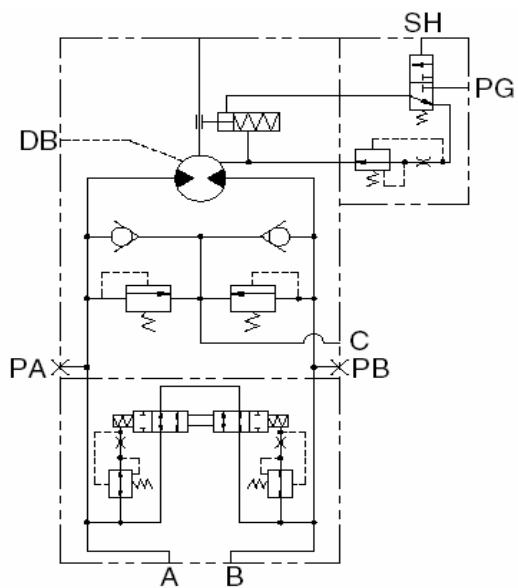
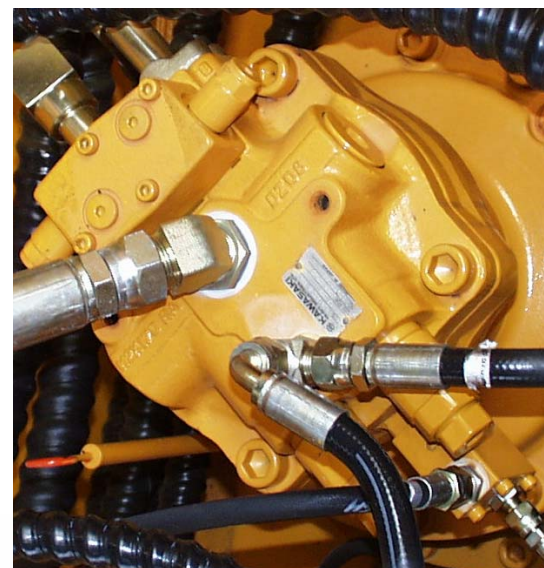
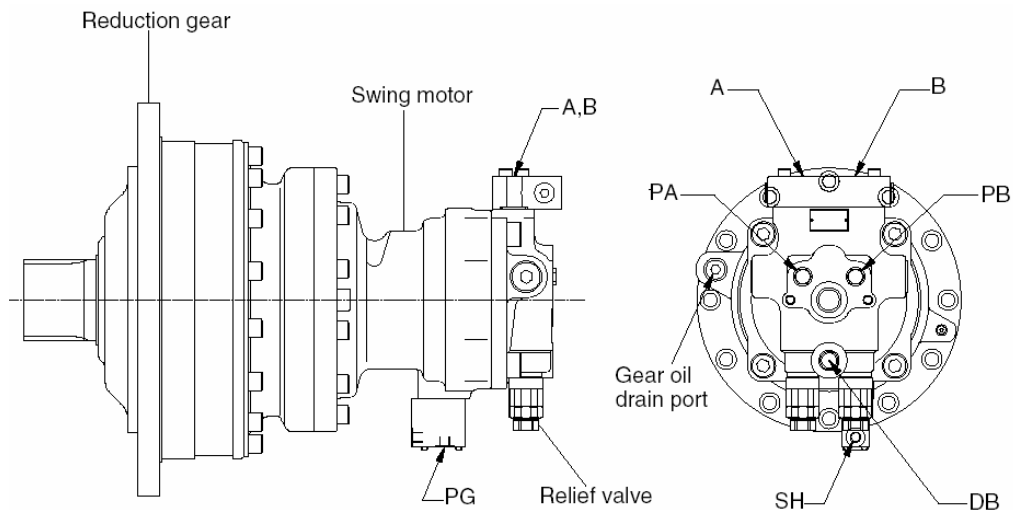
Port	Port name	Port size
A	Main port	PF 3/4
B	Main port	PF 3/4
Dr2	Drain port	PF 3/8
Mu	Make up port	PF 1
SH	Brake release port	PF 1/4
PG	Stand by port	PF 1/4
GA, GB	Gage port	PF 1/4



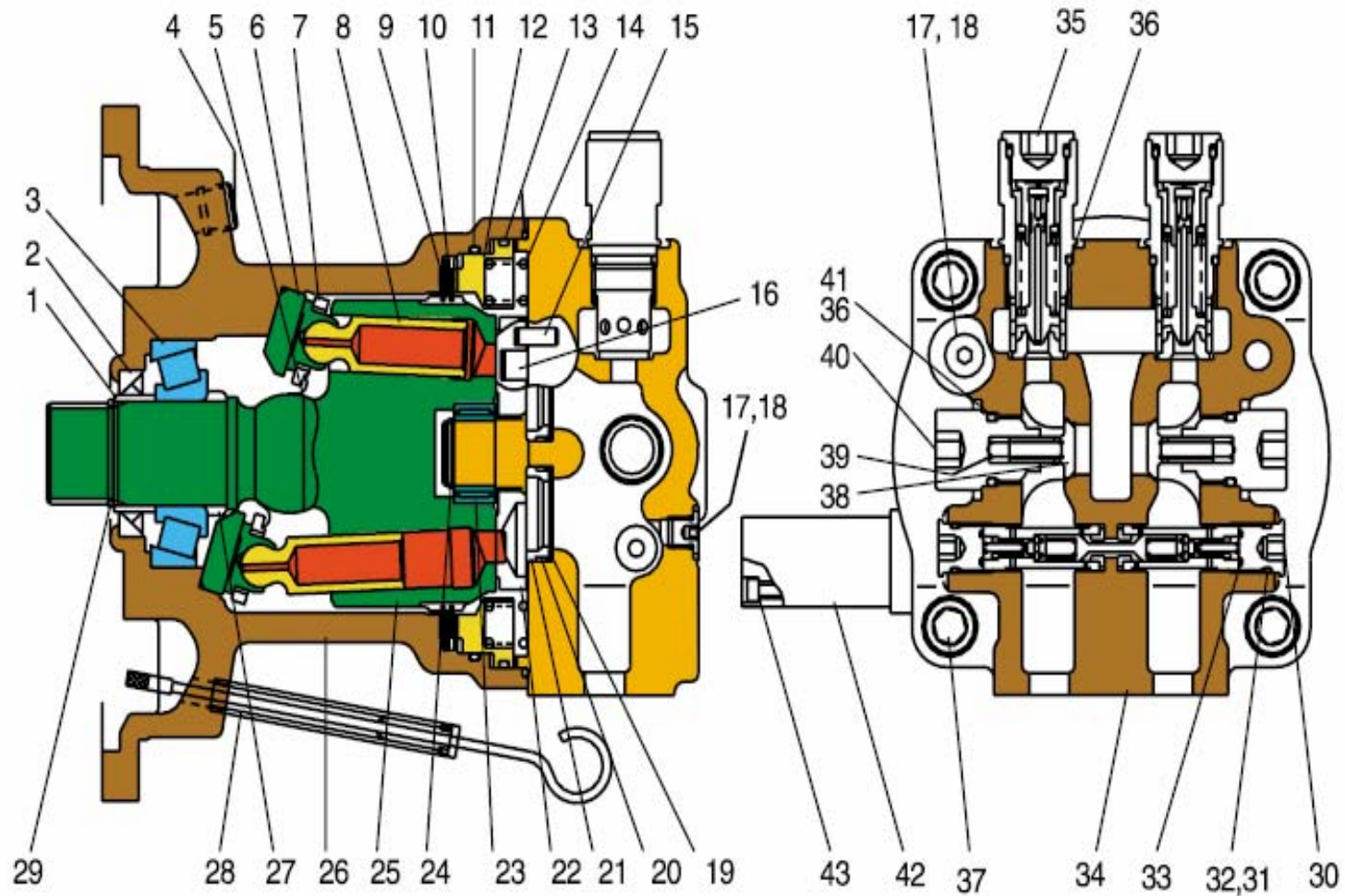
Remark:
 Greasing of the output shaft of swing reduction is required each 1000 hrs !

2) Swing Circuit Operation

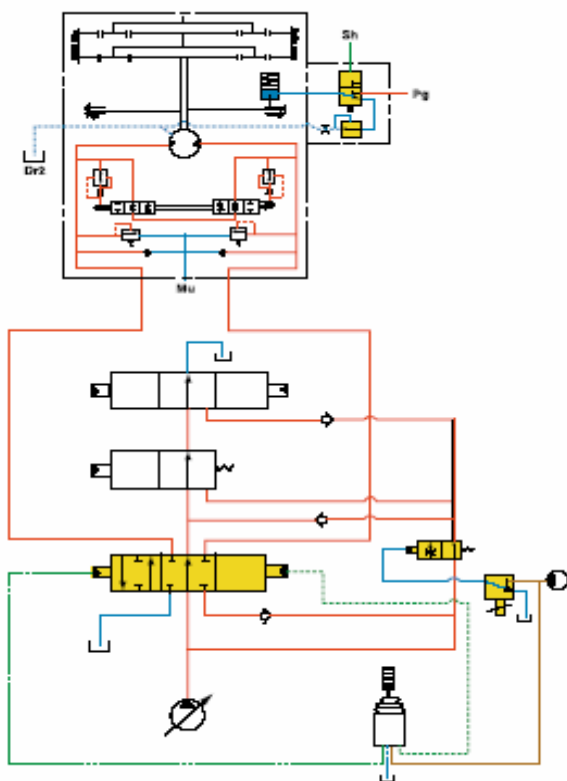




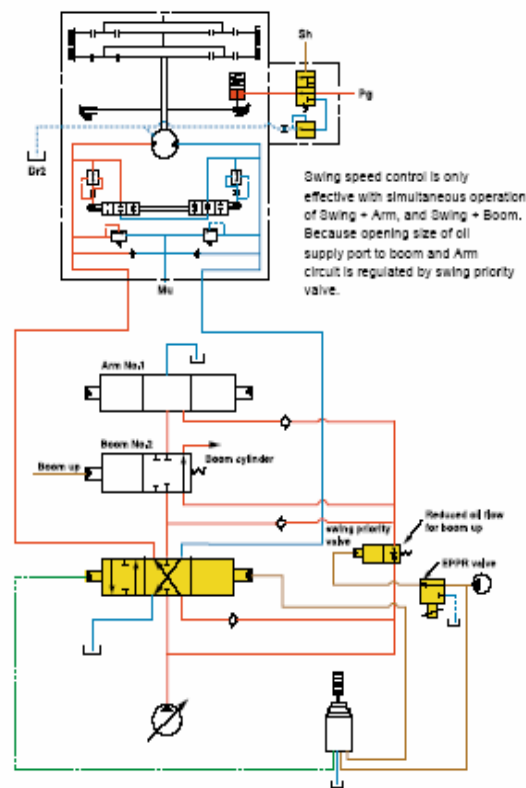
Port	Port name	Port size
A, B	Main port	ø 20
DB	Drain port	PF 1/2-19
M	Make up port	PF 1-24
PA, PB	Gauge port	PF 1/4-15
PG	Brake release port	PF 1/4-12
SH	Brake pilot port	PF 1/4-12
IP	Gear oil inlet port	PT 3/4-19
DR	Gear oil drain port	PT 1/2



Neutral Position

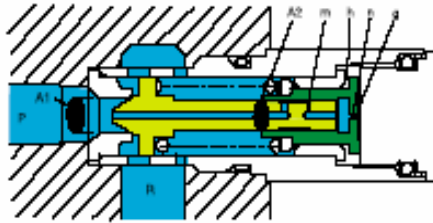


Swing is not operated



3) Swing Port Relief Valve

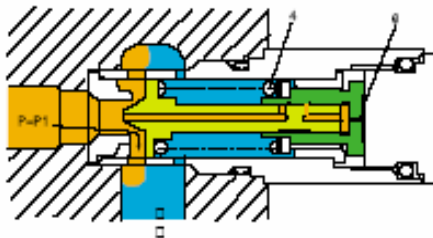
- ① Parts (P,R) at tank pressure.



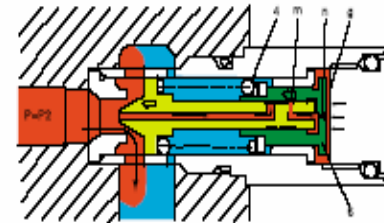
- ② When hydraulic oil pressure ($P \times A1$) reaches the preset force (F_{sp}) of spring (4), the plunger(3) moves to the right as shown.

$$P1 \times A1 = F_{sp} + P_g \times A2$$

$$P1 = \frac{F_{sp} + P_g \times A2}{A1}$$



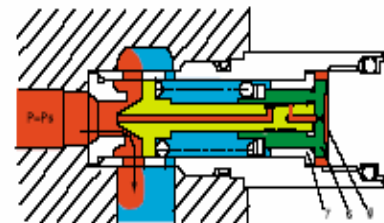
- ③ The oil flows to chamber g via orifice m and n. When the pressure of chamber g reaches the preset force (F_{sp}) of spring (4), the piston(8) moves left and stop the piston (8) hits the bottom of bushing (7).



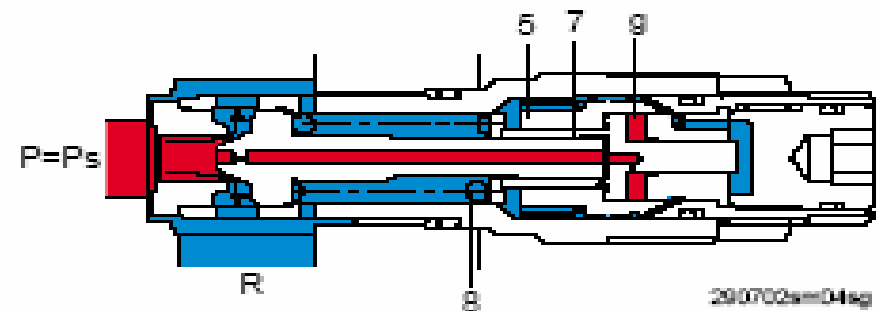
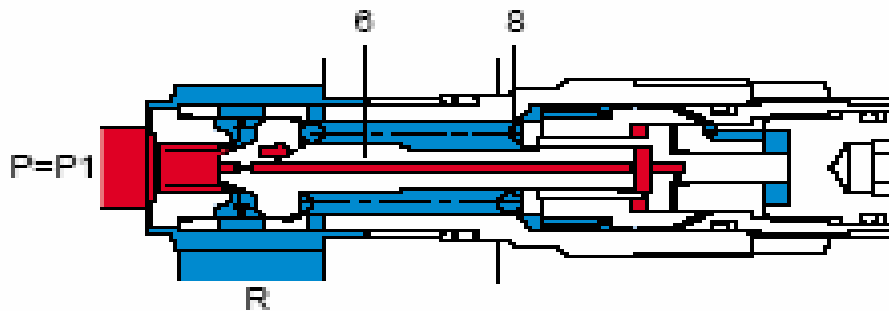
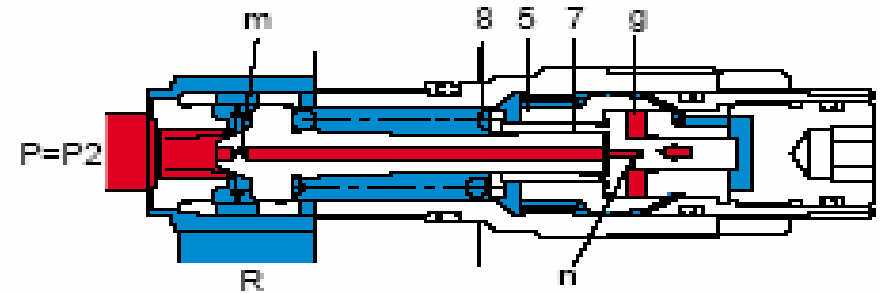
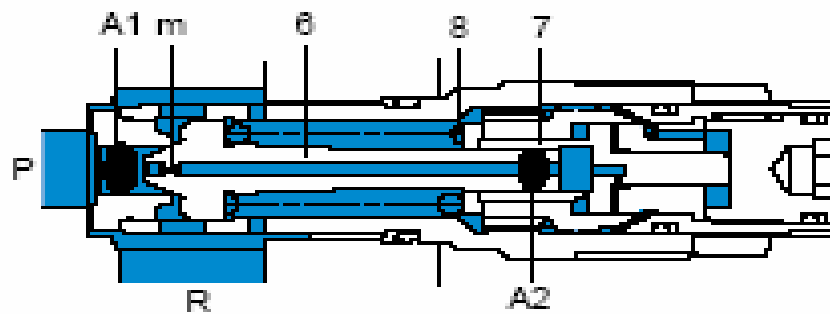
- ④ When piston (8) hits the bottom of bushing (7), it stops moving to the left. As a result, the pressure in chamber(g) equals (P_s).

$$P_s \times A1 = F_{sp} + P_s \times A2$$

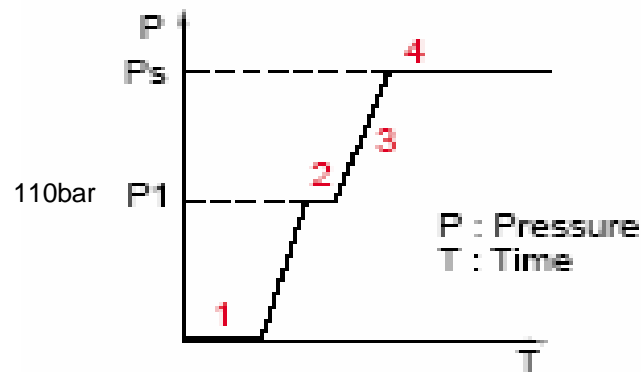
$$P_s = \frac{F_{sp}}{A1 - A2}$$



4. RELIEF VALVE



2007002em04eg



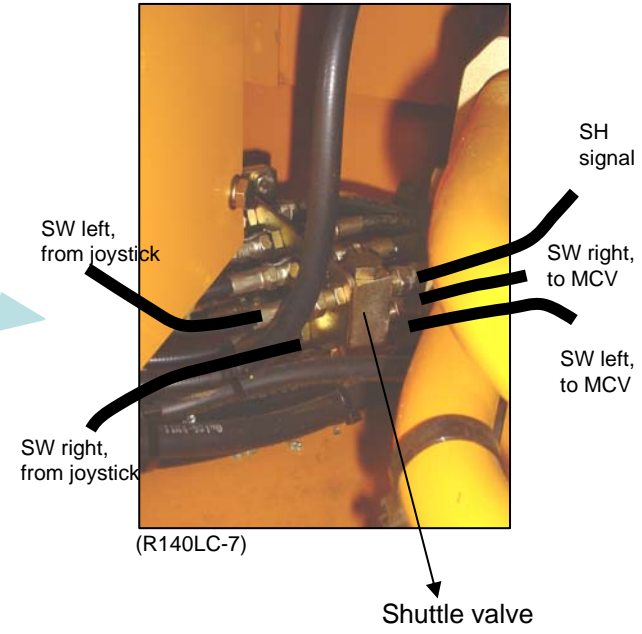
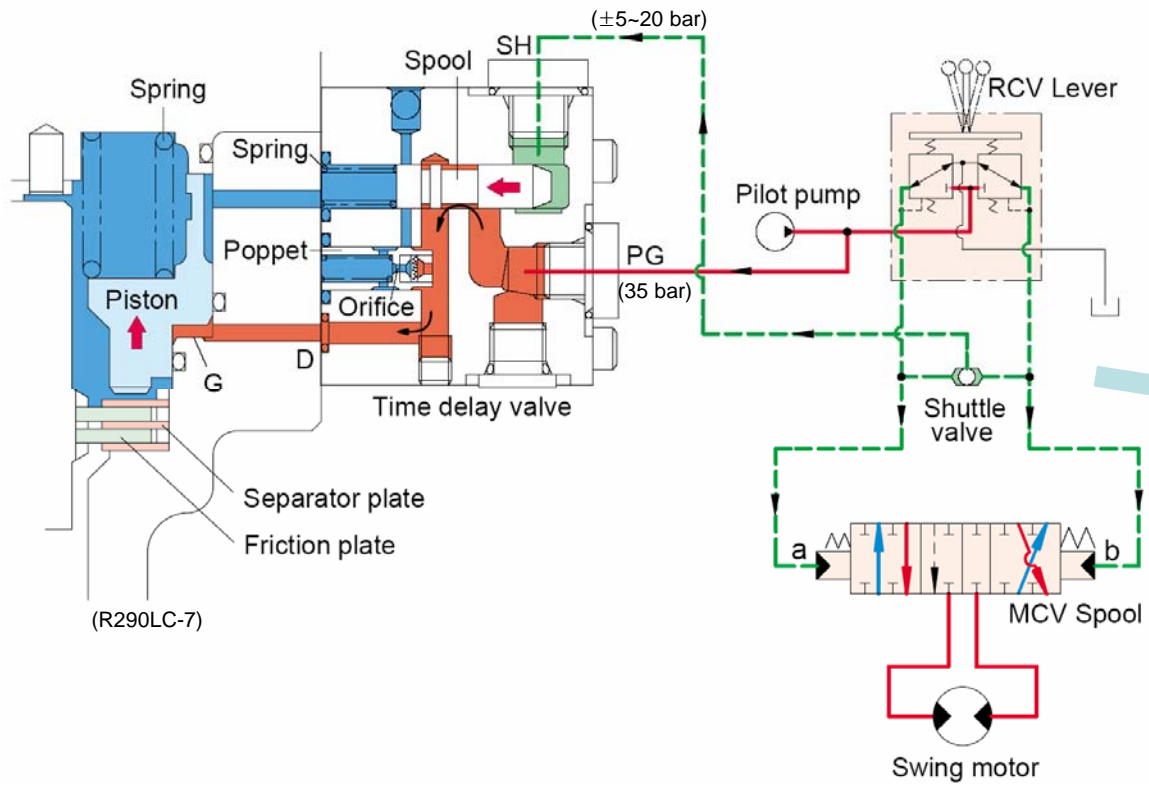
- 2 When hydraulic oil pressure ($P \times A_1$) reaches the preset force (F_{sp}) of spring (8), the plunger (3) moves to the right as shown.

$$P_1 \times A_1 = F_{sp} + P_g \times A_2$$

$$P_1 = (F_{sp} + P_g \times A_2) / A_1$$

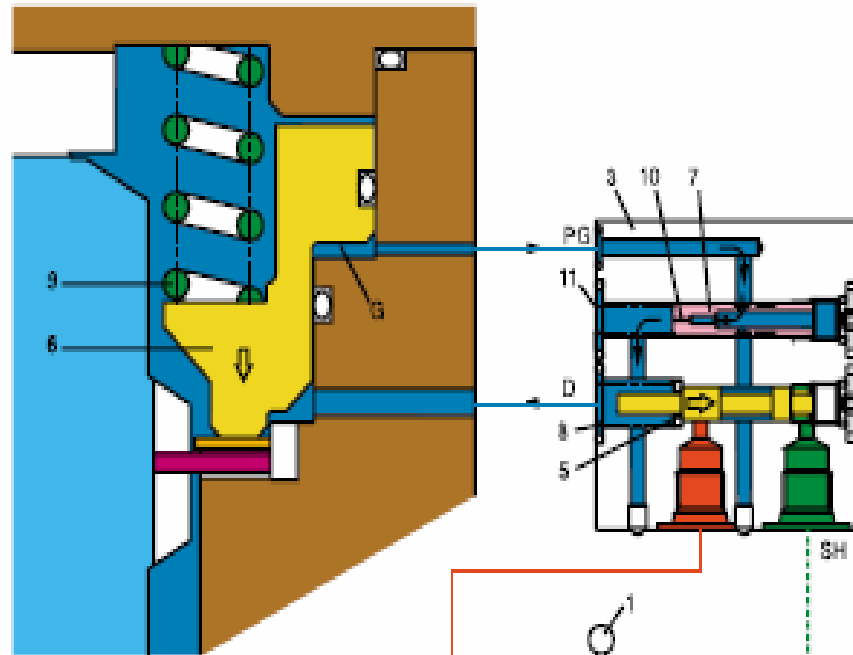
4) Releasing of Swing Brake

By operating the swing (SW), the joystick pressure ($\pm 5\sim 20$ bar) is applied on the MCV swing spool, and at the same time on the "SH" port of the swing motor: this allows pilot oil (35 bar) to enter in the brake section of the swing motor and lift up the swing piston, resulting in releasing of the brake.

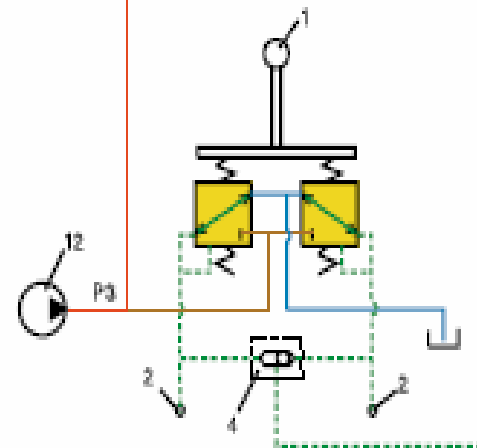


5) Swing Brake (Neutral Position)

① Neutral position : Brake applied by spring force (9)

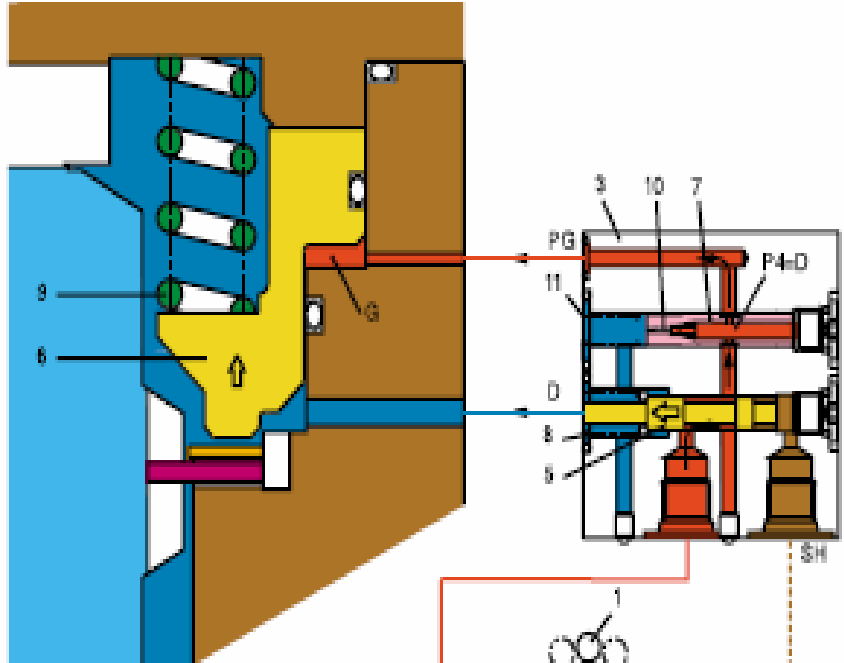


- | | |
|------------------------------|----------------|
| 1. Swing control lever | 7. Poppet |
| 2. Swing control valve (MCV) | 8. Spring |
| 3. Time delay valve | 9. Spring |
| 4. Shuttle valve | 10. Orifice |
| 5. Spool | 11. Spring |
| 6. Piston | 12. Pilot pump |

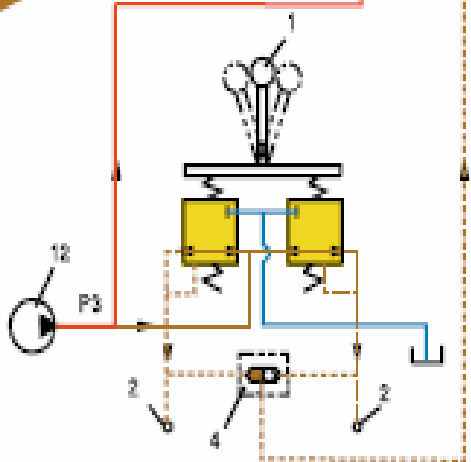


6) Swing Brake (Operating Position)

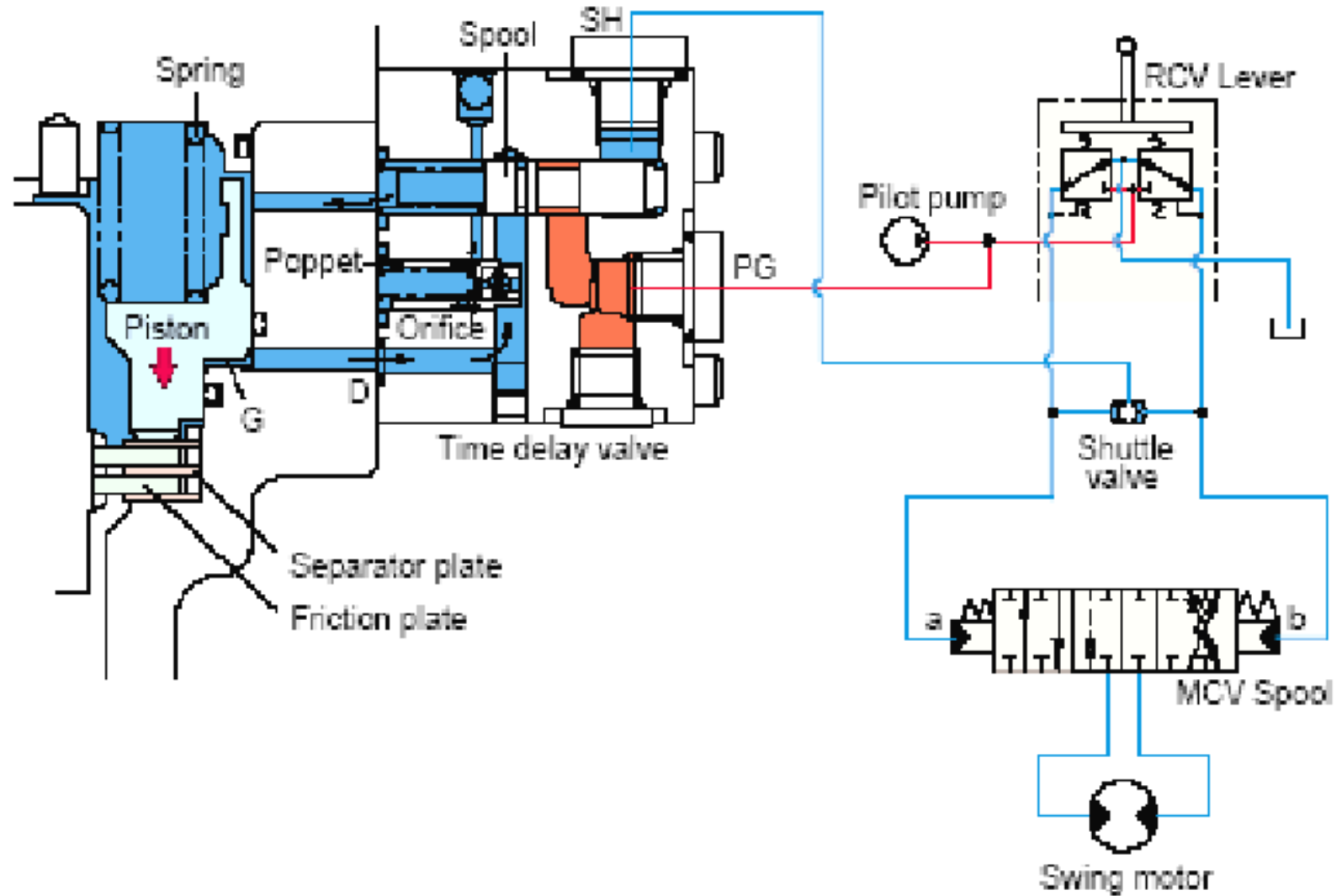
② Operated position : Brake released by pilot pressure (Pg)



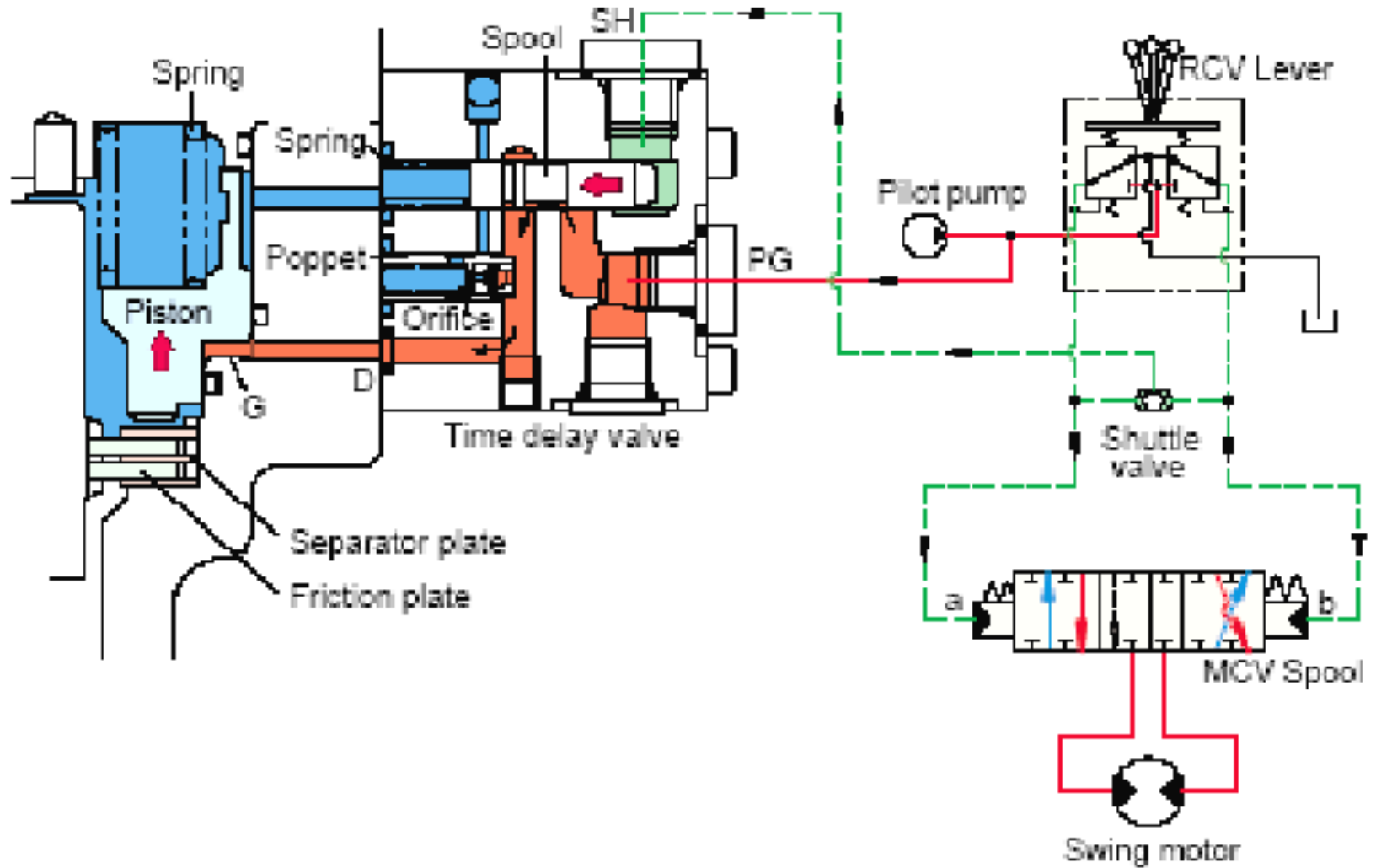
- 1. Swing control lever
- 2. Swing control valve (MCV)
- 3. Time delay valve
- 4. Shuttle valve
- 5. Spool
- 6. Piston
- 7. Poppet
- 8. Spring
- 9. Spring
- 10. Orifice
- 11. Spring
- 12. Pilot pump

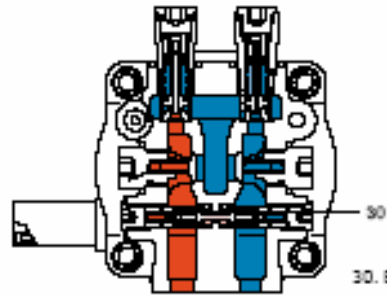


Neutral position

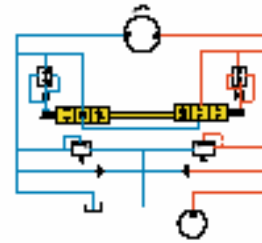
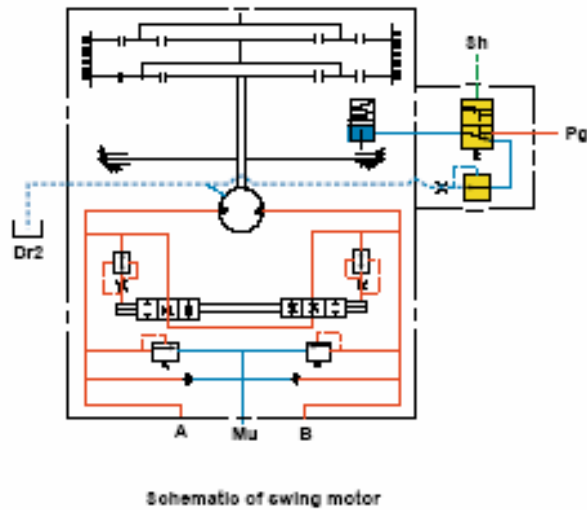


Release position





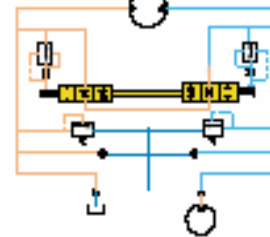
30. Bypass valve assembly (Antirotation valve)



When machine swings.

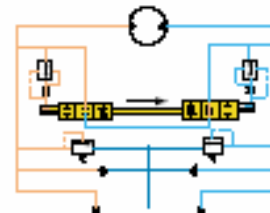
Joystick at neutral

Actual stop slip amount



Swing slip

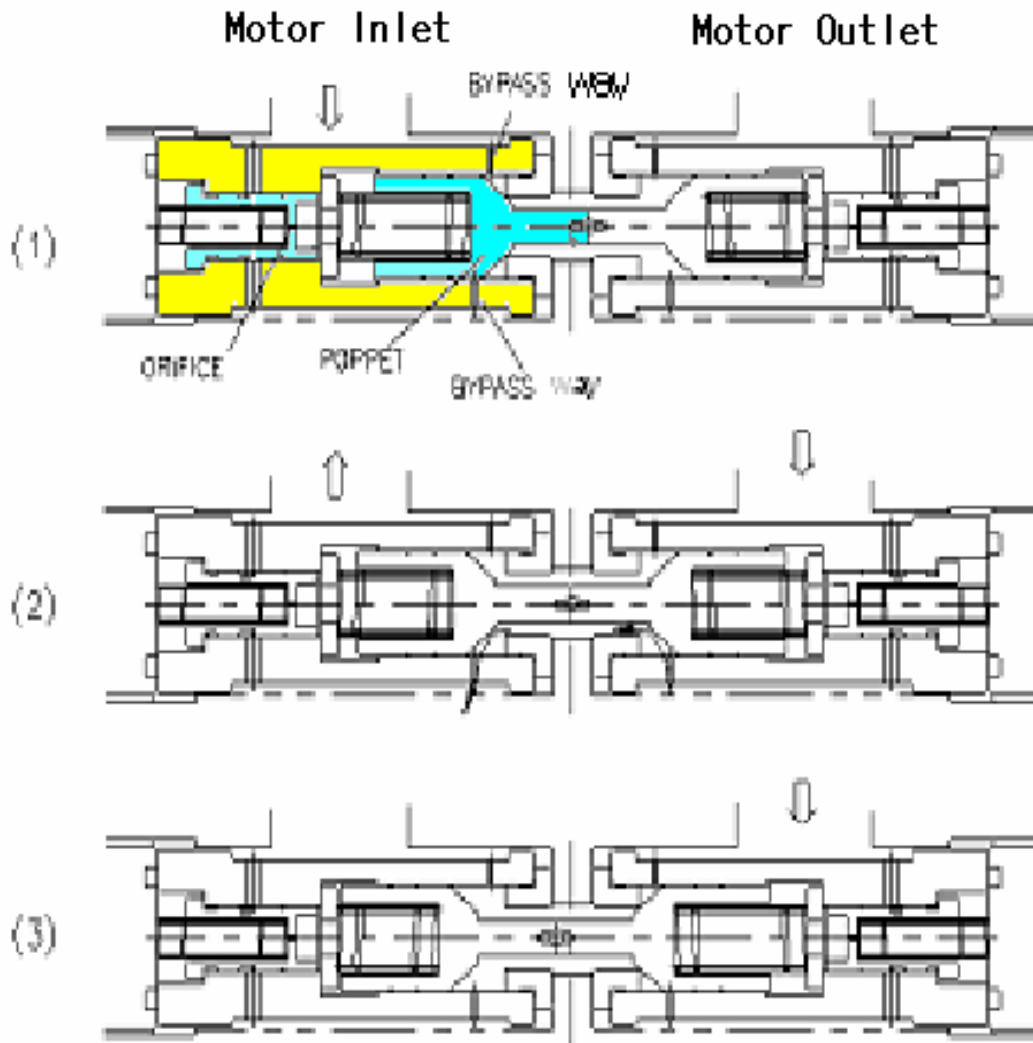
- (When joy stick is returned to neutral.)
- Supply and return are cut off.
 - Return line pressure is increased due to moment of inertia.
 - High pressure oil transfers to LH side through antirotation valve and compensates shortage of oil at RH side to prevent cavitation created by swing slip.
 - Both sides of pressure are stabilized.



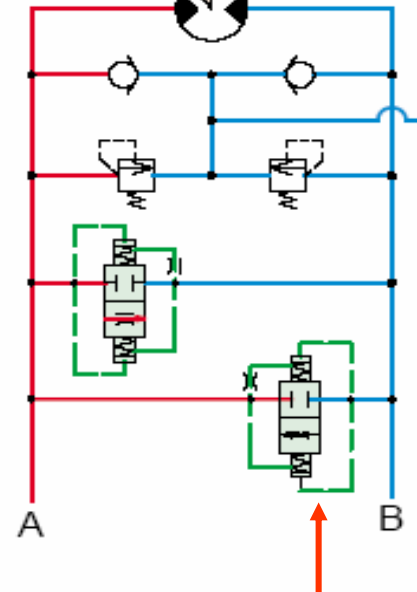
Stop swing motion.

- High pressure at LH side transfers to antirotation valve through reducing valve and cuts off the flow to RH side.
- Stop the swing motion.

After machine is stopped antirotation valve returns to neutral position.



Joystick at neutral
Actual stop Slip amount



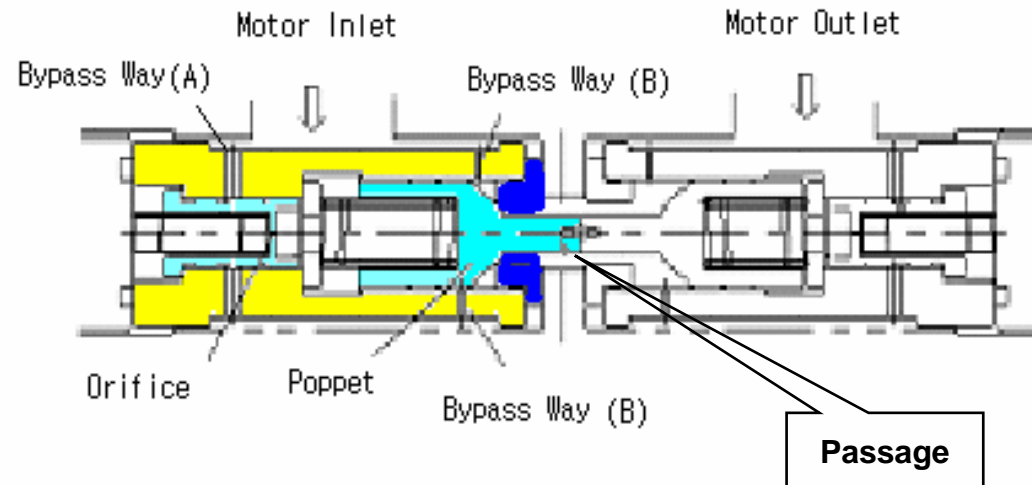
When oil supplies to Motor Inlet, it flows into the chamber through bypass way(B). Then, oil returns to the Motor Outlet very shortly.

Next, oil fills in the chamber of poppet through Bypass Way(A) and it results in the poppet being closed and the swing motor can be rotated

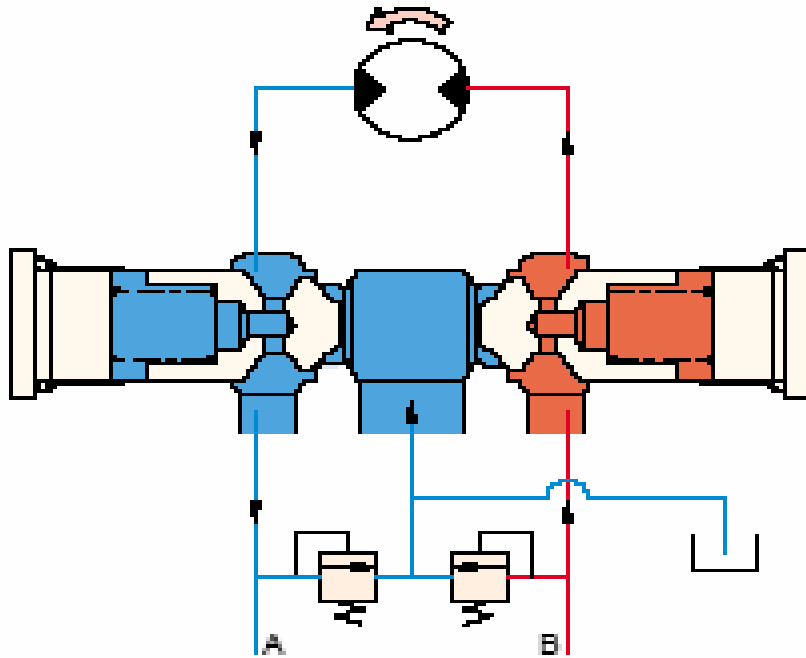
When the spool of MCV is located at the neutral position, the back-pressure happens to Motor Outlet due to the force of inertia and it tries to rotate the motor reversely.

The pressure of Motor Outlet tries to push the poppet to the left side but it is delayed due to the orifice of Motor inlet side. But finally, oil from motor outlet can flows to Motor Inlet through Bypass Way(B)

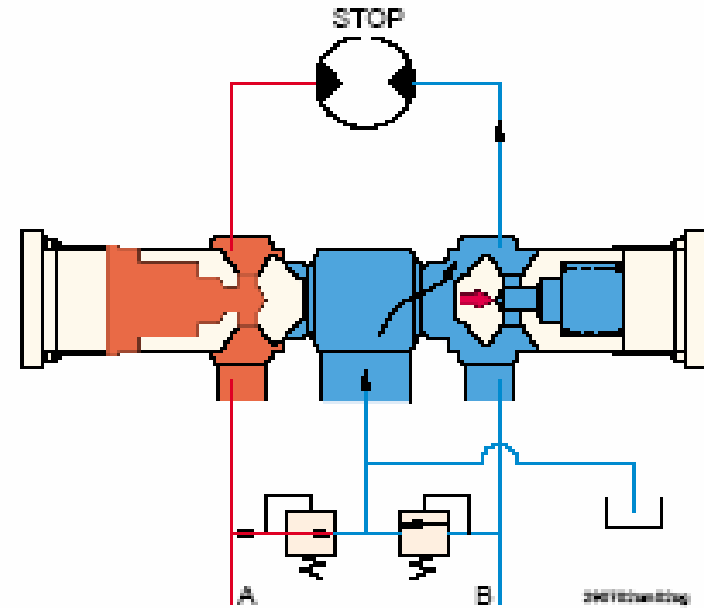
When the poppet of Motor Outlet is reached the right side, the passage is closed to prevent further flow of oil



8) Make Up Valve

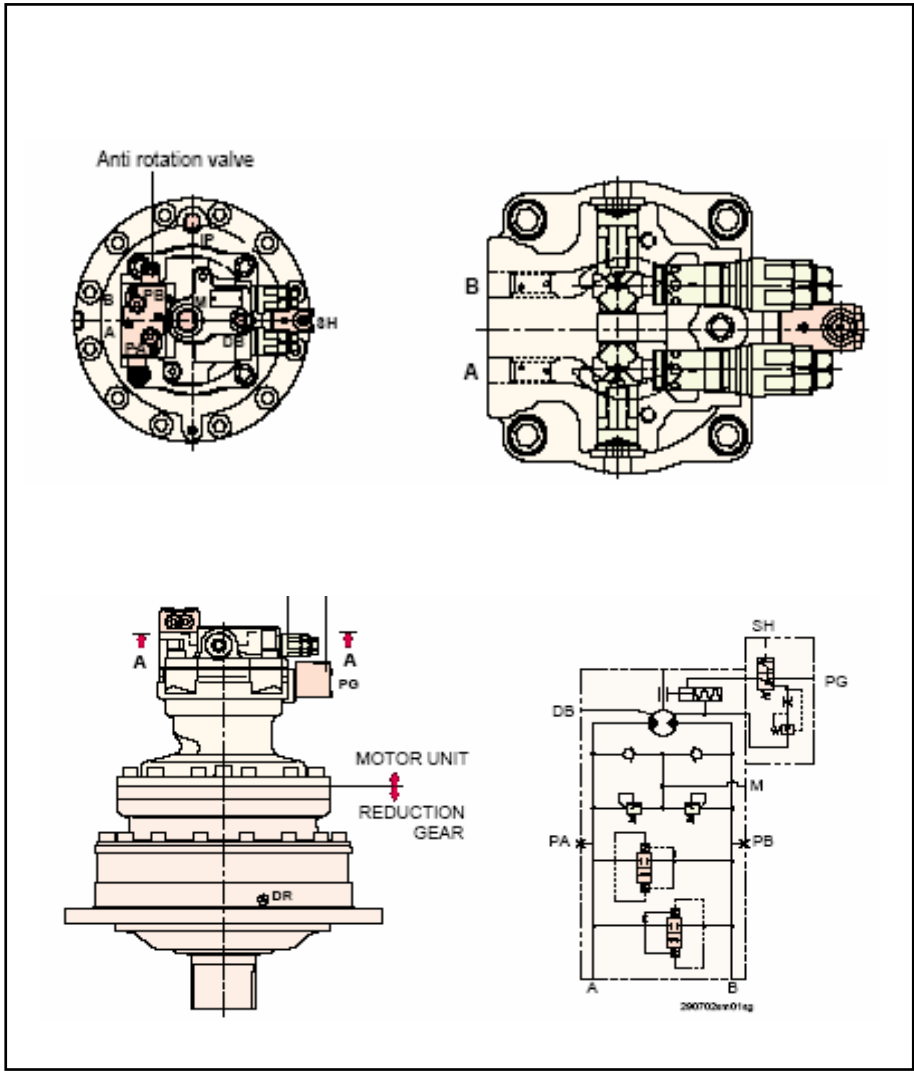


In the neutral position or normal swing operation, two check valves are closed because the pressure of supply and return are applied behind the check valves.



- When the swing motor is stopped from rotation, the flow of supply and return are blocked by the swing spool.
- But the swing motor is still rotated due to the inertia, in this case LH side(A) relief valve is open and the oil comes out.
- At that moment RH side(B) pressure is dropped below zero, in other words vacuum is created because (B) side oil is transferred to (A) side without any oil supply from MCV.
- Therefore the oil pressure in return line can enter to (B)side easily, and fill up the circuit to eliminate cavitation problems.

S&W Drawing



Model	Maker	Relief Press
R140LC-7	Jeil/Sungbo	240
R180LC-7	DongMyung/ Sungbo	240
R210LC-7	Jeil/Sungbo	240
R290LC-7A	DongMyung/ Sungbo	265
R320LC-7	DongMyung/ Sungbo	265
R360LC-7A	Jeil/Sungbo	260
R500LC-7A	Toshiba	285

Subject 1: Both LH and RH swing actions are impossible

- (1) Check hydraulic oil level
- (2) Check gear pump pilot pressure within standard level
- (3) Check safety solenoid valve pressure within standard and main relief valve faulty
- (4) Check if swing control valve spool move lightly by hand
- (5) Check swing brake release valve faulty
- (6) Check swing motor rotation and pilot valve

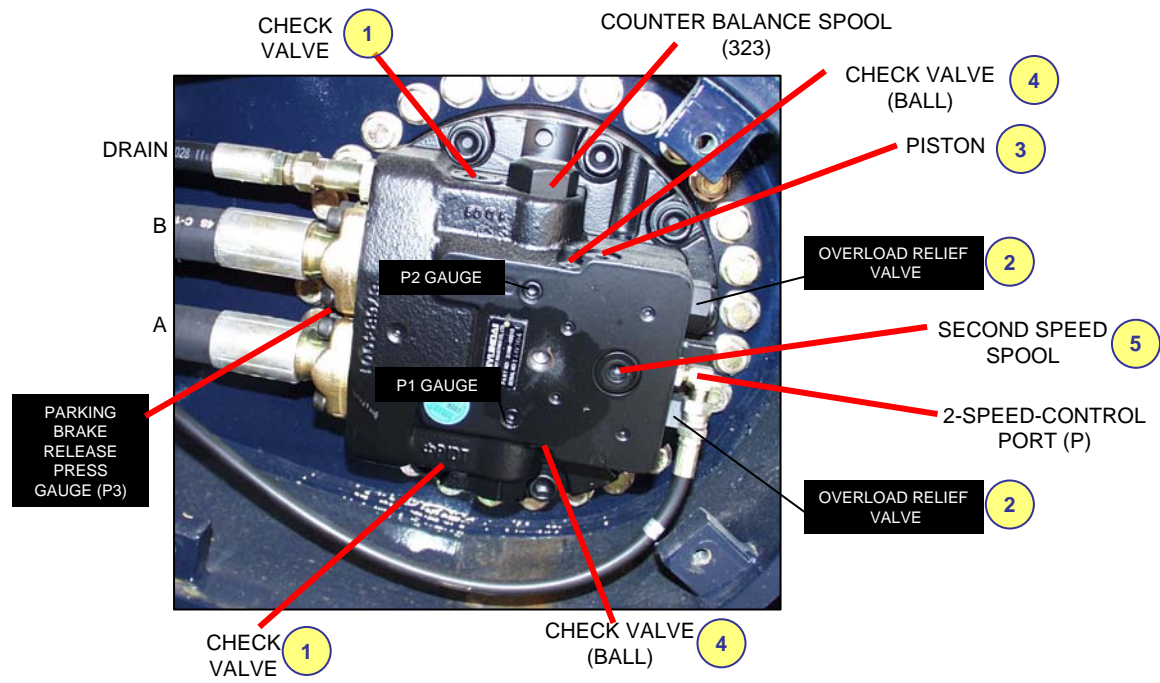
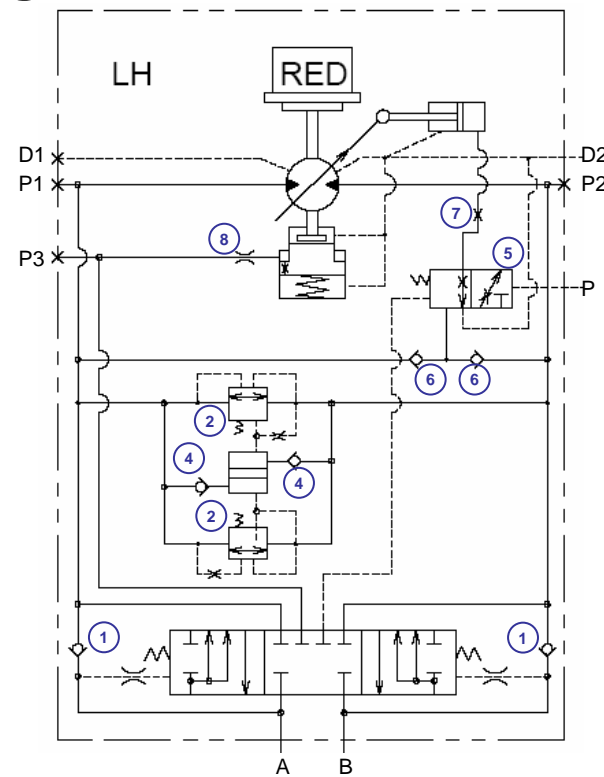
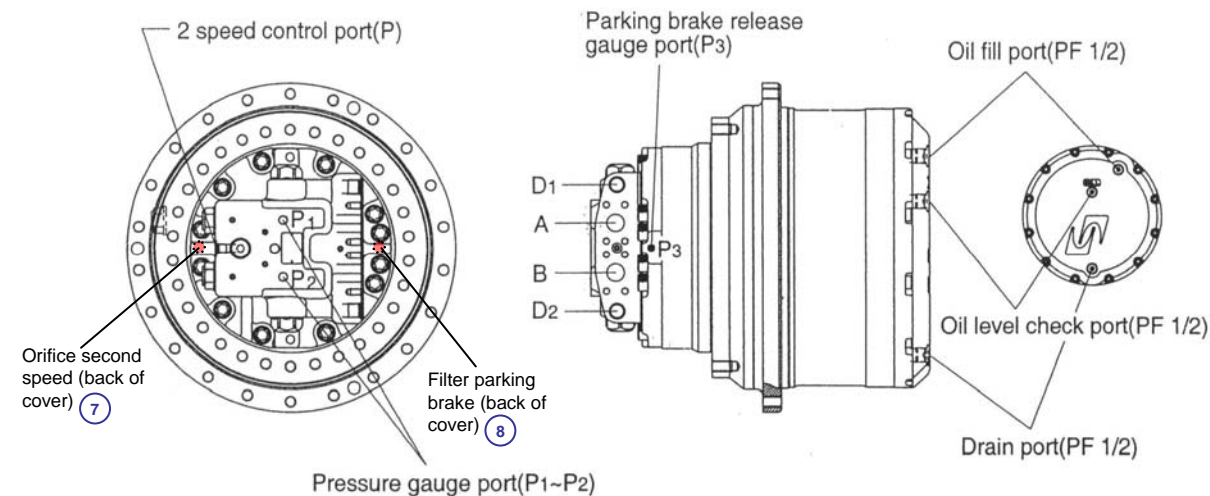
Subject 2 : Machine swings but does not stop

- (1) Check the swing control valve return spring
- (2) Check if swing control valve spool moves smoothly by hand
- (3) Check if MCV pilot pressure is within standard value
- (4) Check if the gear pump pilot pressure is within standard level

4-5.Travel Motor R140/160/180LC-7A (Tong Myung)

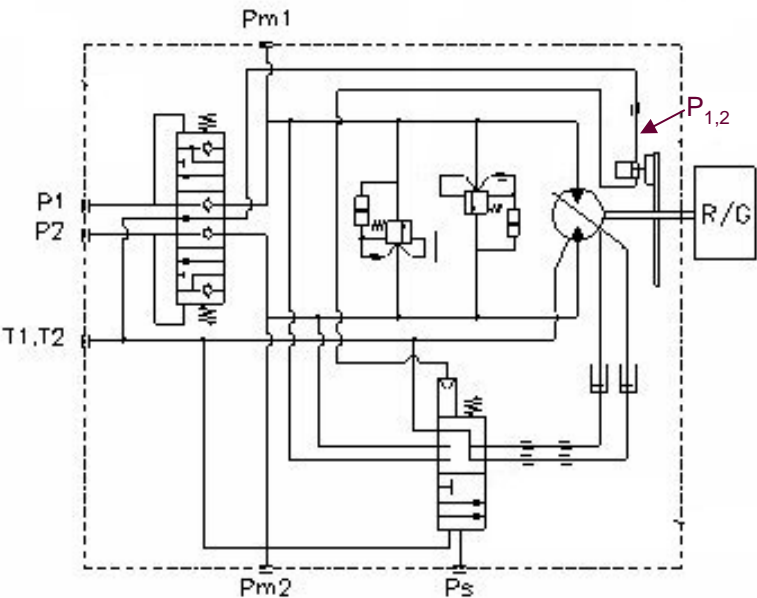
serial nr below E0743

serial nr below E2079



Port	Port name	Port size
A	Main port	SAE 5000psi 1"
B	Main port	SAE 5000psi 1"
P1, P2	Gauge port	PT 1/4
P3	Gauge port	PT 1/8
D1, D2	Drain port	PF 1/2
P	2 speed control port	PF 1/4

Remark
This travel motor shifts automatically in 1st speed, at a pressure of **290 bar** and up.

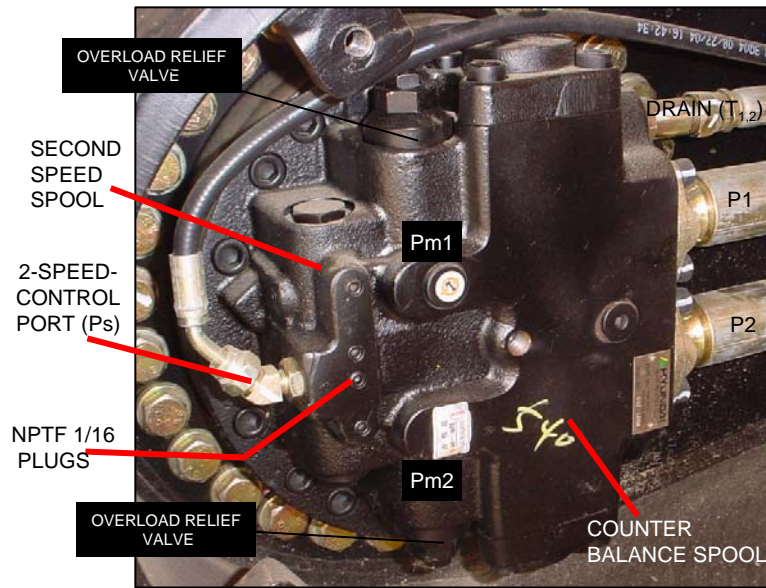
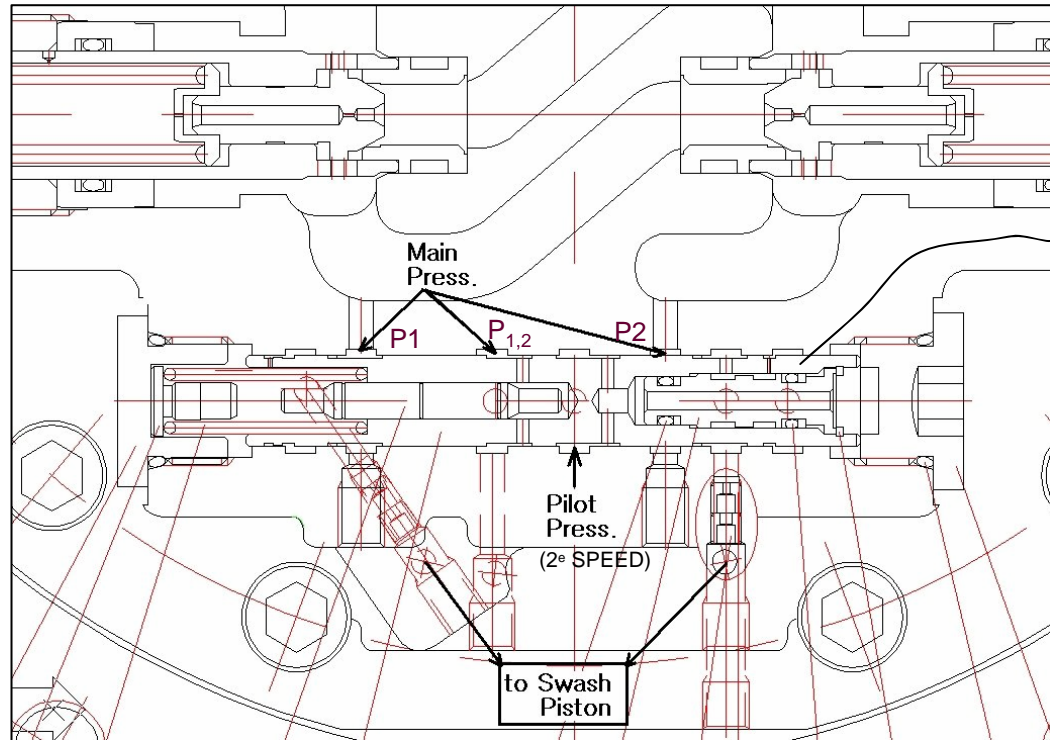


Port	Port name	Port size
P1, P2	Main port(IN)	SAE 4694psi
P2, P1	Main port(OUT)	SAE 4694ps
Pm1, Pm2	Gauge port	PF 1/4
T1, T2	Prain port	PF 1/2
Ps	2 speed control port	PF 1/4

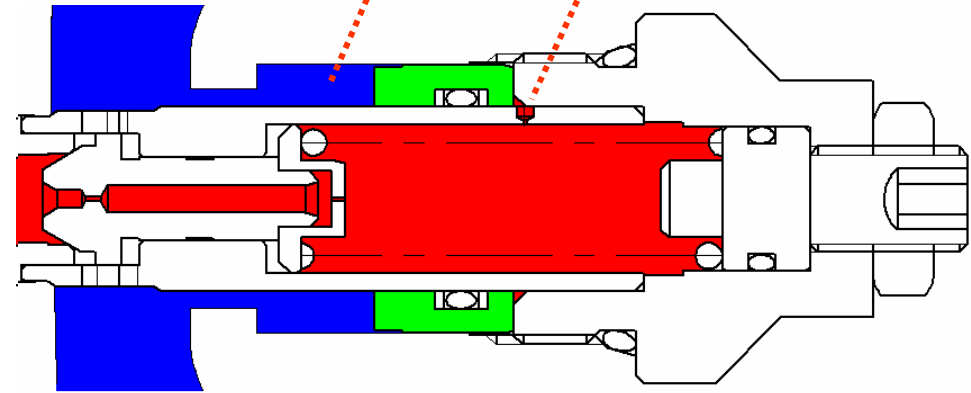
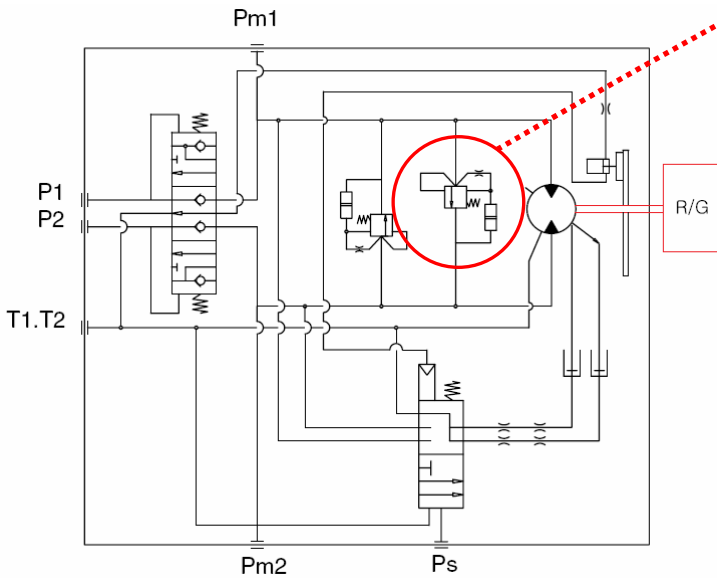
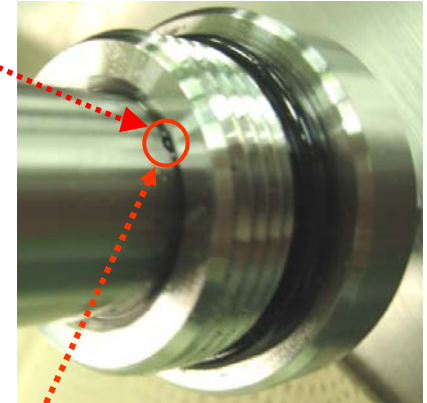
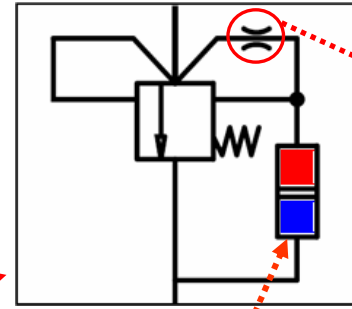
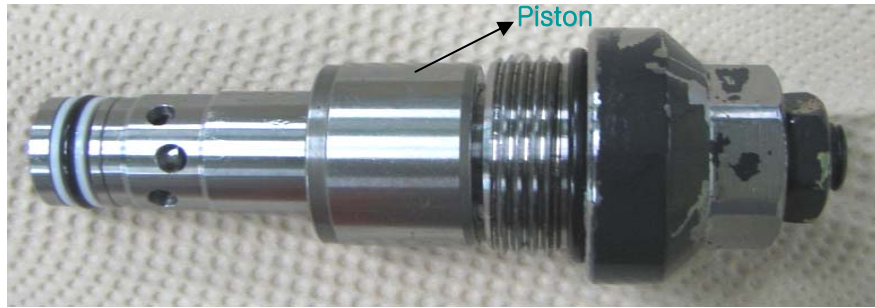
Remark
This travel motor shifts automatically in 1e speed, at a pressure of **250 bar** and up.



SECOND SPEED SPOOL



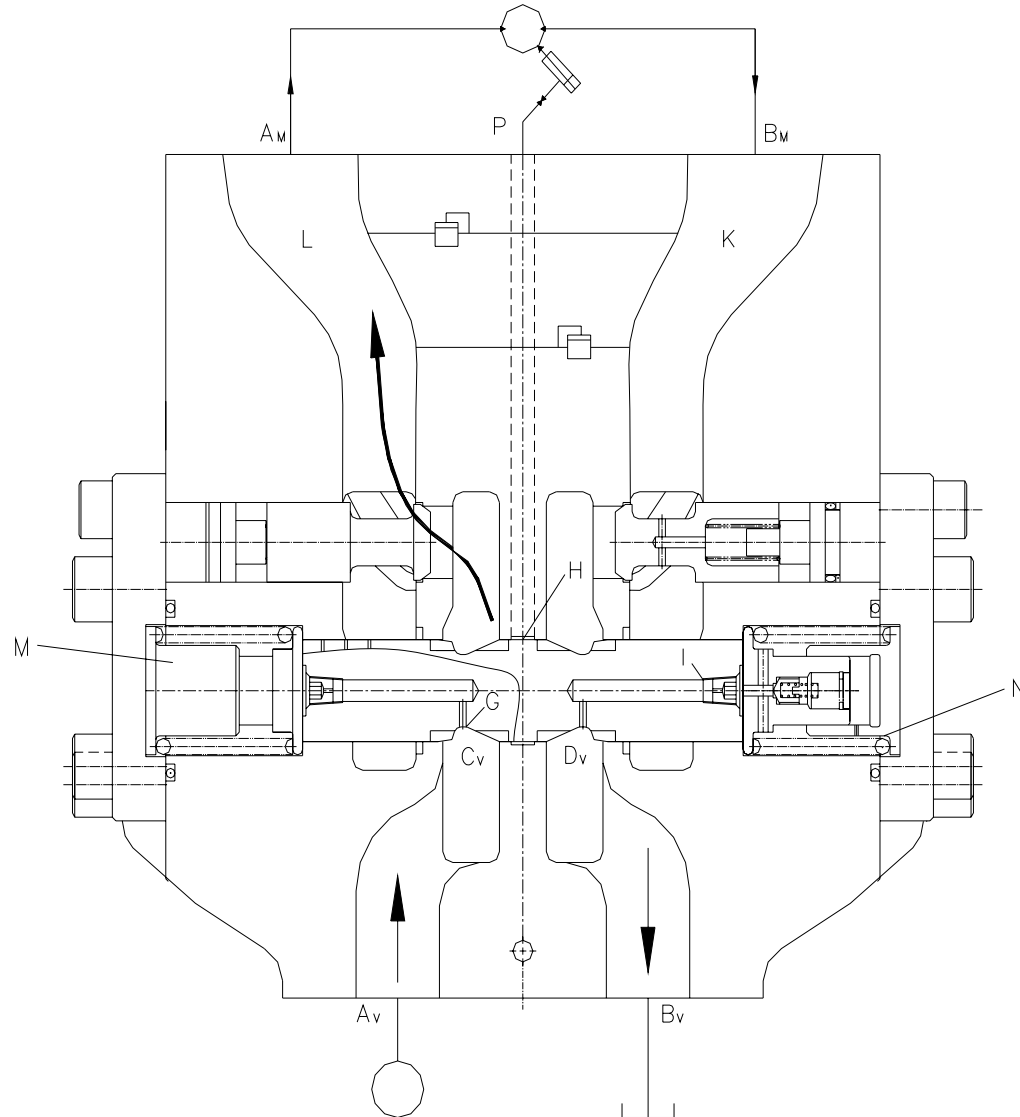
1) Relief Valve



※ Role of the piston

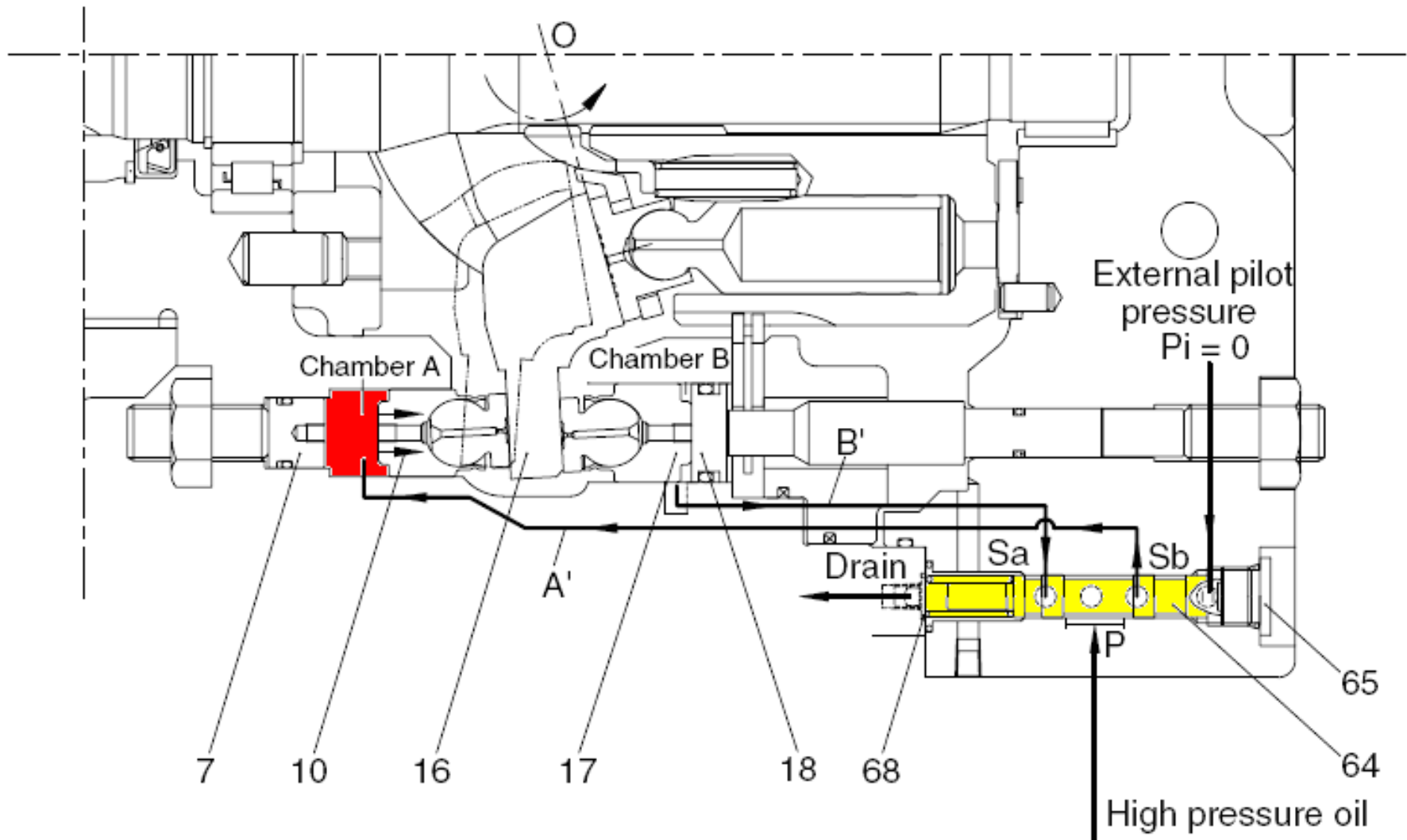
- Reducing shock while the piston moves when relief pressure is activated to the valve (Time delay effect).

2) Counterbalance Valve



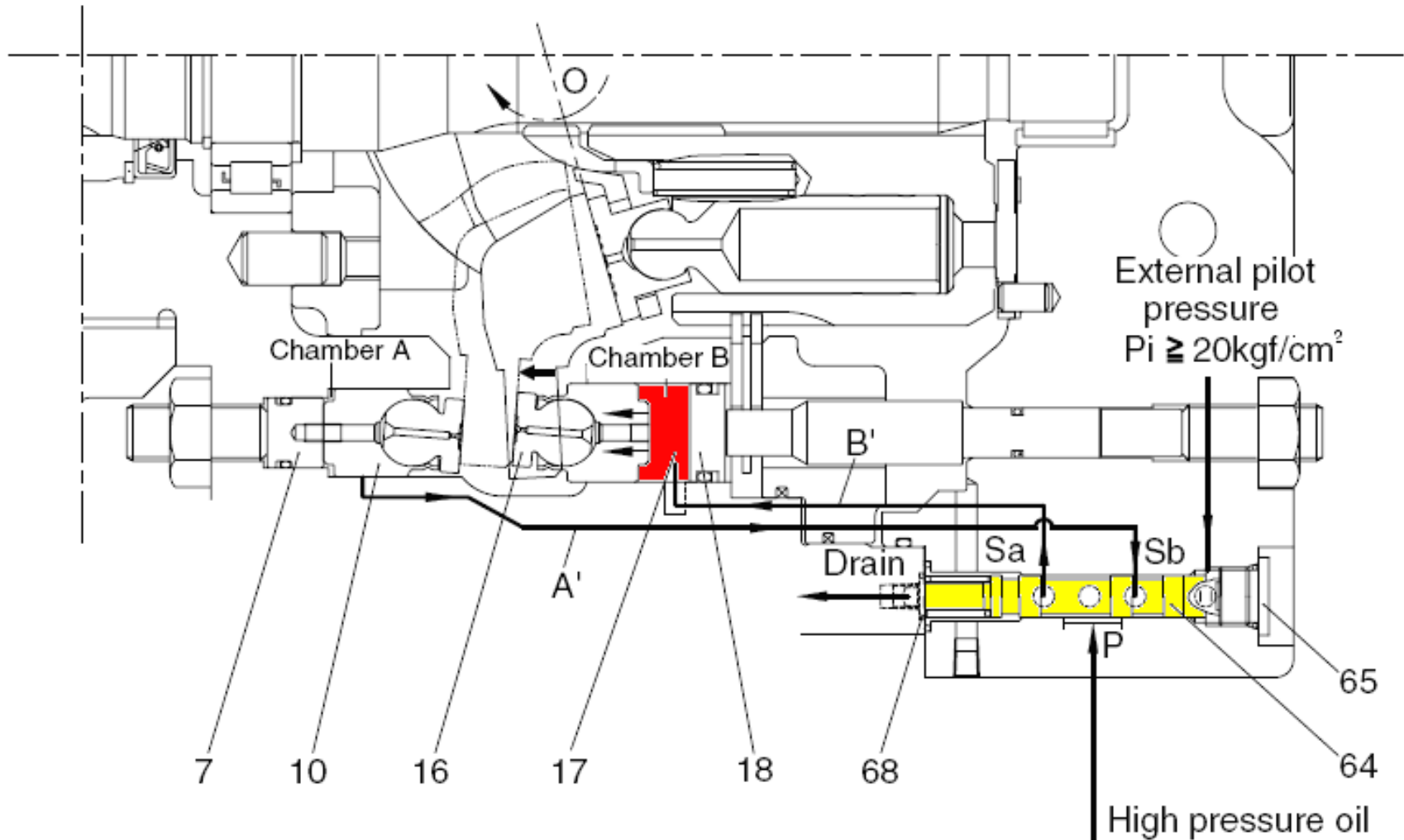
Speed Control(Jeil)

1st Speed Control

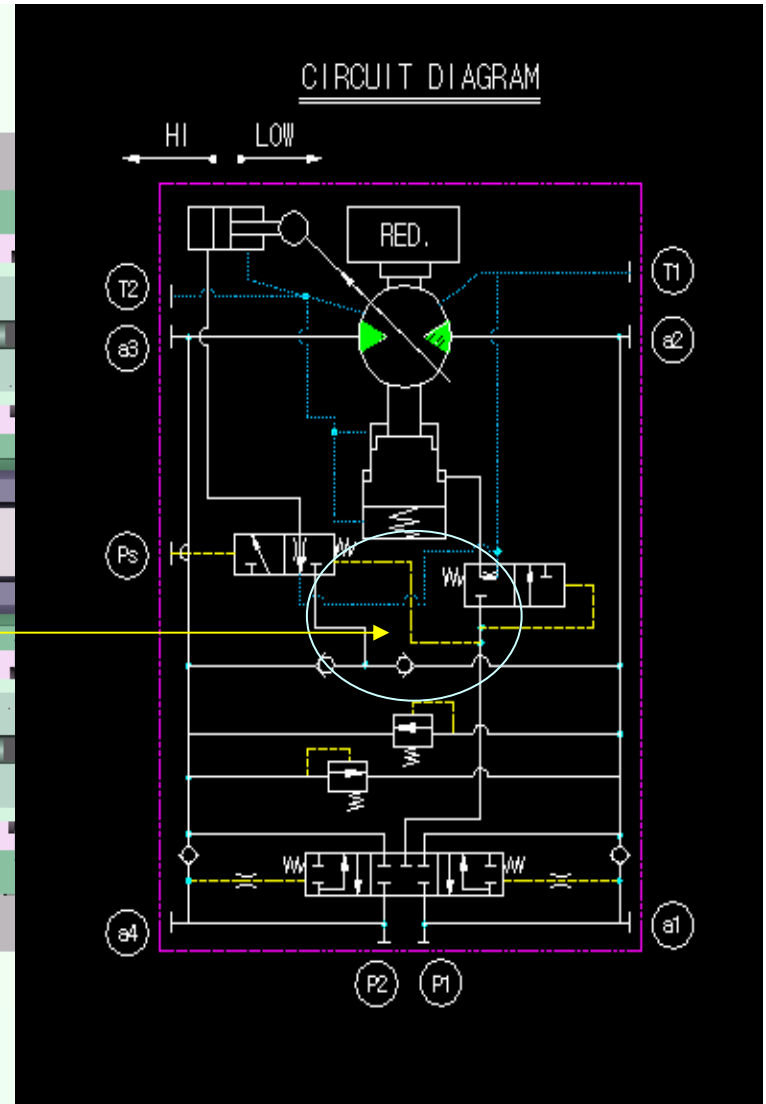
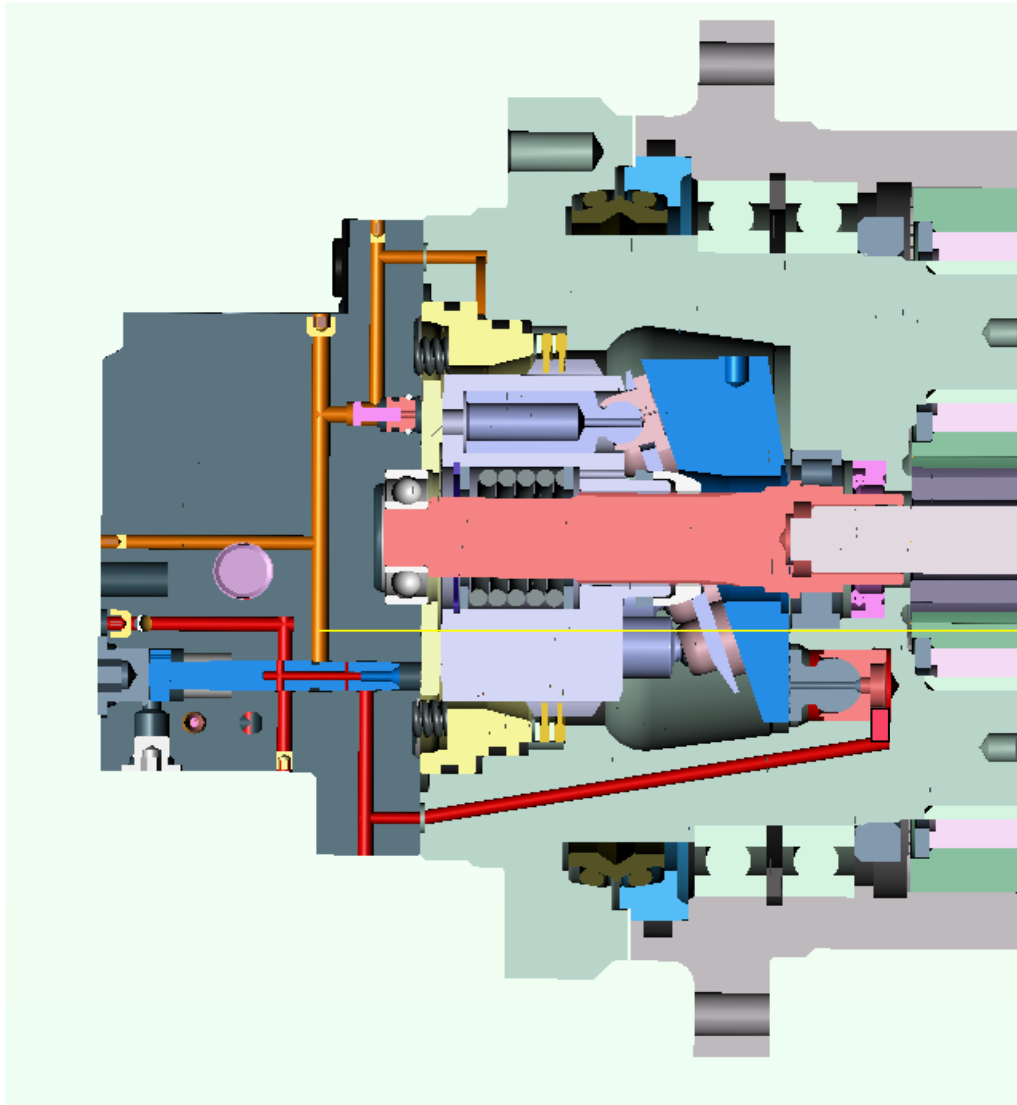


Speed Control(Jeil)

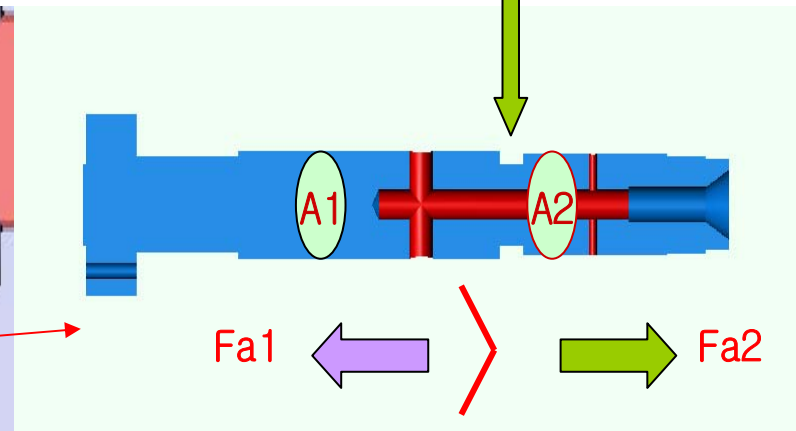
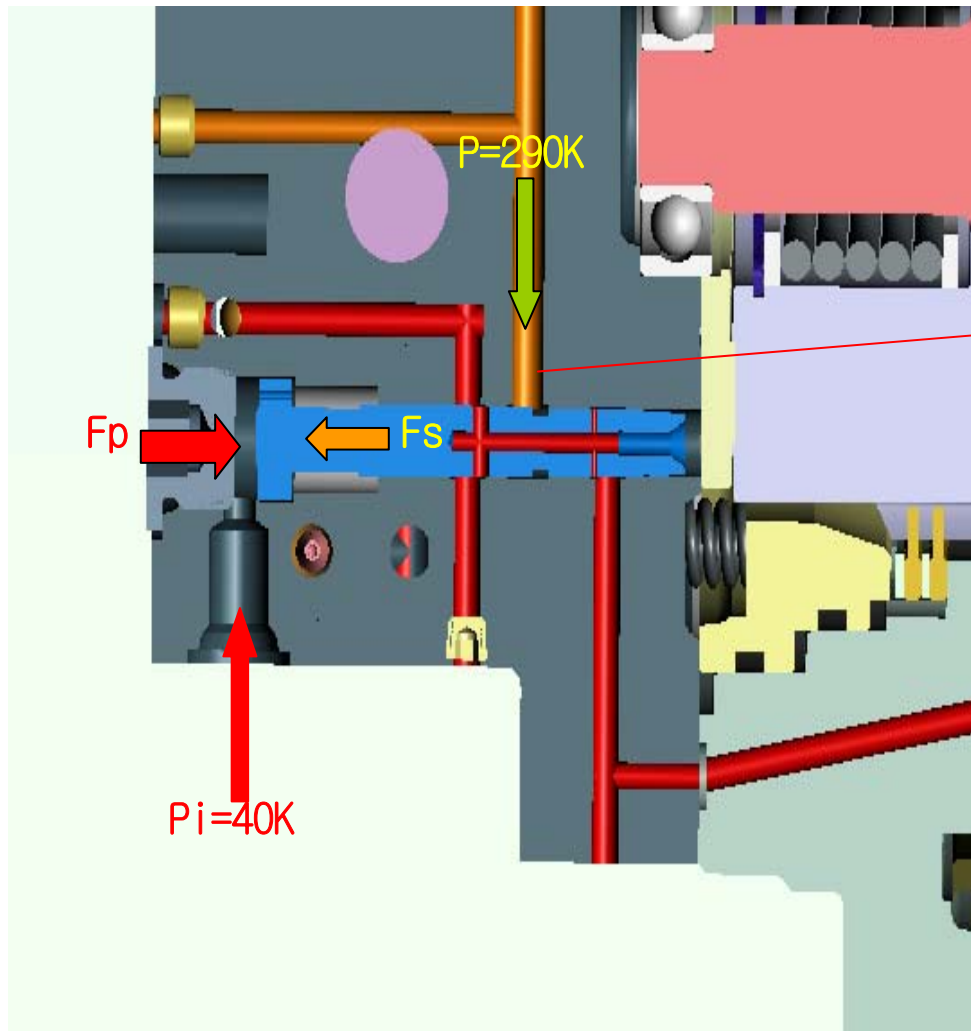
2nd Speed Control



Speed Control



Speed Control

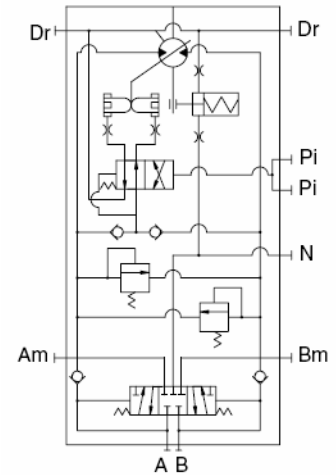


$$F_{a1} + F_s > F_{a2}$$

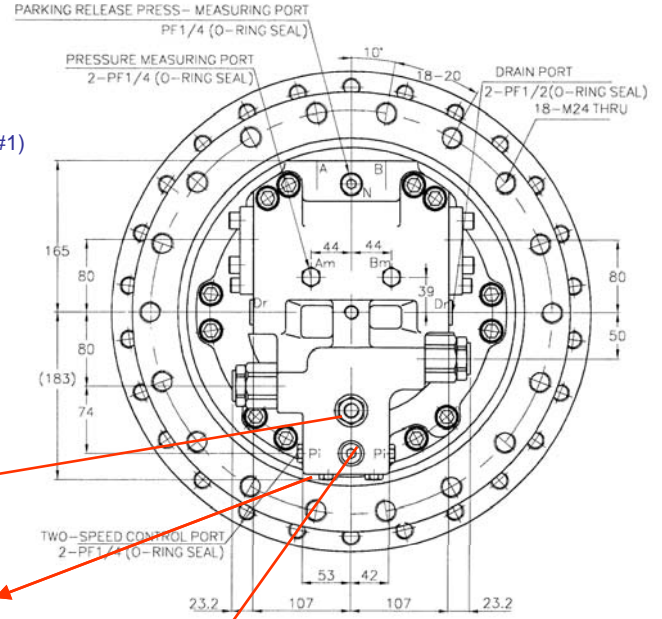
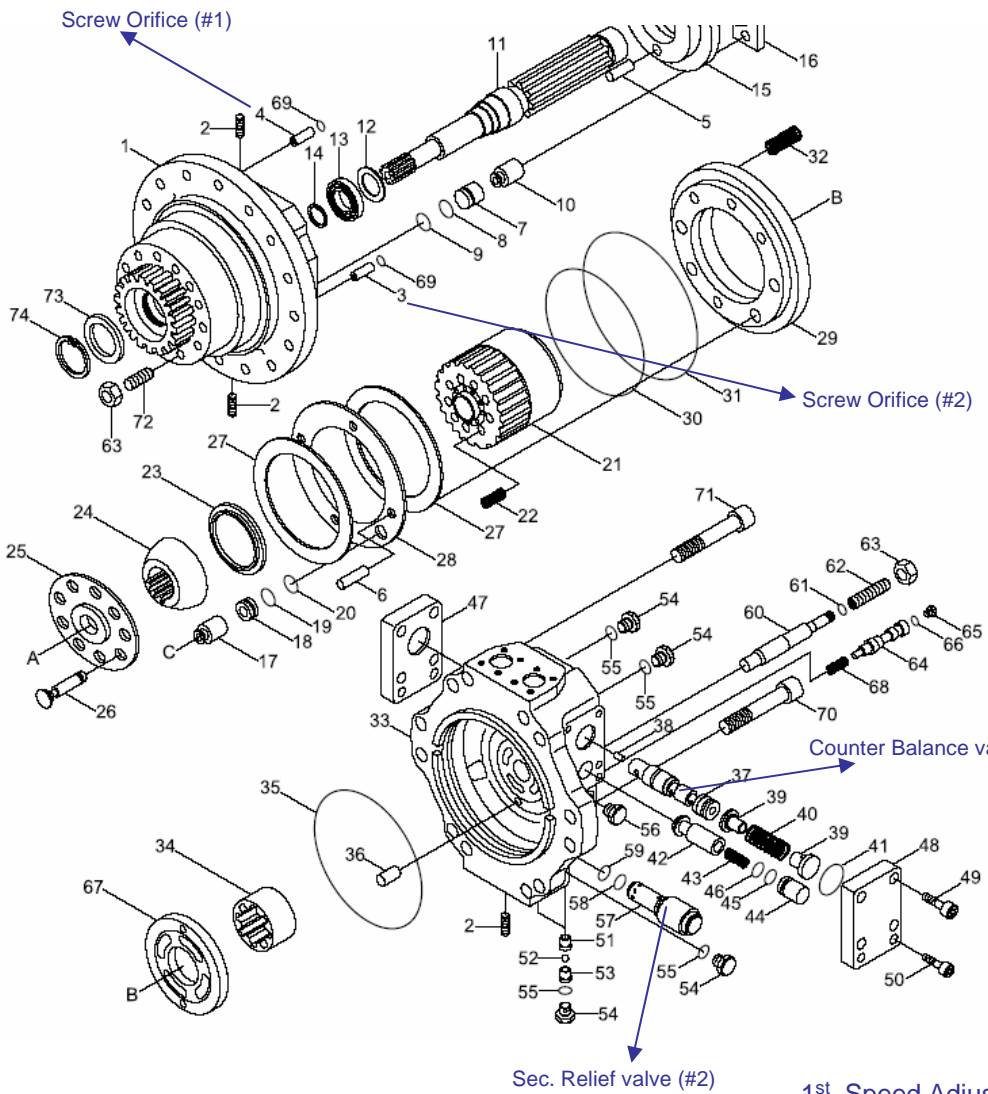
$$\text{IF } P_i = 40\text{kgf/cm}^2$$

$$\text{Main pressure} = 290\text{kgf/cm}^2$$

P/N:31N8-40060(Jeil)



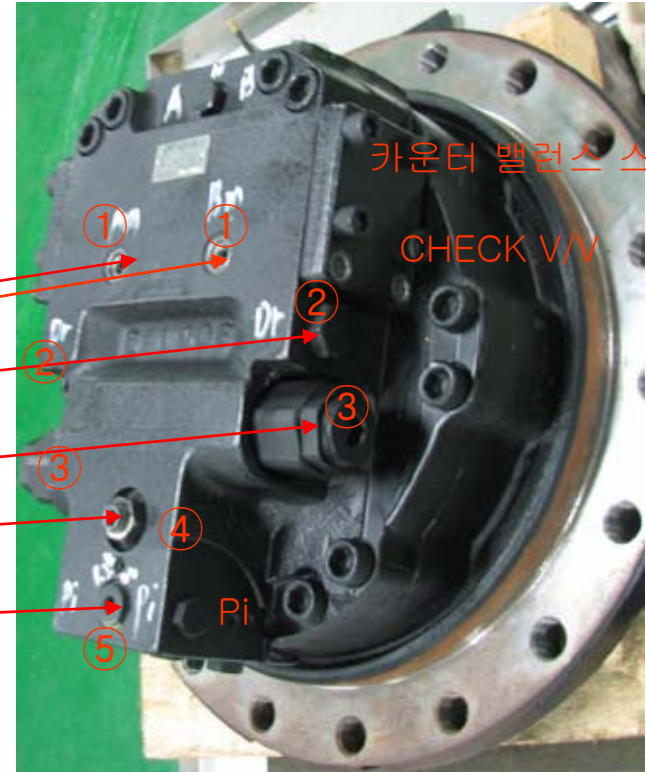
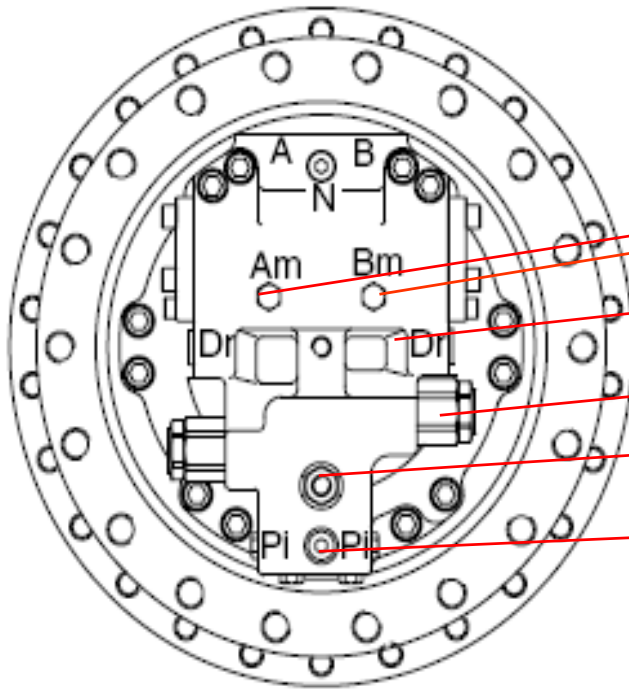
- Relief valve press. 330 bar
- Automatic shift press. 270 bar
- Brake release press. 9 bar



- 1st Speed Adjust Screw
- Check Valve
- 1st/2nd Valve

R320LC-7 (#0456~) (Jeil)Part nr (Assy) 31N9-40020

Regulating valve



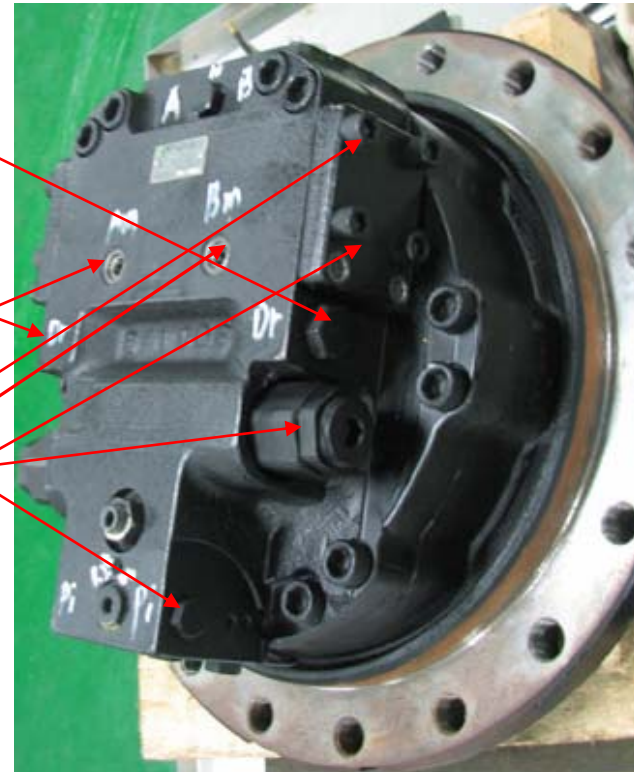
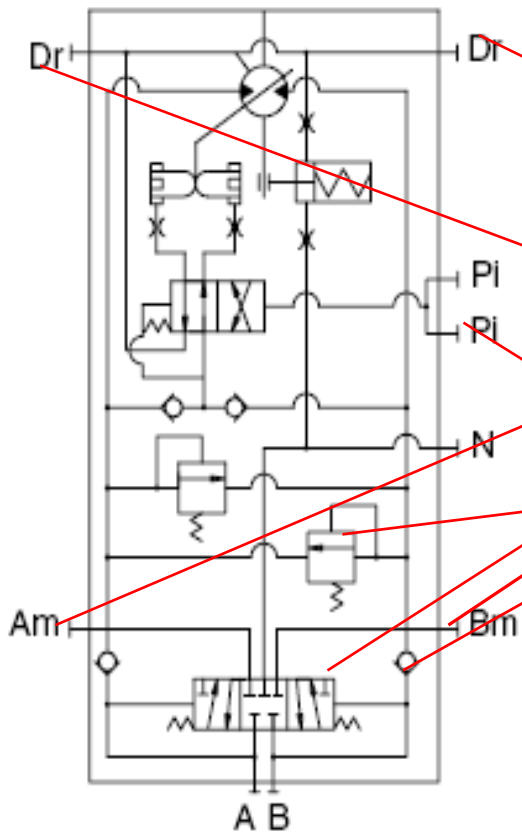
①main pressure check point

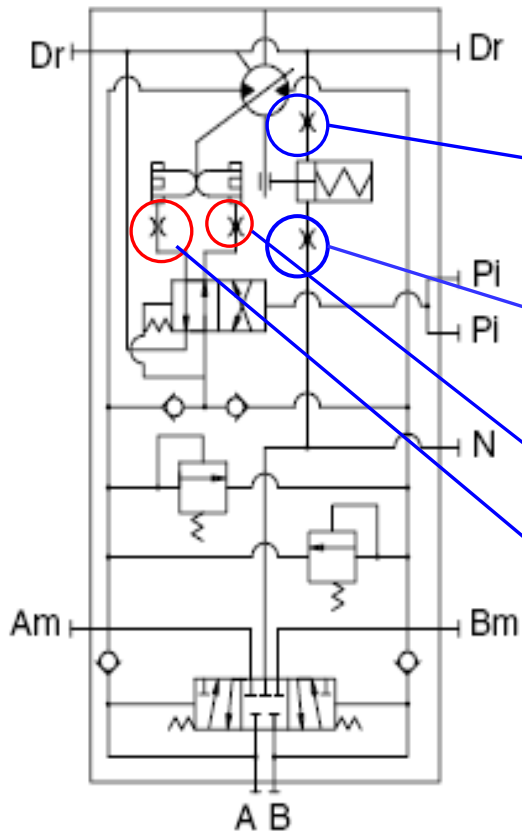
②drain

③relief valve

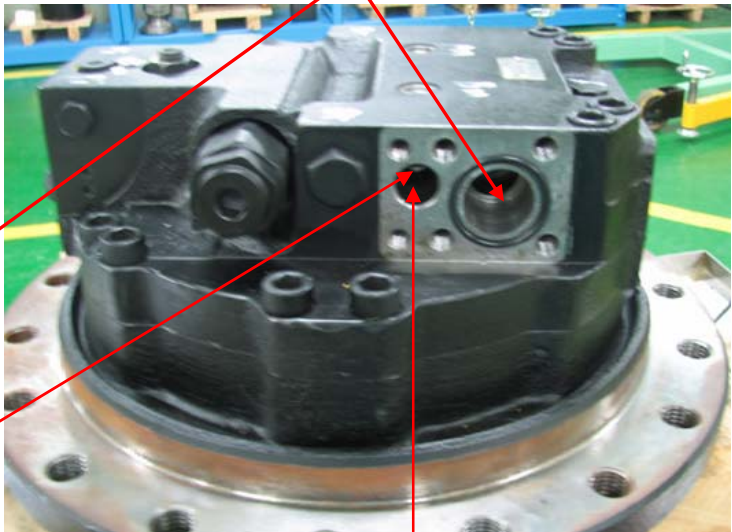
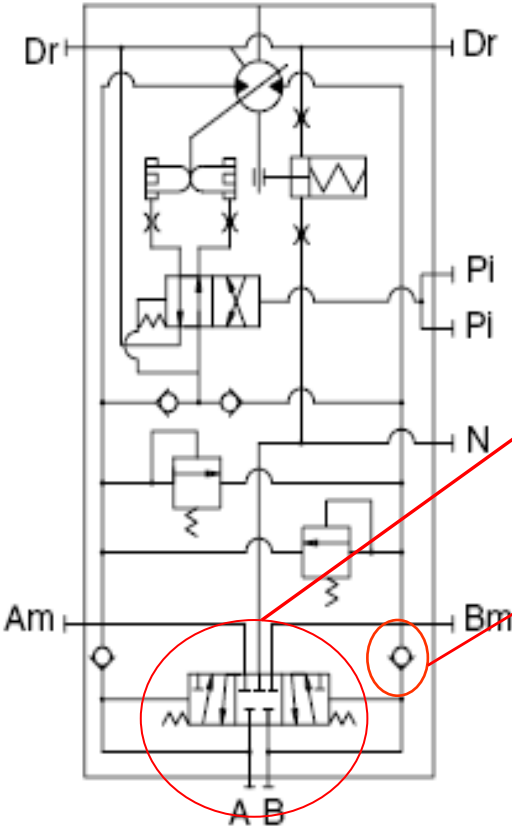
④Tilting rod

⑤2nd speed spool



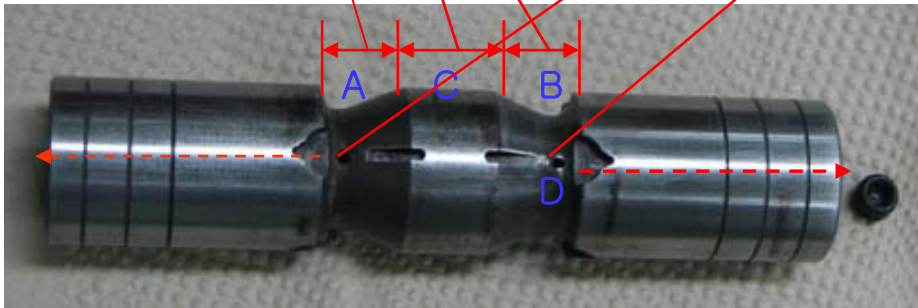
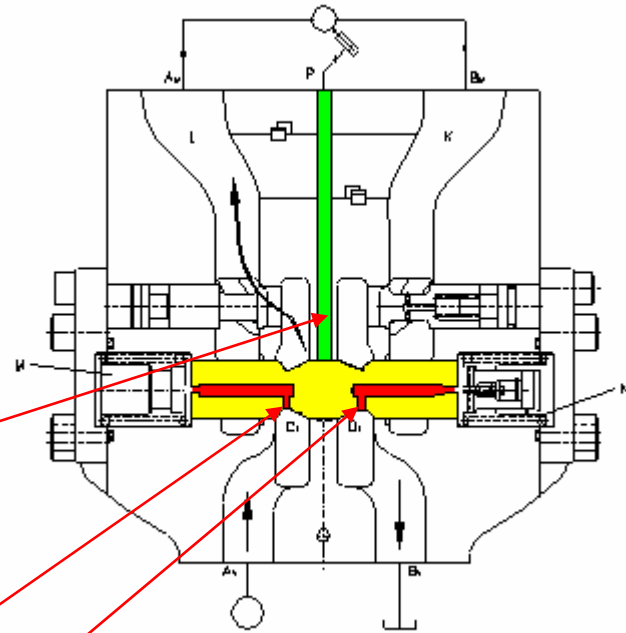
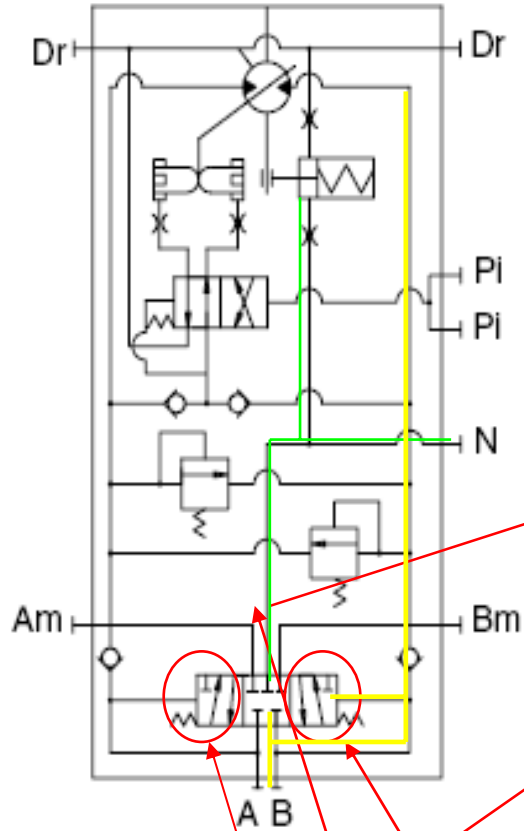


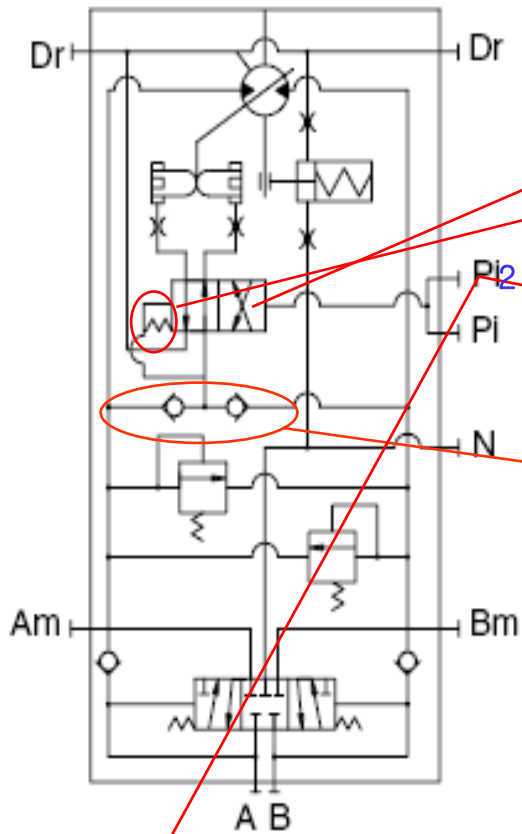
C/balance spool & check V/V



Brake release

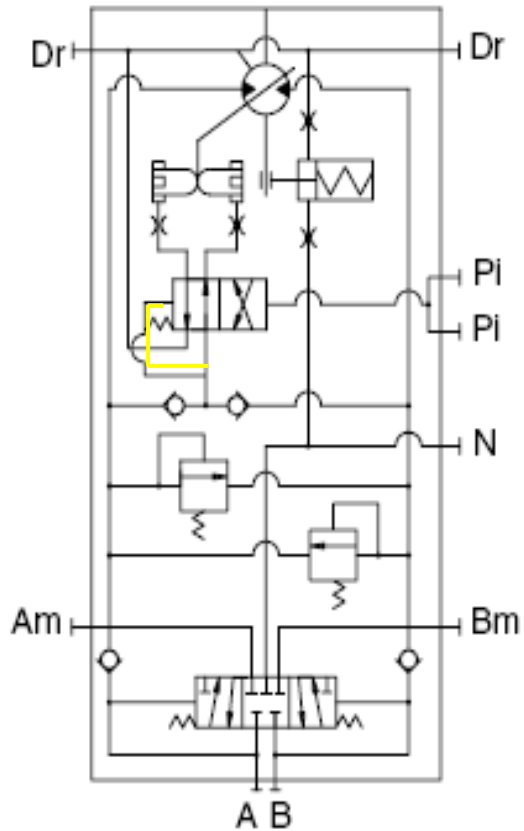
(brake release pressure 9Kg/cm² ~)

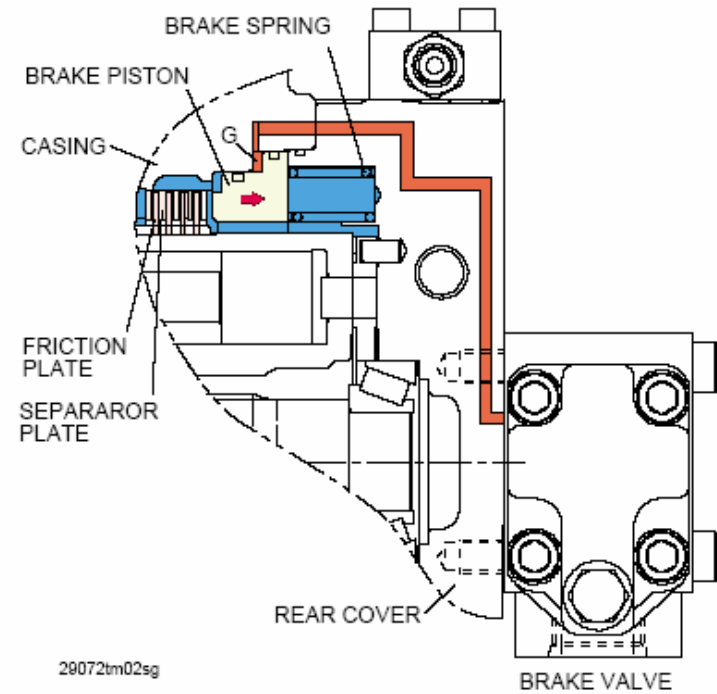
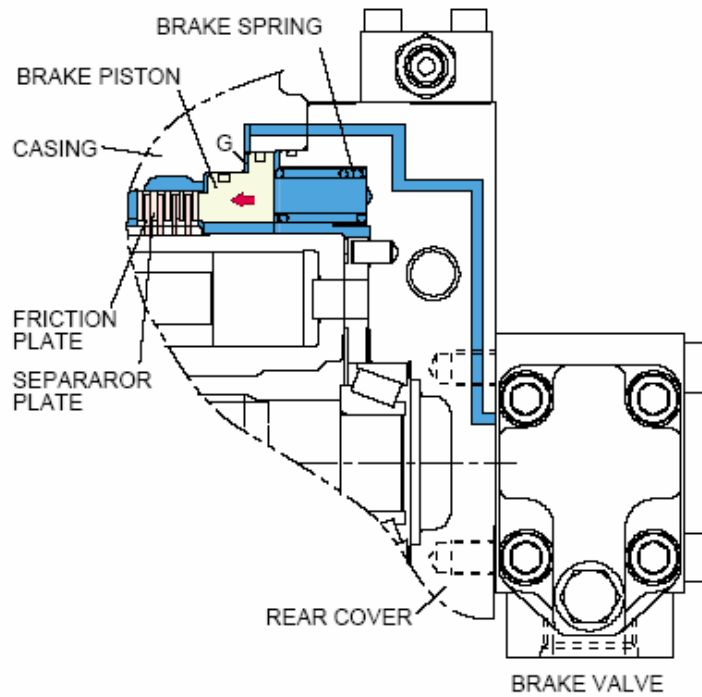


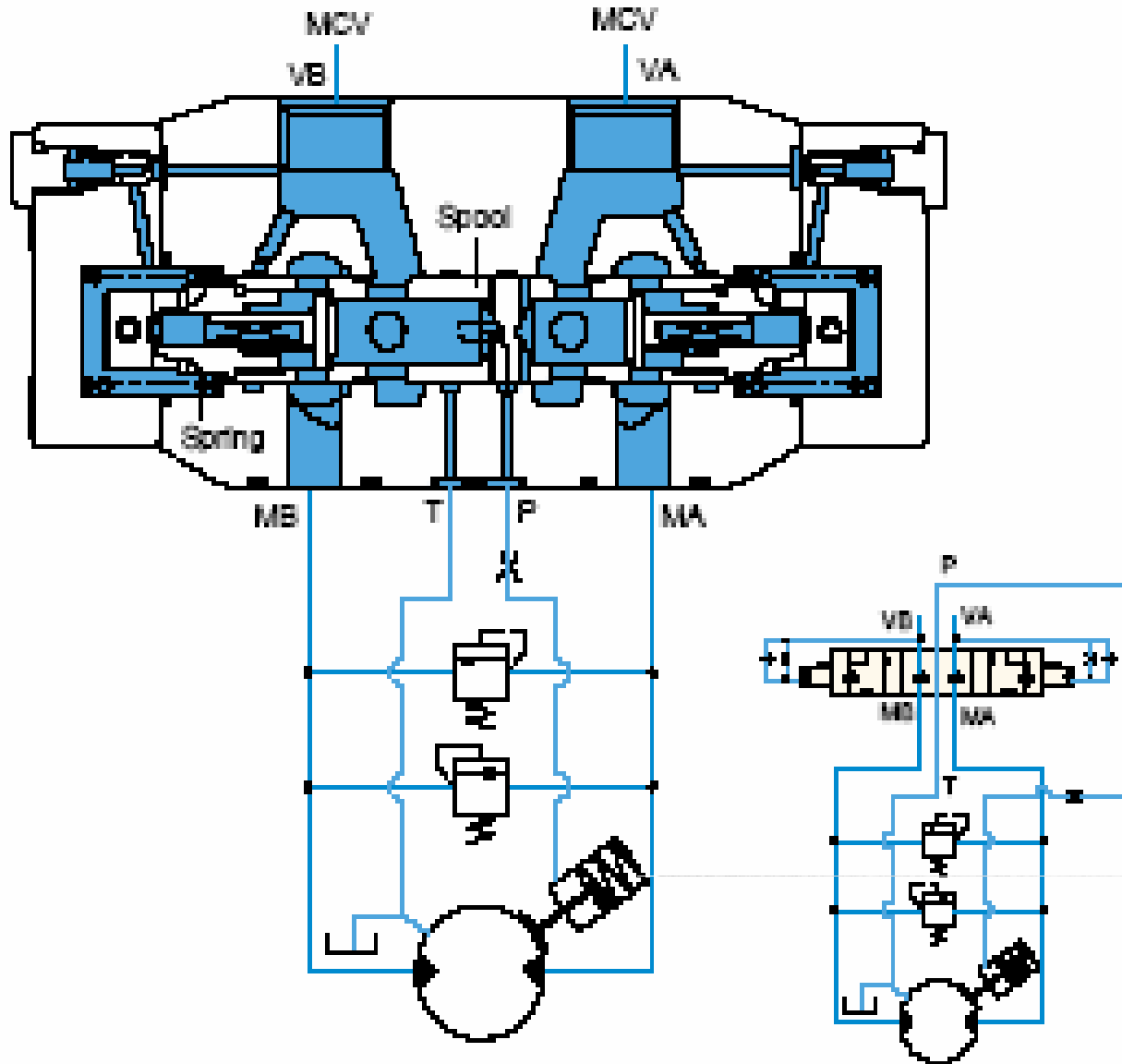


- Pi pressure = 0 bar => 1st speed
- Pi pressure > 20 bar => 2nd speed

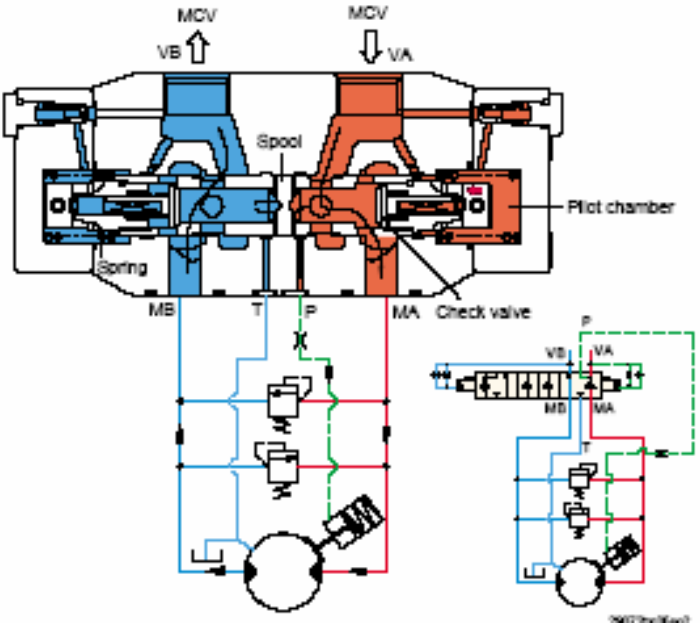
Main pressure > 270 bar => 1st speed changed



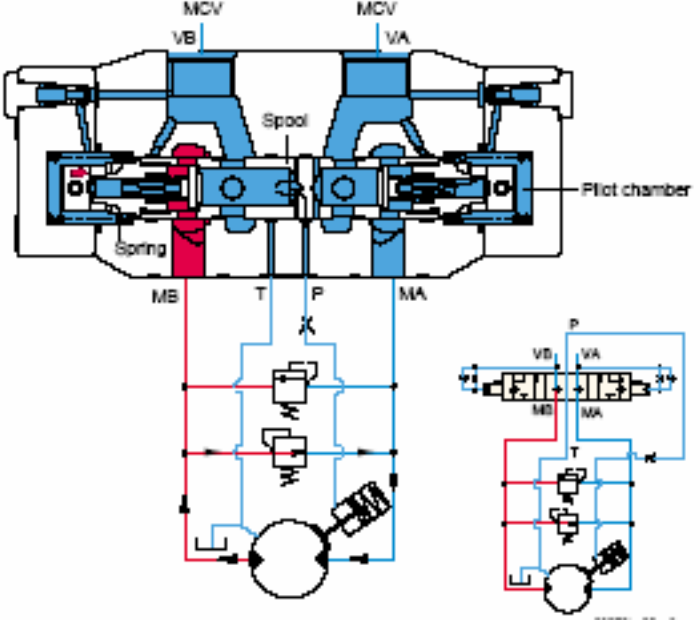




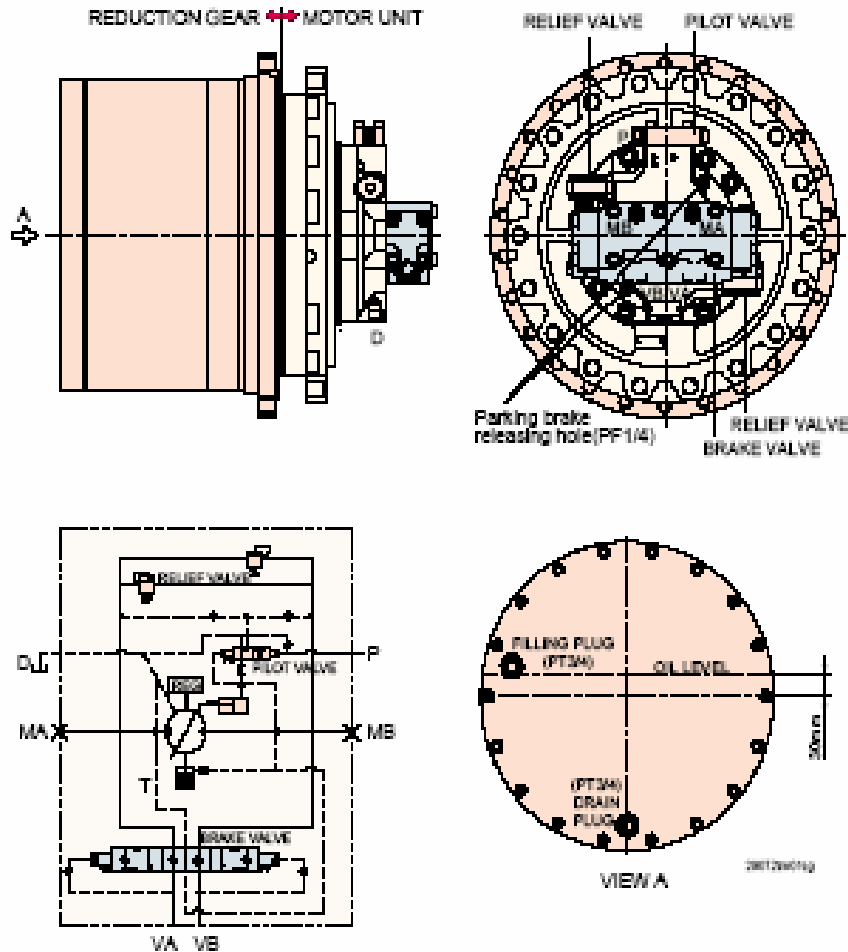
5.2 Accelerating position



5.3 Stopping operation



1. STRUCTURE



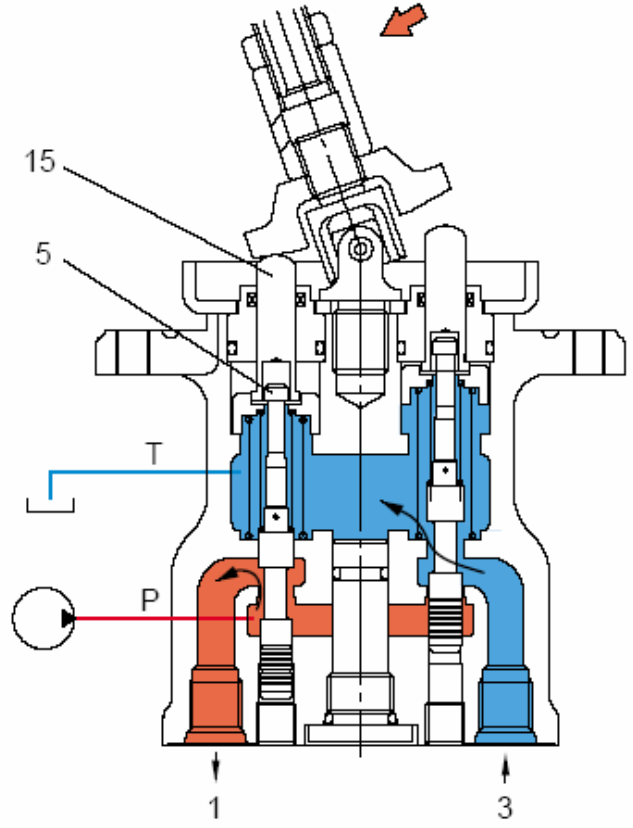
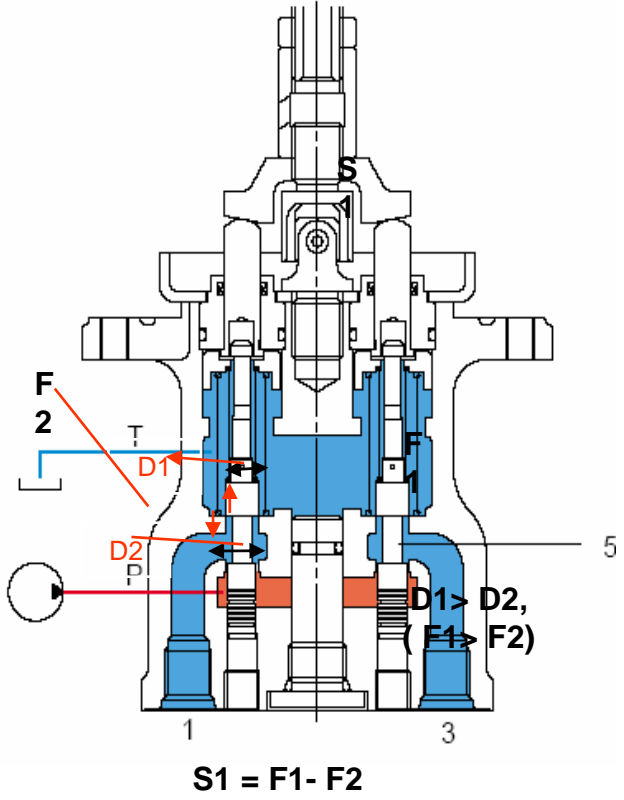
Model	Maker	Relief Pressure (bar)
R55-7	Jeil	220
R140LC-7	DongMyung	330
R180LC-7	DongMyung	330
R210LC-7A	Jeil/Sungbo	330
R290LC-7A	Jeil/Sungbo	330
R320LC-7A	Jeil/Sungbo	330
R360LC-7A	DongMyung	360
R500LC-7A	Hydromatic	345

Subject 1 :Travel does not function at all on one side

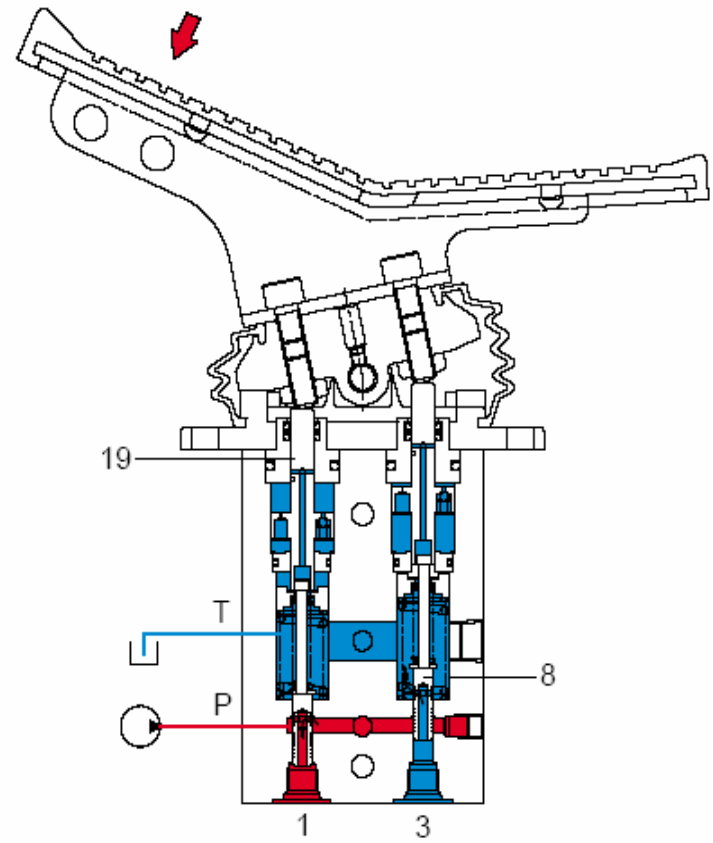
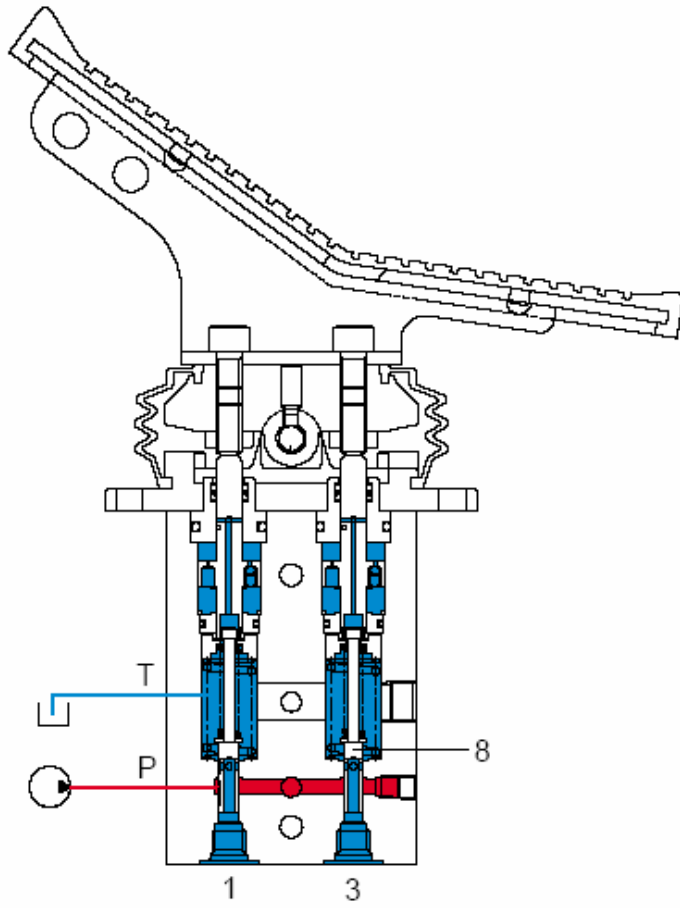
- (1) Check if the travel control valve spool changed over positively
- (2) Check if the symptom change when L/H,R/H travel relief valves are exchanged
- (3) Check if the symptom change when front and rear pump discharge hoses are exchanged => hydraulic pump is broken
- (4) Check if metallic particles come out of drain port in travel reduction unit
- (5) Check if travel brake valve pressure within standard level
- (6) Check if counterbalance spool in travel brake valve move lightly by hand
- (7) Check if the symptom changes when relief valves in travel motor are exchanged

4-6.Remote Control Valve

- ◆ Big spring : S2
- ◆ Small spring : S1

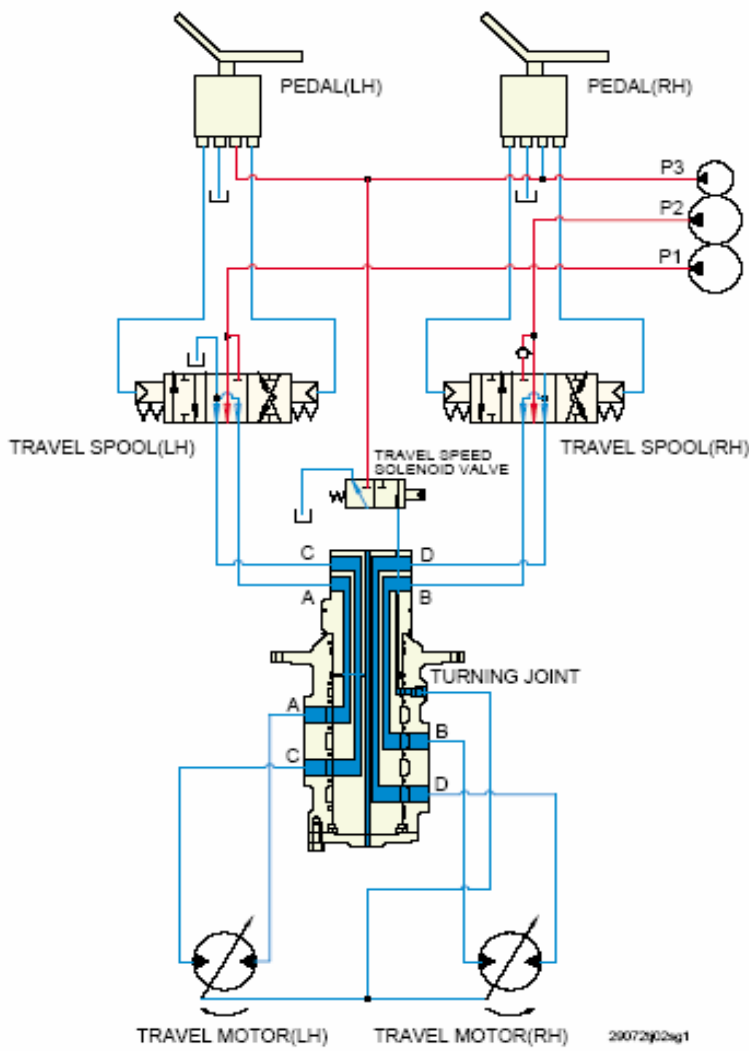


◆ For keeping the balance between the spring force and the force(F1- F2) : $S1 = F1 - F2$

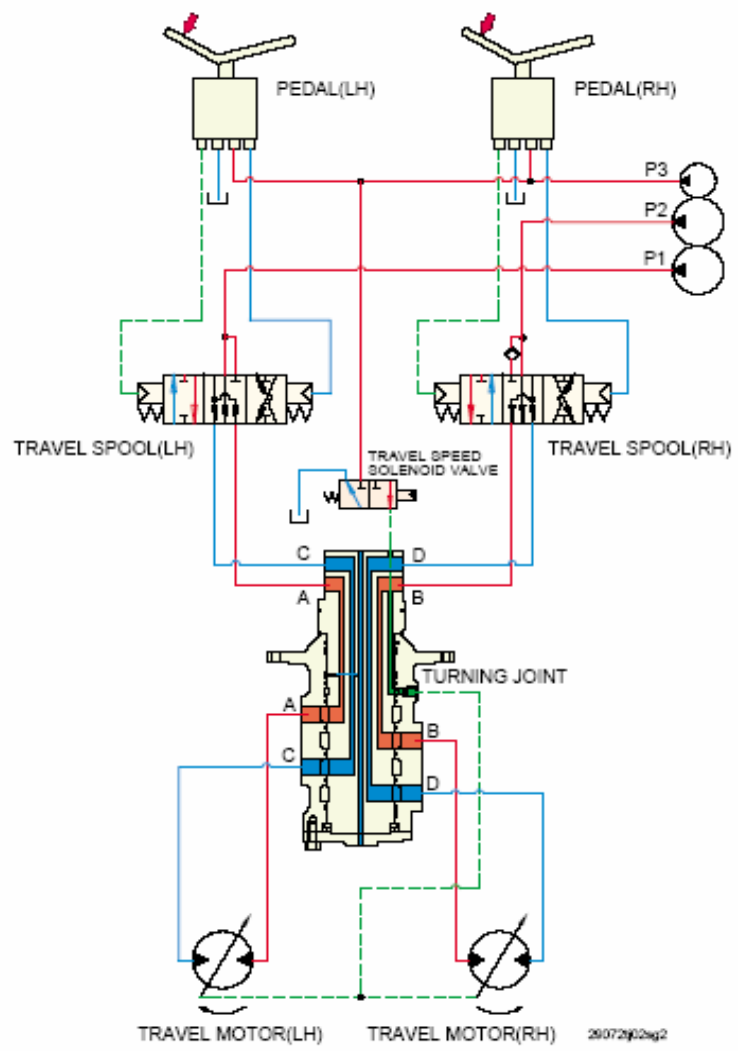


4-8. Turning Joint

2.1 Neutral



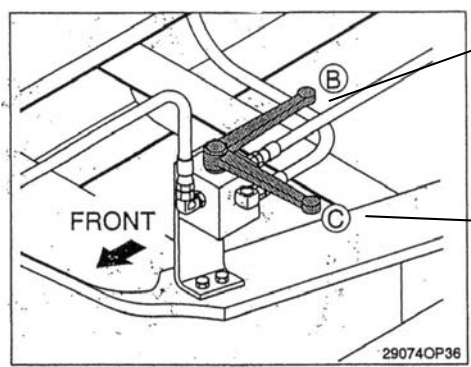
2.2 Forward



5. Breaker / Double Function Piping

The option spool in the MCV can be used for either breaker (single function), either clamshell, shear (double function)

A. POSITIONING OF THE 3 WAY VALVE



In case of **breaker operation**
(In this position is the back pressure minimized)

In case of **clamshell, shear operation**
(In this position, 2 way operation is possible)

D. PRESSURE SETTING

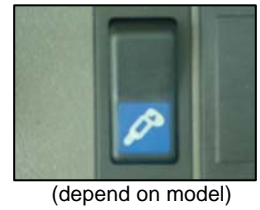
Use the secondary relief valves near the "option spool" for setting the right pressure

Remark.

Find some more information about breaker set-up in the operating manual.

B. OPERATION

Push on the breaker switch at right hand side. At that time the foot pedal can be operated for opening the "option" spool inside the MCV.



BREAKER SOLENOID CN66

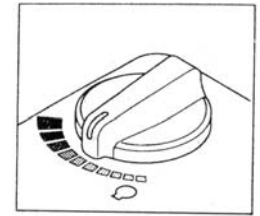
C. LIMITING OIL FLOW FOR BREAKER OPERATION

1. Select "BREAKER mode" on the dash board (So max flow cut off solenoid is activated and the flow is limited)



MAX FLOW SOLENOID CN137

2. Select correct Engine Speed via Accel Dial Switch, for setting the right oil flow:
Find flow specification in the characteristics of the hammer.

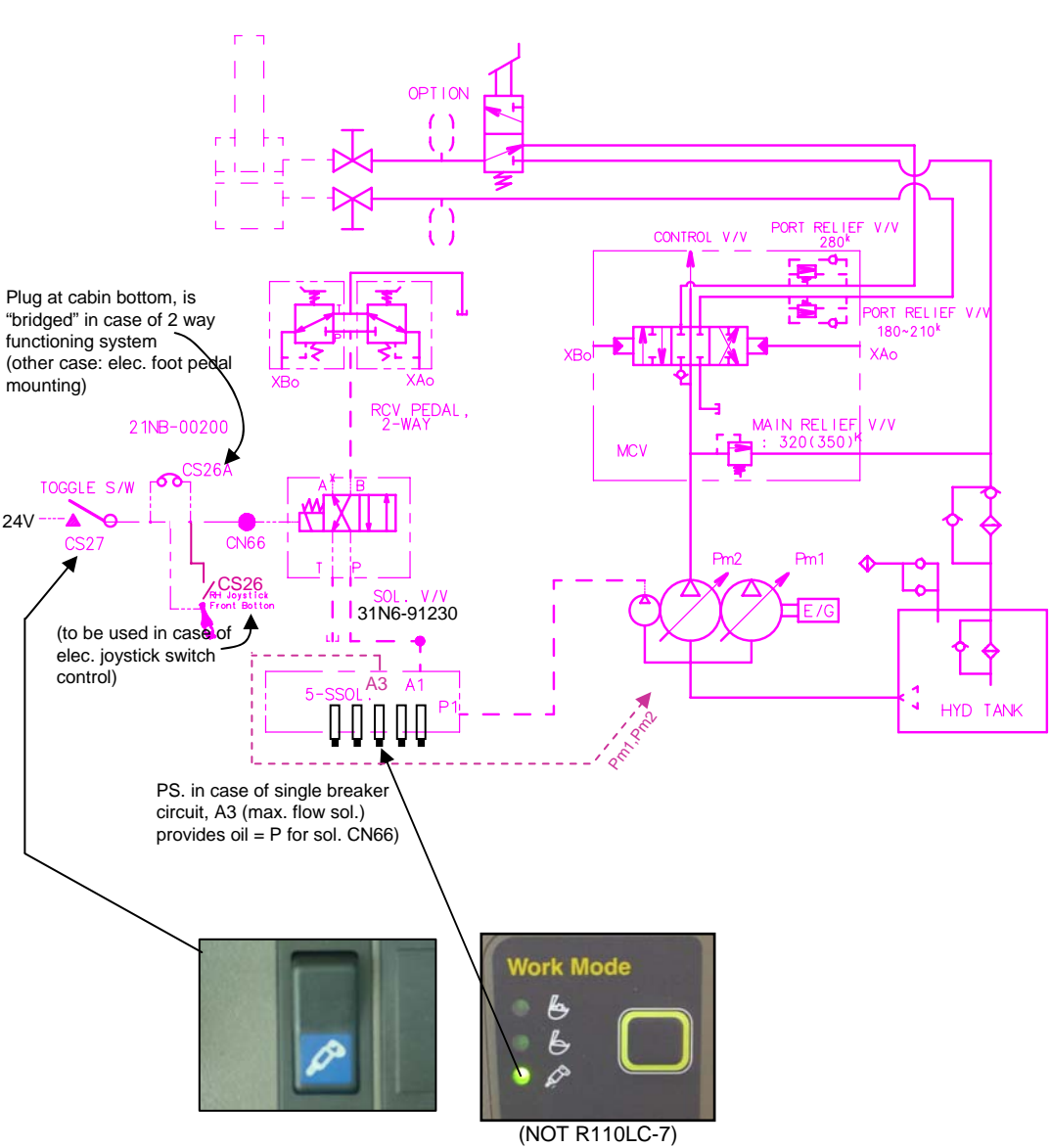


Find on next page the table "Flow / RPM" for each excavator, at BREAKER mode.



Additional flow adjusting can be realised via screw on regulator (NOT R110LC-7)

5-1. Breaker / Clamshell Piping



OIL FLOW / RPM
(select "BREAKER MODE" on the cluster)

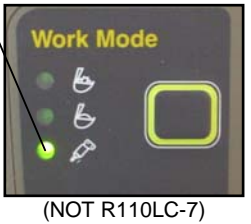
ENGINE RPM	OIL FLOW (l/min)					
	R140LC-7	R160LC-7 R180LC-7	R210LC-7	R290LC-7	R360LC-7	R450LC-7 R500LC-7
1500				172		255
1600				184	208	272
1700	89	116	150	195	221	289
1800	94	122	159	207	234	306
1900	100	129	168	220*	247	323*
2000	105	136	176			
2100	110*	143*	185*			
2200						

(* = default value)

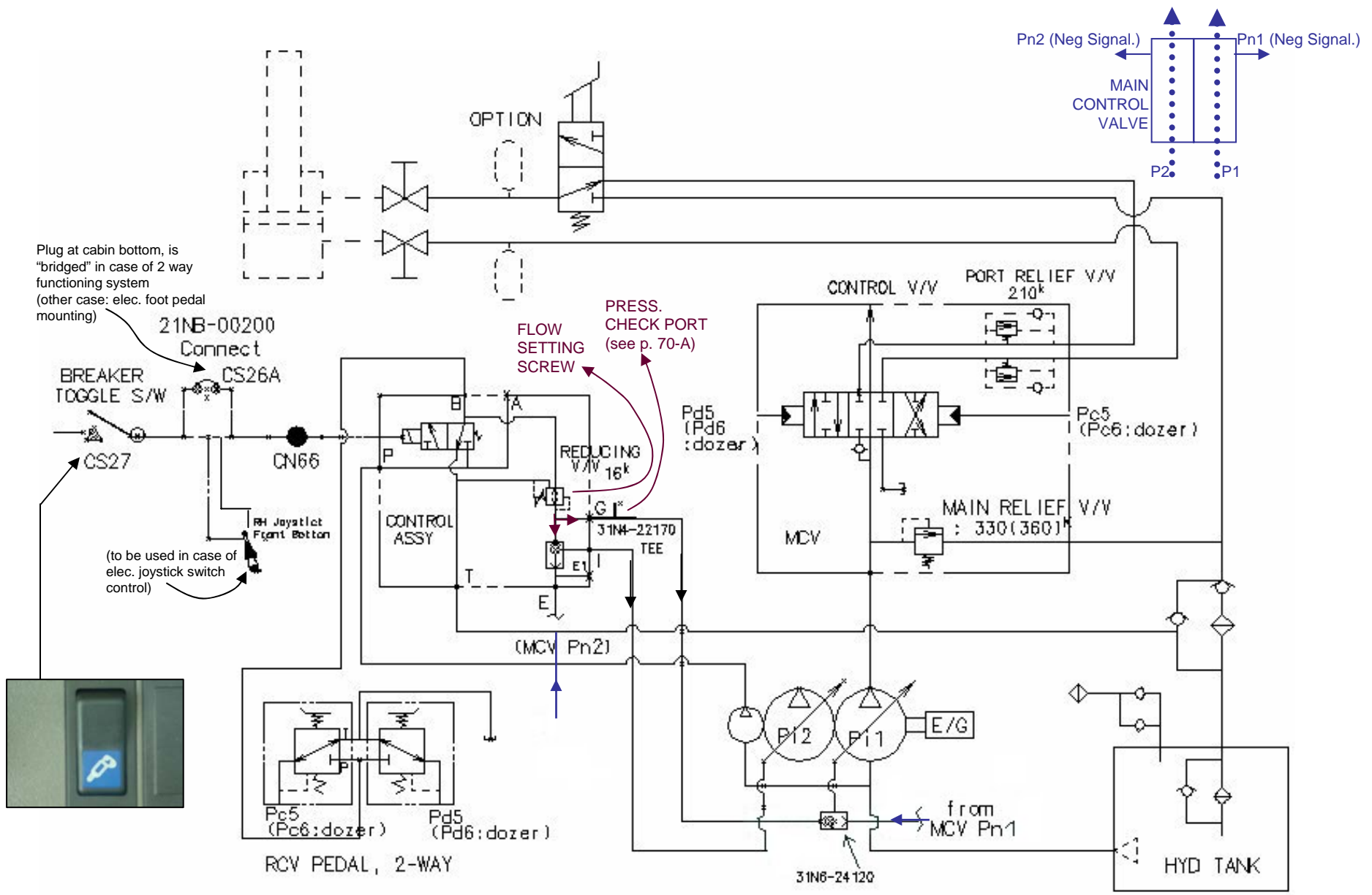
ENGINE RPM	R250LC-7
1500	152
1700	162
1800	171
1900	180
2000	190*

ENGINE RPM	R320LC-7
1450	183
1550	196
1650	208
1750	221*

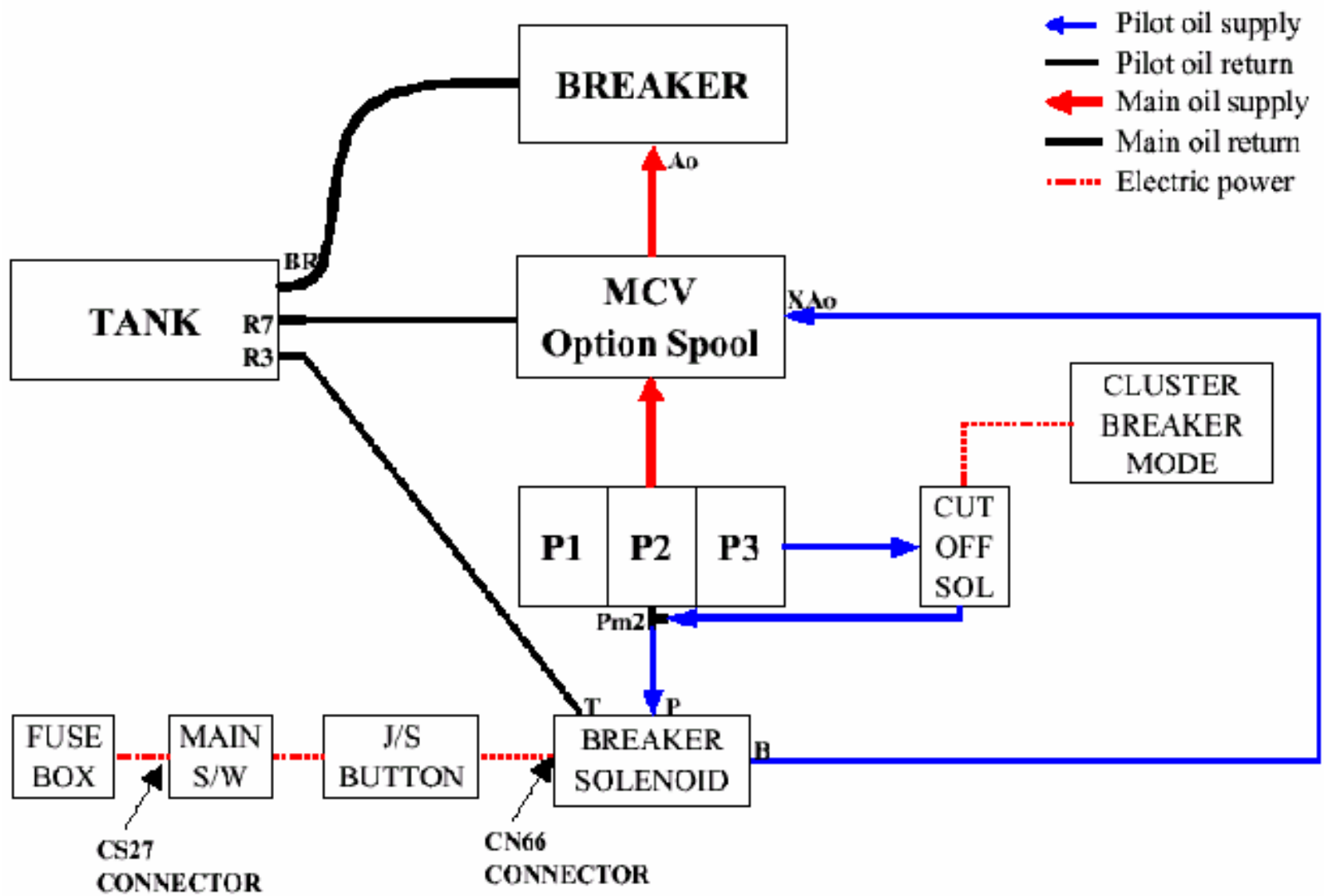
In case of accumulators on breaker piping (R210LC-7):
 -Supply line, accumulator charge press = 65 bar
 -Return line accumulator charge press = 10 bar



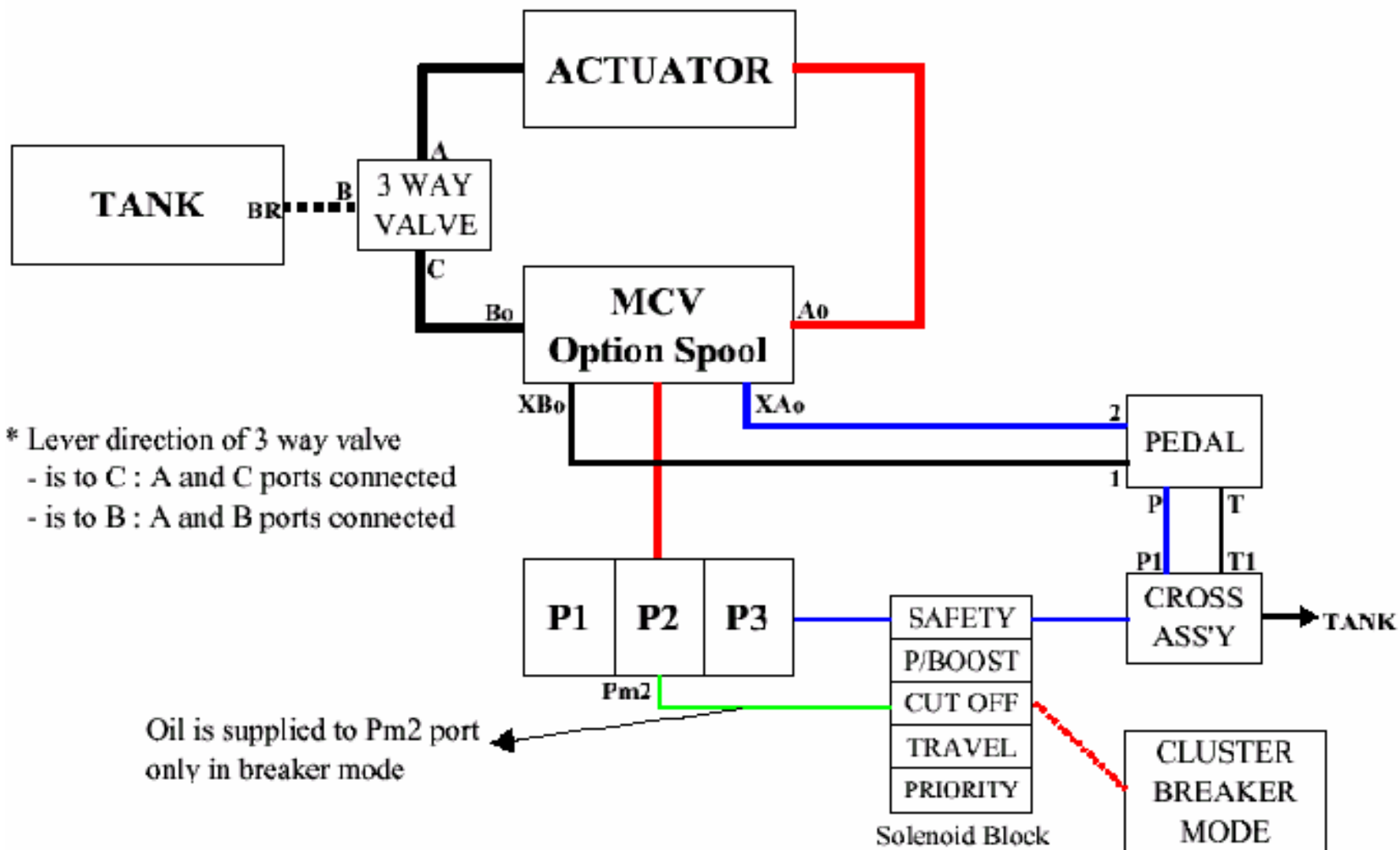
BREAKER / DOUBLE ACTING CIRCUIT (low flow)



5-2.Single Acting Circuit



5-3.Double Acting Circuit



5-4.Comparison Table

	SINGLE	DOUBLE	Remark
Concept	Oil is delivered to just one direction	MCV directs oil to either side of actuator	
Main Switch	One on RH console	N/A	ON/OFF switch
Pilot oil to MCV by	Solenoid valve	Hydraulic Pedal	
Operated by	Button on RH joystick	Hydraulic Pedal	
Used For	BREAKER	BREAKER, CRUSHER, GRAB etc	
Return oil	Breaker to tank	Actuator to MCV or tank	Pilot pipings are different
Main Components	RELIEF V/V : 1 SOLENOID V/V : 1	RELIEF V/V : 2 Hydraulic pedal : 1 3-way joint : 1	

5-5. Oil Flow / rpm, with “Breaker Mode” Switch On

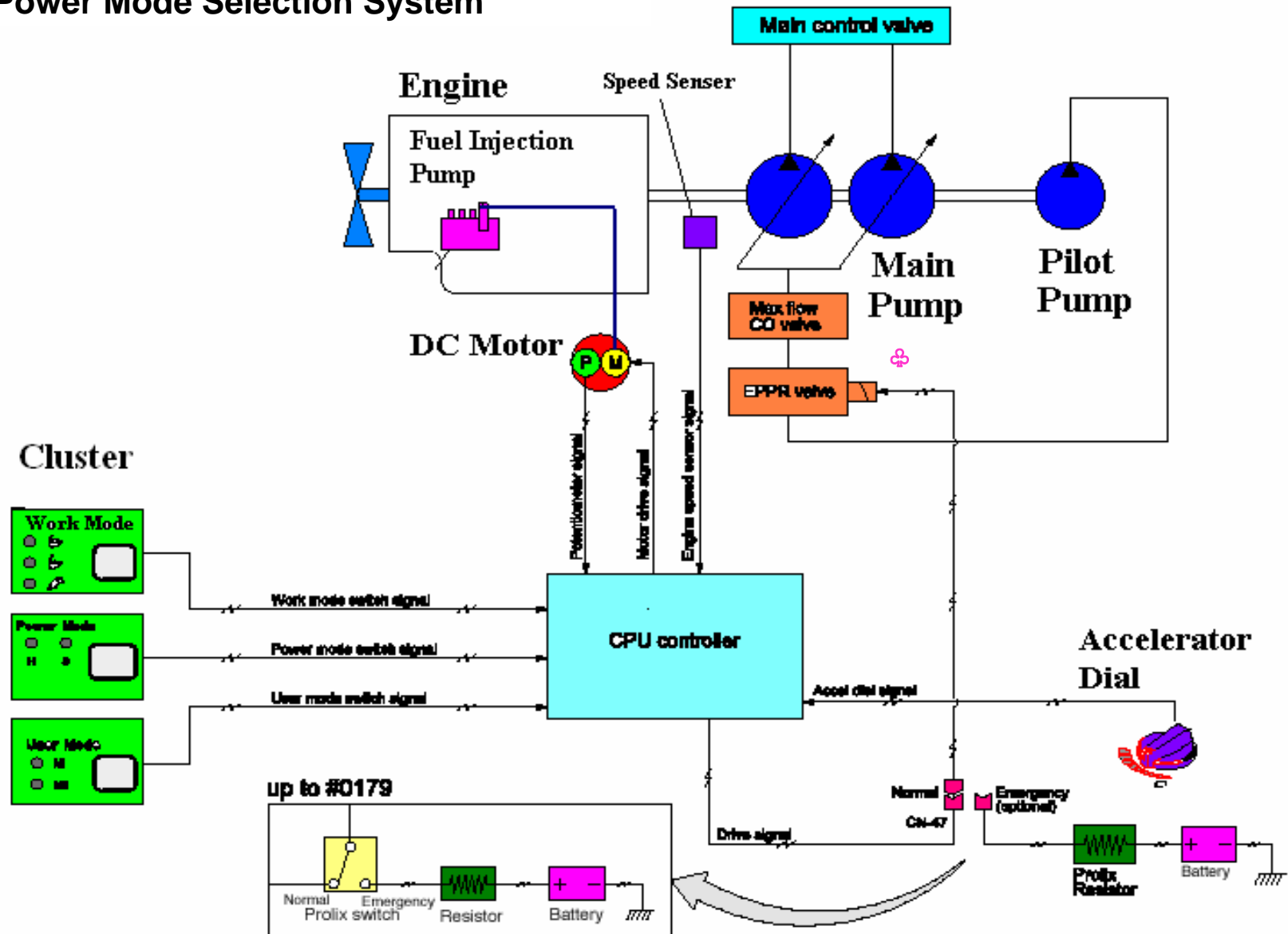
Model	Max. Flow		Breaker mode		Remarks
	Flow (liter)	rpm	Flow (liter)	rpm	
R140LC-7	130×2	2100	110	2100	
R140W-7	130×2	2100	110	2100	
R1400W-7	176×2	2200	150	2200	
R160LC-7	168×2	2100	143	2100	
R170W-7	168×2	2100	143	2100	
R180LC-7	168×2	2100	143	2100	
R200W-7	220×2	1950	187	1950	
R210NLC-7	220×2	1950	187	1950	
R210LC-7(T2)	220×2	1950	187	1950	
R250LC-7	224×2	2000	190	2000	
R290LC-7	260×2	1900	220	1900	
R2900LC-7	260×2	1900	220	1900	
R320LC-7	260×2	1750	221	1750	
R360LC-7	290×2	1900	247	1900	
R450LC-7	380×2	1900	323	1900	

III .Electric & New CAPO System

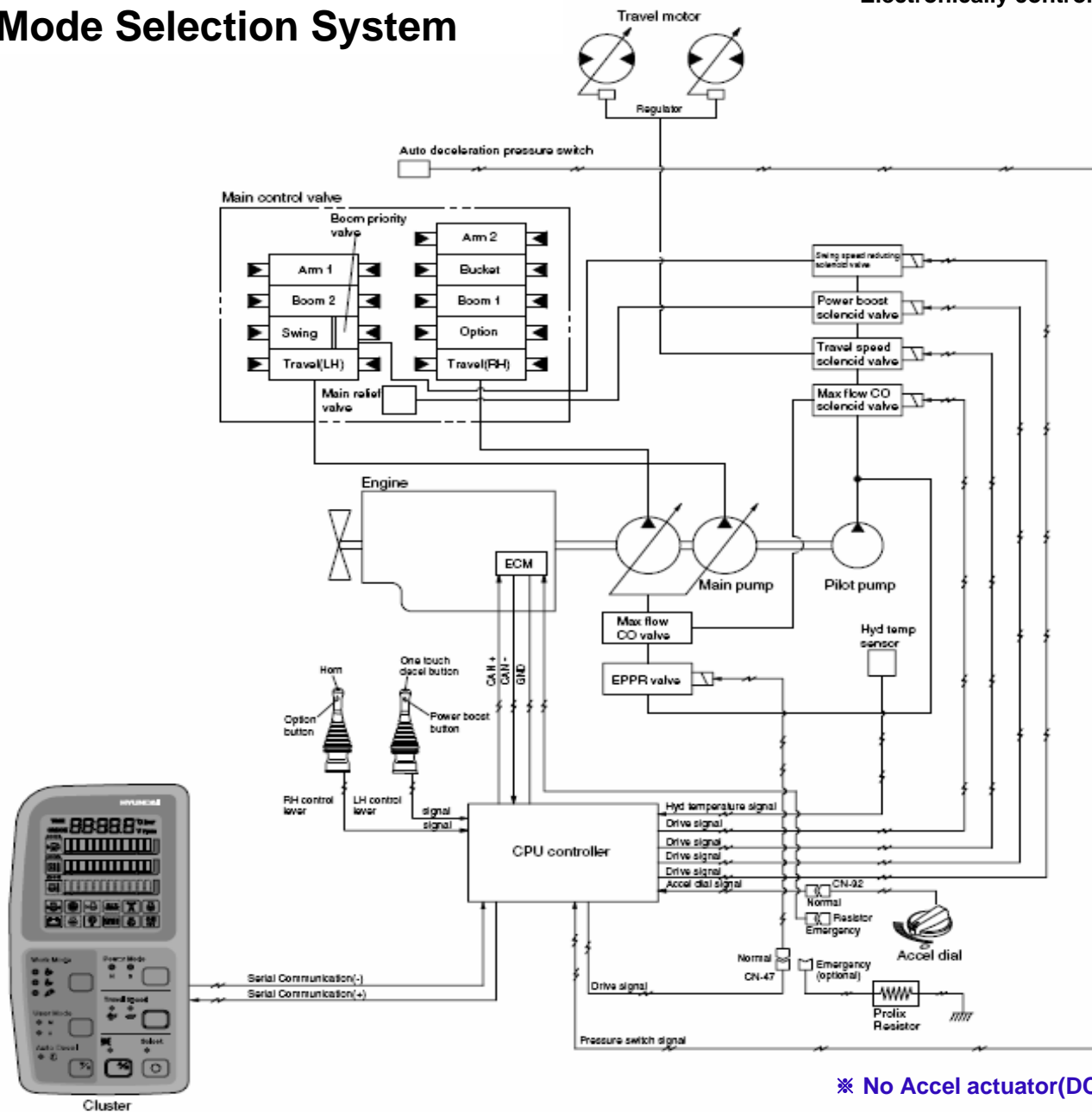
(Computer Aided Power Optimization)

1. CAPO System

1-1. Power Mode Selection System



1-1. Power Mode Selection System



※ No Accel actuator(DC Motor)

SUBJECT 1: Malfunction of RPM Meter on cluster(Mechanically controlled E/G)

Model	Serial No.	Operating Hour	Date
ROBEX210LC-7	#	Hr	Dec. 2004

1. Symptoms (including the operator mention)

- 1) RPM Meter displays 0 RPM when start the Engine.
- 2) Intermittently shows 630 ~ 680RPM on RPM Meter while E/G running.
- 3) Real E/G RPM is in normal.

2. Check & Measure

- 1) Check Voltage & Resistance value

Location	Spec.	Values	Remarks
SPEED SENSOR Resistance: CD-17(1),(2)	0.2 ~ 0.4k Ω	0.25k Ω	Good
SPEED SENSOR Voltage: CD-17(1),(2)	2 ~ 28Vac	1.17 ~ 2.14Vac	No good
CPU CONNECTOR(SPEED SENSOR) Resistance: CN-51(25),(26)	0.2 ~ 0.4k Ω	0.25k Ω	Good
CPU CONNECTOR(SPEED SENSOR) Voltage: CN-51(25),(26)	2 ~ 28Vac	1.17 ~ 2.14Vac	No good

- 2) Communication between CPU Controller and CLUSTER is good.
- 3) No ERROR CODE on CLUSTER.
- 4) CONNECTOR(CN-2,CN-9,CD-17,CN-51) on HARNESS check : **Finding rater in CN-2 connector.**

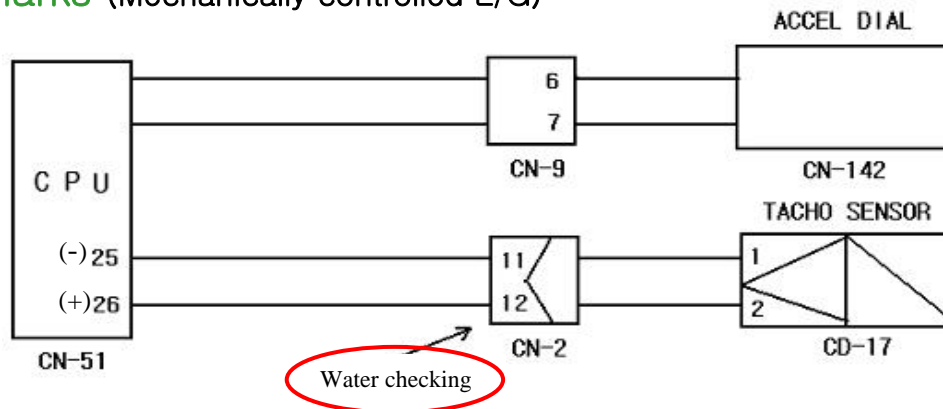
3. Cause

- Short circuit between CN-2(11)-(12) by water (Speed sensor signal is not normal).

4. Remedy

- 1) Re-connection of CN-2 after removal of water and washing.
- 2) Confirmation of normal display.

5. Remarks (Mechanically controlled E/G)

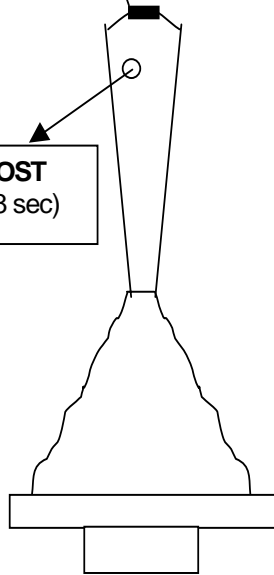


1-2. Switches on Joy Stick Lever

(No auto decel on R110LC-7)

ONE TOUCH DECEL
-high rpm / low rpm
-this button functions only when auto decel function on cluster is canceled

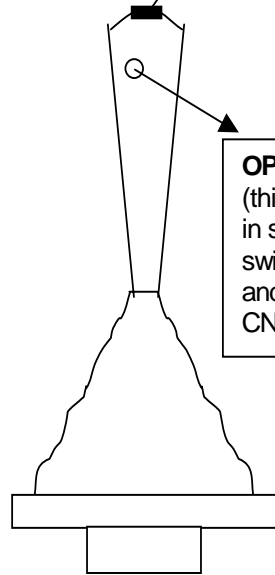
POWER BOOST
(360 bar for 8 sec)



LEFT HANDED

HORN

OPTION
(this button is placed in serial line with switch on dash board and puts voltage on CN66)



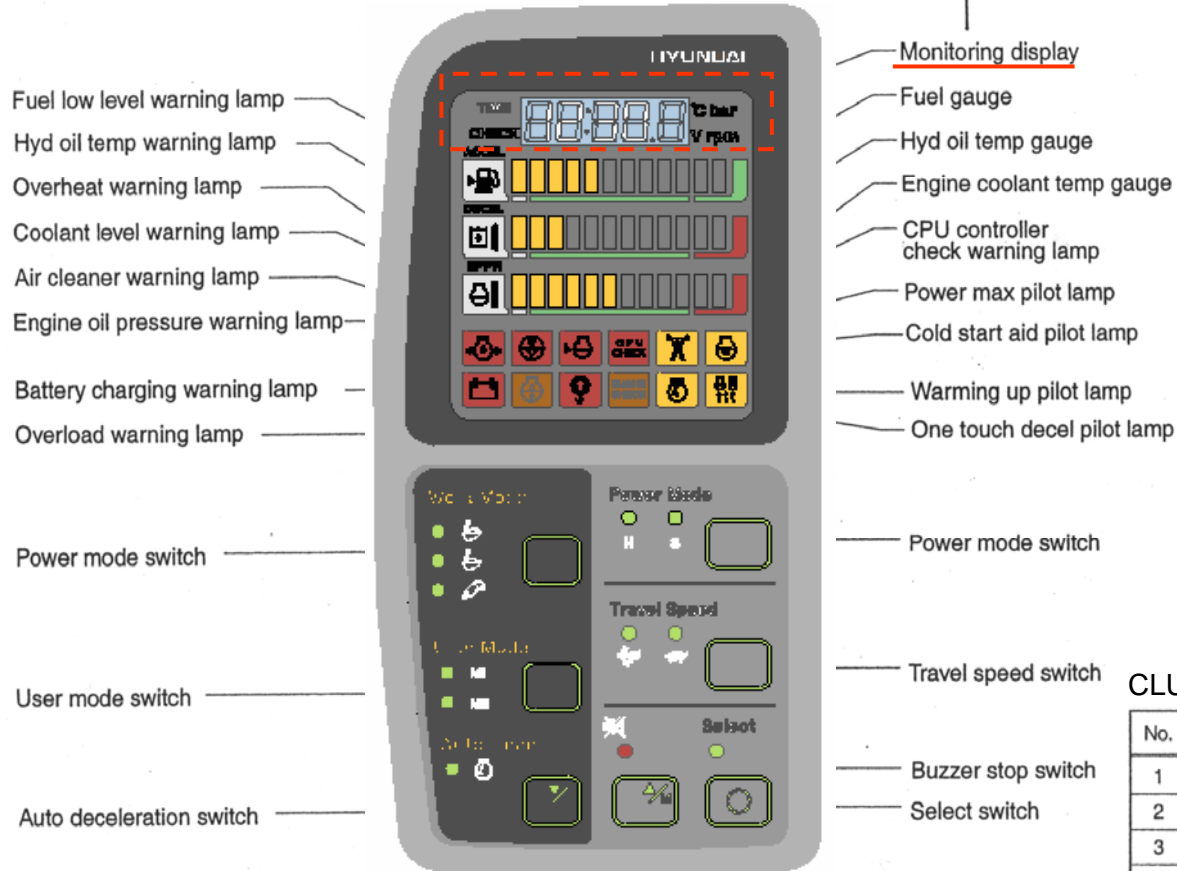
RIGHT HANDED

→ breaker activation for excavators with single breaker piping

1-3. Monitor Panel (Cluster)

1) Monitor panel feature

Via select switch it is possible to show sequentially:
RPM / TIME / EPPR pressure / CPU model & program version



CLUSTER Connector

No.	Signal	Input / Output
1	Power IG(24V)	Input(20~32V)
2	GND	Input(0V)
3	Serial-(RX)	Input(Vpp=12V)
4	Serial+(TX)	Output(Vpp=4V)

2) Cluster Check Procedure

(1) Start key: ON

- ① Check monitor initial 5 seconds
 - a. All lamps light up. → If not, change cluster
 - b. Buzzer sound.
- ② Check monitor after 5 seconds : Indicate cluster version and machine condition
 - a. Cluster program version : CL : 1.2 ← Indicates program version 1.2 for 2 seconds.
 - b. Tachometer : 0rpm
 - c. Fuel gauge : All light up below appropriate level
 - d. Hydraulic temperature : All light up below appropriate level
 - e. Engine coolant temperature gauge : All light up below appropriate level
 - f. Warning lamp
 - ※ During start key **ON** the engine oil pressure lamp and battery charging lamp go on, but it is not abnormal.
 - ※ When engine coolant temperature below 30°C, the warming up lamp lights up.
- ③ Indicating lamp state
 - a. Work mode selection : General work
 - b. Power mode selection : S mode
 - c. User mode selection : No LED ON
 - d. Auto decel LED : ON
 - e. Travel speed pilot lamp : Low(Turtle)

(2) Start of engine



- ① Check machine condition
 - a. Tachometer indicates at present rpm
 - b. Gauge and warning lamp : Indicate at present condition.
 - ※ When normal condition : All warning lamp OFF
 - c. Work mode selection : General work
 - d. Power mode selection : S mode
 - e. User mode selection : No LED ON
 - f. Auto decel LED : ON
 - g. Travel speed pilot lamp : Low(Turtle)
- ② When warming up operation
 - a. Warming up lamp : ON
 - b. 10 seconds after engine started, engine speed increases to 1200 rpm(Auto decel LED : ON)
 - ※ Others same as above ①.
- ③ When abnormal condition
 - a. The lamp lights up and the buzzer sounds.
 - b. If **BUZZER STOP** switch is pressed, buzzer sound is canceled but the lamp light up until normal condition.

3) How To Change The Program Version (1.X <-> 2.X) on The Cluster

You can switch the EPPR valve pressure set by selecting the version(1.x ↔ 2.x).

Step 1. Turn the key switch **ON**.

Step 2. Press the **SELECT** switch 3 times.

Step 3. While 7 segment on the cluster shows the version of the CPU controller program, for example **21C1.2** press the buzzer stop switch() + travel speed control switch() at the same time for 2 seconds.

The display changes to **21C2.2**, and it indicates that version 2.2(Option) is selected.

※ If you want to get back to ver:1.x, go to step 1~3.

CHANGING PROGRAM VERSION VIA
BUZZER STOP & TRAVEL SPEED SWITCH



Ref.] RPM & EPPR SETTING for H & S Mode

※ Refer to the SERVICE manual for the other model.

R210LC-7
#1001 ~

Mode	Application	Ver 5.X(STD)				Ver 6.X(OPT)			
		E/G RPM		Power shift EPPR		E/G RPM		Power shift EPPR	
		Unload	Load	Current (mA)	Pressure (kgf/cm ²)	Unload	Load	Current (mA)	Pressure (kgf/cm ²)
H	High power	2150± 50	1950	190± 30	2.5	2050	1850	220± 30	4
S	Standard power	2050± 50	1850	290± 30	8	1950	1750	260± 30	6
AUTO DECEL	Engine deceleration	1200± 100	-	600± 30	31	600± 30	-	600± 30	31
One touch decel	Engine quick deceleration	1050± 100	-	680± 30	35	680± 30	-	680± 30	35
KEY START	Key switch start position	1050± 100	-	680± 30	35	680± 30	-	680± 30	35

R290LC-7
~ #111

Mode	Application	Power set (%)	Engine rpm		Power shift by EPPR valve			
					Default		Option	
			Unload	Load	Current (mA)	Pressure (kgf/cm ²)	Current (mA)	Pressure (kgf/cm ²)
H	High power	100	2090± 50	1900	300± 30	9	270	7
S	Standard power	85	1950± 50	1800	340± 30	11	210	3
AUTO DECEL	Engine deceleration	-	1200± 100	-	700± 30	35	700± 30	35
One touch decel	Engine quick deceleration	-	800± 100	-	700± 30	35	700± 30	35
KEY START	Key switch start position	-	800± 100	-	700± 30	35	700± 30	35

4) Memory Set (U mode)

Through U mode, an operator can change the engine rpm and pump power and memorize it for his preference.

Mode	Operation
U	High idle rpm, auto decel rpm EPPR pressure can be modulated and memorized separately

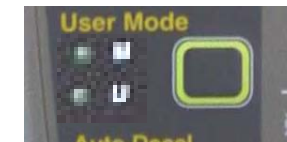
HOW TO MODULATE THE MEMORY SET

- Each memory mode has a initial set which are mid-range of max engine speed, auto decel rpm, and EPPR valve input current. When you select "U", cluster LCD displays.
- To change the engine high idle speed, press the USER mode switch and SELECT switch at the same time and then ACCEL blinks at 0.5 seconds interval.
 - By pressing ▲ or ▼ switch, █ will increase or decrease.
- To change DECEL rpm, press the USER mode switch and SELECT switch once more and then DECEL blinks at 0.5 seconds interval.
 - By pressing ▲ or ▼ switch, █ will increase or decrease.
- To change EPPR current, press the USER mode switch and SELECT switch one more and then EPPR blinks at 0.5 seconds interval.
 - By pressing ▲ or ▼ switch, █ will increase or decrease.
- To memorize the final setting, press the USER mode switch and SELECT switch one more time.



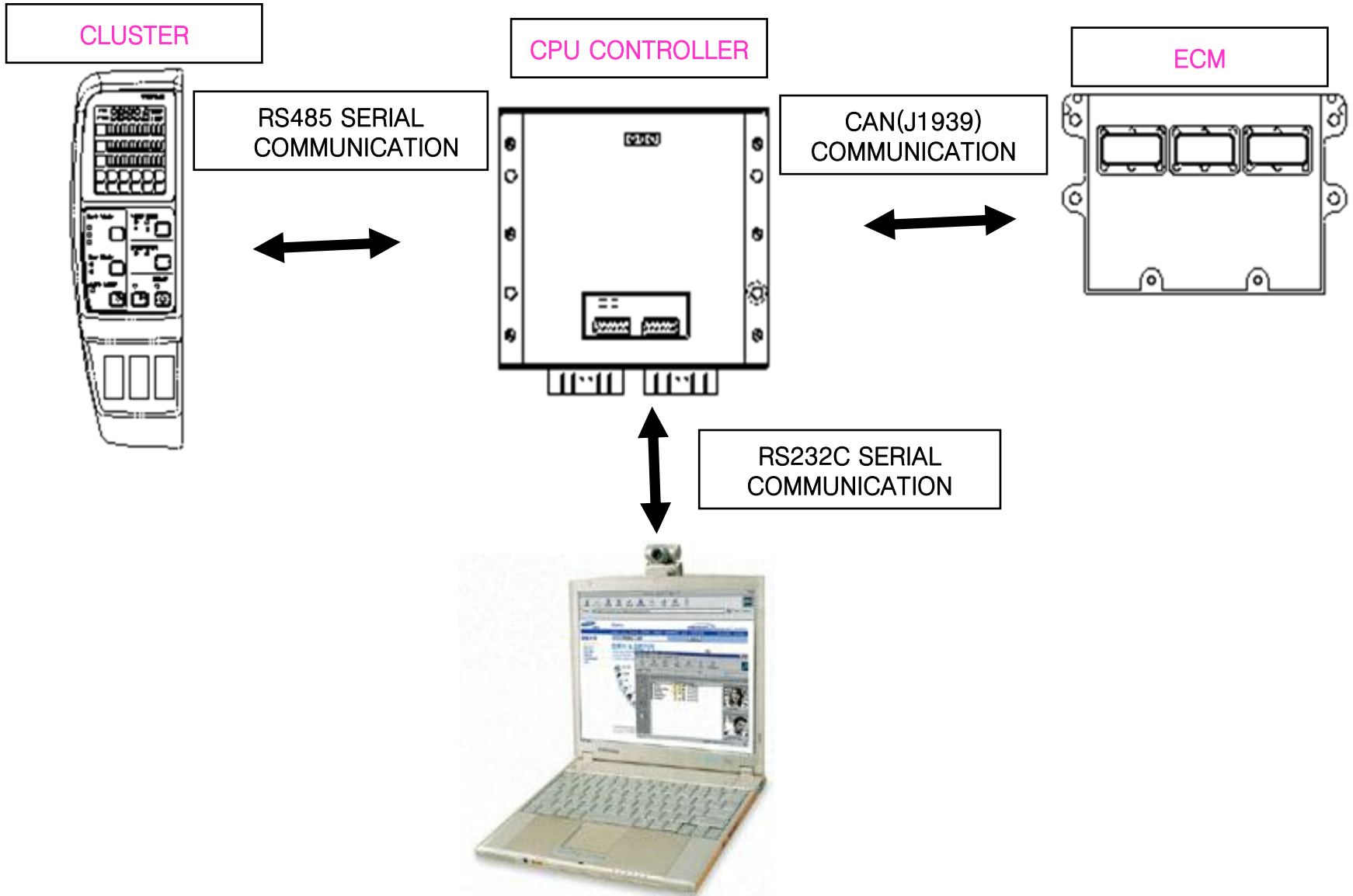
· LCD segment vs parameter setting Ex) R360LC-7A

Segment (█)	ACCEL (rpm)	DECEL (rpm)	EPPR (mA)
1	1400	Low idle(700)	150
2	1450	750	200
3	1500	800	250
4	1550	850	300
5	1600	900	350
6	1650	950	400
7	1700	1000	450
8	1750	1050	500
9	1800	Decel rpm(1100)	550
10	1850	1150	600



(Latest production excavator)

1-4. Communication



1-5. Automatic Deceleration System

1) Diagram

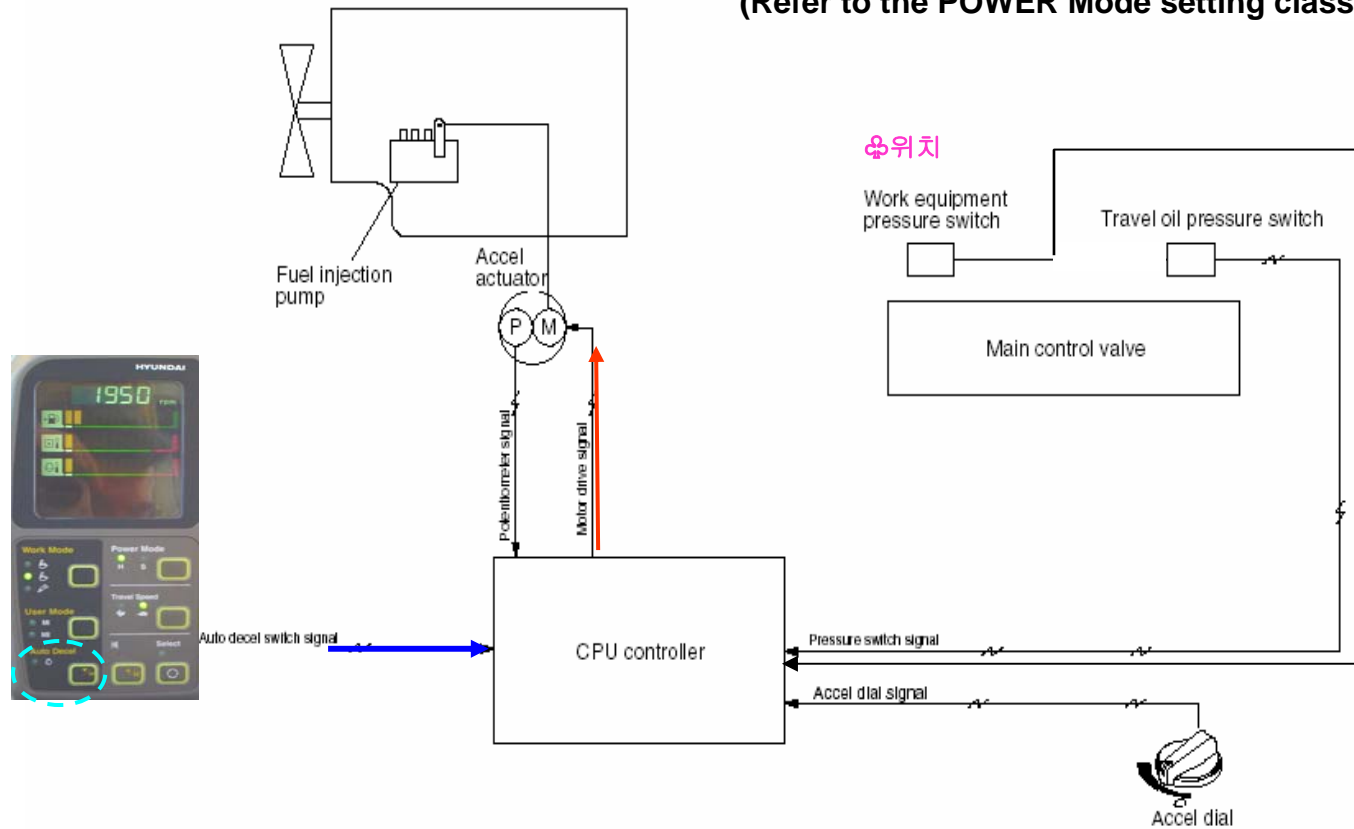
① Operation Delay time: 4 sec

- Work/Travel neutral

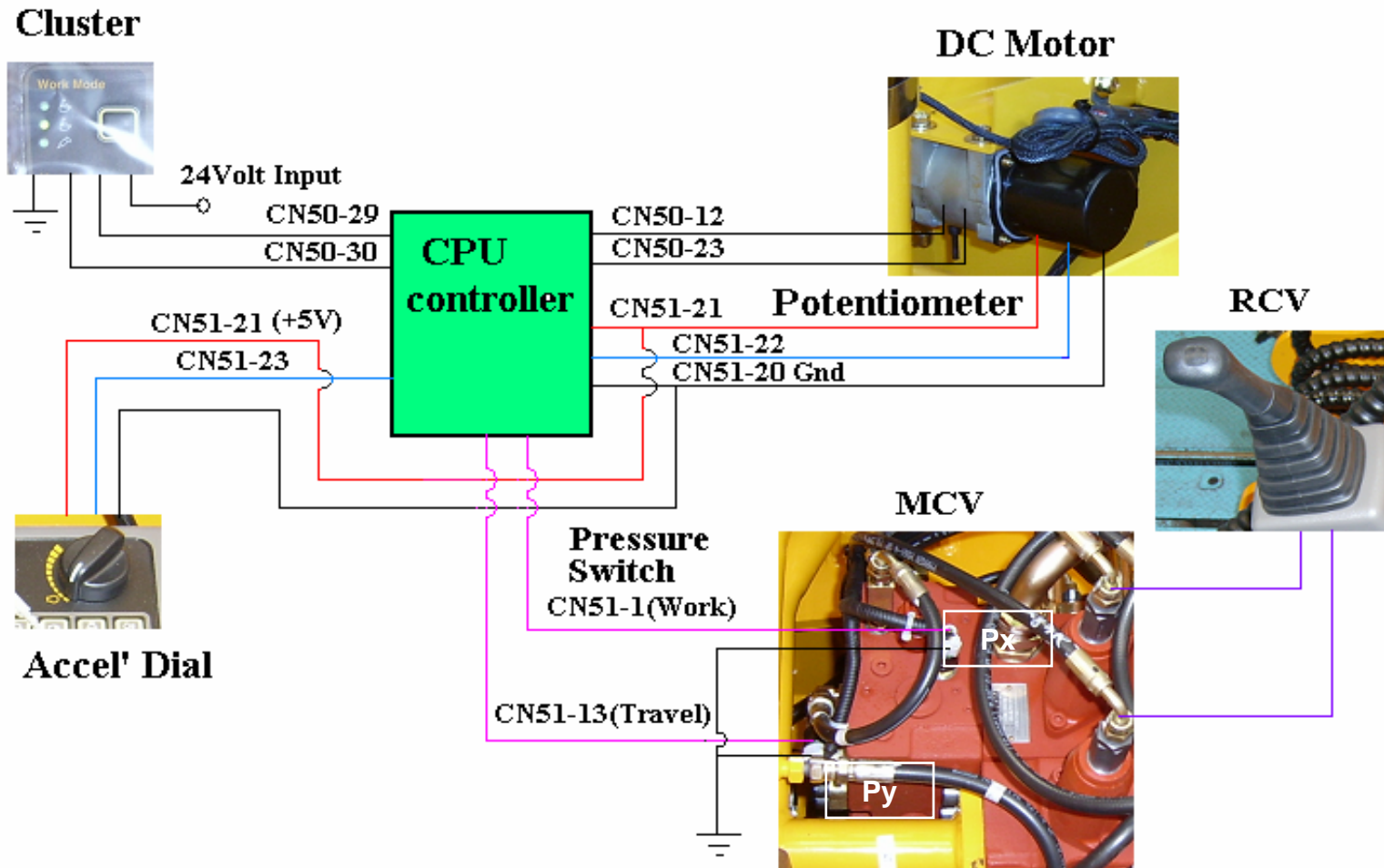
- Accel dial position: Higher than 4th

② E/G speed down shift : 1200 rpm

(Refer to the POWER Mode setting classified by MODEL)



2) Circuit



SUBJECT 1 : Malfunction of Auto deceleration

Model	Serial No.	Operating Hour	Date
ROBEX320LC-7	#	Hr	Dec.2005

1. Symptoms (including the operator mention)

- 1) Engine speed goes up 2000RPM(S-MODE) immediately when start the engine.
- 2) Malfunction of Auto deceleration.
- 3) No error code.

2. Check & Measure

- 1) Accel dial location is in maximum position.
- 2) Not drop to Auto deceleration speed in neutral position.
- 3) Pressure switch check.
 - CD-6(Travel pressure SW) check on CN-51(13) in neutral position : 0Ω --- O.K
 - CD-7(Work pressure SW) check on CN-51(1) in neutral position : $\infty\Omega$ --- Not O.K

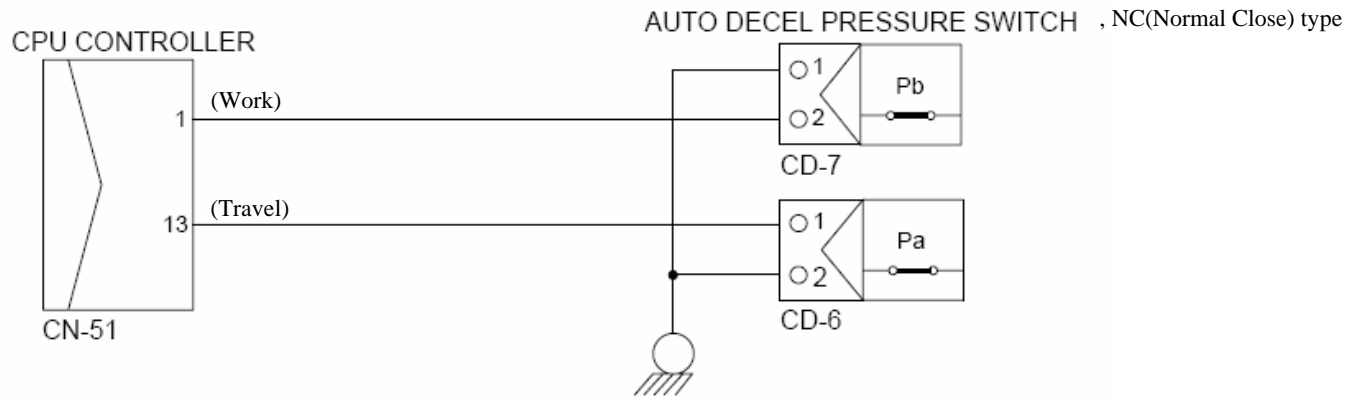
3. Cause

: CD-7(Work pressure SW) connector on MCV is not connected.

4. Remedy

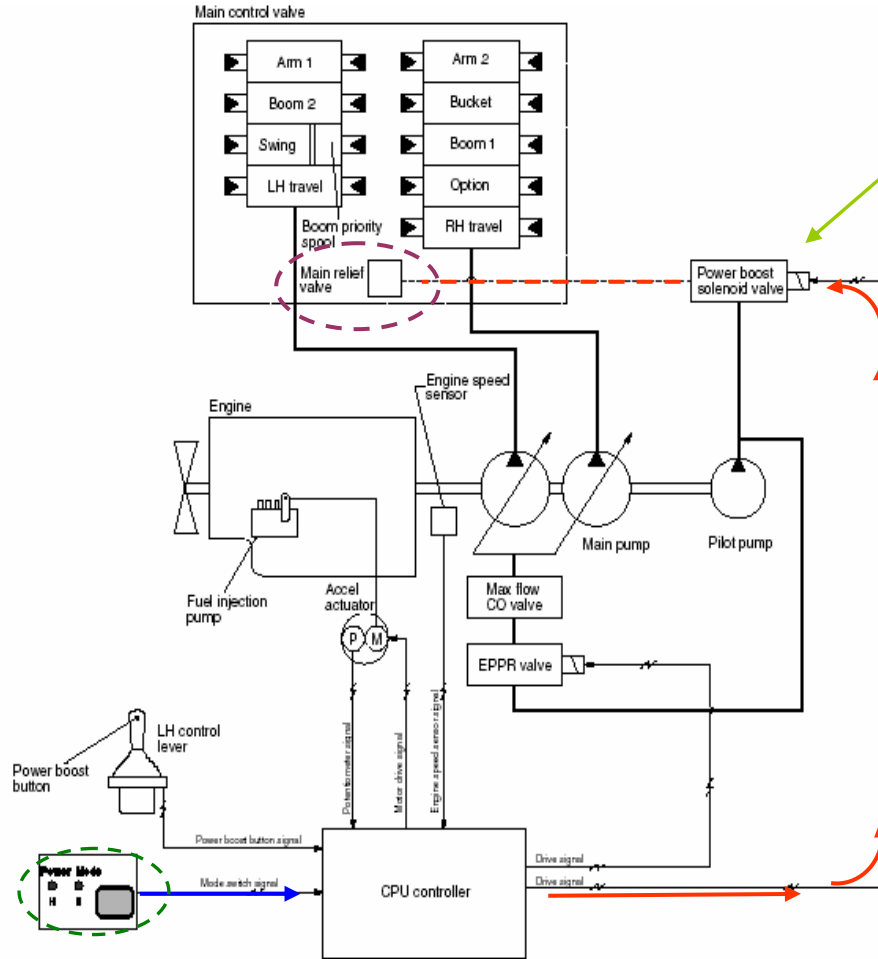
; Connection of CD-7(Work pressure SW) on MCV.

5. Remarks



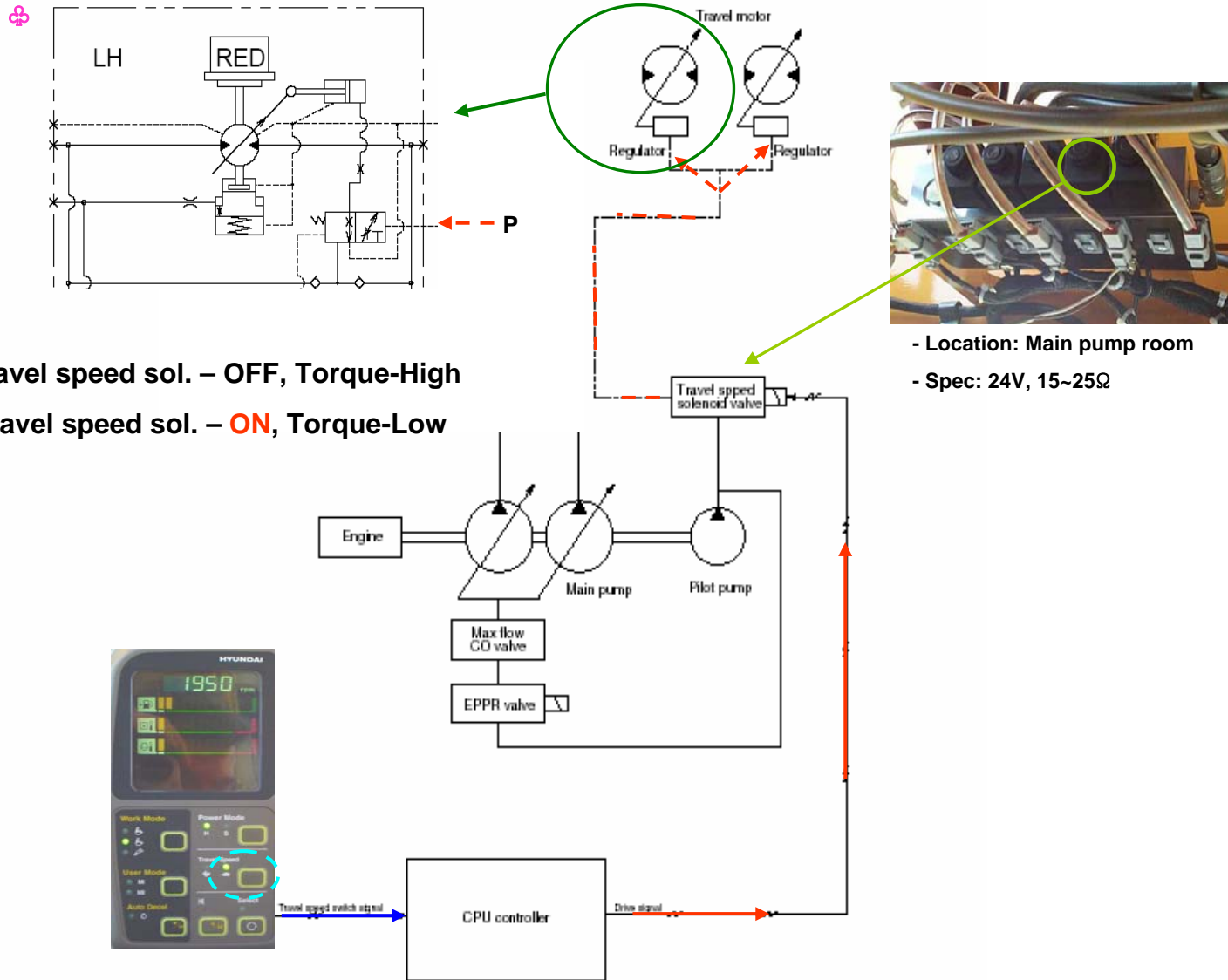
1-6. Power Boost System

- ◆ Power MODE condition: H, S or M
- ◆ Power Boost Pressure: 330 → 360bar



-Location: Main pump room
 -Spec: 24V, 15~25Ω

1-7. Travel Speed Control System



◆ Low speed : Travel speed sol. – OFF, Torque-High

◆ High speed : Travel speed sol. – ON, Torque-Low

- Location: Main pump room
- Spec: 24V, 15~25Ω

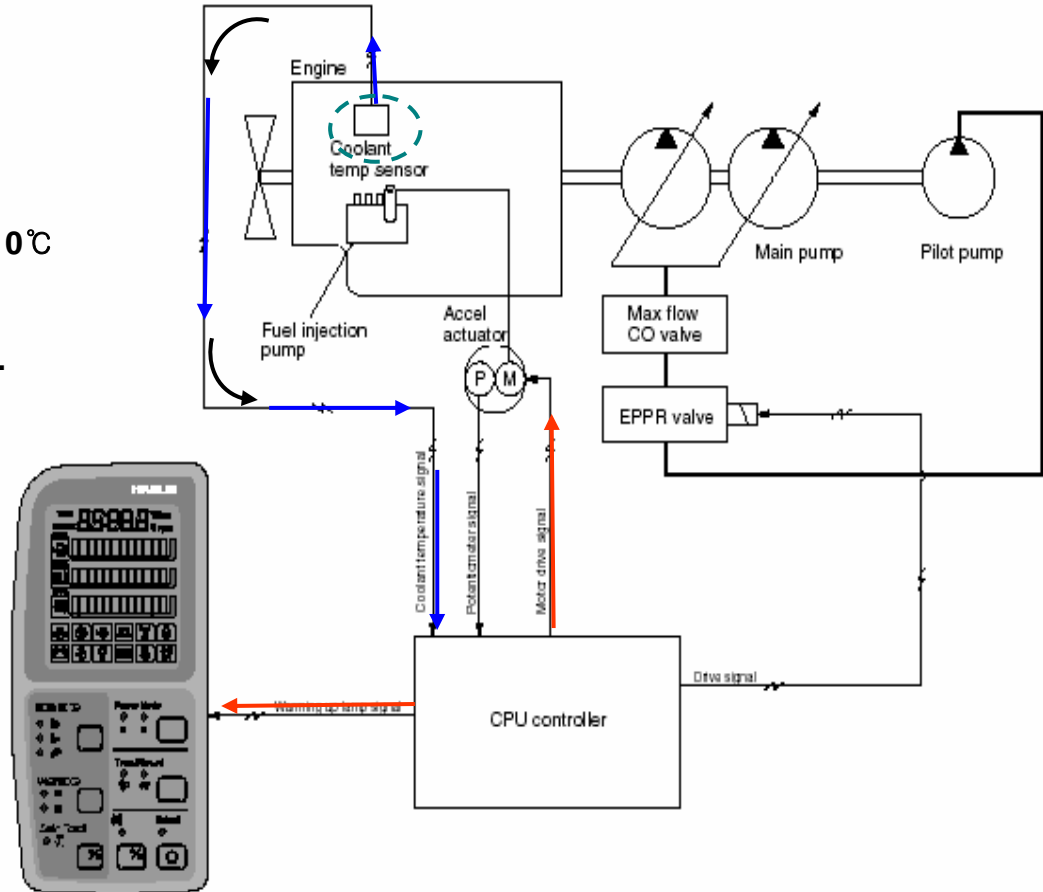
1-8. Automatic Warming Up & Engine Overheat prevention

1) Automatic Warming Up

- Coolant Temperature: Below 30°C
- Accel Dial: Lower than 3rd position
- E/G speed: 1000rpm

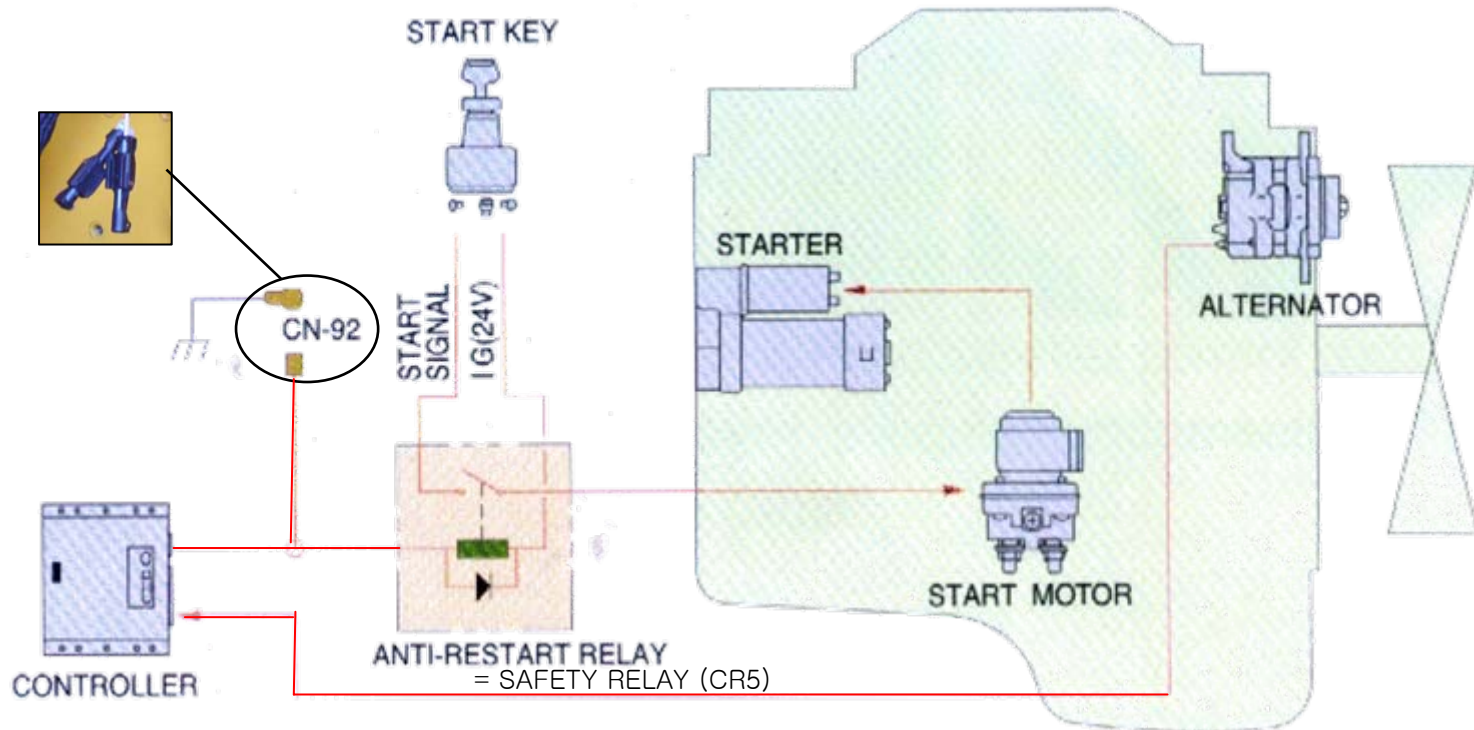
2) Overheat prevention

- Coolant Temperature: Higher than 110°C
- Accel Dial: Higher than 8th position
- E/G speed: Accel dial 7th setting rpm.



1-9. Anti - Restart Function

- ① To **protect the start motor from inadvertent restarting**, CPU controller isolates the start motor control line after the engine is in operation condition.
- Start relay disabled after 10sec of E/G start.
- ② By-pass connector (CN 92) can make the engine start when CPU controller is removed.



SUBJECT : Malfunction of Anti-restart

Model	Serial No.	Operating Hour	Date
ROBEX140LC-7			Oct.2004

1. Symptoms (including the operator mention)

- 1) Engine start is normal.
- 2) Malfunction of Anti-restart
- 3) No Error code.

2. Check & Measure

- 1) Engine speed display and Battery charge lamp are normal.
- 2) Check resistance between CN-50(11) and shsh : 0.3Ω (always).

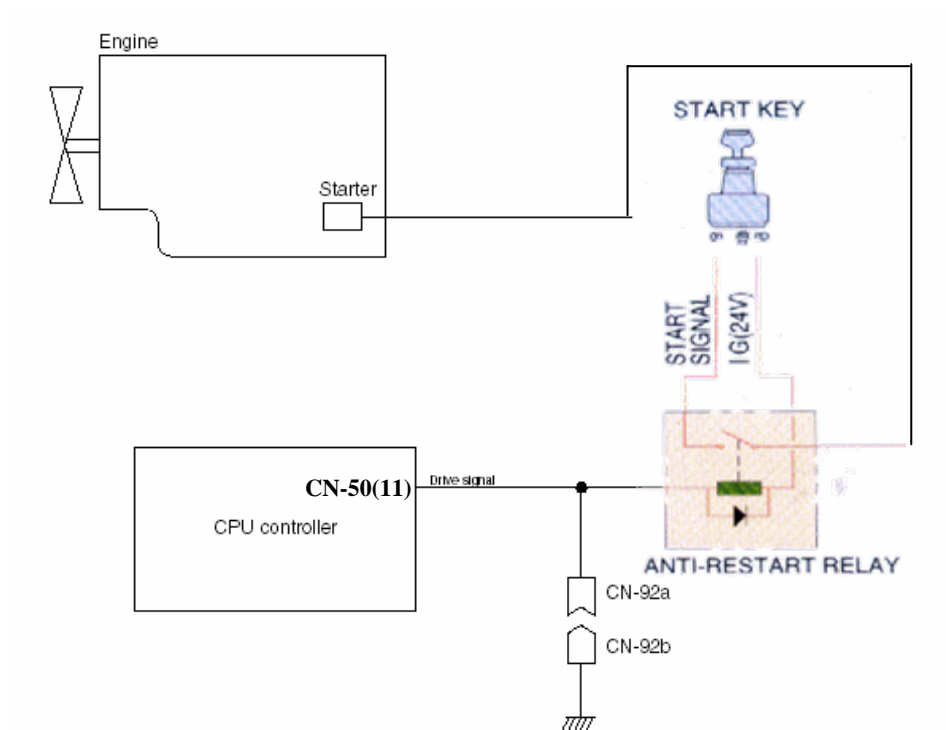
3. Cause

; CN-92a and CN-92b connection.

4. Remedy

- 1) Separation of CN-92a and CN-92b.
- 2) Confirmation of normal Anti-restart function.

5. Remarks



1-10. Location of Solenoid Valves

- 1) Safety SOL.
- 2) Power Booster SOL.
(330<->360bar)
- 3) Max. Flow Cut.Off SOL.
: (85% <-> 100%)
- 4) Travel; Speed
- 5) Boom Priority SOL.
: (90/180도)



1

2

3

4

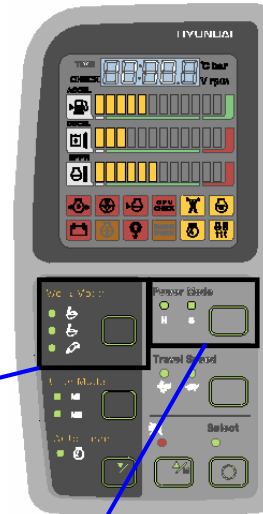
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1-11. Work/Power Mode Selection

1) STRUCTURE OF CAPO SYSTEM

CAPO, Computer Aided Power Optimization system, is the name of mode selection system developed by Hyundai.



(1) Work mode

※ Refer to the next page for details.

3 work modes can be selected for the optimal work speed of the machine operation.

① Heavy duty work mode

The boom priority solenoid is activated to make the boom operation speed faster.

② General work mode

When key switch is turned ON, this mode is selected automatically and swing operation speed is faster than heavy duty work mode.

③ Breaker operation mode

It sets the pump flow to the optimal operation of breaker by activating the max flow cut-off solenoid.

(2) Power mode

Power mode designed for various work loads maintains high performance and reduces fuel consumption.

- H mode : High power
- S mode : Standard power

(3) User mode

Through 2 memory sets of M1 and M2, you can change the engine and pump power and memorize it for your preference.

- M1 : Memory mode 1
- M2 : Memory mode 2

2) Work Mode Selection detail

; One of 3 work modes can be selected properly for the work condition of the machine.

Work Mode	Function	Swing priority solenoid	Max flow cut-off solenoid
Heavy Mode	Operation speed for Boom & arm is faster than G mode	Off	Off
General Mode	Default mode. Swing operation speed is faster than Heavy duty mode	On	Off
Breaker Mode	It sets the pump flow to the optimal operation of Breaker	Off	On

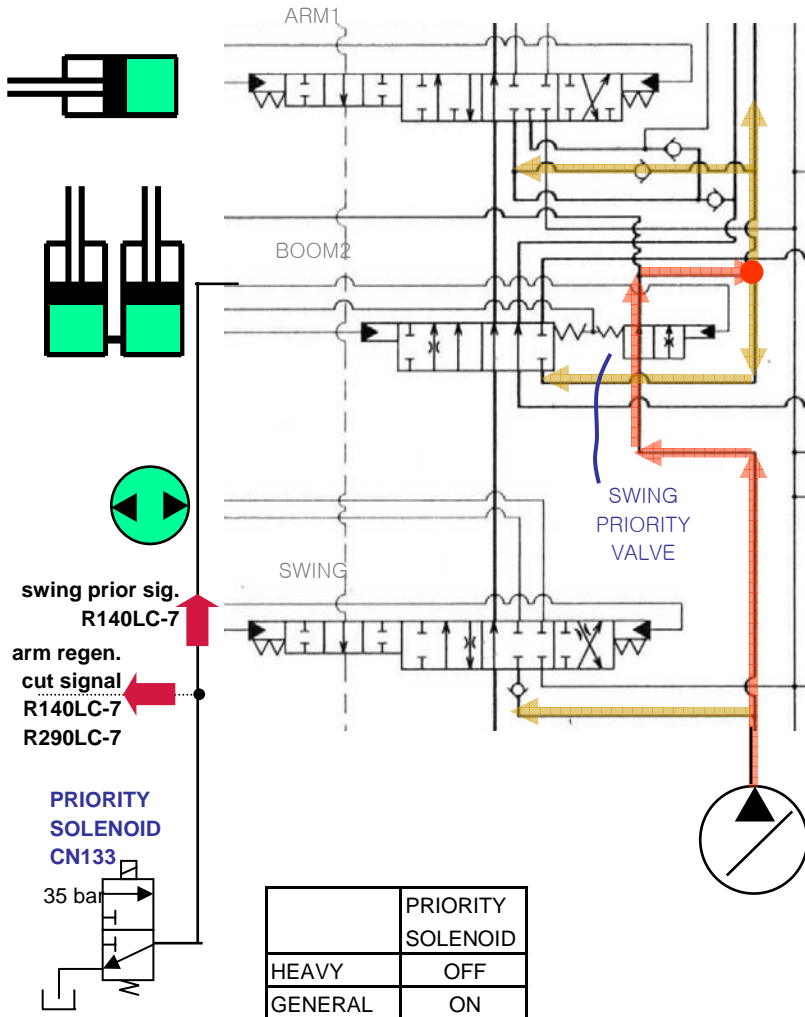


3) Boom Priority System (Heavy Mode/General Mode)

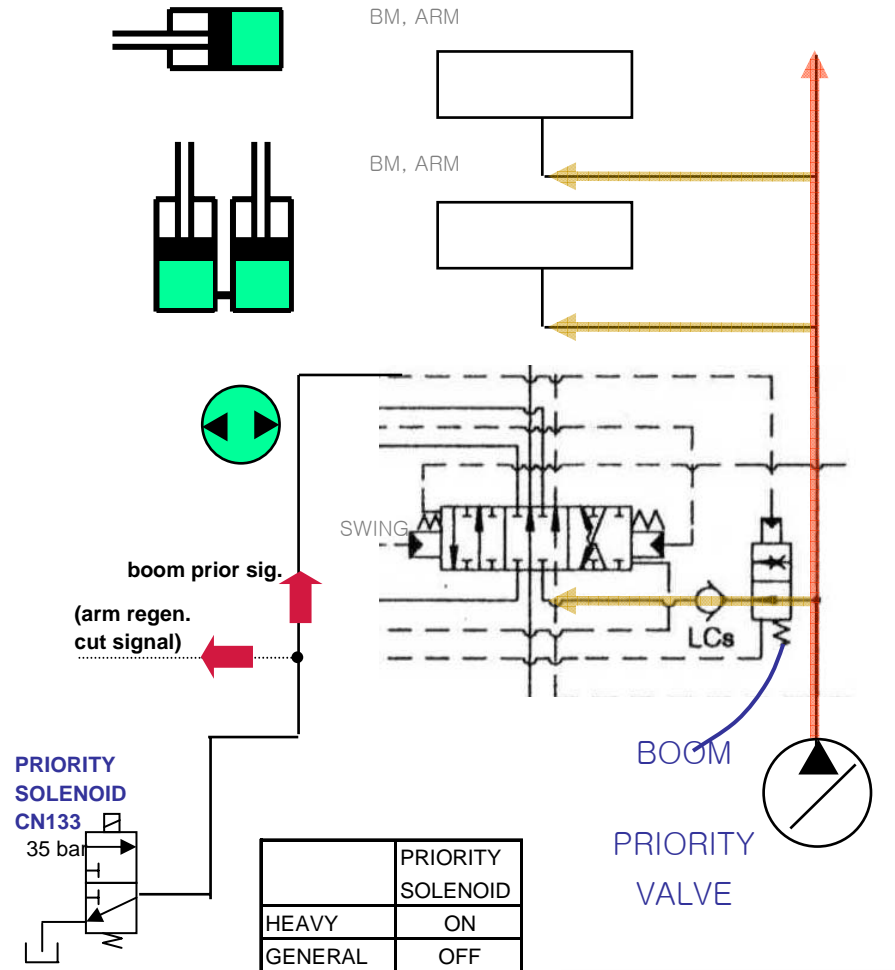
- When selecting HEAVY work mode, the priority solenoid CN133 is either DE-energised, either ENergised. (depends on machine type: see below)
 Anyhow, boom (&arm) speed will be higher and the swing speed will be lower, when operating the work equipment simultaneously.

In **general mode**, there's no arm regeneration (sending oil from rod cyl. side into large cyl. side of arm cyl.), due to the presence of the arm regeneration cut signal (Pb4). This signal commands a specific valve on the MCV. At this time, the arm operates with normal (lower) arm speed.

R140LC-7 & R290LC-7 with Hanil MCV's



R210LC-7<->R320LC-7 with Kawasaki MCV's



In this case a pilotable restriction is placed in the entrance line of the swing spool.

1-12. Monitoring Display on Cluster

Information of machine performance as monitored by the CPU controller can be displayed on the cluster when the operator selects a display mode by touching **SELECT** switch alone or with **BUZZER STOP** switch on the cluster as below.

Display group	How to select display mode		Name	Display on the cluster	
	Group selection	Display mode selection			
Group 0 (Default)	Way 1 Key switch ON or START	Initial	Engine rpm	950 rpm	
		Touch SELECT 1 time	Time	12:30	
		Touch SELECT 2 times	Power shift pressure (EPPR valve)	EP: 10 bar	
		Touch SELECT 3 times	CPU model & version	21C12	
	Way 2 Touch AUTO DECEL switch while pressing BUZZER STOP at group 1-4.	Touch SELECT 4 times	Option (Only when a pressure sensor is installed)	Front pump pressure	P1: 100 bar
		Touch SELECT 5 times		Rear pump pressure	P2: 200 bar
		Touch SELECT 6 times		Pilot pressure	P3: 30 bar
		Default		Battery voltage(V)	b24.8v
Group 1 (Volt, temp, EPPR press, version)	Touch SELECT switch once while pressing BUZZER STOP. In this group SELECT LED ON	Touch SELECT 1 time	Potentiometer voltage(V)	Pa: 25v	
		Touch SELECT 2 times	Accel dial voltage(V)	dL: 3.8v	
		Touch SELECT 3 times	Hydraulic oil temperature(°C)	Hd: 50°C	
		Touch SELECT 4 times	Coolant temperature(°C)	Ct: 85°C	
Group 2 (Error code)	Touch SELECT switch twice while pressing BUZZER STOP. In this group BUZZER STOP LED blinks	Default	Current error	Er: 03	
		Touch SELECT 1 time	Recorded error (Only key switch ON)	Er: 03	
		Press down (⊕) & SELECT at the same time	Recorded error deletion (Only key switch ON)	Er: 00	
Group 3 (Switch input)	Touch SELECT switch 3 times while pressing BUZZER STOP. In this group SELECT LED blinks at 0.5sec interval	Default	Pump prolix switch	PP: on or off	
		Touch SELECT 1 time	Auto decel pressure switch	dP: on or off	
		Touch SELECT 2 times	Power boost switch	Pb: on or off	
		Touch SELECT 3 times	Travel oil pressure switch	aP: on or off	
		Touch SELECT 4 times	One touch decel switch	od: on or off	
		Touch SELECT 5 times	Travel alarm switch	br: on or off	
		Touch SELECT 6 times	Preheat switch	PH: on or off	

SEE ERROR CODES TABLE P. 24

Display group	How to select display mode		Name	Display on the cluster
	Group selection	Display mode selection		
Group 4 (Output)	Touch SELECT switch 4 times while pressing BUZZER STOP. In this group SELECT LED blinks at 1sec interval	Default	Hourmeter	Ho: on or off
		Touch SELECT 1 time	Neutral relay (Anti-restart relay)	nr: on or off
		Touch SELECT 2 times	Travel speed solenoid	tS: on or off
		Touch SELECT 3 times	Power boost solenoid (2-stage relief solenoid)	PS: on or off
		Touch SELECT 4 times	Boom priority solenoid "Swing" "	bS: on or off
		Touch SELECT 5 times	Travel alarm	AU: on or off
		Touch SELECT 6 times	Max flow cut off solenoid	FS: on or off
		Touch SELECT 7 times	Preheat relay	PR: on or off

※ By touching SELECT switch once while pressing BUZZER STOP, display group shifts.
Example : Group 0 → 1 → 2 → 3 → 4 → 0



1) Description of Monitoring Display

Group	Display	Name	Description
Group 0	2250 rpm	Engine speed	It displays current engine speed detected by engine speed sensor from 500 to 3000rpm. Range : 500~3000rpm by 10rpm
	TIME 12 : 30	Time	It displays current time(12 is hour and 30 is minute) Range : Hour(1~12), minute(00~59)
	EP : 10bar	Power shift pressure of EPPR valve	It shows that pump power shift pressure of EPPR valve being controlled by the CPU controller is 10bar. Range : 00~50bar by 1bar
	21 : C1.4 *21 : C5.0	Model and CPU program version	It shows that machine model(R210LC-7) and the program version of the CPU controller is 1.4. Version display range : 0.0~9.9 by 0.1
	P1 : 100bar (Option)	Front pump pressure	It displays front pump pressure of 100bar which is detected by pressure sensor. Range : 000~500bar by 10bar
	P2 : 200bar (Option)	Rear pump pressure	It displays rear pump pressure of 200bar which is detected by pressure sensor. Range : 000~500bar by 10bar
	P3 : 30bar (Option)	Pilot pump pressure	It displays pilot pump pressure of 30bar which is detected by pressure sensor. Range : 00~50bar by 1bar

Group 1	b : 24.8V	Battery voltage	It shows that battery power of 24.8V is supplied into CPU controller. Range : 00.0~48.0V by 0.1V
	Po : 2.5V	Potentiometer voltage	It shows that potentiometer signal voltage is 2.5V. Range : 0.0~5.0V by 0.1V
	dL : 3.8V	Accel dial voltage	It shows that accel dial signal voltage is 3.8V. Range : 0.0~5.0V by 0.1V
	Hd : 50°C	Hydraulic oil temperature	It shows that hydraulic oil temperature detected by temperature sensor is 50°C. Range : 0~150°C by 1°C
	Ct : 85°C	Coolant temperature	It shows that coolant oil temperature detected by temperature sensor is 50°C. Range : 0~150°C by 1°C

Group	Display	Name	Description
Group 2	CHECK Er : 03	Current error	It shows that current error of 03(Short circuit in pump EPPR valve system) is diagnosed by self diagnosis system in the CPU controller. If more than 2 errors, when pressing ▼ or ▲ switch, other error codes show. Range : 00~58
	TIME Er : 03	Recorded error	It shows recorded error code of 03 which is diagnosed before. If more than 2 error codes, when pressing ▼ or ▲ switch, other error codes show. Range : 00~58
	TIME Er : 00	Recorded error deletion	It shows all recorded error codes are removed in the CPU controller memory.

Group 3	PP : on or off	Pump prolix switch	PP : on Shows that pump prolix switch is turned on(At emergency position). PP : off Shows that pump prolix switch is turned off(At normal position).
	dP : on or off	Auto decel pressure switch	dP : on Shows that auto decel pressure switch is pressed on (No operation of control lever). dP : off Shows that auto decel pressure switch is released off (Operation of control lever).
	Pb : on or off	Power boost switch	Pb : on Shows that power boost switch is pressed on (Activated). Pb : off Shows that power boost switch is released off (Canceled).
	oP : on or off	Travel oil pressure switch	oP : on Shows that travel oil pressure switch is pressed on (No operation of travel control lever). oP : off Shows that travel oil pressure switch is released off (Operation of travel control lever).
	od : on or off	One touch decel switch	od : on Shows that one touch decel switch is pressed. od : off Shows that one touch decel switch is released.
	br : on or off	Travel alarm switch	br : on Shows that travel alarm function is selected. br : off Shows that travel alarm function is canceled.
	PH : on or off	Preheat switch	PH : on Shows that preheat switch is pressed. PH : off Shows that preheat switch is released.

Group	Display	Name	Description
Group 4	Ho : on or oFF	Hourmeter	Ho : on Shows that hourmeter is activated by CPU controller. Ho : oFF Shows that hourmeter is turned off.
	nr : on or oFF	Neutral relay (Anti-restart relay)	nr : on Shows that neutral relay for anti-restarting function is activated(Engine start is possible). nr : oFF Shows that neutral relay is turned off to disable the engine restart.
	te : on or oFF	Travel speed solenoid	te : on Shows that travel speed solenoid is activated (High speed). te : oFF Shows that travel speed solenoid is released (Low speed).
	PS : on or oFF	Power boost solenoid	PS : on Shows that power boost solenoid is activated to maximize the power(Power up). PS : oFF Shows that power boost solenoid is turned off(Cancel the power boost function).
	bs : on or oFF	Boom priority solenoid	bs : on Shows that boom priority solenoid is activated. bs : oFF Shows that boom priority solenoid is released.
	Ru : on or oFF	Travel alarm	Ru : on Shows that travel buzzer is activated. Ru :oFF Shows that travel buzzer is canceled.
	FS : on or oFF	Max flow cut off solenoid	FS : on Shows that max flow cut off solenoid is activated. FS : oFF Shows that max flow cut off solenoid is released.
	PR : on or oFF	Preheat relay	PR : on Shows that preheat relay is activated. PR : oFF Shows that preheat relay is released.

2) Error Codes Table

Fault code No.	Description
1	Short circuit in governor motor system
2	Potentiometer circuit is shorted to Vcc(5V) or battery +
3	Short circuit in pump EPPR valve system
4	Short circuit in boom down EPPR valve system (OPTION)
5	Short circuit in travel speed solenoid system
6	Short circuit in power boost solenoid system
7	Short circuit in max flow solenoid system
10	Short circuit in hour-meter system
11	Accel dial circuit is shorted to Vcc(5V) or battery +
12	P1 pressure sensor circuit is shorted to power supply(24V) line (OPTION)
13	P2 pressure sensor circuit is shorted to power supply(24V) line (OPTION)
14	P3 pressure sensor circuit is shorted to power supply(24V) line (OPTION)
15	Boom down pressure circuit is shorted to power supply(24V) line (OPTION)
16	Governor motor circuit is open or shorted to ground
17	Potentiometer circuit is open or shorted to ground
18	Pump EPPR valve circuit is open or shorted to ground
19	Boom down EPPR valve circuit is open or shorted to ground (OPTION)
20	Travel speed solenoid circuit is open or shorted to ground
21	Power boost solenoid circuit is open or shorted to ground
22	Max flow solenoid circuit is open or shorted to ground
25	Hour-meter circuit is open or shorted to ground
26	Accel dial circuit is open or shorted to ground
27	P1 pressure sensor circuit is open or shorted to ground (OPTION)
28	P2 pressure sensor circuit is open or shorted to ground (OPTION)
29	P3 pressure sensor circuit is open or shorted to ground (OPTION)
30	Boom down pressure sensor circuit is open or shorted to ground (OPTION)
31	Engine preheater circuit is open or shorted to ground
32	Travel alarm buzzer circuit is open or shorted to ground
33	Alternator circuit is open or shorted to ground
34	Controller input voltage is below 18V
35	Controller input voltage is over 38V
36	Communication error with cluster
37	Engine speed sensor circuit is open or shorted to ground
38	Anti-restart relay circuit is open or shorted to ground
39	Accel actuator does not stop at a target position
40	There is more than 500rpm difference between target speed and actual speed

After ignition on, push 2 times the buzzer stop & select switch simultaneously, to get into the error code group.

Fault code No.	Description
41	Hydraulic oil temperature sensor circuit is shorted to ground
42	Fuel level sensor circuit is shorted to ground
43	Coolant temperature sensor circuit is shorted to ground
44	Boom up pressure sensor circuit is shorted to power supply(24V) line (OPTION)
45	Hydraulic oil temperature sensor circuit is open or shorted to battery +
46	Fuel level sensor circuit is open or shorted to battery +
47	Coolant temperature sensor circuit is open or shorted to battery +
48	Boom up pressure sensor circuit is open or shorted to ground (OPTION)
49	Engine preheater circuit is shorted to battery +
51	Boom priority solenoid circuit is open or shorted to ground
56	Travel alarm buzzer circuit is shorted to battery +
58	Boom priority solenoid circuit is shorted to battery +

(Not all error codes are applicable for the R110-7)

3) Engine Error Codes List for R290/360LC-7 (Cummins QSB/QSC)

Fault code No.	Description	Description
111	ECM internal hardware error.	Possible no effect or engine may run rough or not start.
115	No engine speed or position signal detected at pin 17 of the engine harness.	Engine power derate. Possible white smoke.
121	No engine speed or position signal detected at pin 9 of the engine harness	No engine speed and position backup for main speed/position sensor.
122	High voltage detected at the boost pressure sensor signal pin 45 of the engine harness.	Engine will derate to no-boost fueling.
123	Low voltage detected at boost pressure sensor signal pin 45 of the engine harness.	Engine will derate to no-boost fueling.
131	High voltage detected at throttle position signal pin 30 of the machine harness.	Engine idles when idle validation switch indicates idle and ramps up to a default set speed when the idle validation switch indicates off-idle.
132	Low voltage detected at throttle position signal pin 30 of the machine harness.	Engine idles when idle validation switch indicates idle and ramps up to a default set speed when the idle validation switch indicates off-idle.
133	High voltage detected at remote throttle position signal pin 9 of the machine harness.	Engine will not respond to remote throttle input.
134	Low voltage detected at remote throttle position signal pin 9 of the machine harness.	Engine will not respond to remote throttle input.
135	High voltage detected at oil pressure signal pin 33 of the engine harness.	Default value used for oil pressure. No engine protection for oil pressure.
141	Low voltage detected at oil pressure signal pin 33 of the engine harness.	Default value used for oil pressure. No engine protection for oil pressure.
143	Oil pressure signal indicates oil pressure below the low engine protection limit.	Power and/or speed derate and possible engine shutdown if engine protection shutdown feature is enabled.
144	High voltage detected at coolant temperature signal pin 23 of the engine harness.	Default value used for coolant temperature. No engine protection for coolant temperature.
145	Low voltage detected at coolant temperature signal pin 23 of the engine harness.	Default value used for coolant temperature. No engine protection for coolant temperature.
146	Coolant temperature signal indicates coolant temperature has exceeded the minimum engine protection limit.	Power derate and possible engine shutdown feature is enabled.
147	A frequency below a calibrated value has been detected at the frequency throttle signal pin 4 of the engine harness.	Engine will not respond to changes in frequency throttle. Engine will go to low idle.
148	A frequency below a calibrated value has been detected at the frequency throttle signal pin 4 of the engine harness.	Engine will not respond to changes in frequency throttle. Engine will go to low idle.
151	Coolant temperature signal indicates coolant temperature has exceeded the maximum engine protection limit.	Speed derate and possible engine shutdown if engine protection shutdown feature is enabled.
153	High voltage detected at intake manifold temperature signal pin 34 of the engine harness.	Default value used for intake manifold temperature. No engine protection for intake manifold temperature.
154	Low voltage detected at intake manifold temperature signal pin 34 of the engine harness.	Default value used for intake manifold temperature. No engine protection for intake manifold temperature.
155	Intake manifold air temperature signal indicates intake manifold air temperature is above the maximum engine protection limit.	Speed derate and possible engine shutdown if engine protection shutdown feature is enabled.
191	Air conditioner clutch driver signal indicates a short to ground when commanded on.	Air conditioner clutch will not operate.
211	Machine specific fault code has occurred.	No effect on engine performance.
221	High voltage detected at ambient air pressure signal pin 32 of the engine harness.	Engine power derate.

Fault code No.	Description	Description
222	Low voltage detected at ambient air pressure signal pin 32 of the engine harness.	Engine power derate.
234	Engine speed signal indicates engine speed has exceeded the overspeed limit.	Fuel to injectors disabled until engine speed falls below the overspeed limit.
235	Coolant level signal at pin 37 of the engine harness indicates coolant level is low.	Power and/or speed derate and possible engine shutdown if engine protection shutdown feature is enabled.
241	Vehicle speed signal on pins 8 and 18 of the machine harness has been lost.	Engine speed limited to "Max. Engine Speed without VSS". Cruise control, gear-down protection and the road speed governor will not work. Trip information data that is based on mileage will be incorrect.
242	Possible tampering has been detected on the vehicle speed circuit pins 8 and 18 of the machine harness	Engine speed limited to " Max. Engine Speed without VSS". Cruise control, gear-down protection and the road speed governor will not work. Trip information data that is based on mileage will be incorrect.
243	Error detected in the exhaust brake relay enable circuit at pin 42 of the engine harness.	Exhaust brake will not work.
245	Error detected in fan clutch relay enable circuit at pin 41 of the engine harness.	Electronic control; module(ECM) can not control the engine cooling fan. Fan will remain on or off.
263	High voltage detected at the fuel temperature sensor signal pin 35 of the engine harness.	Default value used for fuel temperature. Possible low power.
265	Low voltage detected at the fuel temperature sensor signal pin 35 of the engine harness.	Default value used for fuel temperature. Possible low power.
268	Fuel pressure in the accumulator is not changing with engine operating conditions.	Power derate. Engine may run rough.
271	Low or no current detected on front pumping control valve return pin 21. (Set only during control valve click test)	Low power or poor performance.
272	High current detected on front pumping control valve return pin 21.	Low power or poor performance. Possible damage to the ECM.
273	Low or no current detected on rear pumping control valve return pin 15. (Set only during control valve click test)	Low power or poor performance.
274	High current detected on rear pumping control valve return pin 15.	Low power or poor performance. Possible damage to the ECM.
275	Engine ECM has detected a failure in the front pumping element.	Low power or poor performance.
276	High current detected on injection control valve return pin 7.	Injection Control Valve is shutdown and engine will not run. Possible ECM damage.
277	Engine ECM has detected a failure in the injection control valve.	Low power. Engine may not run.
278	Error detected in lift pump circuit at pin 11 of the engine harness.	Possible low power, engine may die, run rough or be difficult to start.
279	Low or no current detected on injection control valve return pin 7. (Set only during control valve click test)	Low power. Engine may not run.
281	Engine ECM has detected a failure in the front pumping element.	Possible no effect or engine power derate.
282	Engine ECM has detected a failure in the rear pumping element.	Possible no effect or engine power derate.
283	High voltage detected at main engine speed/position sensor voltage supply pin 8 of the engine harness.	ECM will use the engine position signal as a backup. Possible white smoke and power loss.

Fault code No.	Description	Description
284	Low voltage detected at main engine speed/ position sensor voltage supply pin 8 of the engine harness.	ECM will use the engine position signal as a backup. Possible white smoke and power loss.
297	High voltage detected at machine pressure signal pin 48 of the machine harness.	Default value used for machine pressure. Lose ability to control machine pressure.
298	Low voltage detected at machine pressure signal pin 48 of the machine harness.	Default value used for machine pressure. Lose ability to control machine pressure.
319	Power to the real time clock has been interrupted and its setting is no longer valid.	Time stamp in ECM powerdown data will be incorrect.
328	Engine ECM has detected a failure in the rear pumping element.	Low power. Engine may not run.
329	Engine ECM has detected an overpumping failure in the CAPS pump.	Engine power derate, engine may die.
349	Auxiliary speed signal frequency indicates the frequency is above a calibrated threshold value.	Engine will go to idle and lose ability to control speed of the auxiliary device.
352	Low voltage detected at engine position sensor +5 VDC supply, pin 10 of the engine harness.	Default value used for sensors connected to this +5 VDC supply. Engine will derate to no-boost fueling and loss of engine protection for oil pressure, intake manifold pressure, and ambient air pressure.
381	Error detected in cold start aid relay 1 enable circuit at pin 41 of the machine harness.	Intake air heater can not be fully energized by the ECM. Possible white smoke and/or hard starting.
382	Error detected in cold start aid relay 2 enable circuit at pin 31 of the machine harness.	Intake air heater can not be fully energized by the ECM. Possible white smoke and/or hard starting.
385	High voltage detected at machine harness sensor +5 VDC supply pin 10 of the machine harness.	Sensors connected to this +5 VDC supply(i.e. remote throttle position sensor) will not function.
386	High voltage detected at the engine harness sensor +5 VDC supply pin 10 of the engine harness.	Default value used for sensors connected to this +5 volts supply. Engine will derate to no-boost fueling and loss of engine protection for oil pressure, intake manifold temperature, and coolant temperature.
387	High voltage detected at the throttle position sensor +5 VDC supply pin 29 of the machine harness.	Engine idles when idle validation switch indicates idle and ramps up to a default set speed when idle validation switch indicates off-idle.
415	Oil pressure signal indicates oil pressure below the very low engine protection limit.	Speed derate and possible engine shutdown if engine protection shutdown feature is enabled.
418	Water-in-fuel signal indicates the water in the fuel filter needs to be drained.	Excessive water in the fuel can lead to severe fuel system damage.
422	Voltage detected simultaneously on both the coolant level high and low signal pins 27 and 37 of the engine harness...OR...no voltage detected on either pin.(Fault is active for switch type coolant level sensors only)	No engine protection for coolant level.
429	Low voltage detected at water-in-fuel signal pin 40 of the machine harness.	No water-in-fuel protection.
431	Idle validation signals on pins 25 and 26 of the machine harness indicate voltage detected simultaneously on both pins...OR...no voltage detected on either pin.	No effect on performance, but loss of idle validation.

Fault code No.	Description	Description
432	Idle validation signal at pin 26 of the machine harness indicates the throttle is at the idle position when the throttle position signal at pin 30 of the machine harness indicates the throttle is not at the idle position...OR...idle validation signal at pin 26 of the machine harness indicates the throttle is not at the idle position when the throttle position signal at pin 30 of the machine harness indicates the throttle is at the idle position.	Engine will only idle.
433	Boost pressure signal indicates boost pressure is high when other engine parameters(i.e. speed and load) indicate boost pressure should be low...OR...boost pressure is low when other engine parameters indicate it should be high.	Possible overfueling during acceleration. Increase in black smoke.
434	All data gathered by the ECM since the last key on(i.e.faults, trip information data. etc.)was not stored to permanent memory at the last key off.	None on performance. Fault code table, trip information data, maintenance monitor data, trending data and user activated datalogger data may be inaccurate.
441	Voltage detected at ECM power supply pins 38, 39, 40 and 50 of the engine harness indicates the ECM supply voltage fell below 6 VDC.	Engine will die or run rough.
442	Voltage detected at ECM power supply pins 38, 39, 40 and 50 of the engine harness indicates the ECM supply voltage is above the maximum system voltage level.	None on performance.
443	Low voltage detected at throttle position sensor +5 VDC supply pin 29 of the machine harness.	Engine idles when idle validation switch indicates idle and ramps up to a default set speed when idle validation switch indicates off-idle.
444	Low voltage detected at machine harness sensor +5 VDC supply pin 10 of the machine harness.	Sensors connected to this +5 VDC supply (i.e. remote throttle position sensor) will not function.
449	Fuel pressure signal indicates that fuel pressure has exceeded the maximum limit for the given engine rating.	Fuel pumping is stopped until pressure returns to normal. Possible fuel pump damage may result.
451	High voltage detected at fuel pressure sensor signal pin 46 of the engine harness.	Low power, reduced performance.
452	Low voltage detected at fuel pressure sensor signal pin 46 of the engine harness.	Low power, reduced performance.
488	Intake manifold temperature signal indicates intake manifold temperature is above the minimum engine protection limit.	Power derate and possible engine shutdown if engine protection shutdown feature is enabled.
489	Auxiliary speed signal frequency indicates the frequency is below a calibrated threshold value.	Engine will go to idle and lose ability to control speed of the auxiliary device.
493	ECM has detected a circuit failure on the injection control valve certifier circuit.	Slight loss of performance.
515	High voltage detected at the auxiliary +5 VDC sensor supply voltage pin 49 of the engine harness.	Auxiliary device will not function.
516	Low voltage detected at the auxiliary +5 VDC sensor supply voltage pin 49 of the engine harness.	Auxiliary device will not function.
524	Error detected on the high speed governor droop selection switch in put pin 24 of the engine harness.	Operator can not select alternate high speed governor droop. Normal droop is used.

Fault code No.	Description	Description
527	Error detected in the dual output driver "A" circuit pin 5 of the machine harness.	The device being controlled by the dual output driver "A" signal will not function properly.
528	Error detected on the torque curve selection switch input pin 39 of the machine harness.	Operator can not select alternate torque curves. Normal torque curve is used.
529	Error detected in the dual output driver "B" circuit pin 1 of the engine harness.	The device being controlled by the dual output driver "B" signal will not function properly.
539	Open circuit failure of the injection control valve transorb pin 6 of the engine harness.	Low power, possible ECM damage.
551	Idle validation signals on pins 25 and 26 of the machine harness indicate voltage detected simultaneously on both pins.	Engine will only idle.
599	Software has initiated an engine shutdown based on machine sensor inputs	Engine will shutdown.
611	ECM detected the engine has initiated a protection shutdown or has been keyed off while above a specified load limit.	No effect.
768	Error detected in the output device driver(VGT or transmission shift modulation signal) signal pin 21 of the machine harness.	Can not control the VGT or transmission, depending on application.

※ Some fault codes are not applied to this machine.

3) Engine Error Codes List for R450LC-7 (Cummins QSM)

Fault code No.	Reason	Effect(only when fault code is active)
111	Error internal to the ECM related to memory hardware failures or internal ECM voltage supply circuits.	Engine will not start.
115	No engine speed signal detected at both engine position sensor circuits.	Engine will die and will not start.
121	No engine speed signal detected from one of the engine position sensor circuits.	None on performance.
122	High voltage detected on the intake manifold pressure circuit.	Derate in power output of the engine.
123	Low voltage detected on the intake manifold pressure circuit.	Derate in power output of the engine.
131	High voltage detected at the throttle position signal circuit.	Severe derate(power and speed). Limp home power only.
132	Low voltage detected at the throttle position signal circuit.	Severe derate(power and speed). Limp home power only.
133	High voltage detected at the remote throttle position signal circuit.	None on performance if remote throttle is not used.
134	Low voltage detected at the remote throttle position signal circuit.	None on performance if remote throttle is not used.
135	High voltage detected at the oil pressure circuit.	No engine protection for oil pressure.
141	Low voltage detected at the oil pressure circuit.	No engine protection for oil pressure.
143	Oil pressure signal indicates oil pressure below the low oil pressure engine protection limit.	Progressive power and speed derate with increasing time after alert. If engine protection shutdown feature is enable, engine will shut down 30 seconds after red lamp starts flashing.
144	High voltage detected at the coolant temperature circuit.	Possible white smoke. Fan will stay on if controlled by the electronic control module (ECM). No engine protection for coolant temperature.
145	Low voltage detected at the coolant temperature circuit.	Possible white smoke. Fan will stay on if controlled by electronic control module (ECM). No engine protection for coolant temperature.
147	A frequency of less than 100Hz was detected at the frequency throttle signal pin of the actuator harness connector at the ECM.	Calibration dependent power and speed derate.
148	A frequency of more than 100Hz was detected at the frequency throttle signal pin of the actuator harness connector at the ECM.	Calibration dependent power and speed derate.
151	Coolant temperature signal indicates coolant temperature above 104° C(220° F).	Progressive power derate with increasing time after alert. If engine protection shutdown feature is enabled, engine will shut down 30 seconds after red lamp starts flashing.
153	High voltage detected at the intake manifold temperature circuit.	Possible white smoke. Fan will stay on if controlled by electronic control module (ECM). No engine protection for coolant temperature.
154	Low voltage detected at the intake manifold temperature circuit.	Possible white smoke. Fan will stay on if controlled by electronic control module (ECM). No engine protection for coolant temperature.
155	Intake manifold temperature signal indicates temperature above 87.8° C(190° F).	Progressive power derate with increasing time after alert. If engine protection shutdown feature is enabled, engine will shut down 30 seconds after red lamp starts flashing.
187	Low voltage detected on the ECM voltage supply line to some sensors(VSEN2 supply).	Engine will run derated. No engine protection for oil pressure and coolant level.

Fault code No.	Reason	Effect(only when fault code is active)
211	Additional machine diagnostic codes have been logged. Check other ECM's for diagnostic codes.	None on engine performance.
212	High voltage detected at the oil temperature circuit.	No engine protection for oil temperature.
213	Low voltage detected at the oil temperature circuit.	No engine protection for oil temperature.
214	Oil temperature signal indicates oil temperature above 123.9° C(225° F).	Progressive power derate with increasing time after alert. If engine protection shutdown feature is enabled, engine will shut down 30sec after the red lamp starts flashing.
219	Low oil level was detected in the Centinel™ makeup oil tank.	None on performance. Centinel™ deactivated.
221	High voltage detected at the ambient air pressure circuit.	Derate in power output of the engine.
222	Low voltage detected at the ambient air pressure circuit.	Derate in power output of the engine.
223	Incorrect voltage detected at the Centinal™ actuator circuit by the ECM.	None on performance. Centinel™ deactivated.
227	High voltage detected on the ECM voltage supply line to some sensors(VSEN2 supply).	Engine will run derated. No engine protection for oil pressure and coolant level.
234	Engine speed signal indicates engine speed is greater than 2730 rpm.	Fuel shutoff valve closes until engine speed falls to 2184 rpm.
235	Coolant level signal indicates coolant level is below the normal range.	Progressive power derate with increasing time after alert. If engine protection shutdown feature is enabled, engine will shut down 30 seconds after red lamp starts flashing.
237	Duty cycle of the throttle input signal to the primary or secondary engine for multiple unit synchronization is less than 3 percent or more than 97 percent.	All engines(primary and secondary) are shut down with increasing time after alert if hard-coupled. Only secondary engines are shut down with increasing time after alert if soft-coupled.
241	The ECM lost the vehicle speed signal.	Engine speed limited to maximum engine speed without vehicle speed sensor parameter value Cruise Control. Gear-Down Protection and Road Speed Governor will not work (automotive only).
242	Invalid or inappropriate vehicle speed signal detected. Signal indicates an intermittent connection or VSS tampering.	Engine speed limited to maximum engine speed without vehicle speed sensor parameter value Cruise Control. Gear-Down Protection and Road Speed Governor will not work (automotive only).
245	Less than 6 VDC detected at fan clutch circuit when on. Indicates an excessive current draw from the ECM or faulty ECM output circuit.	The fan may stay on at all times.
254	Less than 6 VDC detected at FSO circuit when on. Indicates an excessive current draw from the ECM or a faulty ECM output circuit.	The ECM turns off the FSO supply voltage. The engine will shut down.
255	Externally supplied voltage detected going to the fuel shutoff solenoid supply circuit.	None on performance. Fuel shutoff valve stays open.
285	The ECM expected information from a multiplexed device but did not receive it soon enough or did not receive it at all.	At least one multiplexed device will not operate properly.
286	The ECM expected info from a multiplexed device but only received a portion of the necessary information.	At least on multiplexed device will not operate properly.
287	The machine vehicle electronic control unit (VECU) detected a fault with its throttle pedal.	The engine will only idle.

Fault code No.	Reason	Effect(only when fault code is active)
288	The machine vehicle electronic control unit (VECU) detected a fault with its remote throttle.	The engine will not respond to the remote throttle.
293	High voltage detected at the machine temperature sensor signal pin of the 31-pin machine connector.	No engine protection for machine temperature.
294	Low voltage detected at the machine temperature sensor signal pin of the 31-pin machine connector.	No engine protection for machine temperature.
295	An error in the ambient air pressure sensor signal was detected by the ECM.	Engine is derated to no air setting.
297	High voltage detected at the machine pressure sensor signal pin of the 31-pin machine connector.	No engine protection for machine pressure.
298	Low voltage detected at the machine pressure sensor signal pin of the 31-pin machine connector.	No engine protection for machine pressure.
299	Engine shutdown by device other than key switch before proper engine cool down resulting in filtered load factor above maximum shutdown threshold.	No action taken by the ECM.
311	Current detected at No.1 injector when voltage is turned off.	Current to injector is shut off.
312	Current detected at No.5 injector when voltage is turned off.	Current to injector is shut off.
313	Current detected at No.3 injector when the voltage is turned off	Current to injector is shut off.
314	Current detected at No 6 injector when the voltage is turned off.	Current to injector is shut off.
315	Current detected at No.2 injector when the voltage is turned off.	Current to injector is shut off.
319	Real time clock lost power.	None on performance. Data in the ECM will not have accurate time and date information.
321	Current detected at No.4 injector when the voltage is turned on.	Current to injector is shut off.
322	No current detected at No. 1 injector when the voltage is turned on.	Current to injector is shut off.
323	No current detected at No.5 injector when the voltage is turned on.	Current to injector is shut off.
324	No current detected at No.3 injector when the voltage is turned on.	Current to injector is shut off.
325	No current detected at No.6 injector when the voltage is turned on.	Current to injector is shut off.
331	No current detected at No.2 injector when the voltage is turned on.	Current to injector is shut off.
332	No current detected at No.4 injector when the voltage is turned on.	Current to injector is shut off.
341	Severe loss of data from the ECM.	Possible no noticeable performance effects OR engine dying OR hard starting. Fault information, trip information and maintenance monitor data may be inaccurate.
343	Internal ECM error.	Possible none on performance or severe derate.
349	A frequency greater than calibrated threshold was detected at the tail shaft governor signal pin of the 31-pin machine connector.	Calibration dependent power and speed derate.
352	Low voltage detected on the ECM voltage supply line to some sensors (VSEN 1 supply).	Engine is derated to no air setting.

Fault code No.	Reason	Effect(only when fault code is active)
386	High voltage detected on the ECM voltage supply line to some sensors (VSEN 1 supply).	Engine is derated to no air setting.
387	High voltage detected on the ECM voltage supply line to the throttle(VTP supply).	Engine will only idle.
415	Oil pressure signal indicates oil pressure below the very low oil pressure engine protection limit.	Progressive power derate with increasing time from alert. If engine protection shutdown feature is enabled, engine will shut down 30 seconds after red lamp starts flashing.
418	Water has been detected in the fuel filter.	Possible white smoke, loss of power, or hard starting.
419	An error in the intake manifold pressure sensor signal was detected by the ECM.	Engine is derated to no air setting.
422	Voltage detected simultaneously on both the coolant level high and low signal circuits OR no voltage detected on both circuits.	No engine protection for coolant level.
426	Communication between the ECM and the J1939 data link has been lost.	None on performance. J1939 devices may not operate.
428	High voltage detected at water-in-fuel sensor.	None on performance.
429	Low voltage detected at water-in-fuel sensor.	None on performance.
431	Voltage detected simultaneously on both the idle validation off-idle and on-idle circuits.	None on performance.
432	Voltage detected at idle validation on-idle circuit when voltage at throttle position circuit indicates the pedal is not at idle OR voltage detected at idle validation off-idle circuit when voltage at throttle position circuit indicates the pedal is at idle.	Engine will only idle.
433	Voltage signal at intake manifold pressure circuit indicates high intake manifold pressure but other engine characteristics indicate intake manifold pressure must be low.	Derate to no air setting.
434	Supply voltage to the ECM fell below 6.2 VDC for a fraction of a second OR the ECM was not allowed to power down correctly (retain battery voltage for 30 seconds after key off).	Possible no noticeable performance effects OR possibility of engine dying OR hard starting. Fault information, trip information and maintenance monitor data may be inaccurate.
435	An error in the oil pressure sensor signal was detected by the ECM.	None on performance. No engine protection for oil pressure.
441	Battery voltage below normal operating level.	Possible no noticeable performance effects OR possibility of rough idle.
442	Battery voltage below normal operating level.	None on performance.
443	Low voltage detected on the ECM voltage supply line to the throttle(s) (VTP supply).	Engine will only idle.
489	Auxiliary speed frequency on input pin indicated that the frequency is below a calibration dependent threshold.	Engine will only idle.
527	Less than 17.0 VDC detected at the dual output A signal pin of the 31-pin machine connector.	No action taken by the ECM.
528	Less than 17.0 VDC detected at the dual output B signal pin of the 31-pin machine connector.	No action taken by the ECM.
529	Less than 17.0 VDC detected at the dual output B signal pin at the ECM.	No action taken by the ECM.
551	No voltage detected simultaneously on both the idle validation off-idle and on-idle circuits.	Engine will only idle.
581	High voltage detected at the fuel inlet restriction sensor signal pin.	Fuel inlet restriction monitor deactivated.

Fault code No.	Reason	Effect(only when fault code is active)
582	Low voltage detected at the fuel inlet restriction sensor signal pin	Fuel inlet restriction monitor deactivated.
583	Restriction has been detected at the fuel pump inlet.	Fuel inlet restriction monitor warning is set.
596	High battery voltage detected by the battery voltage monitor feature.	Yellow lamp will be lit until high battery voltage condition is corrected.
597	ICON™ has restarted the engine three times within three hours due to low battery voltage (automotive only) OR low battery voltage detected by the battery voltage monitor feature.	Yellow lamp will be lit until low battery voltage condition is corrected. The ECM may increase idle speed and deactivate idle decrement switch if idle speedup is enabled. The engine will run continuously if ICON™ is active (automotive only).
598	Very low battery voltage detected by the battery voltage monitor feature.	Red lamp lit until very low battery voltage condition is corrected.
611	Engine shutdown by operator before proper engine cool down resulting in filtered load factor above maximum shutdown threshold.	No action taken by the ECM.
951	A power imbalance between cylinders was detected by the ECM.	Engine may have rough idle or misfire.

4) Explanation of Error Code System(Self Diagnostic System)

1. OUTLINE

When any abnormality occurs in the NEW CAPO system caused by electric parts malfunction and by open or short circuit, the CPU controller diagnoses the problem and sends the error codes to the cluster and also stores them in the memory.

The current or recorded error codes are displayed at the error display mode selected by touching **SELECT** switch 2 times while pressing **BUZZER STOP** switch.

2. CURRENT ERROR DISPLAY

Cluster displays **Co : Er** and makes buzzer sound itself to warn the communication error when communication problem caused by wire-cut or malfunction of the CPU controller occurs.

Cluster displays real time error codes received from CPU controller through communication. In case of no problem it displays **CHECK Er : 00**.

If there are more than 2 error codes, each one can be displayed by pressing **▲** and **▼** switch respectively.

Examples :

1) Communication Error

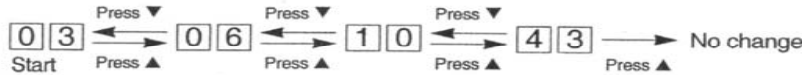
Co : Er & Buzzer sound

2) No problem

CHECK Er : 00

3) 4 Error codes(03, 06, 10, 43) display

CHECK Er : 03



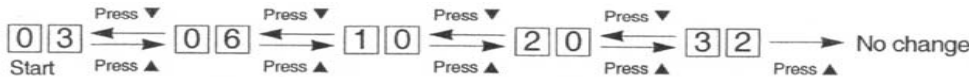
Memorised errors:
only visible at "IGNITION ON"
(not at running engine!)

3. RECORDED ERROR DISPLAY

The recorded error can be displayed only when the key switch is at ON position.

Examples : 5 Recorded error codes(03, 06, 10, 20, 32) display

TIME Er : 03



4. DELETE ALL RECORDED ERROR CODES

Select recorded error(TIME Er) display and press engine **☹** and select switch **☹** at the same time for 2 seconds or more. Cluster display changes to **TIME Er : 00**, which shows that CPU controller deleted all the recorded error codes in the memory.

1-13. Malfunction of Cluster or Mode Selection System

- **Check display of cluster first 5 sec after ignition on:**

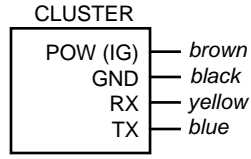
All lamps should light up, with buzzer sound

- If nothing appears, check on cluster:
 - Feed line (Brown)
 - Ground line (Black)

In case of no feed voltage: check fuse for cluster, power relay, wiring

- If display is blurred or some lamps do not lighten up

24 V
GND



→ replace cluster (or light board inside)

- **Check display of cluster: If “Co Err” appears, it indicates:**

serial communication problem between cluster and CPU





- Check Rx & Tx Voltage on cluster:
 - Serial- (Rx) line, input (Yellow) 12V
 - Serial+(Tx) line, output (Blue) 4V

In case of no voltages: check wiring (Rx & Tx lines)

In case of voltages:

→ replace CPU

- **Check LED's on CPU:**

-  Green: Normal condition
-  None: Feed problem (24V) to CPU
-  Yellow & Green: Communication problem = “Co Err”
-  Red & Green: CPU problem

→ replace CPU

- Check  warning light on cluster

- In case of blinking

→ replace CPU

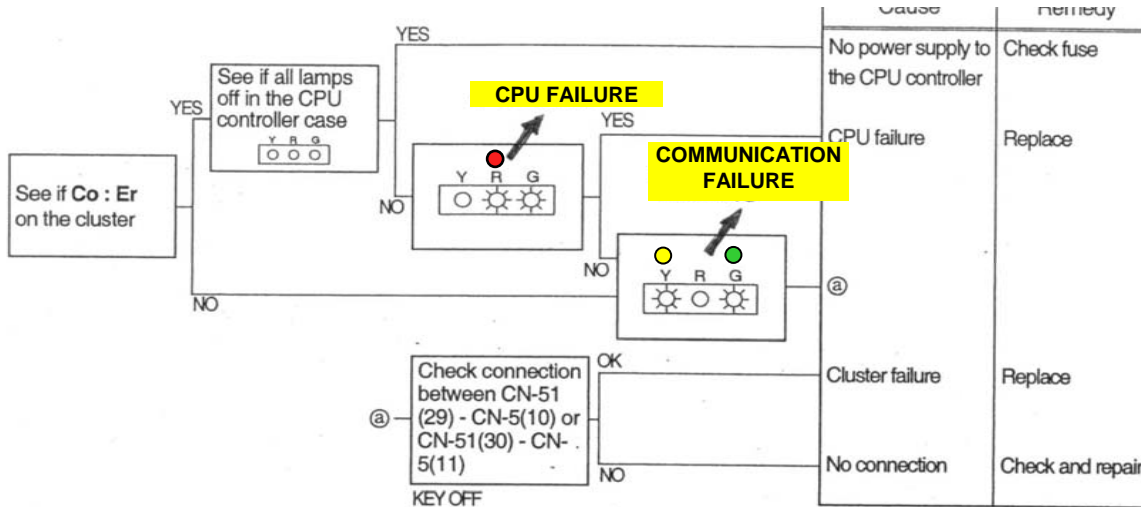
- **Check also Error Code system (see previous)**

1) CPU Check(Troubleshooting)

F. MALFUNCTION OF CLUSTER OR MODE SELECTION SYSTEM

※ Before carrying out below procedure, check all the related connectors are properly inserted.

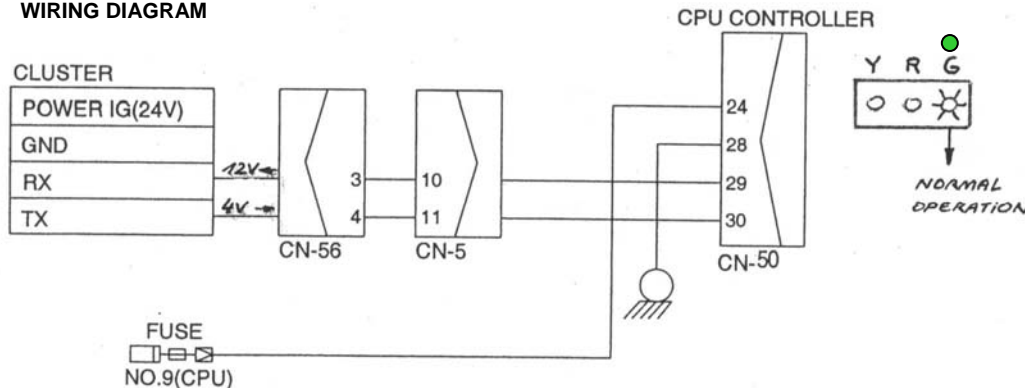
INSPECTION PROCEDURE



CPU CONTROLLER CHECK WARNING LAMP



WIRING DIAGRAM



- (1) Communication problem with CPU controller makes the lamp blinks and the buzzer sounds.
- (2) With lamp blinks all of the lamp on the cluster LCD will be OFF.

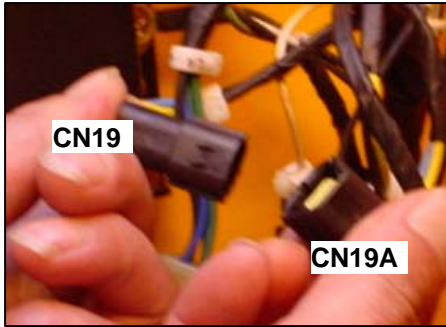
2) Self Diagnosis for CPU controller



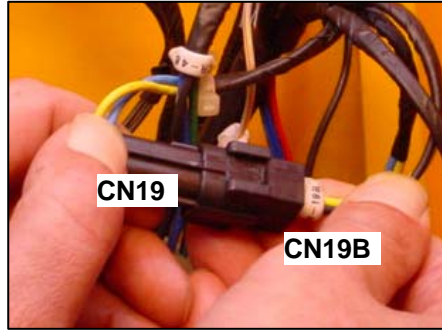
LED Lamp	Trouble	Service
G is Turned on	Normal	
R are Turned on	Trouble on CPU or ROM	Change the controller
G and Y are Turned on	Trouble on serial communication line	Check serial lines between controller and cluster.
Three LED Are turned on	Trouble on CPU controller power	Check the input power wire(24V) of controller.

3) Emergency Procedure, in case of faulty CPU

3-1) ASSURING PUMP POWER CONTROL VIA EMERGENCY RESISTOR:

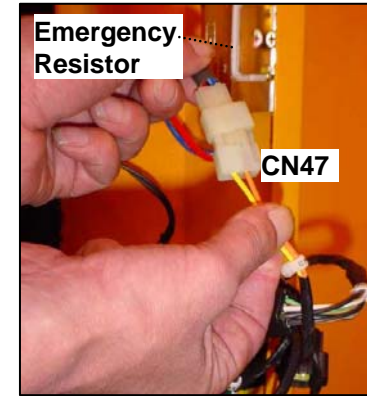


Disconnect CN19<>CN19A



Connect CN19<>CN19B

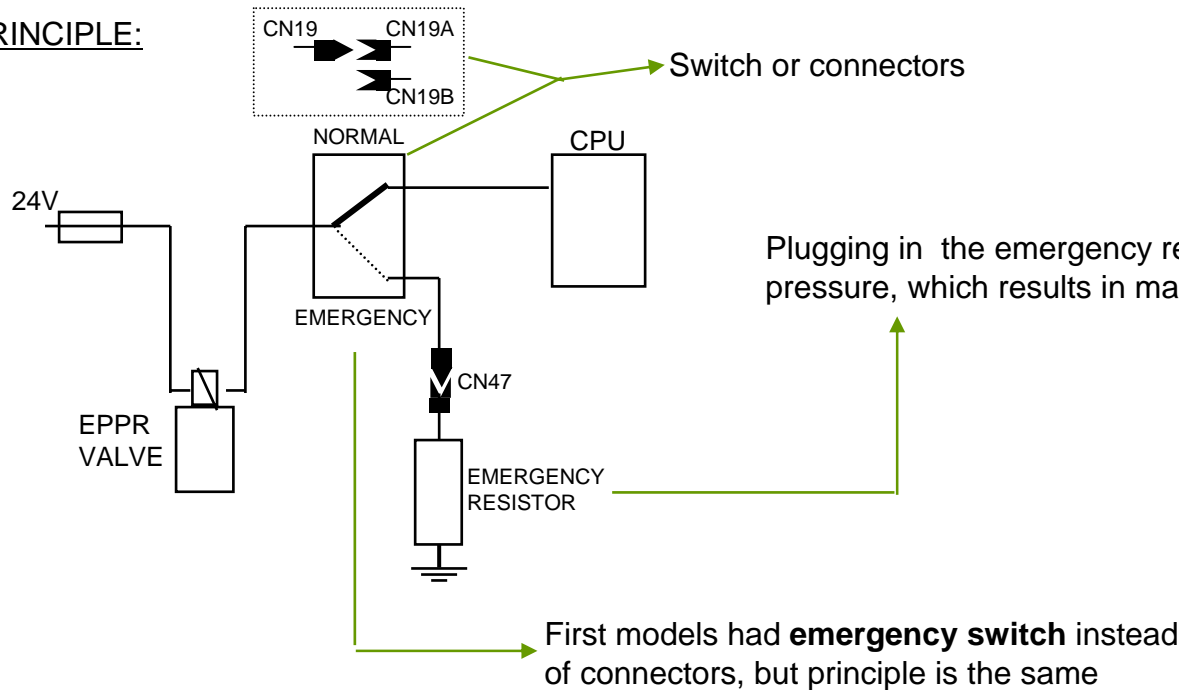
&



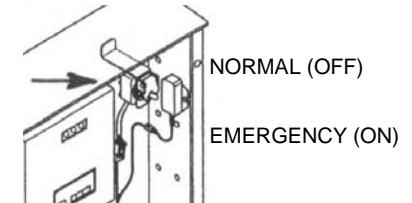
Connect Resistor with CN47

It might be that this connection was already established during normal operation: it has no effect as long as CN19 is connected with CN19A.

PRINCIPLE:



※ Emergency switch

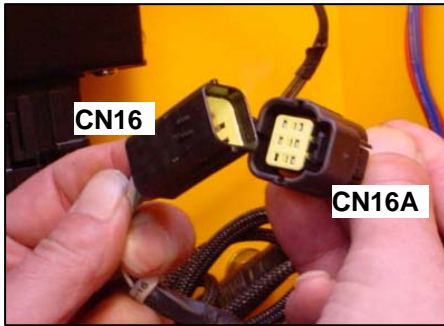


3-2) ASSURING ENGINE SPEED CONTROL (Electronically controlled CMS E/G)

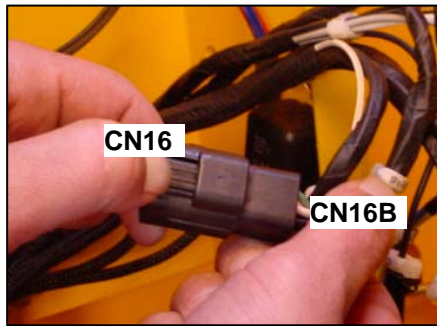
For B3.9, B5.9, C8.3, M11 engine:

- DISCONNECT accelerator cable from injection pump lever
- CONNECT emergency (Push-pull) cable on injection pump lever
→ So, in this case MANUAL control of RPM is possible
(SEE NEXT PAGE)

For QSB, QSC, QSM engine:

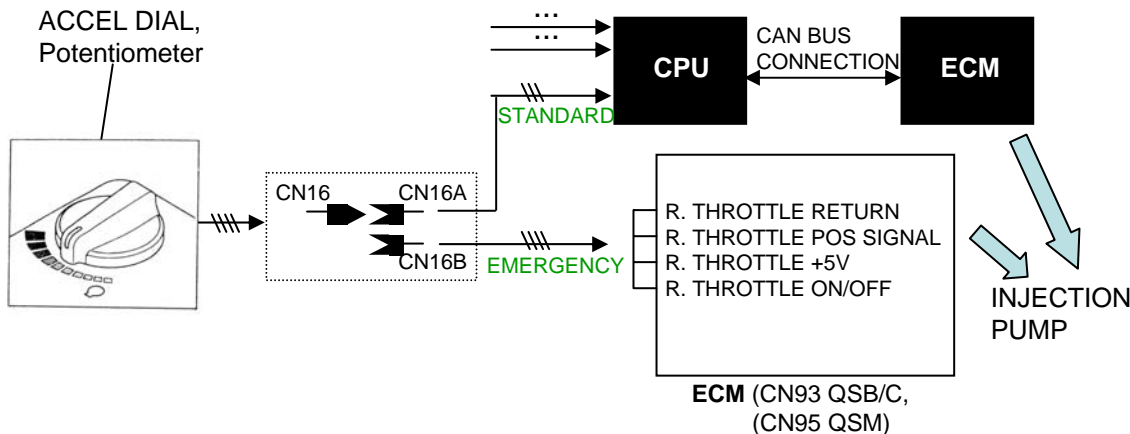


Disconnect CN16<>CN16A

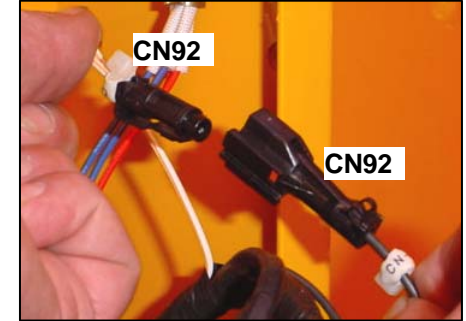


Connect CN16<>CN16B

→ In emergency, engine control is ONLY possible via ACCEL DIAL:



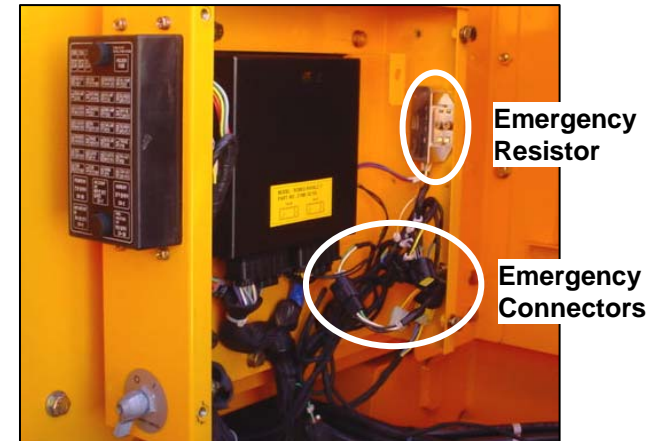
3-3) ASSURING STARTING OF MACHINE



Connect CN92: male <> female

→ In case of faulty CPU, starting is impossible as the “anti restart function” is active all the thime. With above connection, the machine can “always” be started.

※ ALL EMERGENCY CONNECTORS: NEAR CPU



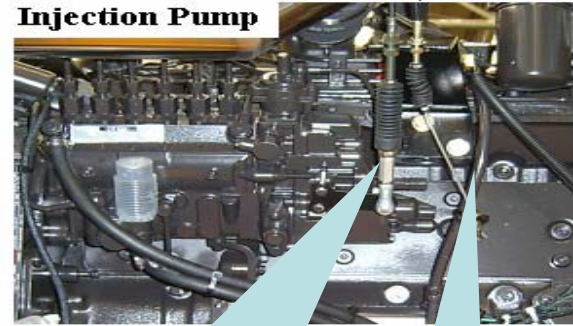
4) Emergency Engine rpm Control



Emergency Engine Throttle Lever

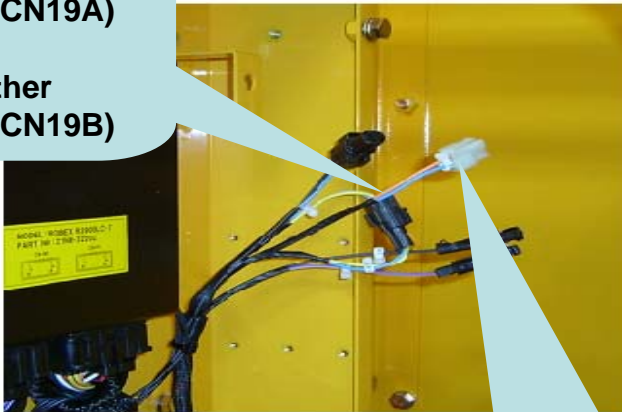
Emergency Cable

Injection Pump



3. Disconnect the connector(CN19-CN19A)

4. Connect the other connector(CN19-CN19B)

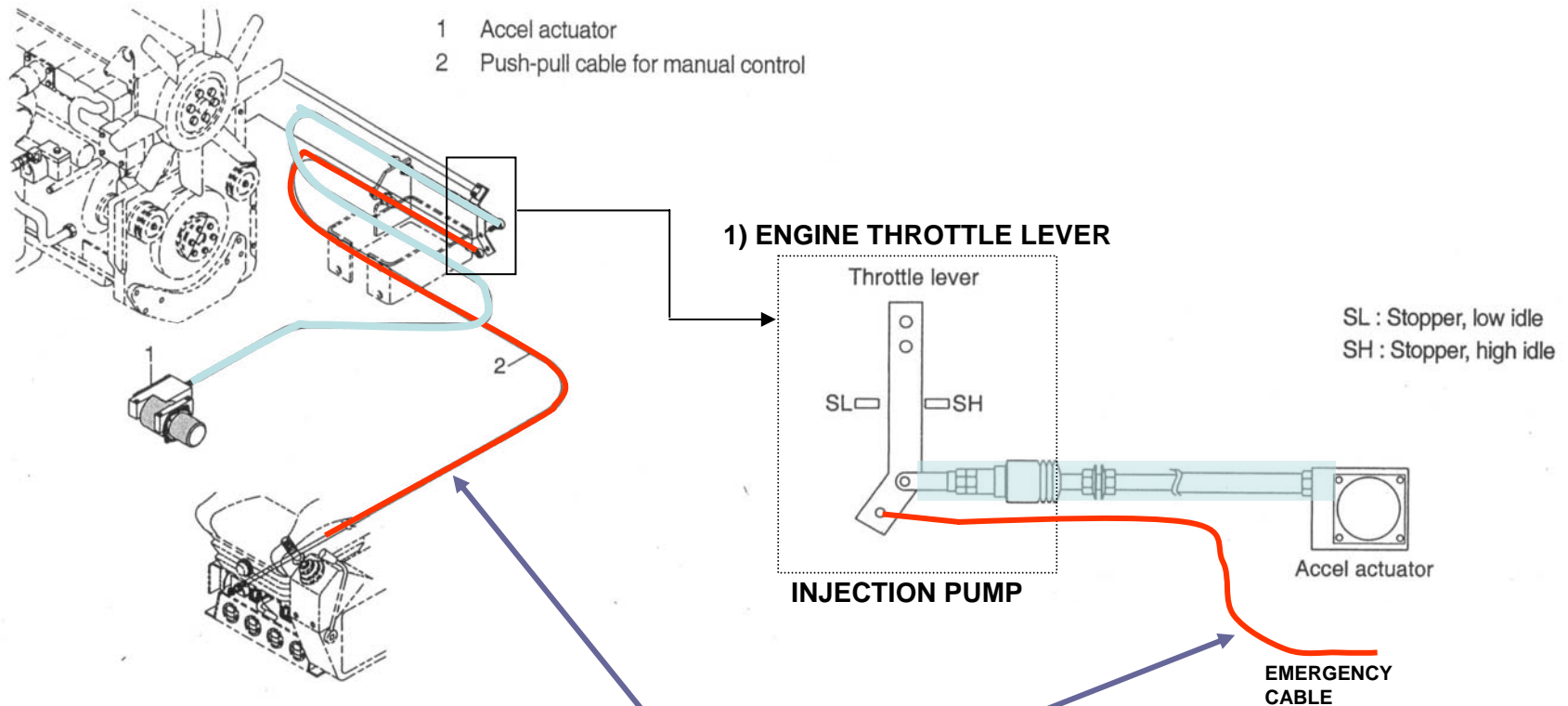


1. Disconnect the cable (main cable)

2. Connect the emergency cable

5. Connect the connector, CN-47

5) ENGINE ACCEL ACTUATOR (not for excavators with QS-engines)



2) EMERGENCY CABLE (Push-pull cable)

It controls engine speed by connecting onto the lever of the injection pump when the malfunction of the CPU controller or the accel actuator happen.

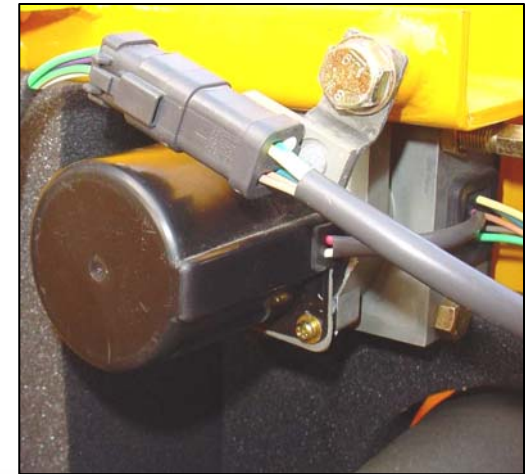
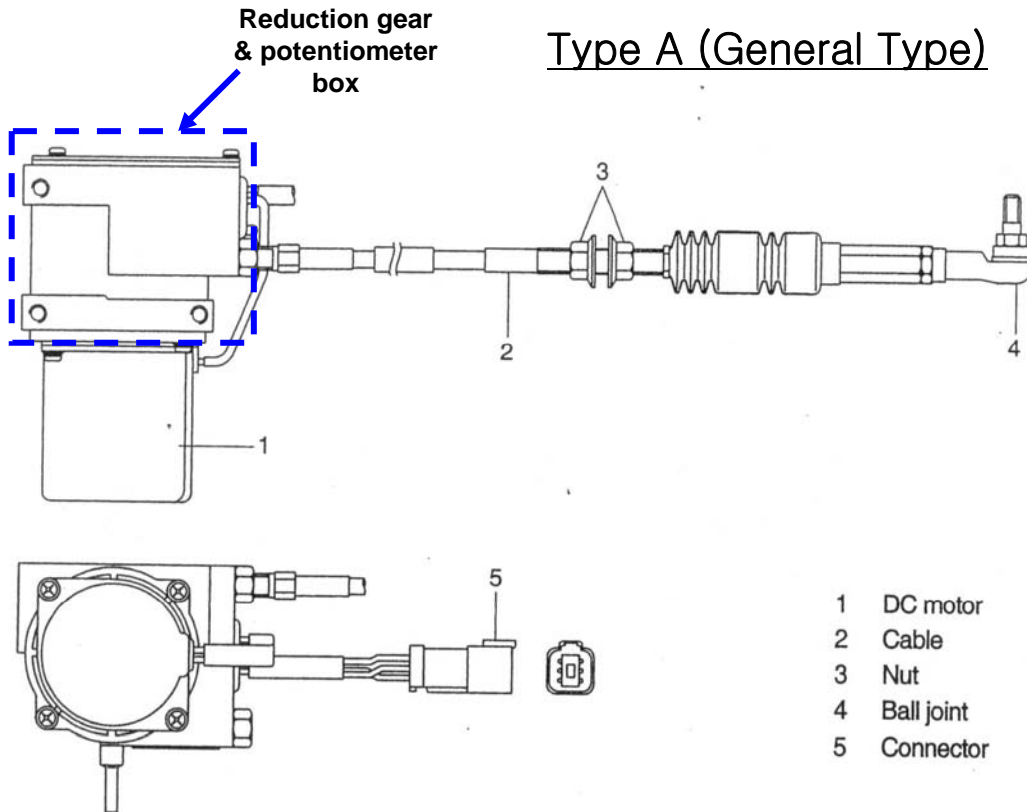
6) Preparation for Emergency Operation

COMPARISON TABLE OF PROLIX SWITCH

	3-SERIES & 7-SERIES original Circuit	1st Changed Circuit	2nd Changed Circuit	Remark
Changed items	1. PROLIX SWITCH is Installed 2. CN-47+ Emer. Resistor are Installed as standard. 3. Emer. throttle Cable is option	1. PROLIX SWITCH is Deleted 2. Emer. Resistor is Option(Deleted) 3. Emer. throttle Cable is option	1. PROLIX SWITCH is Deleted 2. Emer. Resistor is Installed as standard. 3. Emer. throttle Cable is option	
Applied Serial No.	R210LC7 : ~#177 R290LC7 : ~#62	RT40LC7 : ~ #253 R210LC7 : #178 ~#489 R290LC7 : #63 ~#252 R320LC7 : ~#9 R450LC7 : ~#21	RT40LC7 : #254 ~ R210LC7 : #490 ~ R290LC7 : #253 ~ R320LC7 : #10 ~ R450LC7 : #22 ~	
Method of Repair	When CPU-CONTROLLER is out of order, please ON the Prolix Switch.	When CPU-CONTROLLER is out of order, please connect CN-47 with Emer. Resistor.	When CPU-CONTROLLER is out of order, please connect CN-19B with CN-19A which is connected with CN-19A.	Location: Electric box In E/G hood
Circuit				

1-14. Accel. Actuator

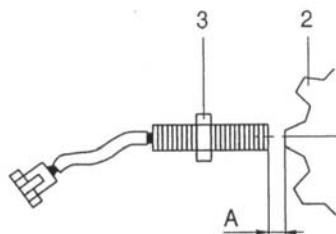
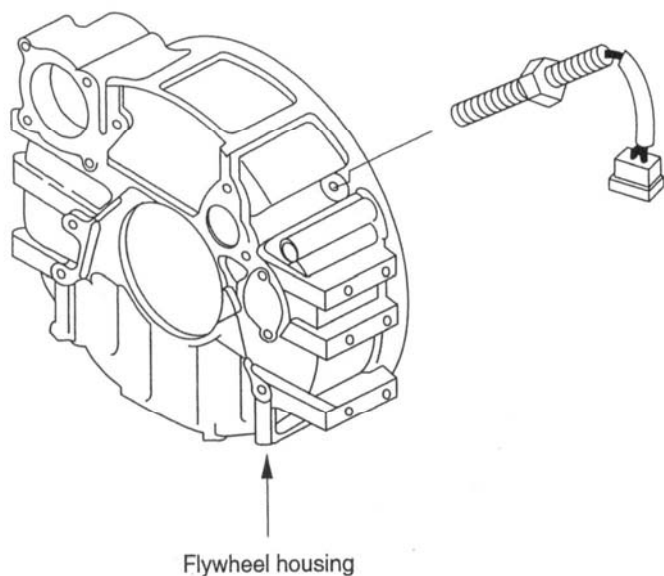
Type A (General Type)



Connector		
Type	6P, female	
Line color & description	1	White(Potentiometer 5V)
	2	Blue(Potentiometer SIG)
	3	Black(Potentiometer GND)
	4	-
	5	Green(Motor+)
	6	Yellow(Motor -)
Inspection	Check resistance Spec : 1~2 Ω (Between No.5-6) 0.8~1.2kΩ (Between No.1-3)	

1-15. Engine Speed Sensor (not for excavators with QS-engines)

1) DETECT ACTUAL ENGINE RPM AND SEND SIGNAL TO TACHOMETER



- 2 Gear teeth, flywheel
- 3 Lock nut, speed sensor
- A Clearance

2) INSTALLATION

A. CUMMINS ENG (B, C series)

- (1) Clean contacting point of sensor.
- (2) Loosen lock nut.
- (3) Screw speed sensor into flywheel housing.
- (4) Turn it back 135° when it contacts with gear teeth.
- (5) Tight lock nut and connect wiring.

B. MITSUBISHI ENG

- (1) Clean contacting point of sensor.
- (2) Screw speed sensor into flywheel housing(A = 2.5± 0.1mm).

3) INSPECTION

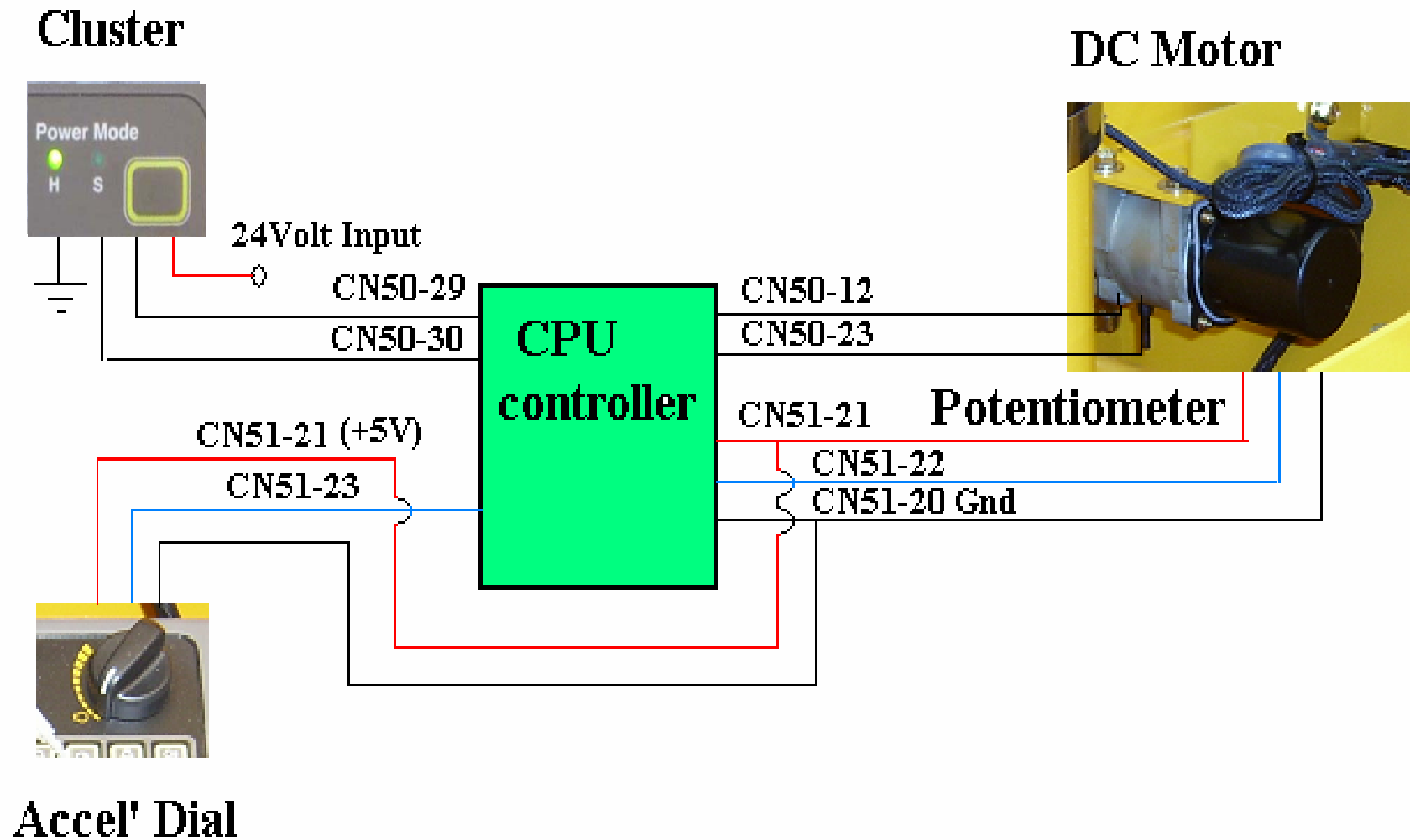
A. CUMMINS ENG (B, C series)

- (1) Check resistance
 - SPEC : 300 Ω
- (2) Check voltage while engine run.
 - SPEC : 2~28Vac, dependent on the engine speed(rpm)

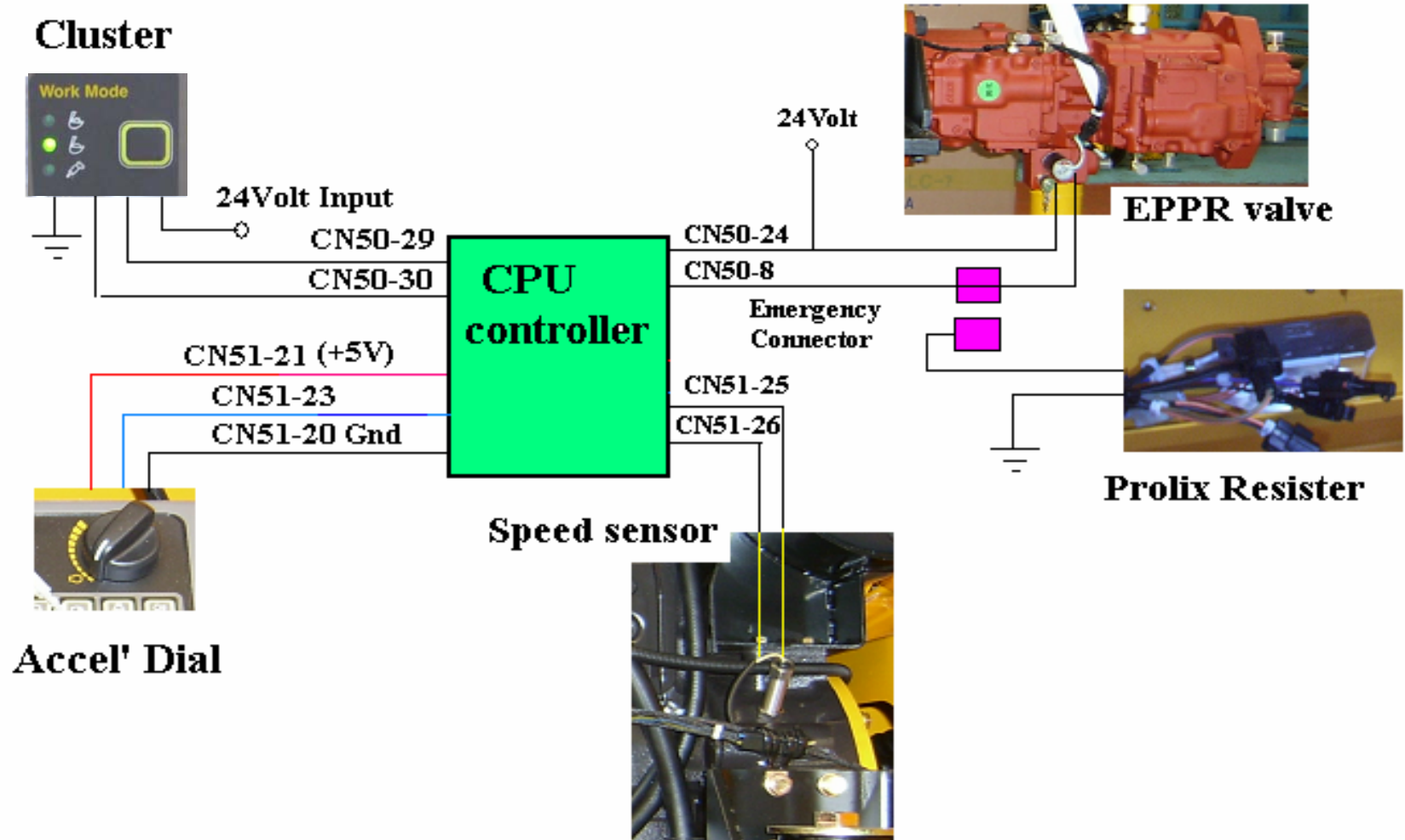
B. MITSUBISHI ENG

- (1) Check resistance
 - SPEC : 2.3± 0.2 kΩ
- (2) Check voltage while engine run.
 - SPEC : 2~28Vac, dependent on the engine speed(rpm)

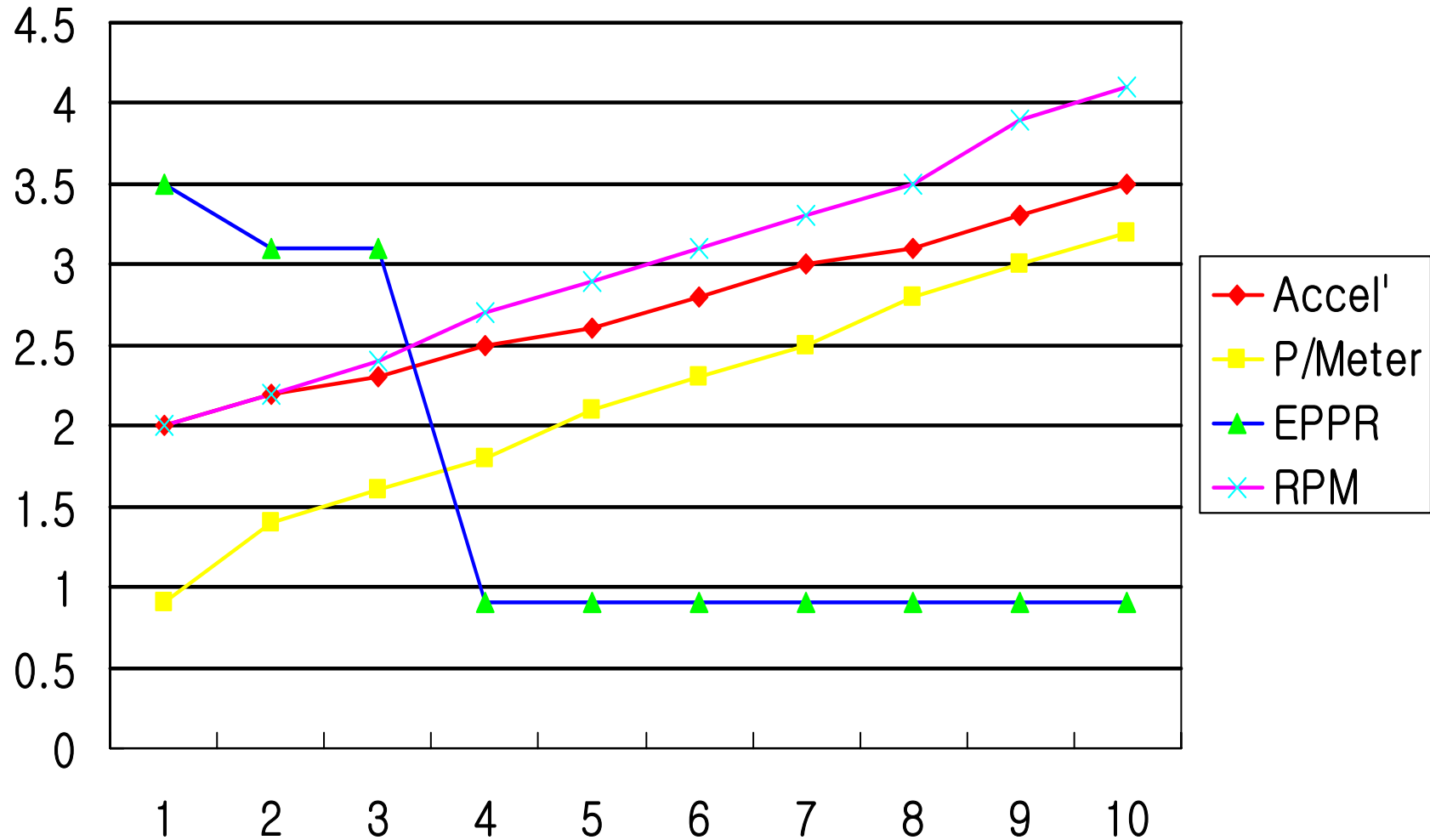
1-16. Engine rpm control System



1-17. Hydraulic Oil Flow Control system



1) Graphs for 4 signals



2) Value table

Step	Input (Volt)	Output signal (Volt)				EPPR valve Pressure
	Accel' Dial	Potentiometer		Engine rpm		
		S mode	H mode	S mode	H mode	H/S mode
1	2.0	0.9	0.9	1020	1020	35
2	2.2	1.4	1.4	1110	1110	31
3	2.3	1.6	1.6	1200	1200	31
4	2.5	1.8	1.9	1310	1360	9
5	2.6	2.1	2.2	1420	1470	9
6	2.8	2.3	2.4	1520	1560	9
7	3.0	2.5	2.6	1620	1670	9
8	3.1	2.8	2.9	1730	1780	9
9	3.3	3.0	3.2	1840	1960	9
10	3.5	3.2	3.5	1950	2060	9

1-19. Troubleshooting Guide

① CPU Controller connectors : CN-50(1)~(18)

Conn ector	Pin No.		Input /Output	Normal value		Remark
				mA	V	
CN-50	(1)	BOOM PRIORITY SOL.	O		24	
	(2)	MAX.FLOW SOL.	O		24	
	(3)	POWER MAX. SOL.	O		24	
	(4)	HOUR-METER	O		24	Actual:16V
	(5)	ENGINE PREHEATER	O		24	
	(6)	CO. CANCEL SOL.	O		24	
	(7)	BATTERY 24V(+)	PWR		24	
	(8)	PUMP EPPR(-)	I	100~700	24	18Ω
	(9)	NC	-		-	
	(10)	RS232(Program dump)	I		0~5	PC Communication
	(11)	ANTI-RESTART RY	O		24	
	(12)	ACCEL ACT(+)	I/O		24/0	Tier-1 only
	(13)	TRAVEL SPEED SOL.	O		24	
	(14)	T/M OIL LAMP	-		24	Wheel type only
	(15)	BRAKE FAIL LAMP	-		24	Wheel type only
	(16)	TRAVEL BUZZER	O		24	
	(17)	PREHEAT SW	I		5	
	(18)	NC	-		-	

- CPU Controller connectors : CN-50(19)~(36)

Conn ector	Pin No.		Input /Output	Normal value		Remark
				mA	V	
CN-50	(19)	PARKING SW	-		-	Wheel type only
	(20)	OVERLOAD SIG	I		0~5	'Active' condition
	(21)	ENG OIL FILTER SW	I		5V	Tier-1 only
	(22)	NC	-		-	
	(23)	ACCEL ACT(-)	O/I		0/24	Tier-1, Deactive/Active condition
	(24)	POWER IG	PWR		24	Key 'ON'
	(25)	CAN_H	COMM.		0~5	Tier-2, With E/G ECM
	(26)	CAN_L	COMM.		0~5	Tier-2, With E/G ECM
	(27)	CAN_SHELD	-		-	Tier-2, With E/G ECM
	(28)	GND(Main)	-		-	
	(29)	SERIAL-TX	COMM.		0~12	With CLUSTER
	(30)	SERIAL-RX	COMM.		0~4	With CLUSTER
	(31)	GND			-	
	(32)	RS232(+)	COMM.		0~5	PC Communication
	(33)	RS232(-)	COMM.		0~5	PC Communication
	(34)	RS232(GND)	-		-	PC Communication
	(35)	NC	-		-	
(36)	PUMP EPPR(+)	O	100~700	24	'Active' condition	

② CPU Controller connectors : CN-51(1)~(18)

Conn ector	Pin No.		Input /Output	Normal value		Remark
				mA	V	
CN-51	(1)	WORKING OIL PS			5	
	(2)	POWER MAX. SW			5	
	(3)	TRAVEL ALARM SW			5	
	(4)	E/G OIL PS			5	Tier-1 only
	(5)	NC	-		-	
	(6)	BOOM UP PS			5	
	(7)	24V(PRESS SENSOR)	PWR		24	
	(8)	GND(PRESS SENSOR)	-		-	
	(9)	ALTERNATOR LEVEL			26~29	E/G run condition
	(10)	P1 PRESS SIG			1~5	500 kg/cm ² , Option
	(11)	P2 PRESS SIG			1~5	↑
	(12)	P3 PRESS SIG			1~5	50 kg/cm ² , Option
	(13)	TRAVEL OIL PS			5	
	(14)	AUTO DECEL SW			5	
	(15)	WATER LEVEL SW			5	
	(16)	AIR CLEANER SW				
	(17)	NC	-		5	HEAVY LIFT SW,option(spare)
	(18)	NC	-		5	ECONO SW ON, BKT&ARM IN PS(domestic option)

- CPU Controller connectors : CN-51(19)~(36)

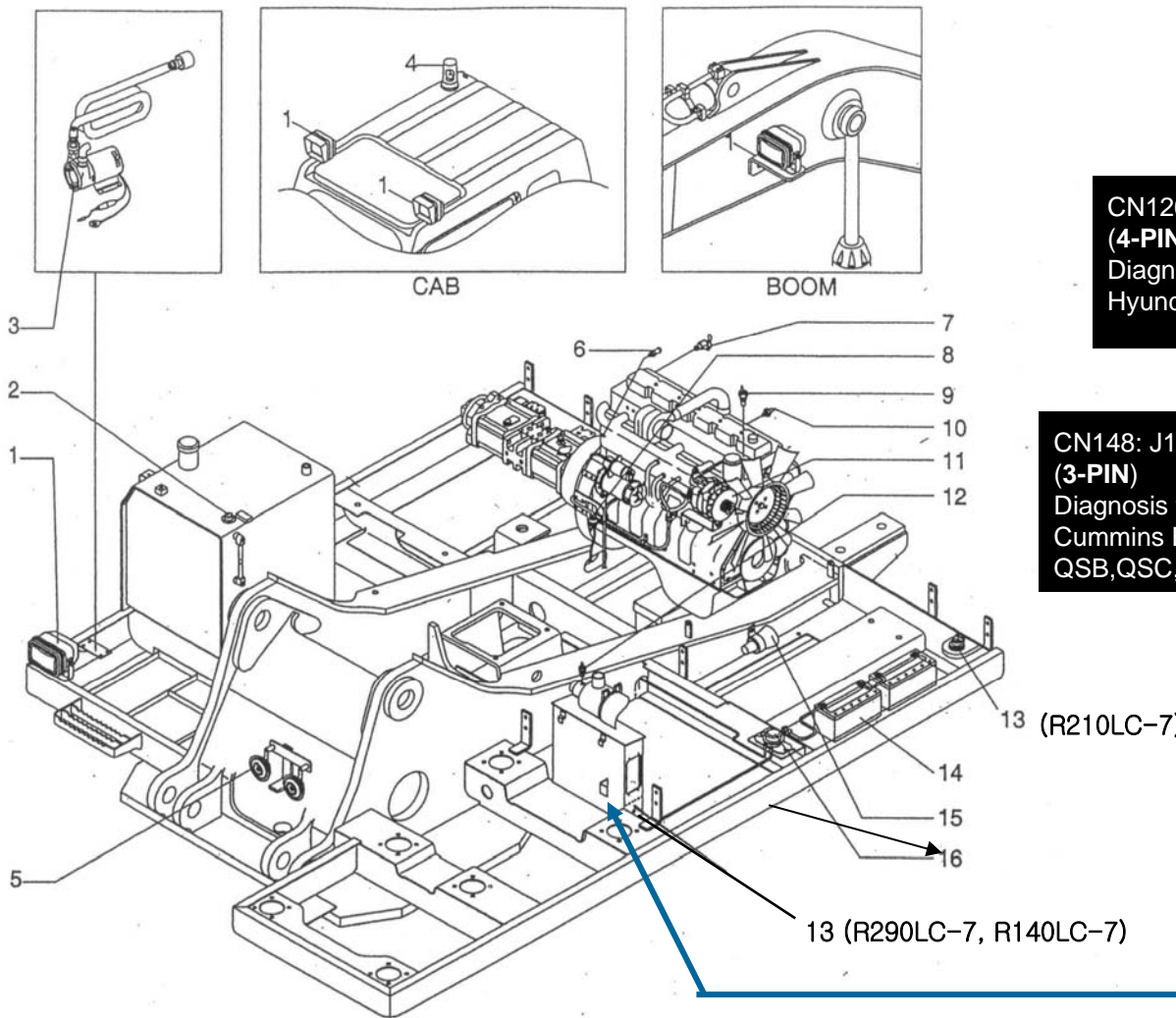
Conn ector	Pin No.		Input /Output	Normal value		Remark
				mA	V	
CN-51	(19)	TRAVEL Hi/Lo SW	I		5	
	(20)	GND(POT&DIAL)	-		-	Tier-1 only
	(21)	5V(POT&DIAL)	O		5	Tier-1 only
	(22)	POT-SIG	I		0.3~4.2	Tier-1, 'Active' condition
	(23)	ACCEL DIAL SIG	I		1~3.4	'Active' condition
	(24)	FUEL LEVEL SENSOR	I		0~5	'Active' condition
	(25)	TACHO SENSOR(-)	-		-	Tier-1 only
	(26)	TACHO SENSOR(+)	I		1~28 pulse	Tier-1 only
	(27)	BRAKE FAIL SW	-		5	Wheel type only
	(28)	T/M OIL PS	-		5	Wheel type only
	(29)	ACCEL SW	-		5	Wheel type only
	(30)	NC	-		-	
	(31)	GND(SENSOR)	-		-	
	(32)	NC	-		-	PUMP PROLIX SW(spare)
	(33)	WATER TEMP.SENSOR	I		0~5	Tier-1, 'Active' condition
	(34)	HYD TEMP.SENSOR	I		0~5	'Active' condition
	(35)	NC	-		-	
(36)	NC	-		-		

Note]

1. if there are no remarks,
Electrical power condition is
Key'ON' and Neutral condition,

2. Tolerance : *Voltage: ± 1 Volt,
*Current: 30mA

2. Electric System

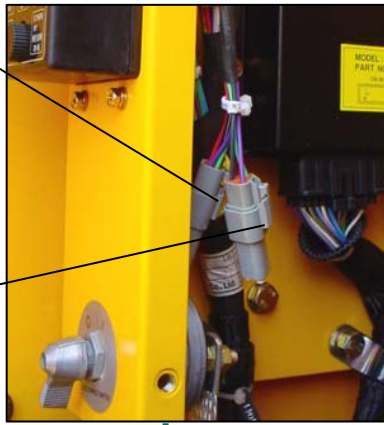


- | | | |
|--------------------|-------------------------------|-------------------------|
| 1 Lamp | 6 Speed sensor | 11 Alternator |
| 2 Fuel sender | 7 Heater valve | 12 Air cleaner switch |
| 3 Fuel filler pump | 8 Start relay | 13 <u>Master switch</u> |
| 4 Beacon lamp | 9 Temp sender | 14 Battery |
| 5 Horn | 10 Engine oil pressure switch | 15 Travel alarm buzzer |
| | | 16 Battery relay |

CN126: RS232 (4-PIN)
Diagnosis for Hyundai CPU

CN148: J1939 (3-PIN)
Diagnosis for Cummins ECM on QSB, QSC, QSM eng

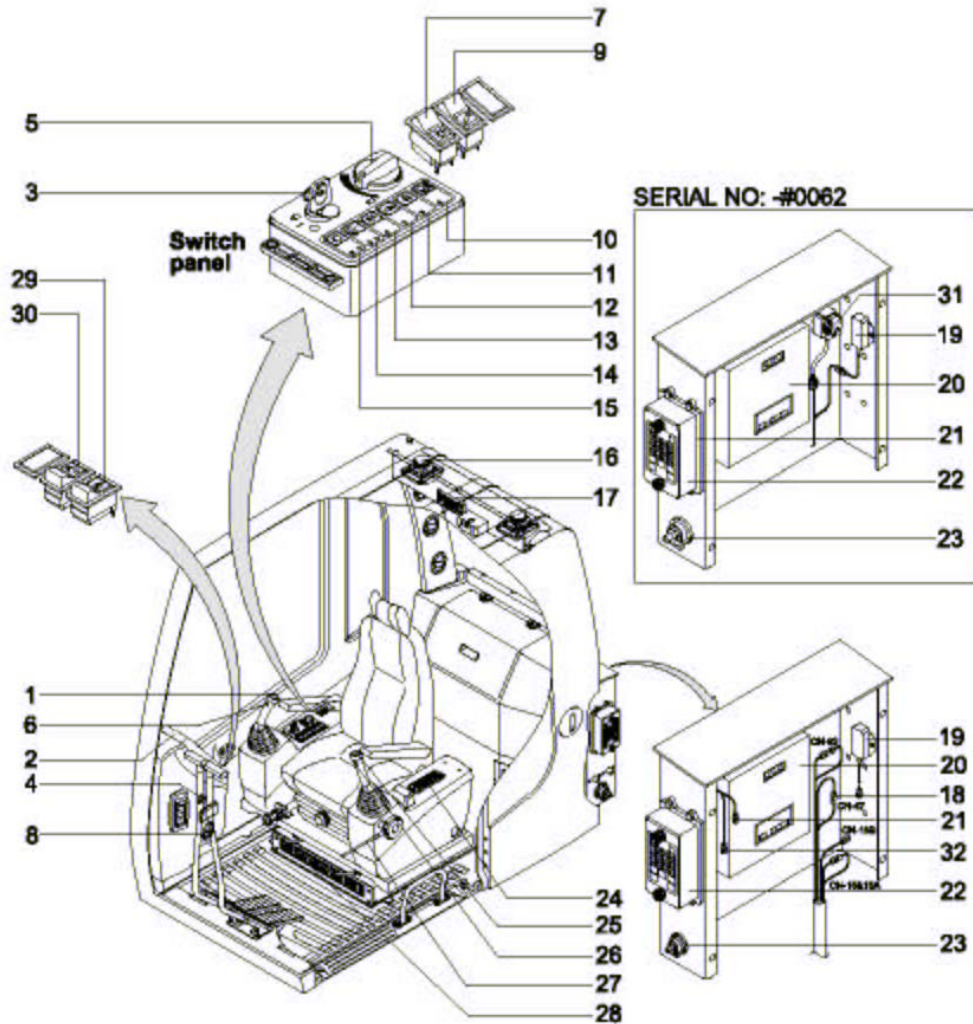
R290LC-7, with QSB-engine



Box with:

- fuses
- CPU
- relays
- emergency resistor (and/or emergency switch)
- connectors for Hyundai & Cummins diagnosis & software updating

2-1. Components Location (Cabin)



- | | | | |
|----|-------------------------------------|----|--|
| 1 | Horn switch | 24 | Air con & heater switch panel |
| 2 | Cluster | 25 | One touch decel switch |
| 3 | Starting switch | 26 | Power max switch |
| 4 | Cigar lighter | 27 | Safety lever |
| 5 | Accel dial | 28 | Emergency engine control lever
(Push pull cable, up to #0062) |
| 6 | Breaker switch | 29 | Overload switch |
| 7 | Beacon switch | 30 | Quick clamp switch |
| 8 | Service meter | 31 | Prolix switch |
| 9 | Breaker selection switch | 32 | J1939 serial connector
(#0112 and up, TIER II) |
| 10 | Cab light switch | | |
| 11 | Travel alarm stop switch | | |
| 12 | Preheat switch | | |
| 13 | Washer switch | | |
| 14 | Wiper switch | | |
| 15 | Main light switch | | |
| 16 | Speaker | | |
| 17 | Cassette & radio | | |
| 18 | Emergency engine starting connector | | |
| 19 | Resistor | | |
| 20 | CPU controller | | |
| 21 | RS232 serial port | | |
| 22 | Fuse box | | |
| 23 | Master switch | | |

POWER RY

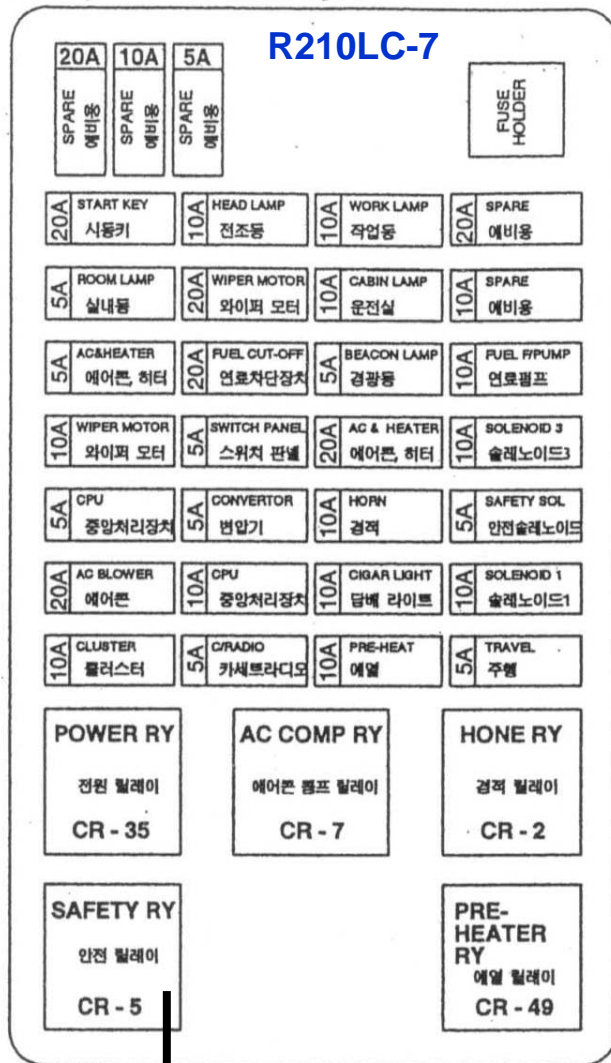
SAFETY RY



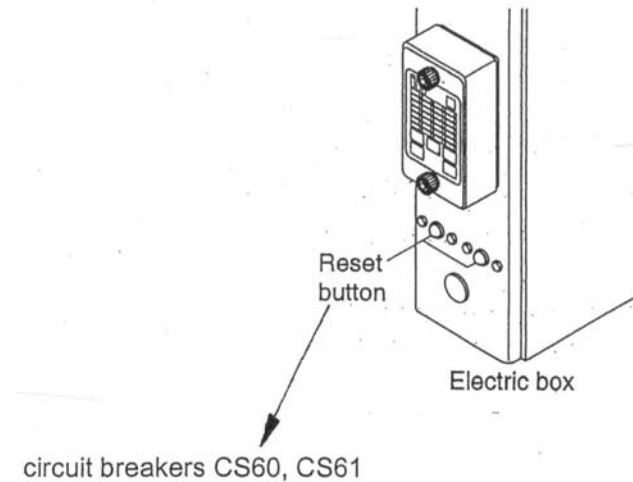
(Fuse box)

2-2. Fuses & Relays

LOCATION: OUTSIDE OF CPU COMPARTMENT

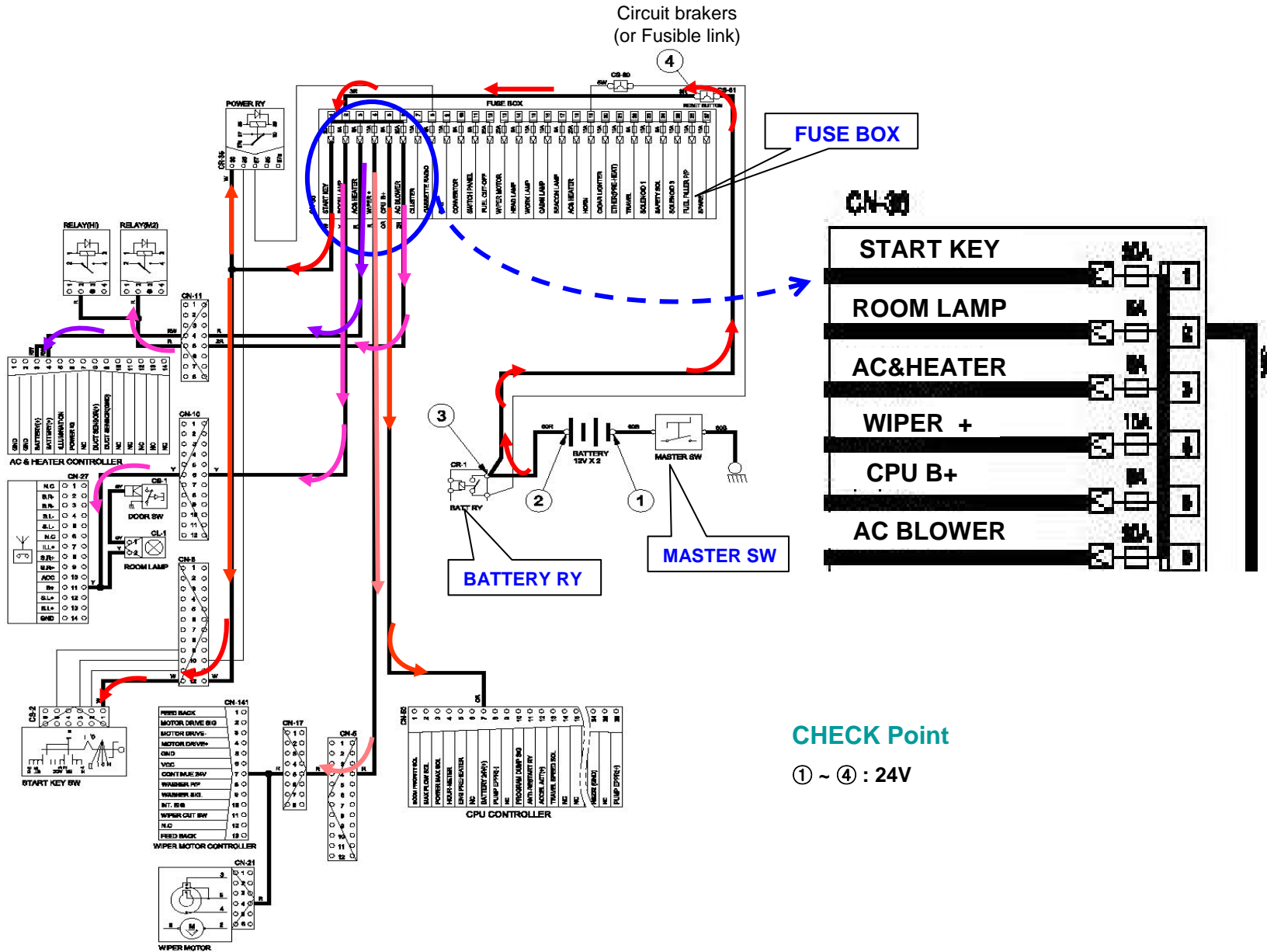


Some machines (R210LC-7,...) have “circuit breakers” which have to be “reset” in case of short circuit

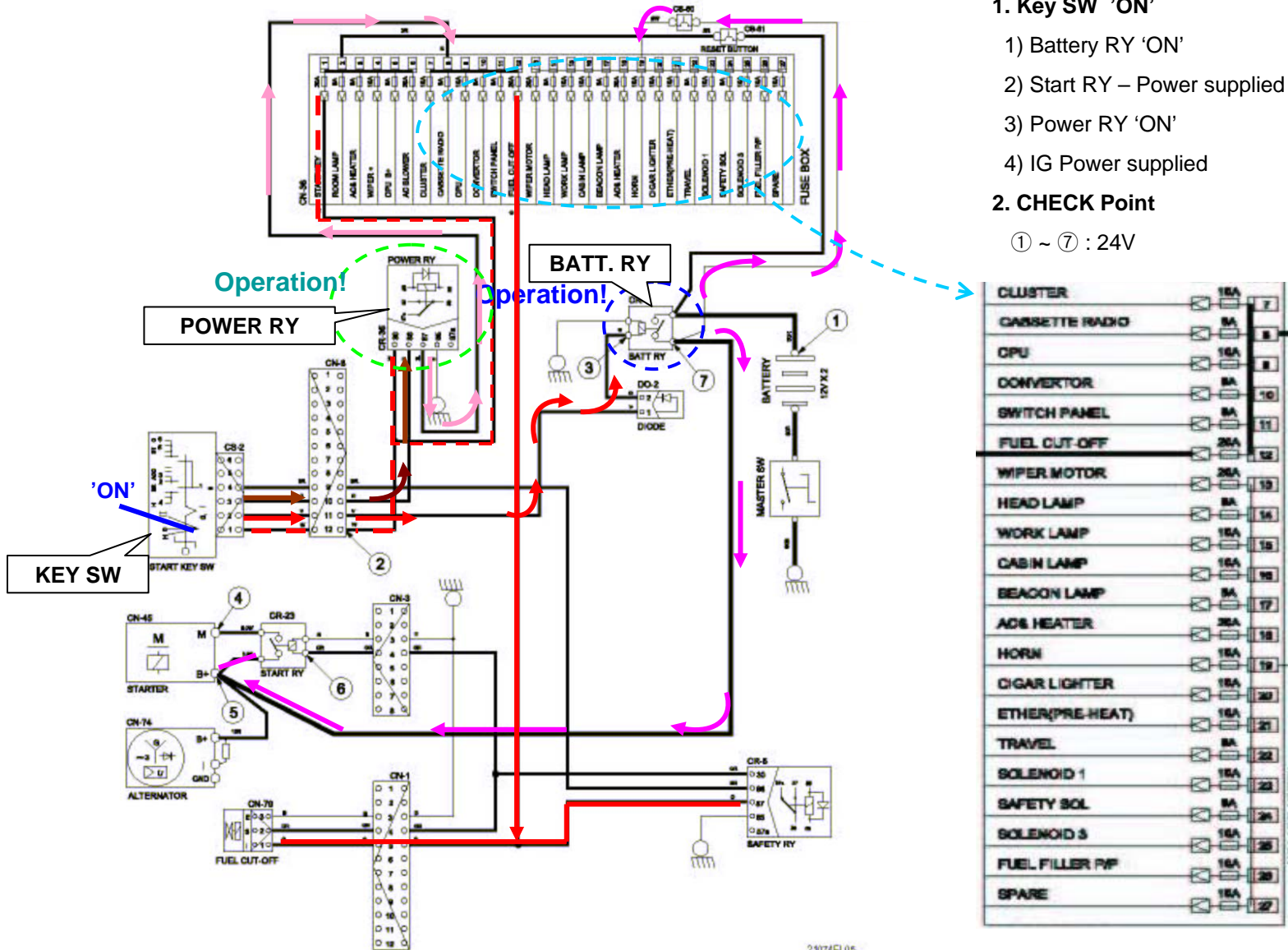


→ Safety Relay has an anti-restart function

2-3. CONTINUAL POWER



2-4. IG Circuit



1. Key SW 'ON'

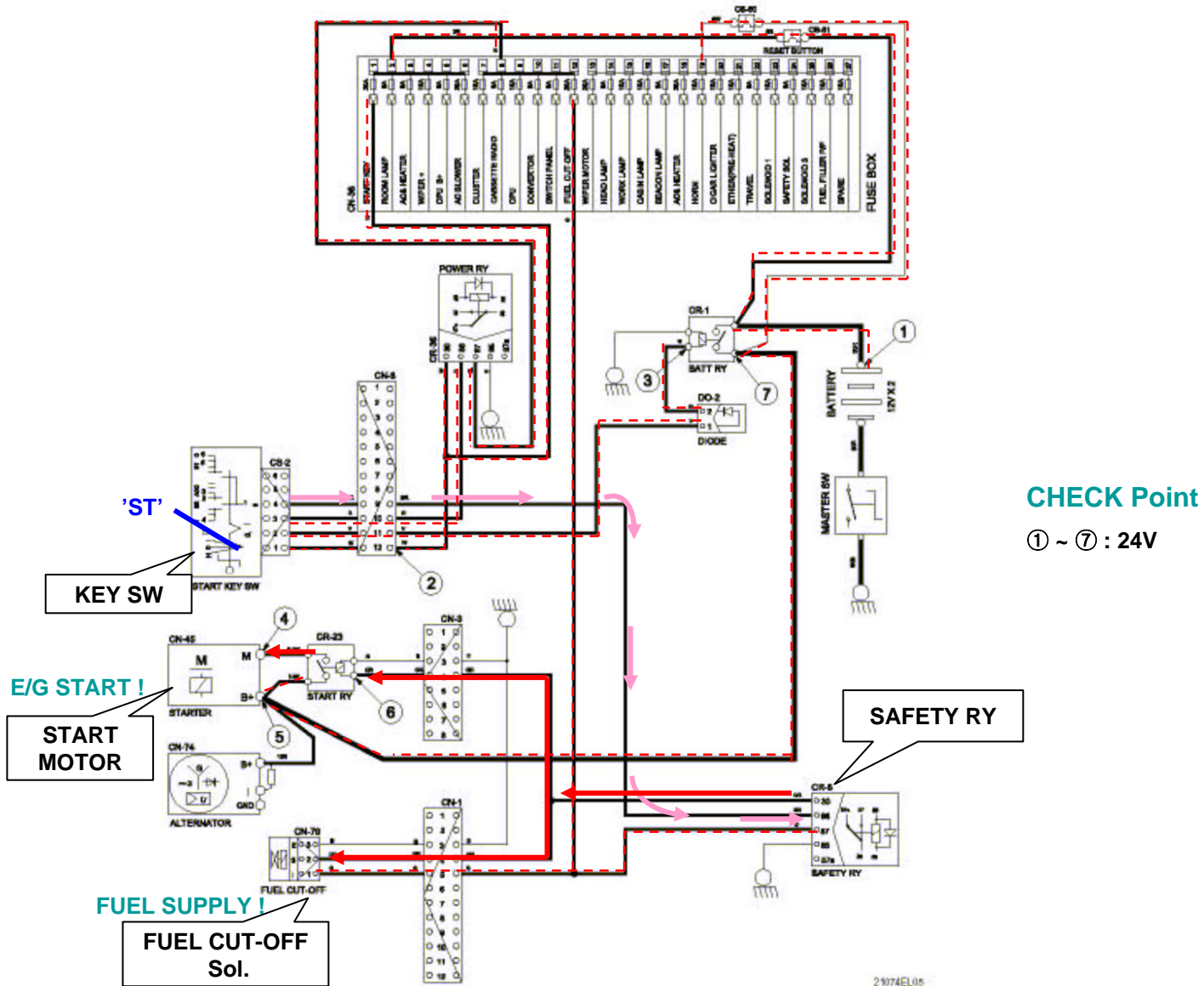
- 1) Battery RY 'ON'
- 2) Start RY – Power supplied
- 3) Power RY 'ON'
- 4) IG Power supplied

2. CHECK Point

① ~ ⑦ : 24V

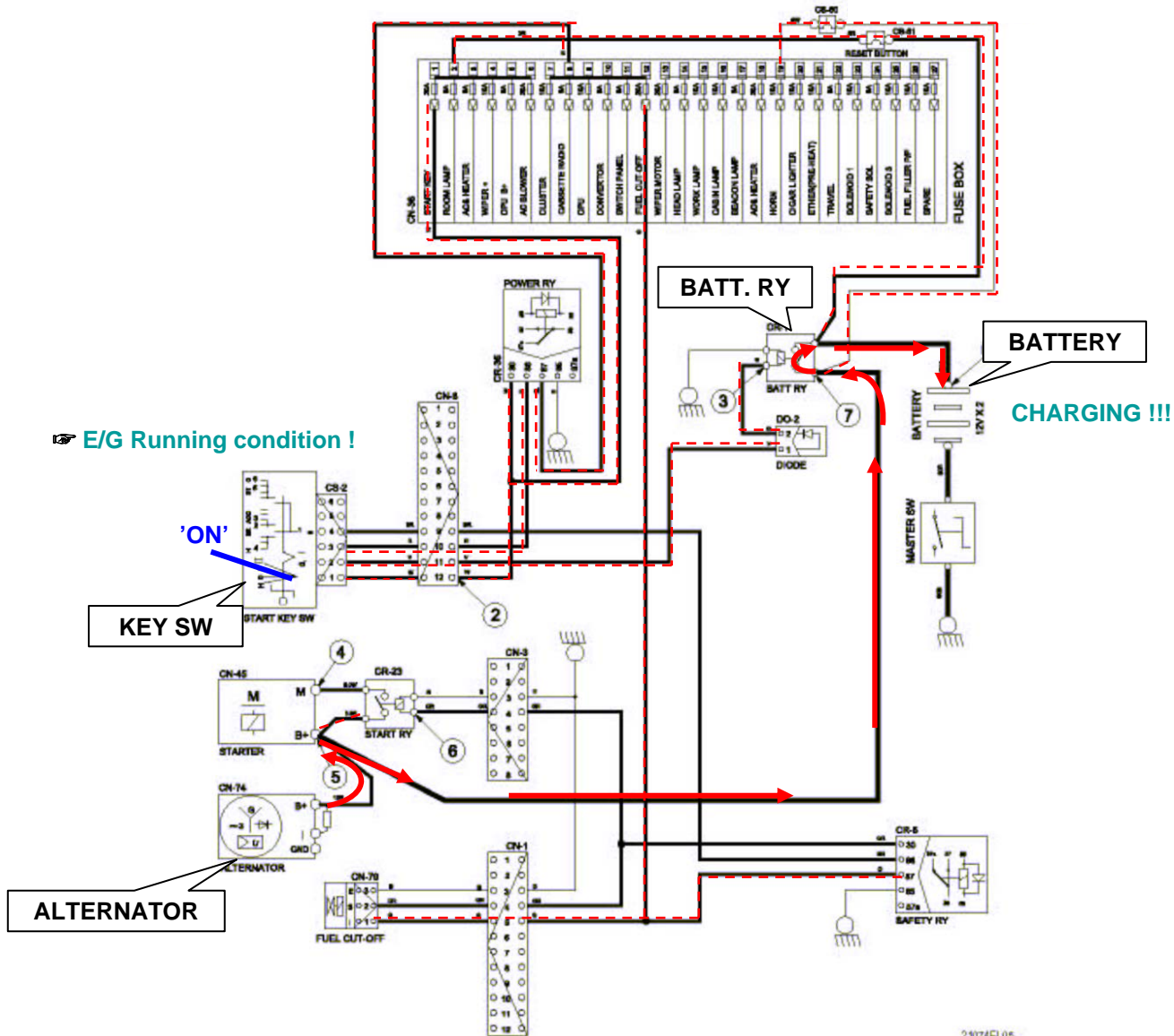
21074EL05

2-5. START Circuit



21074EL05

2-6. CHARGING Circuit



21074EL05

2-7. LIGHTS Circuit

Condition : KEY SW 'ON'

1	START KEY
2	ROOM LAMP
3	ACA HEATER
4	WIPER +
5	CPU B+
6	AC BLOWER
7	CLUSTER
8	CASSETTE RADIO
9	CPU
10	CONVERTOR
11	SWITCH PANEL
12	FUEL CUT OFF
13	WIPER MOTOR
14	HEAD LAMP
15	WORK LAMP
16	CABIN LAMP
17	BEACON LAMP
18	ACA HEATER
19	HORN
20	CIGAR LIGHTER
21	ETHER(PRE-HEAT)
22	TRAVEL
23	SOLENOID 1
24	SAFETY SOL
25	SOLENOID 2
26	FUEL FILLER P/P
27	SPW/E

FUSE BOX

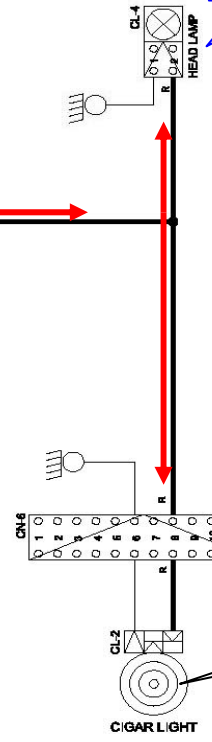
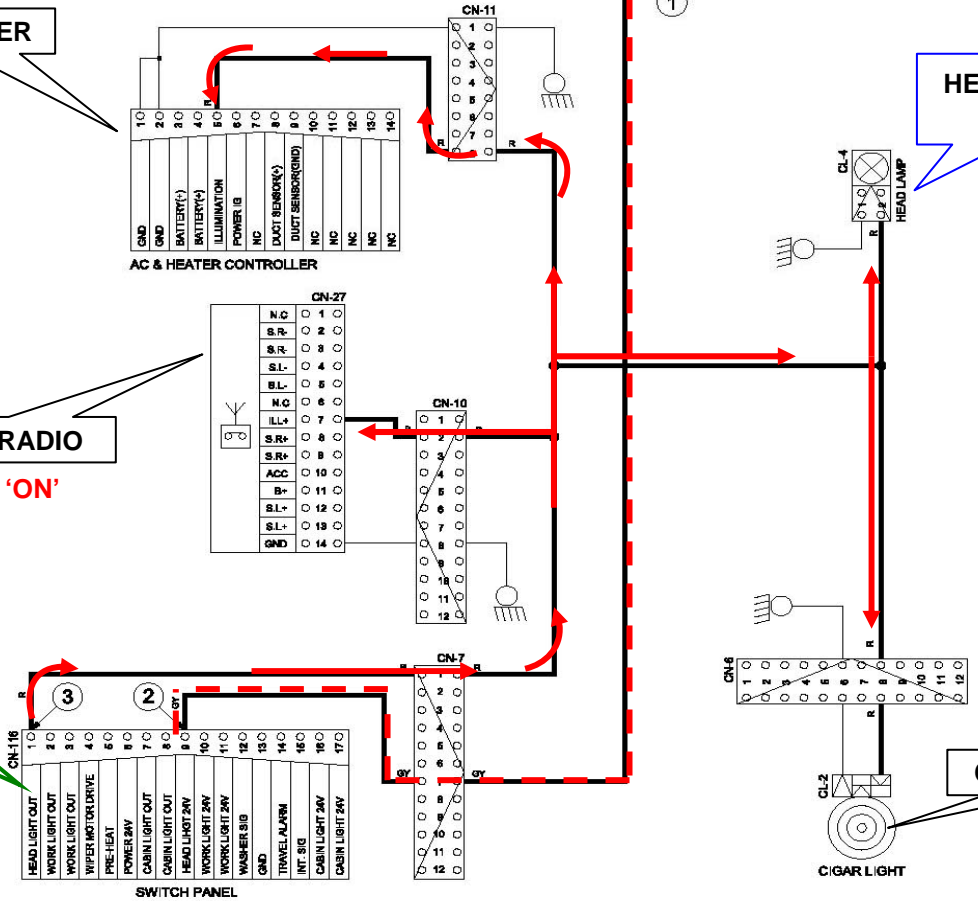
AC&HEATER
- Back light 'ON'

HEAD LAMP
'ON'

CASSETRADIO
- Back light 'ON'

CHECK Point
① ~ ③ : 24V

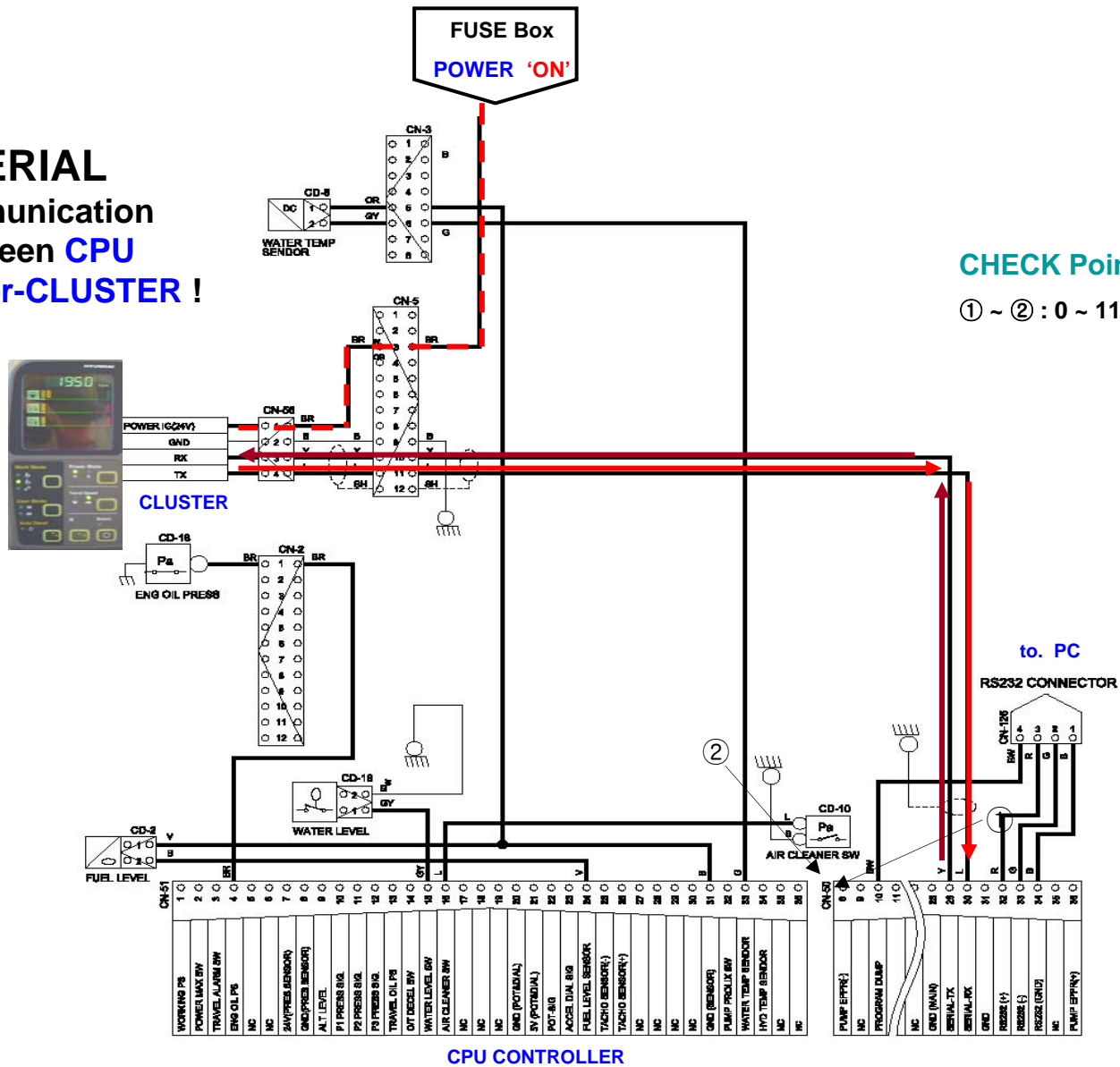
SWITCH PANEL
- Back Light 'ON'



CIGAR LIGHT
- Back light 'ON'

2-8. MONITORING Circuit

SERIAL
Communication
between CPU
Controller-CLUSTER !



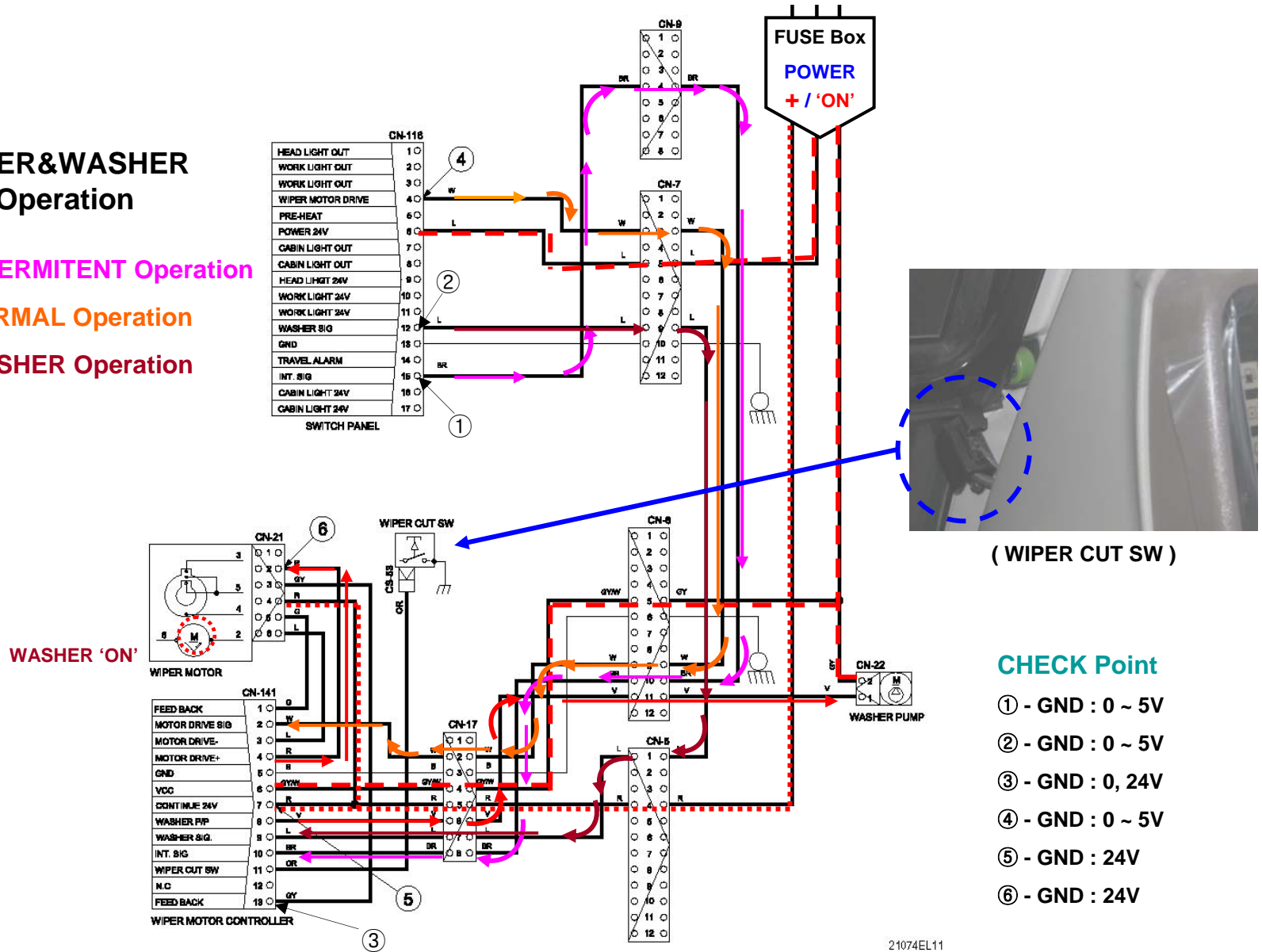
CHECK Point

① ~ ② : 0 ~ 11V Pulse

2-9. WIPER & WASHER Circuit

WIPER & WASHER Operation

- A. INTERMITTENT Operation
- B. NORMAL Operation
- C. WASHER Operation



(WIPER CUT SW)

CHECK Point

- ① - GND : 0 ~ 5V
- ② - GND : 0 ~ 5V
- ③ - GND : 0, 24V
- ④ - GND : 0 ~ 5V
- ⑤ - GND : 24V
- ⑥ - GND : 24V

21074EL11

THANK YOU FOR YOUR PARTICIPATION!!



END

