Section E

Hydraulics

Service Manual - JS160, JS180, JS190 - Tier III Auto

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Notes:

Contents **Page No.**

Contents **Page No.**

E - ii

Contents **Page No.**

Contents Page No.

Technical Data

General Data

Main Hydraulic Pump

Table 1.

	JS160/JS180	JS190
Type	Twin variable displacement axial piston pump	Twin variable displacement axial piston pump
Displacement volume	63 cm^3/rev x2	80 cm^3/rev x2
Operating pressure RATED	343 bar (4977 lb/in^2)	343 bar (4977 lb/in^2)
Maximum output @ 2200 rev/min.	136.6 litre/min. (30.5 UK gal/min.) x2	156.6 litre/min. (34.4 UK gal/min.) x2
Maximum input power	79 kW	87 kW
Dry weight	91 kg (201 lb)	127 kg (280 lb)

Table 2.

Torque settings	JS160-JS190
Pump coupling	
Grub screws	120 Nm
Axial screws	220 Nm
Radial screws	220 Nm
Pump housing flange to engine	57 Nm

Servo Pump

Table 3.

	JS160-JS190
Type	Fixed displacement gear pump
Displacement volume	10 cm^3/rev
Working pressure	39.2 bar (568.5 lb/in^2)

Proportional Pressure Reducing Valve

Table 4.

	JS160-JS190
Maximum primary pressure	39 bar (529 lb/in^2)
Maximum back pressure (allowable pressure)	1 bar (14.5 lb/in^2)
Secondary pressure setting range	0 - 40 bar (0 - 580 lb/in^2)
Maximum flow rate	10 l/min. (2.2 UK gal/min.)
Electrical specifications	
1. Rated current	700 mA
2. Coil resistance (at 20 °C)	17.5 +/-0.7 W
3. Recommended fluctuation of proportional solenoid current	80 Hz, 22 mA

Slew Motor

Table 5.

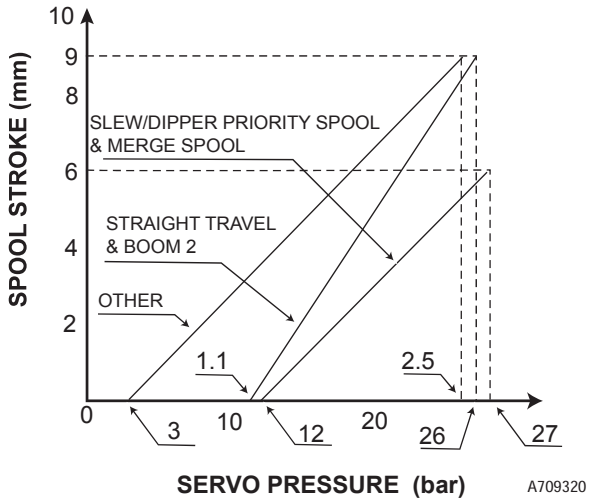
	JS160-JS190
Type	Fixed displacement piston motor
Suction capacity	87.3 cm^3/rev (0.33 in^3/rev)
Working pressure maximum	279 bar (4052 lb/in^2)
Work flow	138 l/min. (30.35 UK gal/min.)
Set pressure relief	289 bar (4191 lb/in^2)
Reduction gears	Planetary gears with 2 gear reduction
Reduction gear ratio	24.73 :1
Motor max. speed	1518 rpm
Brake torque	490 Nm
Brake pressure release	
Min.	20 bar (290 lb/in^2)
Max.	40 bar (580 lb/in^2)
Gearbox max. output torque	8560 Nm
Gearbox max. output speed	61.4 rpm
Motor oil	Mineral hydraulic oil HLP (DIN51526) or HM (ISO6743/4) viscosity VG46 with filtering grade 10 or better
Gearbox oil	SAE80W/90 or API GL5 for temperate climate / Shell transaxle oil 75W90 or equivalent for lower temperatures
Oil quantity	6l (1.32 UK gal) +/- 10%
Dry weight	220 kg (485 lb)

Main Control Valve

Table 6.

	JS160-JS190
Type	Hydraulic pilot system
Operating system	Set pressure relief
Main relief pressure	
Standard	314 bar (4554 lb/in^2) at 91 litre/min. (20 UK gal/min.)
Pressure raising (boost)	343 bar (4975 lb/in^2) at 83 litre/min. (18.3 UK gal/min.)
Overload relief pressure	
Bucket open/closed	363 bar (5076 lb/in^2) at 20 litre/min. (4.4 UK gal/min.)
Dipper	363 bar (5076 lb/in^2) at 20 litre/min. (4.4 UK gal/min.)
Boom raising	363 bar (5076 lb/in^2) at 20 litre/min. (4.4 UK gal/min.)
Boom lowering pressure	294 bar (4206 lb/in^2) at 20 litre/min. (4.4 UK gal/min.)
TAB/dozer raising	250 bar (3625 lb/in^2) at 20 litre/min. (4.4 UK gal/min.)
TAB/dozer lowering	250 bar (3625 lb/in^2) at 20 litre/min. (4.4 UK gal/min.)
Option 1	363 bar (5076 lb/in^2) at 20 litre/min. (4.4 UK gal/min.)
Option 1	363 bar (5076 lb/in^2) at 20 litre/min. (4.4 UK gal/min.)
Low flow option pressure	240 bar (3481 lb/in^2) at 20 litre/min. (4.4 UK gal/min.)
Low flow option return	240 bar (3481 lb/in^2) at 20 litre/min. (4.4 UK gal/min.)
Function boom and dipper 2 speed confluence	Slew or boom priority and dipper load holding valve
Dry weight	
Without option slices	132.5 kg (292 lb)
With option slices	180 kg (397 lb)

Spool Stroke versus Pilot Pressure



Boom Ram

Table 7.

	JS160-JS190
Cylinder diameter	115 mm (4.53 in)
Rod diameter	80 mm (3.15 in)
Maximum contracted length	1693 mm (66.65 in)
Stroke	1184 mm (46.61 in)
Dry weight	154 kg (340 lb)

Dipper Ram

Table 8.

	JS160-JS190
Cylinder diameter	120 mm (4.72 in)
Rod diameter	85 mm (3.35 in)
Maximum contracted length	1875 mm (73.82 in)
Stroke	1335 mm (52.56 in)
Dry weight	244 kg (538 lb)

Bucket Ram

Table 9.

	JS160-JS190
Cylinder diameter	105 mm (4.13 in)
Rod diameter	75 mm (2.95 in)
Maximum contracted length	1507 mm (59.33 in)
Stroke	997 mm (39.25 in)
Dry weight	147 kg (313 lb)

TAB Ram

Table 10.

	JS160-JS190
Cylinder diameter	135 mm (5.31 in)
Rod diameter	90 mm (3.54 in)
Maximum contracted length	1687 mm (66.42 in)
Stroke	1073 mm (42.24 in)
Dry weight	325 kg (716 lb)

Ram Torque Settings

Table 11.

Ram Location	Dimensions Bore x Rod	Piston Nut A/F	Piston Nut Torque		Grub Screw Torque		Gland Torque	
	mm	mm	Nm	lb/ft	Nm	lb/ft	Nm	lb/ft
Boom	115 x 80	85	3840	2832	56.9 +/- 10.7	42.1 +/- 7.9	267	198
Dipper	120 x 85	95	6980	5148	56.9 +/- 10.7	42.1 +/- 7.9	267	198
Bucket	105 x 75	80	4440	3274	31.5 +/- 5.9	23.3 +-/ 4.4	171	127
TAB	130 x 90	95	6980	5148	56.9 +/- 10.7	42.1 +/- 7.9	267	198

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Basic System Operation

Introduction to Hydraulic Schematic Symbols

TE-001

General (Basic and Functional Symbols)

Complex hydraulic components and circuits can be described to the engineer by using graphical symbols. The following pages illustrate and give a brief description for some of the more common symbols used.

There are many symbols in use and it would be impossible to include them all here. However it should be noted that most are only variations or refinements on the basic principles explained here. If more detailed information is required you are recommended to obtain a copy of BS2917 or IS01219.

Once familiar with the symbols, the engineer can use hydraulic circuit diagrams as an aid to fault finding. It will be possible to see the complete hydraulic circuit and decipher the relationship between hydraulic components.

Table 1. General

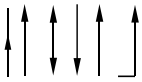
	Spring
	Flow restriction affected by viscosity
	Direction of flow
	Indication of rotation
	Indication of direction and paths of flow
	Variable control

Table 2. Rams

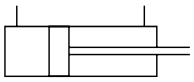
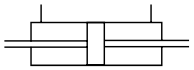
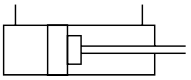
	Single acting
	Double acting
	Double ended
	Double acting with damping at rod area end

Table 3. Pumps and Motors

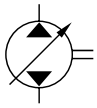
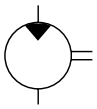
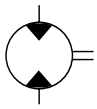
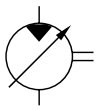
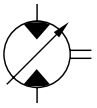
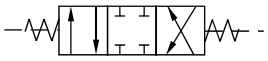
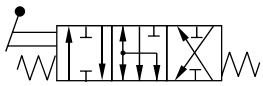
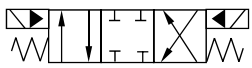
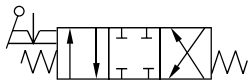
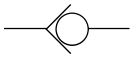
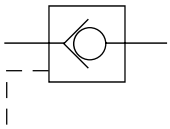
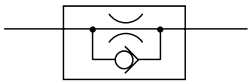
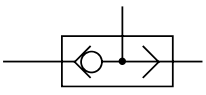
	Variable capacity pump two directions of flow
	Fixed capacity motor one direction of flow
	Fixed capacity motor two directions of flow
	Variable capacity motor one direction of flow
	Variable capacity motor two directions of flow

Table 4. Control Valves

	Used to enclose several valves indicating they are supplied as one unit
	3-Position, 4-port spring centered pilot operated valve
	3-position, 6-port spring centered pilot operated valve
	3-Position, 4-port spring centered solenoid & pilot pressure operated valve
	3-Position, 4-port spring centered detent hand operated valve
	Non-return valve
	Non-return valve with back pressure spring
	Pilot operated non-return valve
	One way restrictor
	High pressure selector (shuttle valve)

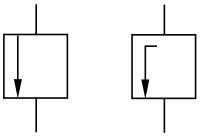
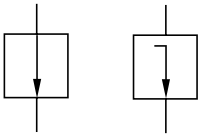
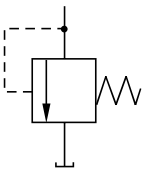
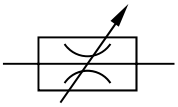
	Throttling orifice - normally closed
	Throttling orifice - normally open
	Relief valve
	Variable restrictor

Table 5. Energy Transmissions and Conditioning

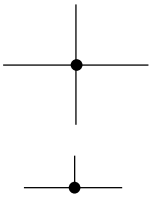
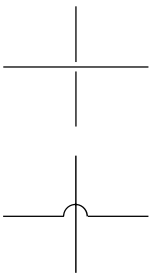
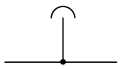
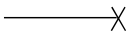
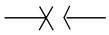
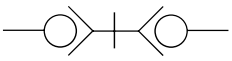
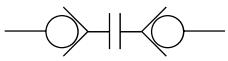
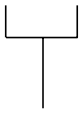
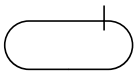
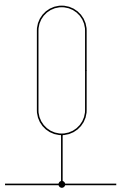
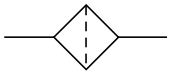
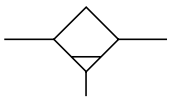
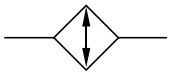
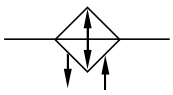
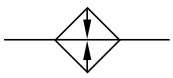
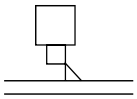
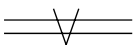
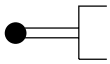
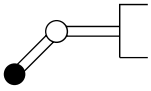
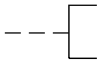
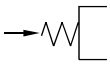
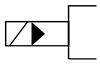
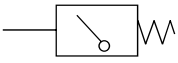
	Working line, return or feed
	Pilot control
	Drain lines
	Flexible pipe
	Line junction
	Crossing lines
	Air bleed
	Line plugged, also pressure test point
	Line plugged with take off line
	Quick release couplings - connected
	Quick release couplings - disconnected
	Reservoir - return line above fluid level
	Reservoir - return line below fluid level
	Header tank
	Pressure sealed tank
	Accumulator
	Filter or strainer
	Water trap
	Cooler - with no indication of coolant flow
	Cooler - indicating direction of coolant flow
	Heater

Table 6. Control Mechanisms

	Rotating shaft - one direction
	Rotating shaft - two directions
	Detent
	Locking device
	Over centre device
	Simple linkage
	General control
	Push button operated
	Lever operated
	Pedal operated
	Stem operated
	Spring operated
	Roller operated
	Roller trip operated (one directional)

	Solenoid one winding
	Solenoid two windings
	Electric motor operated
	Internal pressure pilot operated
	External pressure pilot operated
	Pressure operated spring release
	Pilot operated by solenoid pilot valve
	Pilot operated by a solenoid or seperate pilot valve
	Pressure guage
	Pressure switch

Control Valves

Control valves are usually represented by one or more square boxes.

⇨ *Fig 1. (E-11)* shows a control valve represented by three boxes. The number of boxes indicates the number of possible valve operating positions, (3 boxes - 3 positions etc).

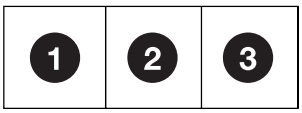


Fig 1.

⇨ *Fig 2. (E-11)* - In circuit diagrams the pipework is usually shown connected to the box which represents the unoperated condition. (Hydraulic circuit diagrams are usually shown in the unoperated condition).

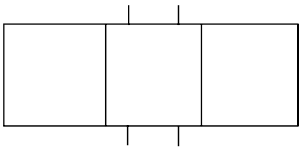


Fig 2.

⇨ *Fig 4. (E-11)* shows a valve described as a 3-position, 4-port control valve. Port describes the openings to and from the valve by which the hydraulic fluid enters or leaves. In the fig shown, Position **2** indicates that in an unoperated condition all 4 ports are blocked.

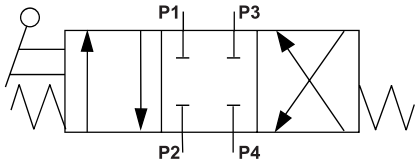


Fig 3.

If the valve spool was moved to Position **1**, movement of the spool would connect Port **P1** to Port **P2**, and Port **P3** to Port **P4**. ⇨ *Fig 4. (E-11)*.

If the valve spool was moved to Position **3**, movement of the spool would connect Port **P1** to Port **P4**, and Port **P3** to Port P2. ⇨ *Fig 4. (E-11)*.

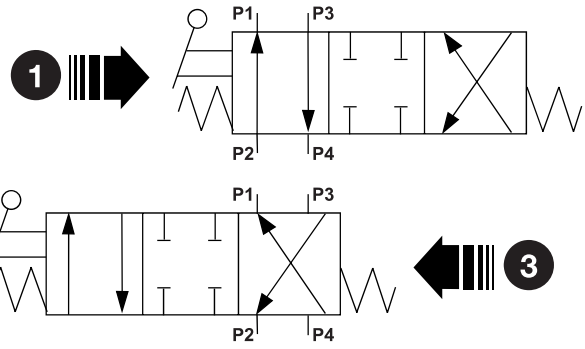


Fig 4.

It must be noted that not all spools are of the same type. Their operating designs can be seen by following the path the flow arrows take in their respective operating squares.

Three typical JCB style spools are known as 'D' spools, 'F' spools and 'N' spools.

The 'D' spools generally control rams because when in the neutral position the outlet ports are blocked, preventing ram movement. ⇨ *Fig 4. (E-11)* shows a 'D' type spool.

⇨ *Fig 5. (E-11)* - 'F' spools are often shown as four position spools with the three normal positions for neutral and service control; and the forth position, which has a detent, connects both sides of the ram together to allow the service to 'float'.

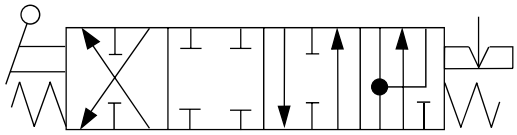


Fig 5.

⇨ *Fig 6. (E-11)* - 'N' spools are sometimes used to control hydraulic motors, and it can be seen from the flow arrows, that in neutral position both service ports are connected to the exhaust oil port

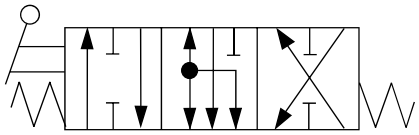


Fig 6.

Example of Schematic Circuit

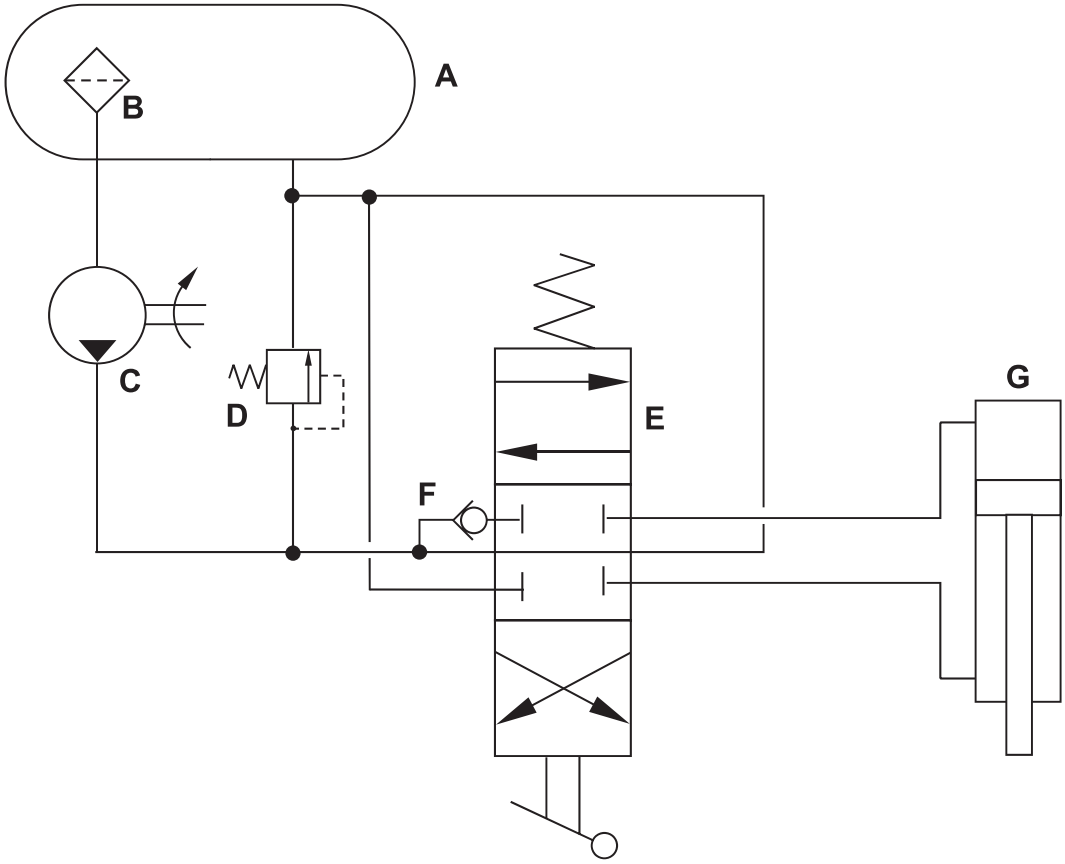


Fig 7. Simple Schematic Circuit

Some of the symbols described on the preceding pages have been arranged into a simple schematic circuit. ⇨ *Fig 7. (E-12)*.

Hydraulic tank **7-A** is a pressurised tank with an internally mounted strainer **7-B** on the suction line to the fixed displacement pump **7-C**. System pressure is limited to the setting of relief valve **7-D**.

Valve spool **7-E** is an open-centre spool that is in neutral position; flow from the pump passes through the spool and returns to the hydraulic tank.

If the lever operated spool is moved away from neutral position hydraulic fluid is directed to either head side or rod side of hydraulic ram **7-G**. Notice that the fluid must first open one way valve **7-F** before flowing to the ram.

Example Circuit Key

7-A	Hydraulic Tank
7-B	Strainer
7-C	Fixed Displacement Pump
7-D	Relief Valve
7-E	Spool
7-F	One Way Valve
7-G	Double Acting Hydraulic Ram

Circuit Descriptions

Hydraulic Schematics

JS160/JS180

The item numbers in the following table are identified on the hydraulic schematic diagram. ⇒ *Fig 1. (E-15)*.

Table 1. Component Identification

Item	Part number	Description	Location
1	20/925533	Slew motor	Centre section of machine
2	45/920020	Rotary coupling 6 port	Centre section of machine
3	331/42329	Cylinder arm	On the boom
4	25/222741	HBCV arm	Dipper ram
5	20/925532	Motor travel and gearbox	Lower frame sprocket drive
6	25/221980	HBCV TAB adjust	
9	45/910500	Coupling male 1/2	Dipper
10	45/910400	Coupling female 1/2	Dipper
11	JBV0510	Cylinder TAB	On boom
12	25/221979	HBCV/TAB	TAB ram
13	331/42330	Cylinder bucket	On dipper
14	25/222663	Main control valve	Centre section of machine
15	25/222664	Main control valve with TAB option	Centre section of machine
16	331/42327	Cylinder monoboom LH	On boom
17	JRJ0343	Valve L/F closed centre	Above main control valve
18	331/42328	Cylinder TAB boom	On boom
19	331/45484	Manifold HBCV	Centre of machine between boom rams
20	JRJ0344	Valve L/F open centre	Above main control valve
22	701/80197	Overload pressure switch	On rear of item 21
23	701/80195	Pressure switch	On rear of item 19
27	25/222216	Valve logic	Centre of machine
28	25/222140	Valve check 3 Bar	Control valve
29	JNJ0611	Filter return	Inside hydraulic tank
30	KHJ0897	Plexus filter stop valves	Below plexus filter
31	30/926082	Oil cooler	Radiator bay
32	25/222139	Valve check 1 bar	Cooler return pipe
34	KNJ0287	Filter drain	Right hand compartment
35	KRJ3460	Hydraulic tank air breather	On top of hydraulic tank
36	JLJ0495	Plexus filter	Right hand compartment
37	331/31535	Hydraulic tank	Right hand side of machine
38	KHJ0568	Inline filter cushion	Centre of machine on cooler pipe
39	32/925359	Filter strainer	Inside hydraulic tank
40	KRJ1600	Valve relief	On top of main return filter
41	32/925185	Filter main return	Inside hydraulic tank
42	331/27235	Manifold return	Under hydraulic tank

Item	Part number	Description	Location
43	701/80372	Auto mode pressure switch	On servo control shuttle block
44	25/221066	Valve dual controls ISO/SAE	Under cab
45	701/80373	Pressure switch	On servo control shuttle block
46	25/222638	Valve shuttle	Battery bay on the bulkhead panel
47	25/22263	Valve logic	
48	25/221095	Valve RH hand control	Cab
49	25/220040	Valve cushion	Battery bay
50	25/221094	Valve LH hand control	Cab
51	701/80375	Pressure switch	On main control valve
52	701/80374	Pressure switch	On main control valve
53	928/60209	Option pedal valve	Under cab floor
54	25/221009	Hammer/auxiliary change over solenoid	Under cab floor
55	KSJ2465	Travel pedal valve	Under cab floor
56	45/920078	Manifold	
59	701/80462	Pressure switch	On main control valve
60	25/222203	Valve 8 spool	Pump bay
61	JHJ0050	Accumulator	On item 60
62	32/925214	Filter servo	
63	20/925506	Main pump	Right hand rear compartment
64	JTJ0027	Test point	
65	25/221758	Low flow priority valve	Pump bay
69	25/221757	Priority 36 l/min.	Pump bay
70	928/60044	Valve check	

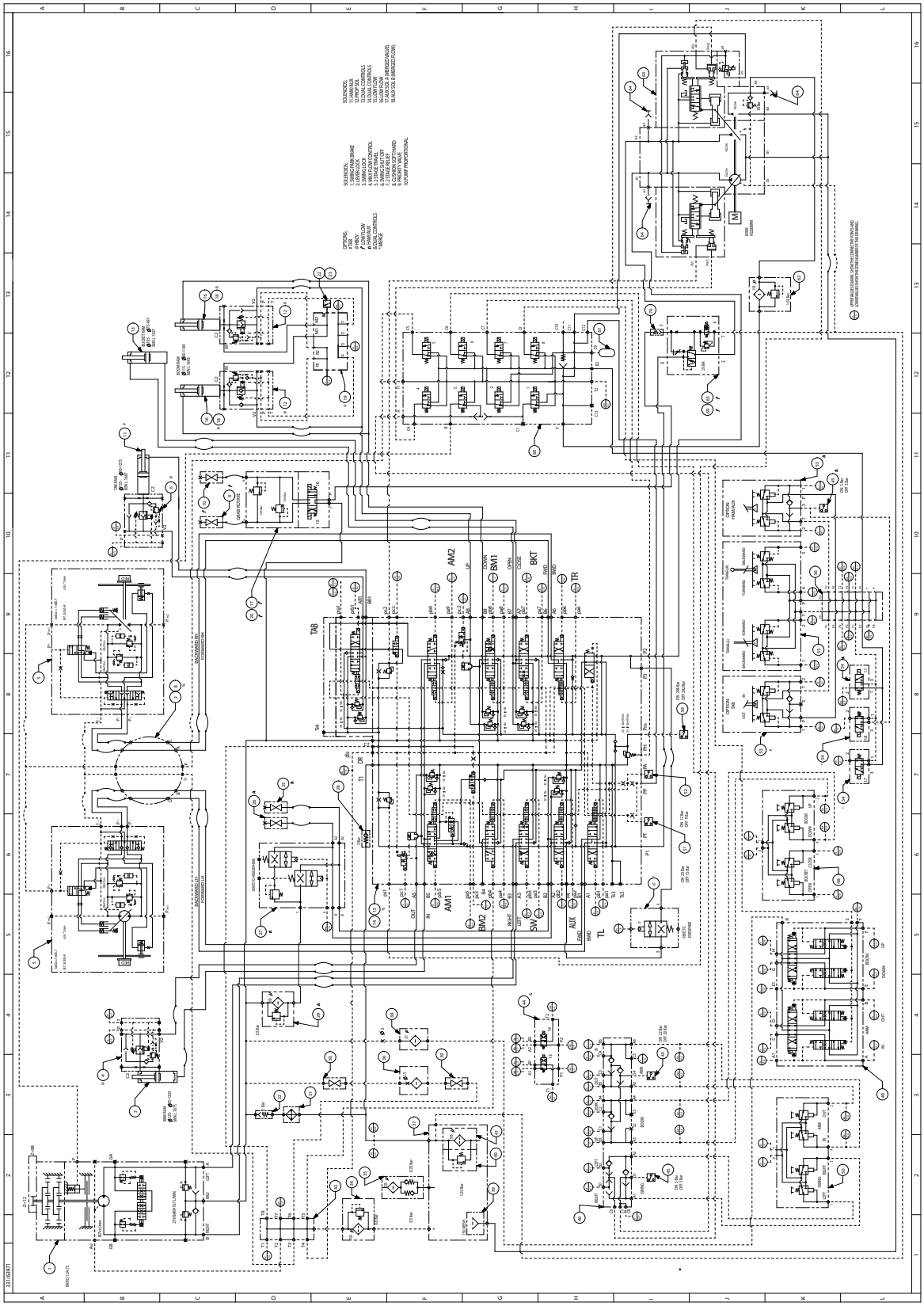


Fig 1. 331/63971 - Issue 4

JS190

The item numbers in the following table are identified on the hydraulic schematic diagram. ⇨ *Fig 1. (E-15)*.

Table 2. Component Identification

Item	Part number	Description	Location
1	20/925533	Slew motor	Centre section of machine
2	45/920020	Rotary coupling 6 port	Centre section of machine
3	331/42329	Cylinder arm	On the boom
4	25/222741	HBCV arm	Dipper ram
5	20/925532	Motor travel and gearbox	Lower frame sprocket drive
6	25/221980	HBCV TAB adjust	
9	45/910500	Coupling male 1/2	Dipper
10	45/910400	Coupling female 1/2	Dipper
11	JBV0510	Cylinder TAB	On boom
12	25/221979	HBCV/TAB	TAB ram
13	331/42330	Cylinder bucket	On dipper
14	25/222473	Main control valve	Centre section of machine
15	25/222474	Main control valve with TAB option	Centre section of machine
16	331/42327	Cylinder monoboom LH	On boom
17	JRJ0343	Valve L/F closed centre	Above main control valve
18	331/42328	Cylinder TAB boom	On Boom
19	331/45484	Manifold HBCV	Centre of machine between boom rams
20	JRJ0344	Valve L/F open centre	Above main control valve
22	701/80197	Overload pressure switch	On rear of item 21
23	701/80195	Pressure switch	On rear of item 19
27	25/222216	Valve logic	Centre of machine
28	25/222140	Valve check 3 bar	Control valve
29	JNJ0611	Filter return	Inside hydraulic tank
30	KHJ0897	Plexus filter stop valves	Below plexus filter
31	30/926082	Oil cooler	Radiator bay
32	25/222139	Valve check 1 bar	Cooler return pipe
34	KNJ0287	Filter drain	Right hand compartment
35	KRJ3460	Hydraulic tank air breather	On top of hydraulic tank
36	JLJ0495	Plexus filter	Right hand compartment
37	331/31535	Hydraulic tank	Right hand side of machine
38	KHJ0568	Inline filter cushion	Centre of machine on cooler pipe
39	32/925359	Filter strainer	Inside hydraulic tank
40	KRJ1600	Valve relief	On top of main return filter

Item	Part number	Description	Location
41	32/925185	Filter main return	Inside hydraulic tank
42	331/27235	Manifold return	Under hydraulic tank
43	701/80372	Auto mode pressure switch	On servo control shuttle block
44	25/221066	Valve dual controls ISO/SAE	Under cab
45	701/80373	Pressure switch	On servo control shuttle block
46	25/220830	Valve shuttle	Battery bay on the bulkhead panel
47	25/222263	Valve logic	
48	25/221095	Valve RH hand control	Cab
49	25/220040	Valve cushion	Battery bay
50	25/221094	Valve LH hand control	Cab
51	701/80375	Pressure switch	On main control valve
52	701/80374	Pressure switch	On main control valve
53	928/60209	Option pedal valve	Under cab floor
54	25/221009	Hammer/auxiliary change over solenoid	Under cab floor
55	KSJ2465	Travel pedal valve	Under cab floor
56	45/920078	Manifold	
59	701/80462	Pressure switch	On main control valve
60	25/222203	Valve 8 spool	Pump bay
61	JHJ0050	Accumulator	On item 60
62	32/925214	Filter servo	
63	20/925506	Main pump	Right hand rear compartment
64	JTJ0027	Test point	
65	25/221758	Low flow priority valve	Pump bay
69	25/221757	Priority 36 l/min.	Pump bay
70	928/60044	Valve check	

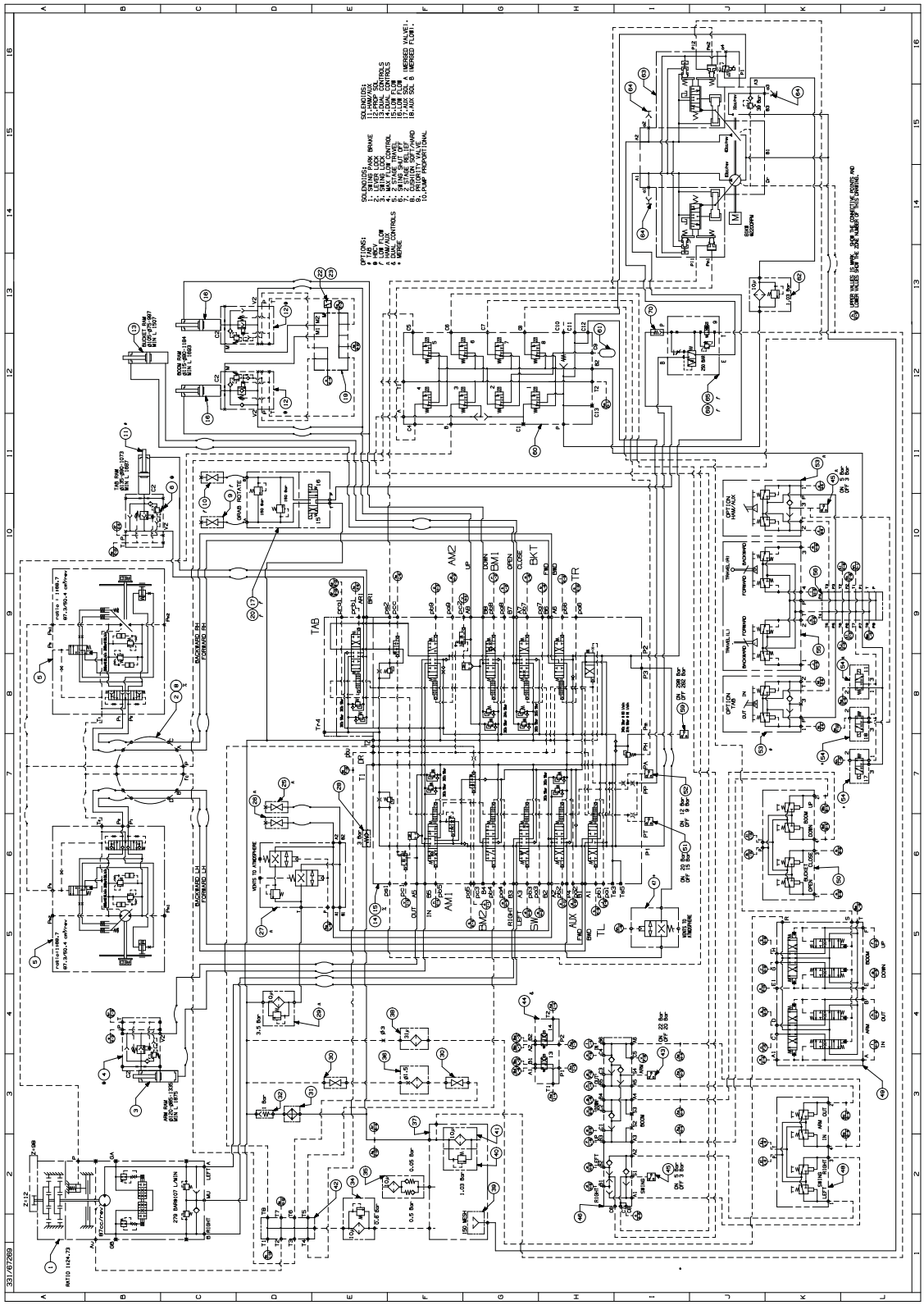


Fig 2. 331/67269 - Issue 1

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Servo Line

Components

1 Cab manifold

2 RH hand control

3 LH hand control

4 Travel pedal

5 Solenoid valve

6 Shuttle valve

7 Cushion valve

8 Main control valve

- **a** Dipper 2
- **b** Boom
- **c** Bucket
- **d** Travel RH
- **e** Dipper 1
- **f** Boom
- **g** Slew
- **h** Option
- **i** Travel LH
- **j** Dipper holding valve
- **k** Boom holding valve
- **l** Slew over dipper priority valve

Hose Colour

BL	Blue
BR	Brown
CI	Colourless
G	Green
GR	Grey
LB	Light Blue
O	Orange
P	Pink
R	Red
V	Violet
W	White
Y	Yellow
LG	Light Green
DG	Dark Green

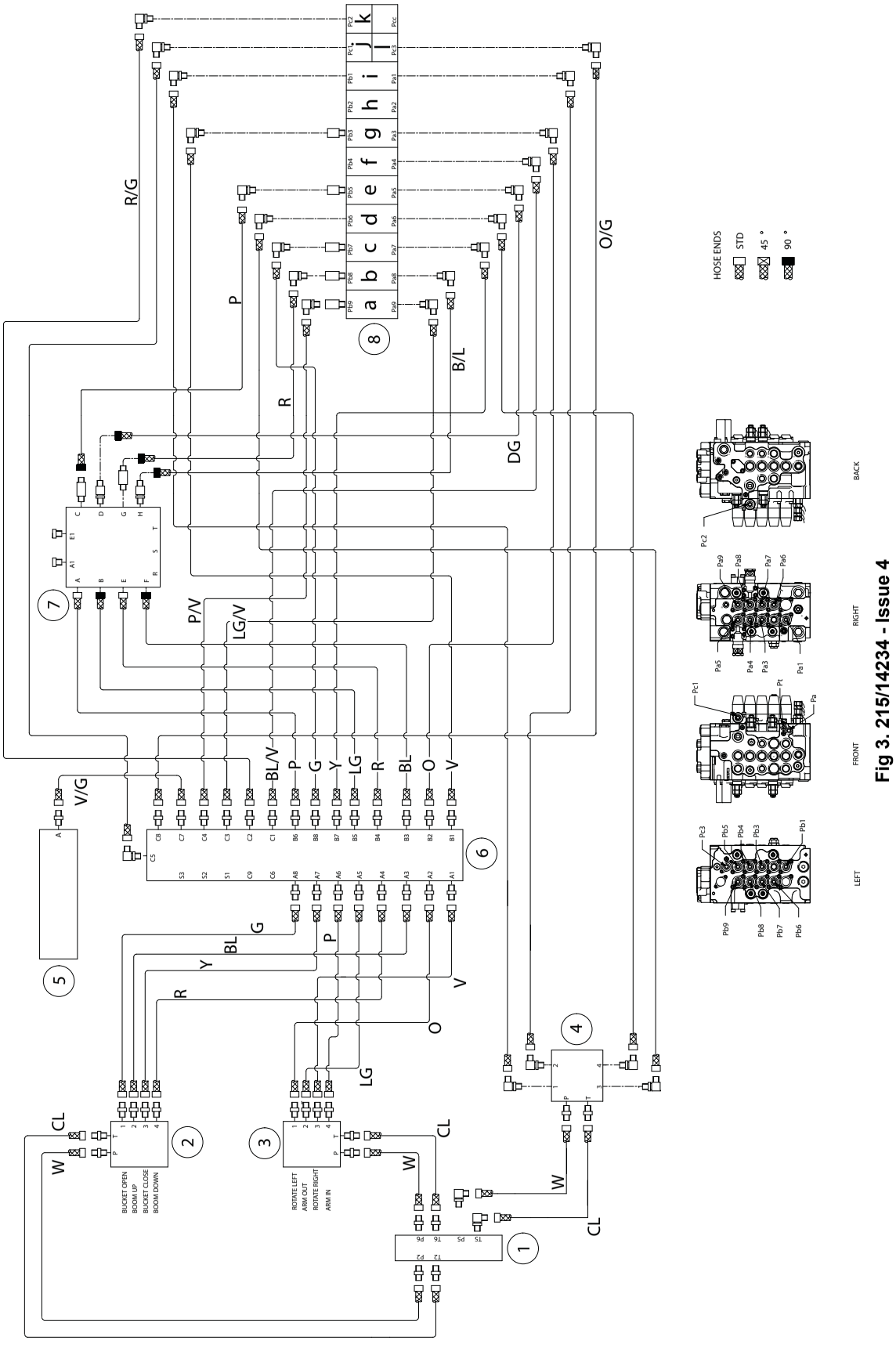

Fig 3. 215/14234 - Issue 4

Servo Pressure and Return Line

Components

1 Shuttle valve

2 Rotary coupling

3 Slew motor

4 Solenoid valve (8 spool)

5 Pump assembly

6 Cushion valve

7 Cab manifold

8 Main control valve

9 Servo filter

10 Tank manifold

11 Plexus filter

12 Servo pump

Hose Colour	
BL	Blue
BR	Brown
CL	Colourless
G	Green
GR	Grey
LB	Light Blue
O	Orange
P	Pink
R	Red
V	Violet
W	White
Y	Yellow
LG	Light Green
DG	Dark Green

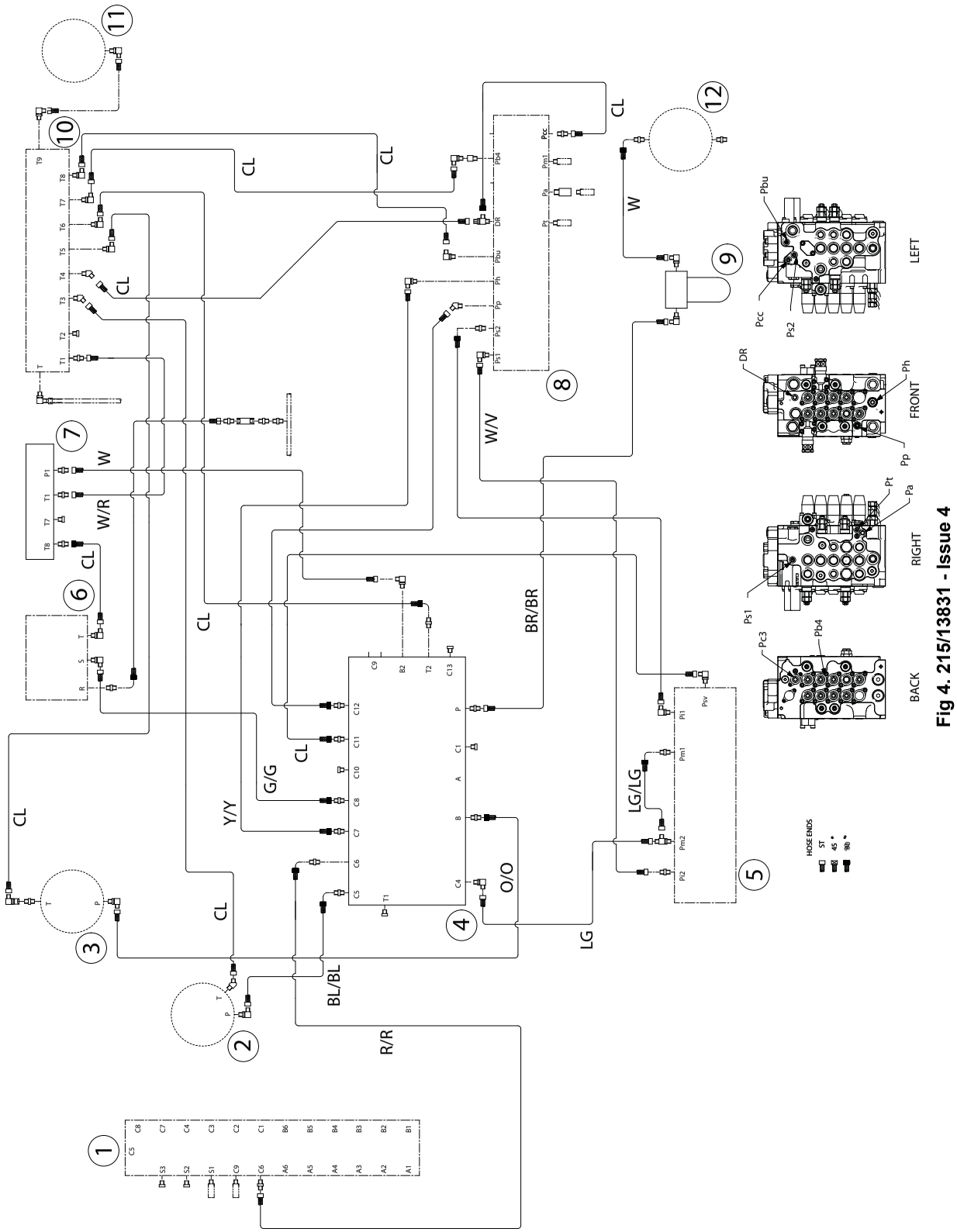

Fig 4. 215/13831 - Issue 4

Hydraulic Pump Regulation

For this description pump **A2** has been used. For Schematic, ⇨ *Fig 5. (E-25)*.

On start up, the swash plate piston **F** is held in the maximum flow position by the spring **A**.

Once oil as passed through the valve block a 37 bar (537 lb in^2) negative control signal enters port Pi2 and is available to the negative control piston **E**. This acts against spring **A** to move the spool across allowing pump pressure to cross the spool and pressurise the large diameter side of the swash plate piston **F.** Pressure is now available to both sides of the swash piston **F,** but due to the difference in surface areas the piston moves to the minimum flow position.

When a service is selected the negative control pressure drops. Piston **E** now moves back due to the spring pressure. This allows the oil in the larger area side of the swash plate piston **F** to vent to tank, but pump pressure oil is still available to the smaller diameter side so the pump moves over to the maximum flow position.

As the pump pressure increases, the pressure seen at the small diameter end of the swash plate piston **F** is also seen at the piston **C**. At the same time any pressure generated at pump A1 is also seen at pump A2 at the piston **C**. As the pressure increases at piston **C** via line **B**, it starts to push against spring **A**. When the pressure has increased to approximately 200 bar (2900lb in^2) the spool will start to select. This will now allow pump pressure to the large diameter side of the swash plate piston **F** which will proportionally start to select minimum flow.

When L mode is selected a 40 bar (580 lb in^2 signal from the Max flow cut solenoid on the 8 spool solenoid valve is sent to port Pm2 of the pump. This prevents the pump from selecting 100% flow and limits it to 60% flow.

In A mode the secondary pressure drops to approximately 10 bar (145lb in^2). This reduction in secondary pressure at piston **D** has to be made up for by higher pump pressure at pistons **C** and **E** before the sumater spool starts to select, hence more hydraulic horsepower.

The regulator on pump A1 works the same as above.