Section L

Servo Controls

Service Manual - Backhoe Loader

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World Class
Customer Support

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Introduction

Note Regarding Machine Types

The aim of this section is to help the engineer understand, fault find, test and maintain systems and components unique to joystick control (Servo) machines.

Where systems are not unique to servo machines the reader must refer to the applicable section.

This section covers several servo machine variants which are referred to as follows:

Machine Type and Summary Features:
Precision Control - Fixed flow double gearpump. - Loader valve (Sectional type) with two manual and one servo operated closed-centre spools. - Excavator valve (Sectional type) with seven servo operated closed-centre spools. - Hydraulic load sense and pressure compensator circuit. - Separate Inloader valve for automatic control of output from secondary hydraulic pump (pump P2). **Advanced EasyControl** (formerly known as Advanced Precision Control) - Variable flow pump. - Loader valve (Sectional type) with three servo operated closed-centre spools. - Excavator valve (Sectional type) with seven servo operated closed-centre spools. - Hydraulic load sense and pressure compensator circuit. **EasyControl** - Fixed flow double gearpump. - Loader valve (Monoblock type) with two manual and one servo operated open-centre spools. - Excavator valve (Monoblock type) with six servo operated open-centre spools. - Integrated Unloader valve for automatic control of output from secondary hydraulic pump (pump P2). - Separate servo operated auxiliary valve block for operation of excavator auxiliary service.

Service Tools

Numerical List

The tools listed in the table are special tools required for carrying out the procedures described in this section. These tools are available from JCB Service.

Note: *Tools other than those listed will be required. It is expected that such general tools will be available in any well equipped workshop or be available locally from any good tool supplier.*

Part Number	Description	Tool Detail Reference
716/30313	Test relay - with LED indicator	-
825/10053	Pilot hose release tool - for quick-connect hose fittings	⇨ *Fig 1.* (L-3)
998/11051	Digital pressure test set	⇨ *Fig 2.* (L-3)

Tool Detail Reference

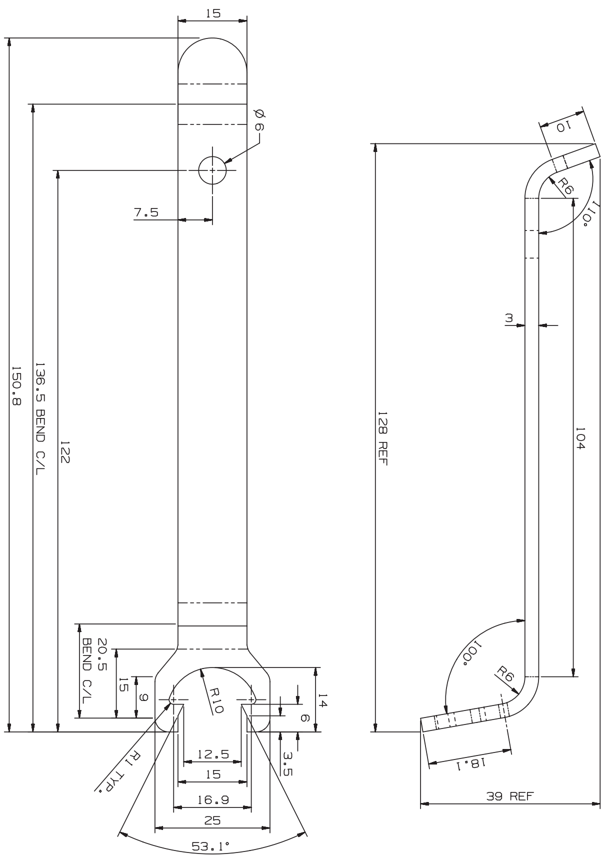


Fig 1. 825/10053 Pilot Hose Release Tool

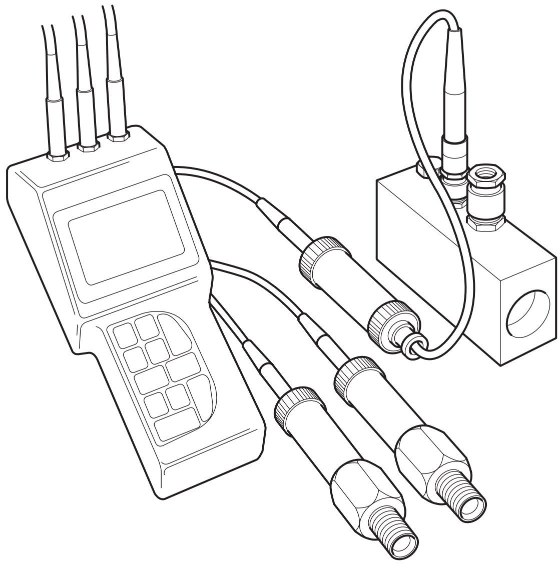


Fig 2. 998/11051 Digital Pressure Test Set

Fuses and Relays

Precision Control Machines

Fuses

⚠ CAUTION

Fuses

Always replace fuses with ones of correct ampere rating to avoid electrical system damage.

8-3-3-5

If a fuse melts, find out why and rectify the fault before fitting a new one. The fuses are identified using column letters (A, B, C and D) and row numbers (1 to 10). Note that all the fuses are shown (including optional equipment fuses). Your machine may not be equipped with all the fuses shown.

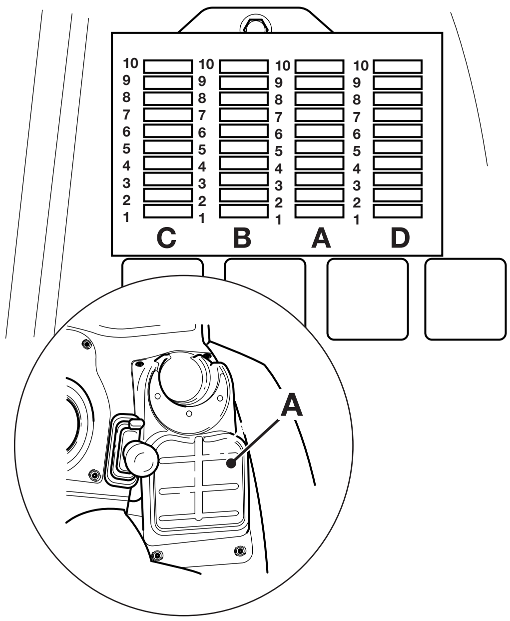


Fig 3.

The fuses listed below are located in the side console underneath cover **A**. ⇒ *Fig 3. (L-4)*.

Fuse No.	Circuit	Rating (Amps)
A1	Engine shut-off solenoid (ESOS)	10
A2	Auxiliary hydraulics	10
A3	Direction indicators	7.5
A4	Steer mode proximity switches	7.5
A5	Transmission	10
A6	Gear select - Forward, Reverse - Lock up torque converter speed sensors (if fitted)	3
A7	Transmission	10
A8	Brake lights	7.5
A9	Left hand side lights	5
A10	Right hand side lights	5
B1	Instruments, Buzzer	5
B2	Front horn, Front washer/wiper	15
B3	Rear horn	7.5
B4	Heated seat, Cigar lighter, Face level fan	15
B5	Rear washer/wiper	10
B6	Brake switch	10
B7	Return to dig, Smooth Ride System (SRS)	5 (1)
B8	Rear working lights	25
B9	Headlights	20
B10	Front working lights	25
C1	Lights	7.5
C2	Hazard warning lights	15
C3	Beacon, Interior light	10
C4	Radio	5
C5	Thermostart	3
C6	Heater blower	30
C7	Ignition relay coils	3

Precision Control Machines

Fuse No.	Circuit	Rating (Amps)
C8	Main beam	15
C9	Fog light	3
C10	Dip beam	15
D1	Hydraulic speed control (HSC), Inloader valve, Servo pilot valve hydraulics	10
D2	Seat position switches, Joystick mode buttons and change-over relays	5
D3	PWM controller (ECU)	5
D4	5V voltage converter, Joystick thumbwheel controls	5

(1) Fuse B7 is 10 Amp if Smooth Ride System (SRS) with Hose Burst Protection Valves (HBPV) is fitted.

Relays - Early Machines

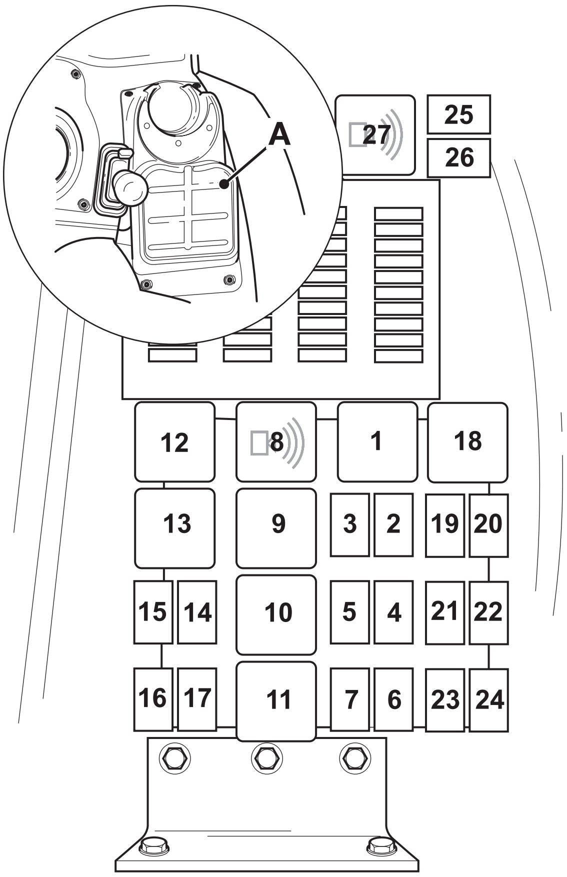


Fig 4.

The relays listed below are located in the side console underneath cover **A**. ⇒ *Fig 4. (L-6)*.

1	Ignition 1
2	Hammer
3	Auxiliary (jaw bucket)
4	Main lights
5	Engine run
6	Hydraulic speed control (HSC)
7	Instruments warning lights buzzer relay
8	Buzzer unit
9	Ignition 2
10	Front working lights
11	Rear working lights
12	Direction indicators
13	Neutral start
14	Rear horn
15	Park brake warning light
16	Air conditioning compressor (not used)
17	Blank
18	Ignition 3
19	Seat facing rear
20	Seat facing forward
21	Extending dipper, Clam shovel changeover
22	Hammer, Jaw bucket changeover
23	Rear horn, Quickhitch changeover
24	Hydraulic speed control (HSC), Inloader valve
25	Clam Shovel/Ext. Dipper Isolator Relay (1)
26	Blank
27	Buzzer unit (Servo)

(1) Not fitted on machines with manual isolator switch.

Relays - Later Machines

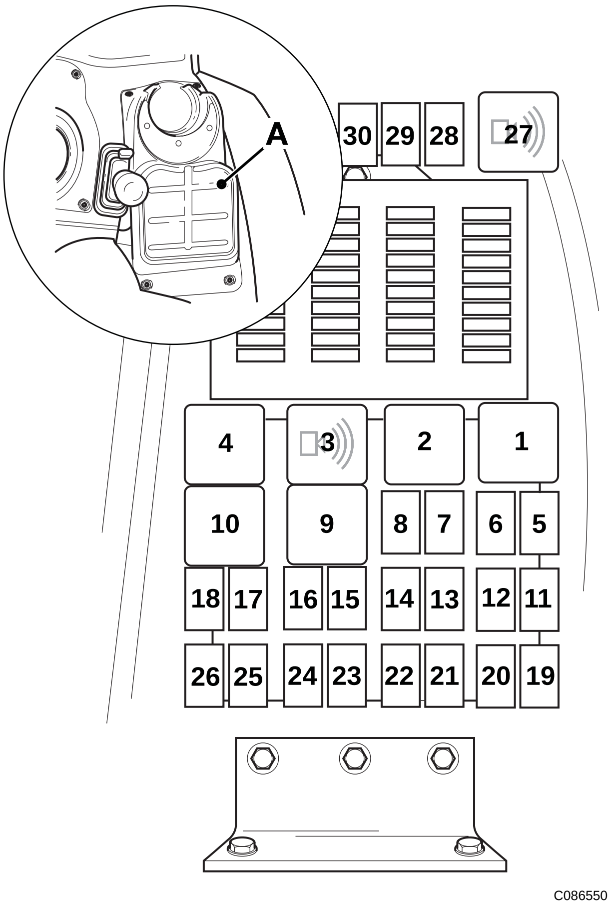


Fig 5.

The relays listed below are located in the side console underneath cover **A**. ⇨ *Fig 5. (L-7)*.

Note: *All the relays are shown (including optional equipment relays). Your machine may not be equipped with all the relays shown.*

1	Ignition 3
2	Ignition 1
3	Buzzer unit
4	Direction indicators
5	Seat facing forward
6	Seat facing rear
7	Hammer
8	Auxiliary (jaw bucket)
9	Ignition 2
10	Neutral start
11	Hammer, Jaw bucket changeover
12	Extending dipper, Clam shovel changeover
13	Main lights
14	Engine run
16	Front working lights
17	Park brake warning light
18	Rear horn
19	Hydraulic speed control (HSC), Inloader valve
20	Rear horn, Quickhitch changeover
21	Hydraulic speed control (HSC)
22	Instruments warning lights buzzer relay
24	Rear working lights
25	Hammer speed
26	Air conditioning compressor (not used)
27	Buzzer unit (Servo)
28	Clam Shovel/Ext. Dipper Isolator Relay
29	ECU cut-out

Machines from serial no. 1347278

15	Stabiliser leg alarm cut-out
23	Stabiliser leg alarm
30	Boom overload alarm

Advanced EasyControl Machines

Fuses

CAUTION

Fuses

Always replace fuses with ones of correct ampere rating to avoid electrical system damage.

8-3-3-5

If a fuse melts, find out why and rectify the fault before fitting a new one. The fuses are identified using column letters (A, B, C and D) and row numbers (1 to 10). Note that all the fuses are shown (including optional equipment fuses). Your machine may not be equipped with all the fuses shown.

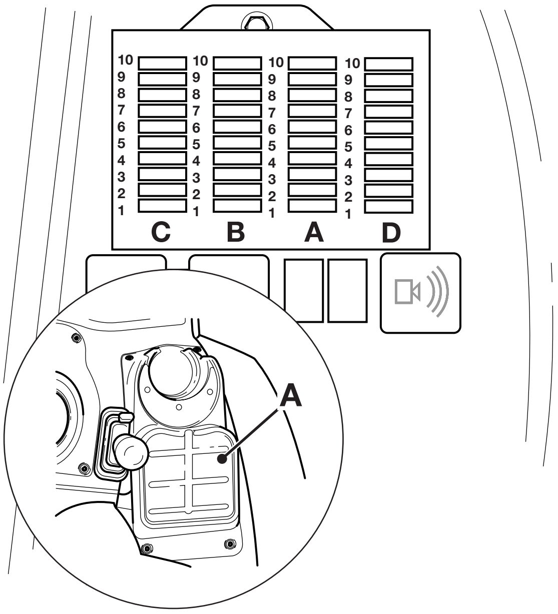


Fig 6.

The fuses listed below are located in the side console underneath cover **A**. ⇒ Fig 6. (L-8).

Fuse No.	Circuit	Rating (Amps)
A1	Engine shut-off solenoid (ESOS)	10
A2	Auxiliary hydraulics	10
A3	Direction indicators	7.5
A4	Steer mode proximity switches	7.5
A5	Transmission	10
A6	Gear select - Forward, Reverse - Lock up torque converter speed sensors (if fitted)	3
A7	Transmission	10
A8	Brake lights	7.5
A9	Left hand side lights	5
A10	Right hand side lights	5
B1	Instruments, Buzzer	5
B2	Front horn, Front washer/wiper	15
B3	Rear horn	7.5
B4	Heated seat, Cigar lighter, Face level fan	15
B5	Rear washer/wiper	10
B6	Brake switch	10
B7	Return to dig, Smooth Ride System (SRS)	5 [(1)]
B8	Rear working lights	25
B9	Headlights	20
B10	Front working lights	25
C1	Lights	7.5
C2	Hazard warning lights	15
C3	Beacon, Interior light	10
C4	Radio	5
C5	Thermostart	3
C6	Heater blower	30
C7	Ignition relay coils	3
C8	Main beam	15
C9	Fog light	3
C10	Dip beam	15

Advanced EasyControl Machines

Fuse No.	Circuit	Rating (Amps)
D1	Servo controls (primary)	20
D2	Seat position switches, Joystick thumbwheel, 5V voltage converter	5
D3	PWM controller (ECU)	5
D4	Seat position relays feed	5
D5	Excavator, loader changeover	15
D6	Extending dipper, clam shovel changeover	10

(1) Fuse B7 is 10 Amp if Smooth Ride System (SRS) with Hose Burst Protection Valves (HBPV) is fitted.

Relays - Early Machines

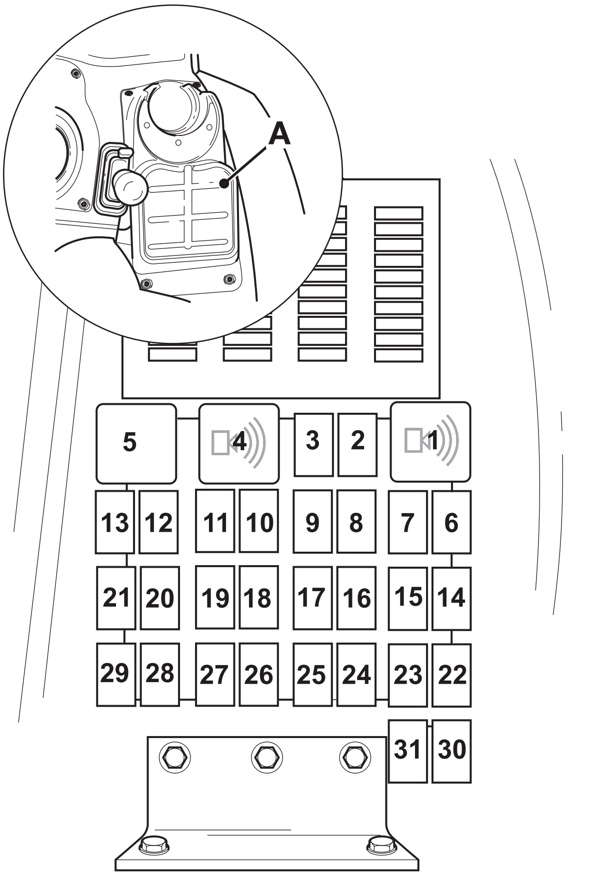


Fig 7.

The relays listed below are located in the side console underneath cover **A**. ⇒ *Fig 7. (L-10)*.

1	Buzzer unit (Servo)
2	Instruments warning lights buzzer relay
3	Ignition 1
4	Buzzer unit
5	Direction indicators
6	Rear horn, Quickhitch changeover
7	Ignition 3
8	Hammer
9	Auxiliary (jaw bucket)
10	Transmission dump control
11	Ignition 2
12	ECU power
13	Neutral start
14	Seat facing forward
15	Seat facing rear
16	Main lights
17	Engine run
18	Front working lights
19	Rear working lights
20	Park brake warning light
21	Rear horn
22	LH joystick pilot
23	RH joystick pilot
24	Joysticks enable (Latching)
25	Joysticks enable (Not latching)
26	PWM changeover (extending dipper, clam shovel)
27	Excavator, loader changeover (lift, lower, crowd, dump)
28	Hammer, jaw bucket changeover
29	Shovel reset
30	ECU cut-out
31	Blank

Relays - Later Machines to May 2009

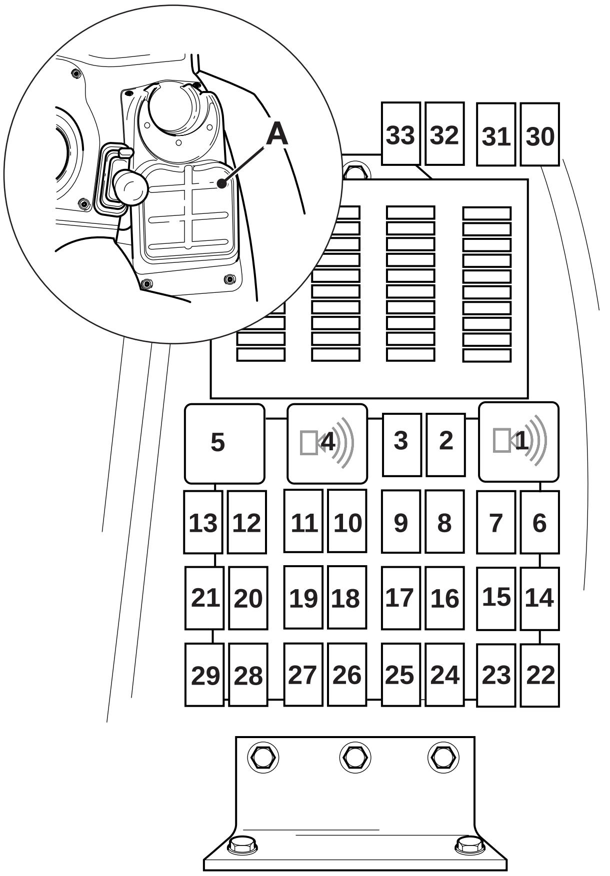


Fig 8.

The relays listed below are located in the side console underneath cover **A**. ⇨ *Fig 8. (L-11)*.

Note: *All the relays are shown (including optional equipment relays). Your machine may not be equipped with all the relays shown.*

1	Buzzer unit (Servo)
2	Instruments warning lights buzzer relay
3	Ignition 1
4	Buzzer unit
5	Direction indicators
6	Rear horn, Quickhitch changeover
7	Ignition 3
8	Hammer
9	Auxiliary (jaw bucket)
10	Transmission dump control
11	Ignition 2
12	ECU power
13	Neutral start
14	Seat facing forward
15	Seat facing rear
16	Main lights
17	Engine run
18	Front working lights
19	Rear working lights
20	Park brake warning light
21	Rear horn
22	LH joystick pilot
23	RH joystick pilot
24	Joysticks enable (Latching)
25	Joysticks enable (Not latching)
26	PWM changeover (extending dipper, clam shovel)
27	Excavator, loader changeover (lift, lower, crowd, dump)
28	Hammer, jaw bucket changeover
29	Shovel reset
30	ECU cut-out

Machines from serial no. 1347278

31	Stabiliser leg alarm cut-out
32	Stabiliser leg alarm
33	Boom overload alarm

Relays - From May 2009

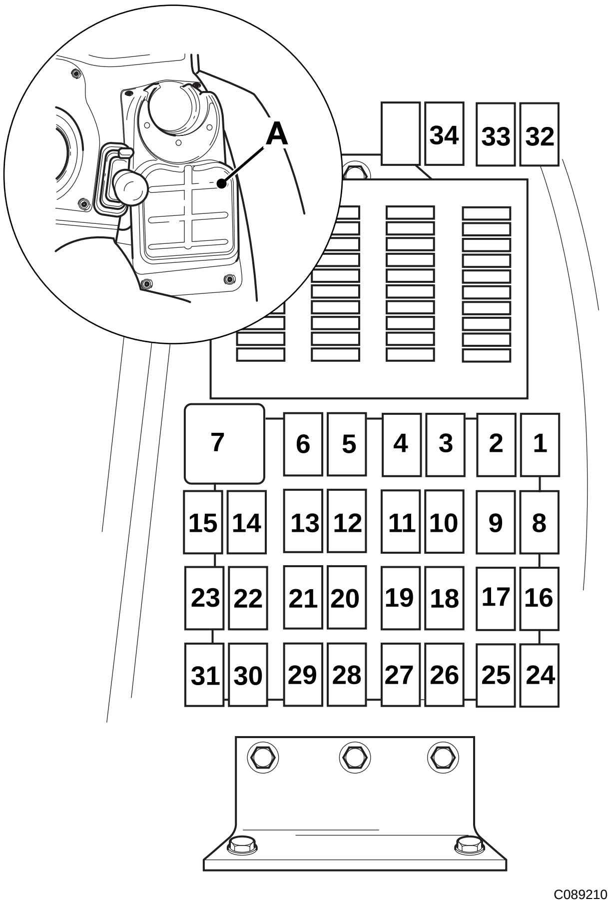


Fig 9.

The relays listed below are located in the side console underneath cover **A**. ⇨ *Fig 9. (L-12)*.

Note: *All the relays are shown (including optional equipment relays). Your machine may not be equipped with all the relays shown.*

1 Blank
2 ECU cut-out
3 Instruments warning lights buzzer relay
4 Ignition 1
5 Blank
6 Instruments warning lights buzzer relay
7 Direction indicators
8 Rear horn, Quickhitch changeover
9 Ignition 3
10 Hammer
11 Auxiliary (jaw bucket)
12 Transmission dump control
13 Ignition 2
14 ECU power
15 Neutral start
16 Seat facing forward
17 Seat facing rear
18 Main lights
19 Engine run
20 Front working lights
21 Rear working lights
22 Park brake warning light
23 Rear horn
24 LH joystick pilot
25 RH joystick pilot
26 Joysticks enable (Latching)
27 Joysticks enable (Not latching)
28 PWM changeover (extending dipper, clam shovel)
29 Excavator, loader changeover (lift, lower, crowd, dump)
30 Hammer, jaw bucket changeover
31 Shovel reset
32 Stabiliser leg alarm 1
33 Stabiliser leg alarm 2
34 Boom overload alarm

EasyControl Machines

Fuses

⚠ CAUTION

Fuses

Always replace fuses with ones of correct ampere rating to avoid electrical system damage.

8-3-3-5

If a fuse melts, find out why and rectify the fault before fitting a new one. The fuses are identified using column letters (A, B, C and D) and row numbers (1 to 10). Note that all the fuses are shown (including optional equipment fuses). Your machine may not be equipped with all the fuses shown.

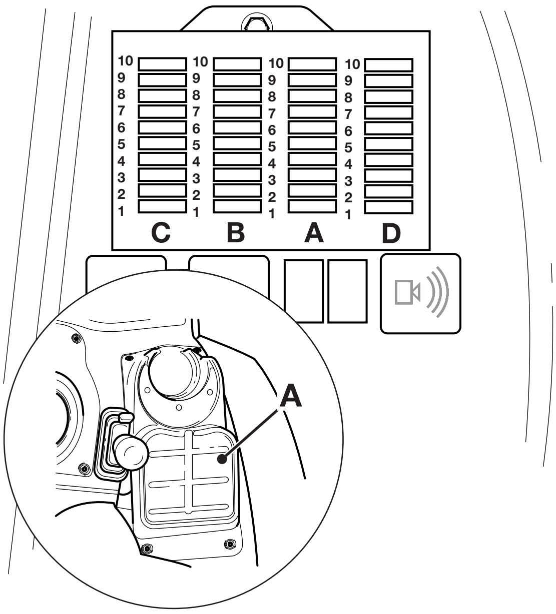


Fig 10.

The fuses listed below are located in the side console underneath cover **A**. ⇒ *Fig 10. (L-13)*.

Fuse No.	Circuit	Rating (Amps)
A1	Engine shut-off solenoid (ESOS)	10
A2	Auxiliary hydraulics	10
A3	Direction indicators	7.5
A4	Steer mode proximity switches	7.5
A5	Transmission	10
A6	Gear select - Forward, Reverse - Lock up torque converter speed sensors (if fitted)	3
A7	Transmission	10
A8	Brake lights	7.5
A9	Left hand side lights	5
A10	Right hand side lights	5
B1	Instruments, Buzzer	5
B2	Front horn, Front washer/wiper	15
B3	Rear horn	7.5
B4	Heated seat, Cigar lighter, Face level fan	15
B5	Rear washer/wiper	10
B6	Brake switch	10
B7	Return to dig, Smooth Ride System (SRS)	5 [1]
B8	Rear working lights	25
B9	Headlights	20
B10	Front working lights	25
C1	Lights	7.5
C2	Hazard warning lights	15
C3	Beacon, Interior light	10
C4	Radio	5
C5	Thermostart	3
C6	Heater blower	30
C7	Ignition relay coils	3
C8	Main beam	15
C9	Fog light	3
C10	Dip beam	15

EasyControl Machines

Fuse No.	Circuit	Rating (Amps)
D1	Servo controls (primary)	20
D2	Seat position switches, Joystick thumbwheel, 5V voltage converter	5
D3	PWM controller (ECU)	5
D4	Seat position relays feed	5
D5	Excavator, loader changeover	15
D6	Extending dipper, clam shovel changeover	10

(1) Fuse B7 is 10 Amp if Smooth Ride System (SRS) with Hose Burst Protection Valves (HBPV) is fitted.

Relays - Early Machines

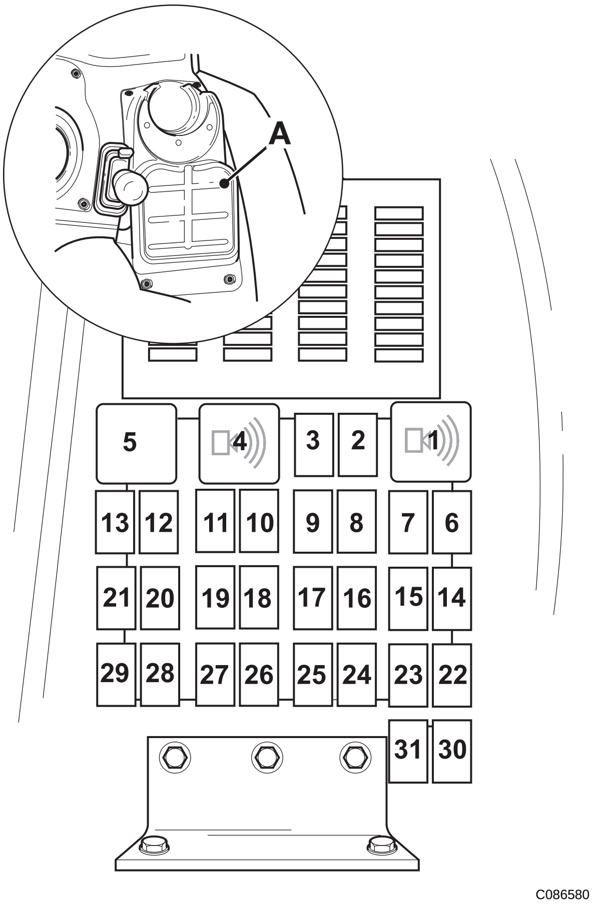


Fig 11.

The relays listed below are located in the side console underneath cover **A**. ⇒ *Fig 11. (L-15)*.

1	Buzzer unit (Servo)
2	Instruments warning lights buzzer relay
3	Ignition 1
4	Buzzer unit
5	Direction indicators
6	Rear horn, Quickhitch changeover
7	Ignition 3
8	Hammer
9	Auxiliary (jaw bucket)
10	Transmission dump control
11	Ignition 2
12	ECU power
13	Neutral start
14	Seat facing forward
15	Seat facing rear
16	Main lights
17	Engine run
18	Front working lights
19	Rear working lights
20	Park brake warning light
21	Rear horn
22	LH joystick pilot
23	RH joystick pilot
24	Joysticks enable (Latching)
25	Joysticks enable (Not latching)
26	PWM changeover (extending dipper, clam shovel)
27	Excavator, loader changeover (auxiliary service)
28	Hammer, jaw bucket changeover
29	Shovel reset
30	ECU cut-out
31	Blank

Relays - Later Machines to May 2009

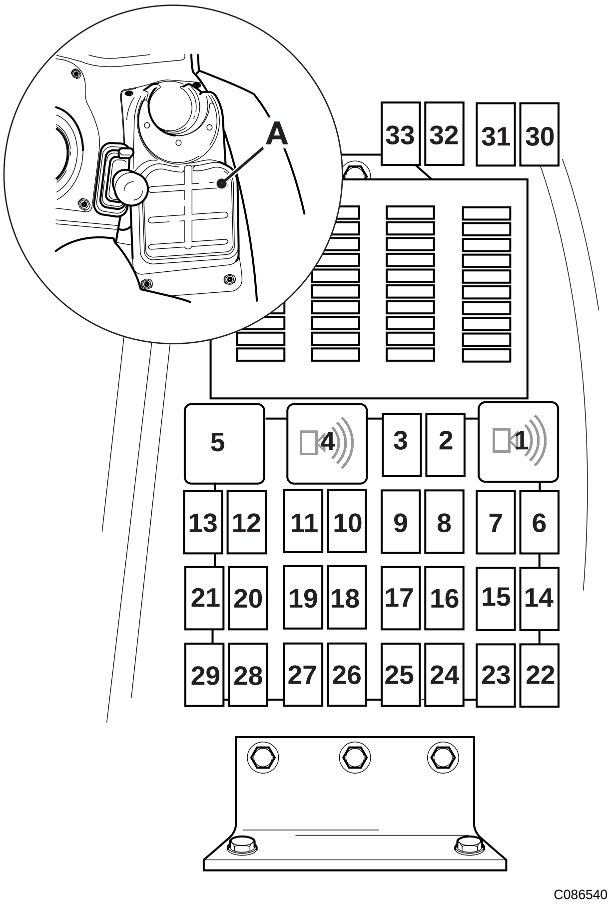


Fig 12.

The relays listed below are located in the side console underneath cover **A**. ⇒ *Fig 12. (L-16)*.

Note: *All the relays are shown (including optional equipment relays). Your machine may not be equipped with all the relays shown.*

1	Buzzer unit (Servo)
2	Instruments warning lights buzzer relay
3	Ignition 1
4	Buzzer unit
5	Direction indicators
6	Rear horn, Quickhitch changeover
7	Ignition 3
8	Hammer
9	Auxiliary (jaw bucket)
10	Transmission dump control
11	Ignition 2
12	ECU power
13	Neutral start
14	Seat facing forward
15	Seat facing rear
16	Main lights
17	Engine run
18	Front working lights
19	Rear working lights
20	Park brake warning light
21	Rear horn
22	LH joystick pilot
23	RH joystick pilot
24	Joysticks enable (Latching)
25	Joysticks enable (Not latching)
26	PWM changeover (extending dipper, clam shovel)
27	Excavator, loader changeover (auxiliary service)
28	Hammer, jaw bucket changeover
29	Shovel reset
30	ECU cut-out

Machines from serial no. 1347278

31	Stabiliser leg alarm cut-out
32	Stabiliser leg alarm
33	Boom overload alarm

Relays - From May 2009

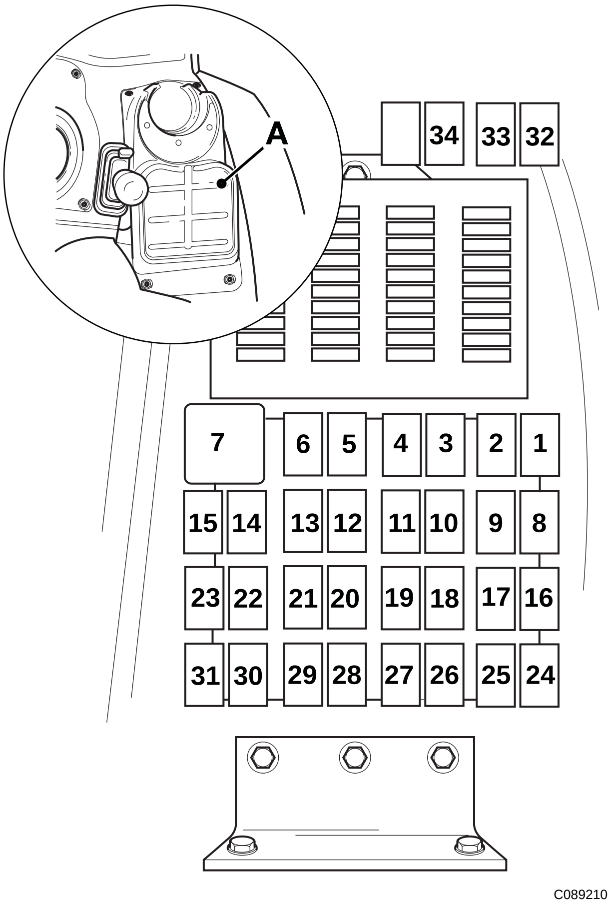


Fig 13.

The relays listed below are located in the side console underneath cover **A**. ⇒ *Fig 13. (L-17)*.

Note: *All the relays are shown (including optional equipment relays). Your machine may not be equipped with all the relays shown.*

1	Blank
2	ECU cut-out
3	Instruments warning lights buzzer relay
4	Ignition 1
5	Blank
6	Instruments warning lights buzzer relay
7	Direction indicators
8	Rear horn, Quickhitch changeover
9	Ignition 3
10	Hammer
11	Auxiliary (jaw bucket)
12	Transmission dump control
13	Ignition 2
14	ECU power
15	Neutral start
16	Seat facing forward
17	Seat facing rear
18	Main lights
19	Engine run
20	Front working lights
21	Rear working lights
22	Park brake warning light
23	Rear horn
24	LH joystick pilot
25	RH joystick pilot
26	Joysticks enable (Latching)
27	Joysticks enable (Not latching)
28	PWM changeover (extending dipper, clam shovel)
29	Excavator, loader changeover (auxiliary service)
30	Hammer, jaw bucket changeover
31	Shovel reset
32	Stabiliser leg alarm 1
33	Stabiliser leg alarm 2
34	Boom overload alarm

Schematic Circuits - Electrics

Precision Control Machines

Machines with Clam Shovel/Ext. Dipper Manual Isolator Switch

Component Key: Sheet 1 of 2 ⇒ *Fig 14. (L-19)*

1 Rear Horn
2 Rear Horn Relay
3 Horn/Quickhitch C/O Relay
4 Horn/Quickhitch Pushbutton (LH Joystick)
5 Quickhitch Buzzer
6 Quickhitch Valve Solenoid
7 Quickhitch Relay
8 Quickhitch Selector Switch
9 Joysticks Enable/Quickhitch Pushbutton (RH Joystick)
10 Joysticks Enabled LED (LH Joystick)
11 Joysticks Enabled LED (RH Joystick)
12 Seat Rear/Servo Pilot Latching Relay
13 Joysticks Cut-out Pushbutton
14 Seat Rear Sensor Switch (Vane Type)
15 Servo Pilot Valve Solenoid
16 Seat Forward/Servo Pilot Relay
17 Seat Forward Sensor Switch (Vane Type)
18 Joysticks Enabled Warning Buzzer (Seat Forward)
19 Inloader Valve Solenoid
20 Inloader Relay
21 System Pressure Switch (Servo Pilot Valve) (1)
22 HSC Relay
23 HSC Pushbutton (Loader Lever)
24 HSC/Grading Mode Selector Switch
25 Grading Valve Solenoid

Connections:

A To PWM Controller (ECU) ⇒ *Fig 15. (L-20)*
B From HSC Cut-out Relay - Pin 9 (not shown).

(1) No longer fitted on machines from serial no. 976693.

Component Key: Sheet 2 of 2 ⇒ *Fig 15. (L-20)*

26 5V Voltage Regulator
27 Clam Shovel/Ext. Dipper Isolator Switch
28 PWM Controller (ECU)
29 Ext. Dipper Thumbwheel (RH Joystick)
30 Ext. Dipper Proportional Solenoids (Servo Pilot Valve)
31 Clam Shovel Thumbwheel (Loader Lever)
32 Clam Shovel Proportional Solenoids (Servo Pilot Valve)
33 150W Resistor
34 Clam Shovel/Ext. Dipper C/O Relay
35 Auxiliary Hydraulics C/O Relay
36 Auxiliary Hydraulics Pushbutton (LH Joystick)
37 Auxiliary/Jaw C/O Valve Solenoids
38 Auxiliary/Jaw C/O Relay
39 Auxiliary Hydraulics Selector Switch
40 Hammer Relay
41 Hammer and Hi-flow Cooling Valve Solenoids
42 Hammer/Ext. Dipper C/O Valve Solenoids (Boom)

Connections:

A From Seat Rear Sensor Switch ⇒ *Fig 14. (L-19)*
C From Hydraclamps Selector Switch - (***Section C Electrics, Schematic Circuits - Options***).

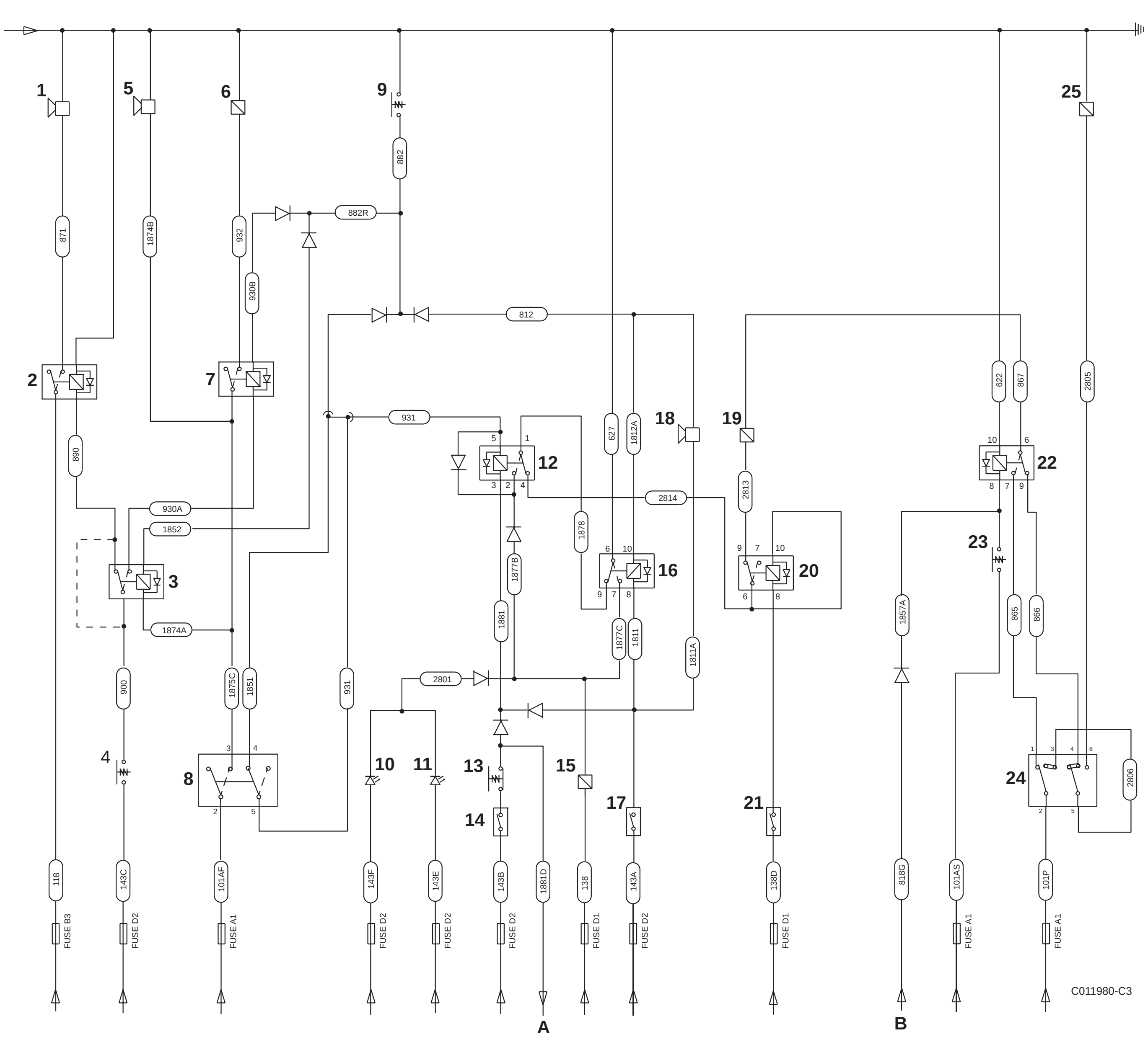


Fig 14. Machines with Clam Shovel/Ext. Dipper Manual Isolator Switch, Sheet 1 of 2

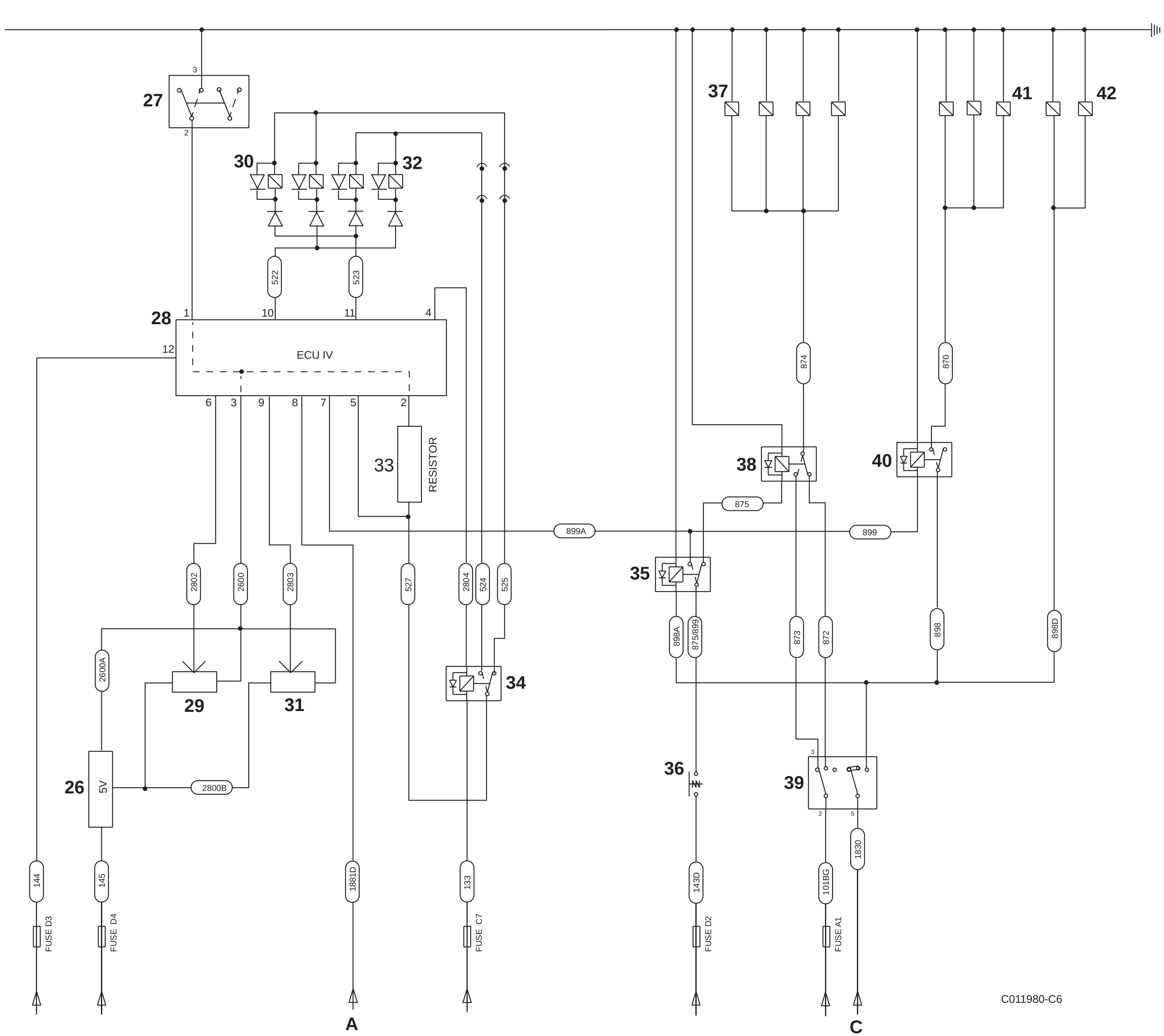


Fig 15. Machines with Clam Shovel/Ext. Dipper Manual Isolator Switch, Sheet 2 of 2

Machines with Clam Shovel/Ext. Dipper Isolator Relay

Component Key: Sheet 1 of 2 *⇒ Fig 16. (L-22)*

1 Rear Horn
2 Rear Horn Relay
3 Horn/Quickhitch C/O Relay
4 Horn/Quickhitch Pushbutton (LH Joystick)
5 Quickhitch Buzzer
6 Quickhitch Valve Solenoid
7 Quickhitch Relay
8 Quickhitch Selector Switch
9 Joysticks Enable/Quickhitch Pushbutton (RH Joystick)
10 Joysticks Enabled LED (LH Joystick)
11 Joysticks Enabled LED (RH Joystick)
12 Seat Rear/Servo Pilot Latching Relay
13 Joysticks Cut-out Pushbutton
14 Seat Rear Sensor Switch (Vane Type)
15 Servo Pilot Valve Solenoid
16 Seat Forward/Servo Pilot Relay
17 Seat Forward Sensor Switch (Vane Type)
18 Joysticks Enabled Warning Buzzer (Seat Forward)
19 Inloader Valve Solenoid
20 Inloader Relay
21 System Pressure Switch (Servo Pilot Valve) (1)
22 HSC Relay
23 HSC Pushbutton (Loader Lever)
24 HSC/Grading Mode Selector Switch
25 Grading Valve Solenoid
43 Clam Shovel/Ext. Dipper Isolator Latching Relay

Connections:

A To PWM Controller (ECU) *⇒ Fig 17. (L-23)*
B From HSC Cut-out Relay - Pin 9 (not shown).
D From PWM Controller (ECU) *⇒ Fig 17. (L-23)*

(1) No longer fitted on machines from serial no. 976693.

Component Key: Sheet 2 of 2 *⇒ Fig 17. (L-23)*

26 5V Voltage Regulator
28 PWM Controller (ECU)
29 Ext. Dipper Thumbwheel (RH Joystick)
30 Ext. Dipper Proportional Solenoids (Servo Pilot Valve)
31 Clam Shovel Thumbwheel (Loader Lever)
32 Clam Shovel Proportional Solenoids (Servo Pilot Valve)
33 150W Resistor
34 Clam Shovel/Ext. Dipper C/O Relay
35 Auxiliary Hydraulics C/O Relay
36 Auxiliary Hydraulics Pushbutton (LH Joystick)
37 Auxiliary/Jaw C/O Valve Solenoids
38 Auxiliary/Jaw C/O Relay
39 Auxiliary Hydraulics Selector Switch
40 Hammer Relay
41 Hammer and Hi-flow Cooling Valve Solenoids
42 Hammer/Ext. Dipper C/O Valve Solenoids (Boom)

Connections:

A From Seat Rear Sensor Switch *⇒ Fig 16. (L-22)*
C From Hydraclamps Selector Switch - (***Section C Electrics, Schematic Circuits - Options***).
D To Clam Shovel/Ext. Dipper Isolator Latching Relay *⇒ Fig 16. (L-22)*

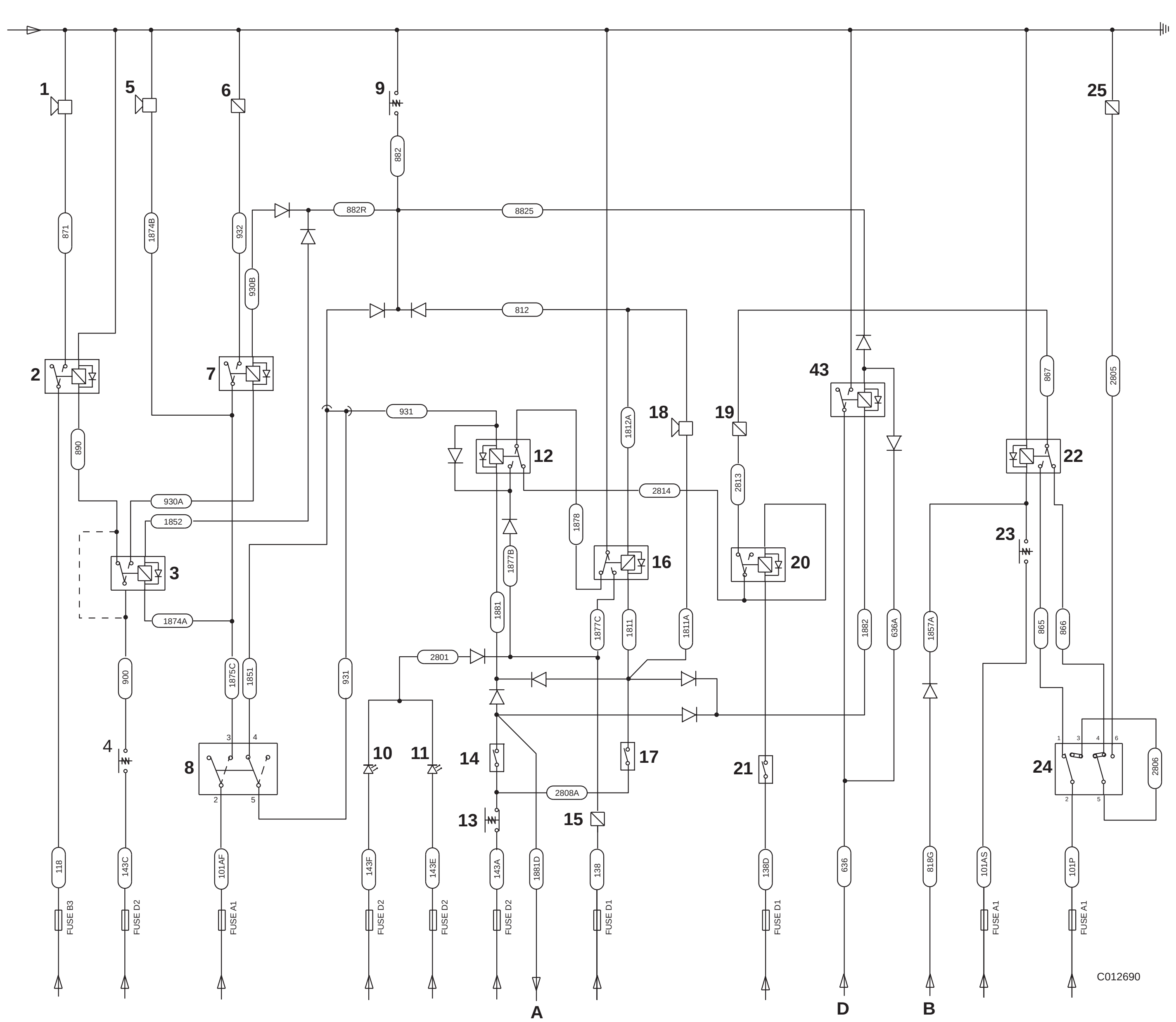


Fig 16. Machines with Clam Shovel/Ext. Dipper Isolator Relay, Sheet 1 of 2

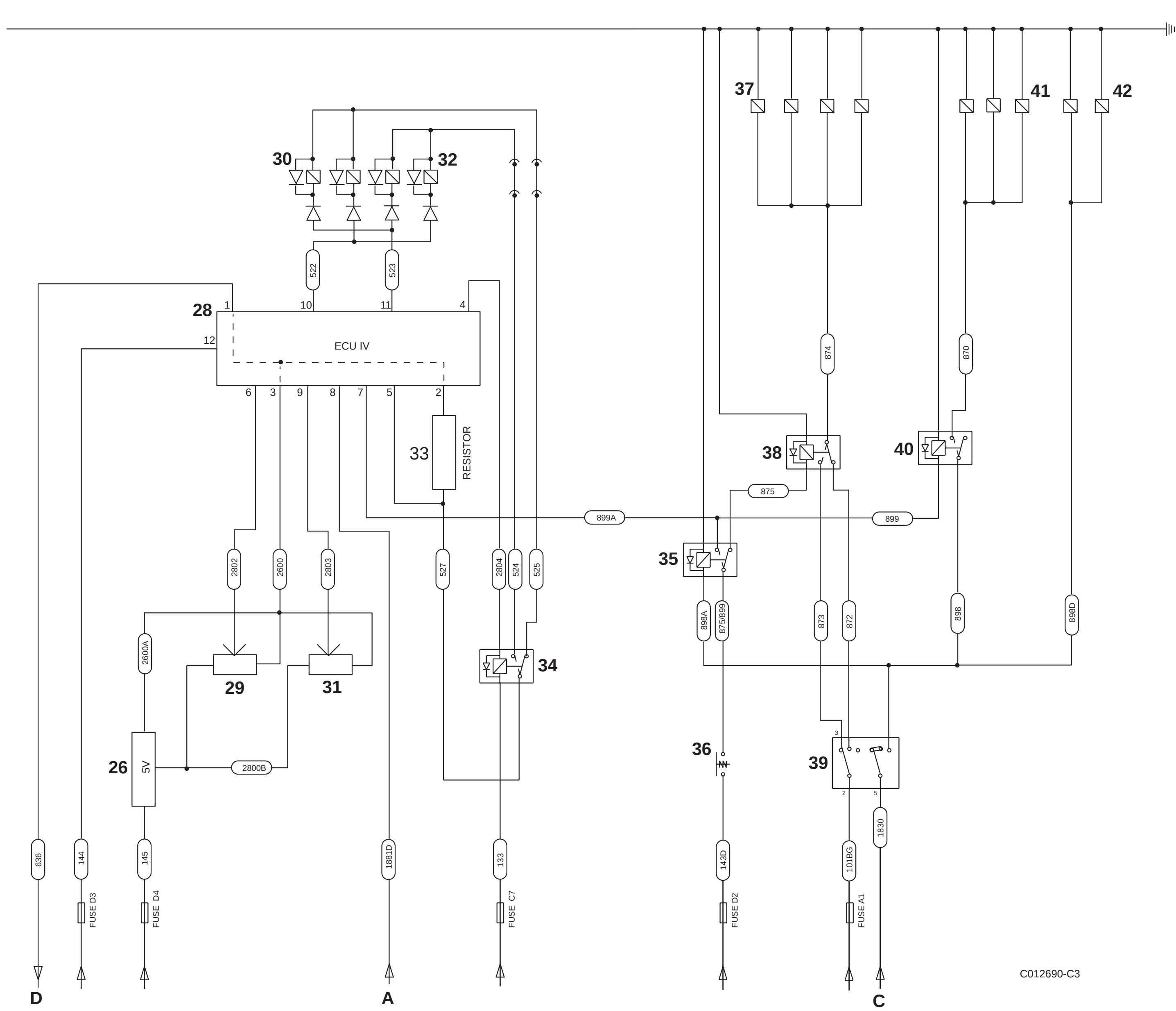


Fig 17. Machines with Clam Shovel/Ext. Dipper Isolator Relay, Sheet 2 of 2

Advanced EasyControl Machines - To May 2009 (Analog Instruments)

Component Key: Sheet 1 of 3 ⇨ *Fig 18. (L-25)*

1 Rear Horn
2 Rear Horn Relay
3 Horn/Quickhitch C/O Relay
4 Horn/Quickhitch Pushbutton (LH Joystick)
5 Quickhitch Buzzer
6 Excavator Quickhitch Valve Solenoid
6A Excavator Quickhitch Relay
6B Excavator Quickhitch Selector Switch
7 `Float' Mode Electro-magnet
8 Excavator/Loader Selector Switch
9 Joysticks Enable/Quickhitch Pushbutton (RH Joystick)
10 Joystick `Active' LED (LH Joystick)
11 Joystick `Active' LED (RH Joystick)
12 Joysticks Enable Latching Relay
13 Joysticks Enable Relay
14 Servo Pilot Valve Relay
15 Servo Pilot Valve Relay
16 Servo Pilot Valve Solenoid (LH Joystick)
17 Servo Pilot Valve Solenoid (RH Joystick)
18 Joysticks `Active' Warning Buzzer
19 Seat Forward Relay
20 Seat Rear Relay
21 Seat Forward Sensor Switch (Vane Type)
22 Seat Rear Sensor Switch (Vane Type)
23 Excavator/Loader C/O Relay
24 Excavator/Loader C/O Relay
25 Excavator/Loader C/O Valve Solenoids (Lift, Lower, Crowd and Dump Services)
26 Pump Dual Horsepower Valve Solenoid (1)
27 Excavator/Loader C/O Valve Solenoids (Auxiliary Extend and Retract Services)
46 Transmission Dump Control Relay

Connections:

A From Transmission Dump Pushbutton (not shown)
B To PWM Controller (ECU) ⇨ *Fig 19. (L-26)*
C From ECU Power Relay ⇨ *Fig 19. (L-26)*
D To ECU Power Relay ⇨ *Fig 19. (L-26)*

(1) No longer fitted on machines from serial no. 975289.

Component Key: Sheet 2 of 3 ⇨ *Fig 19. (L-26)*

28 5V Voltage Regulator
29 PWM Controller (ECU)
29A ECU Power Relay
30 Auxiliary Service Thumbwheel (RH Joystick)
31 `Extend' Proportional Solenoid (Servo Pilot Valve)
32 `Retract' Proportional Solenoid (Servo Pilot Valve)
33 150W Resistor
34 Auxiliary Hydraulics C/O Relay
35 Auxiliary Hydraulics Pushbutton (LH Joystick)
36 Auxiliary/Jaw C/O Valve Solenoids
37 Grading Valve Solenoid
38 Jaw Relay
39 Hammer Relay
40 Jaw/Grading Mode Selector Switch
41 Hammer Selector Switch
42 Hammer/Ext. Dipper C/O Valve Solenoids (Boom Base)
43 Hi-flow Cooling Valve Solenoid
44 Hammer Valve Solenoids (Chassis)
45 ECU Cutout Relay

Connections:

B From Joystick `Active' LED (RH Joystick) ⇨ *Fig 18. (L-25)*
C To Joysticks Enable Relay ⇨ *Fig 18. (L-25)*
D From Excavator/Loader Selector Switch ⇨ *Fig 18. (L-25)*

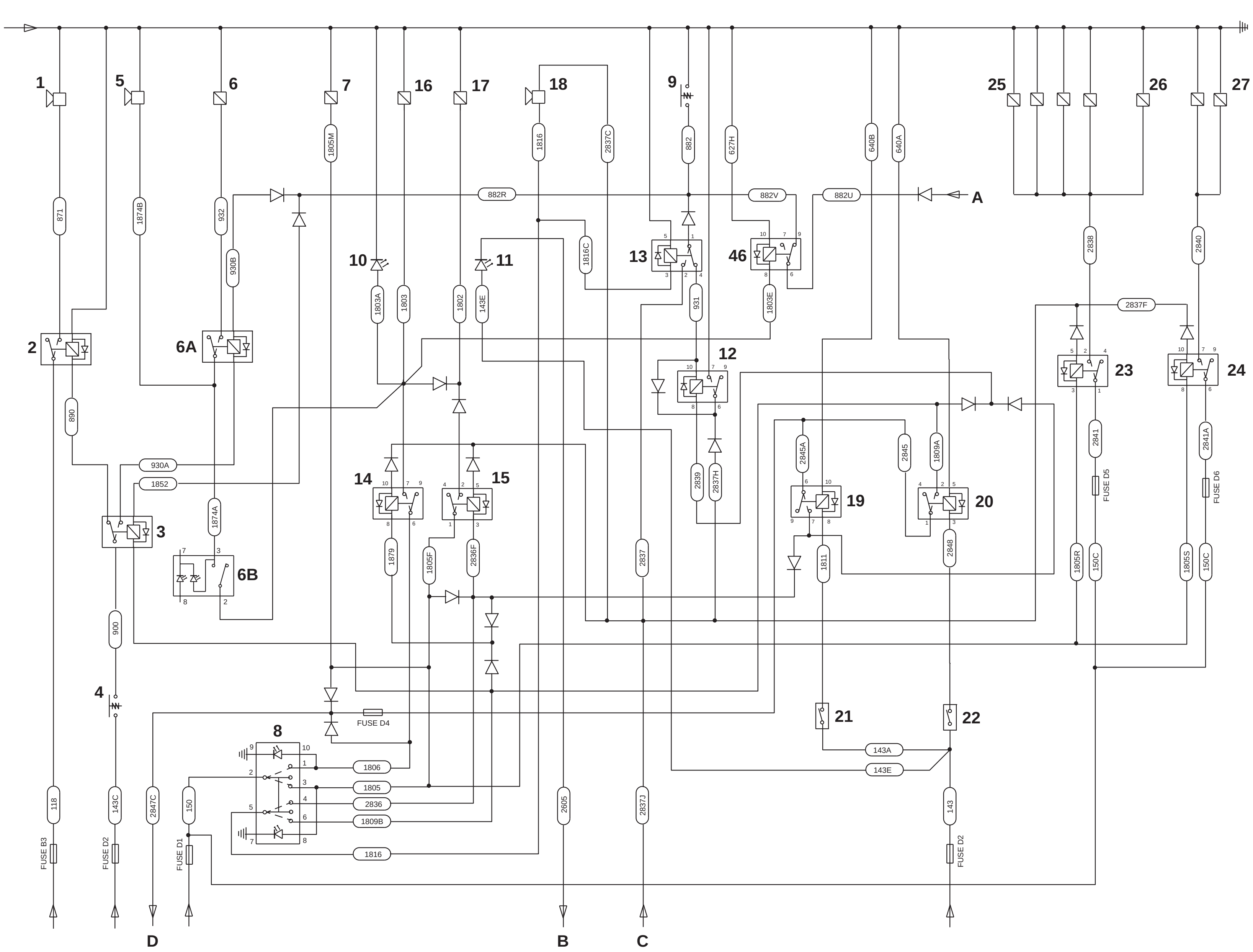


Fig 18. Sheet 1 of 3

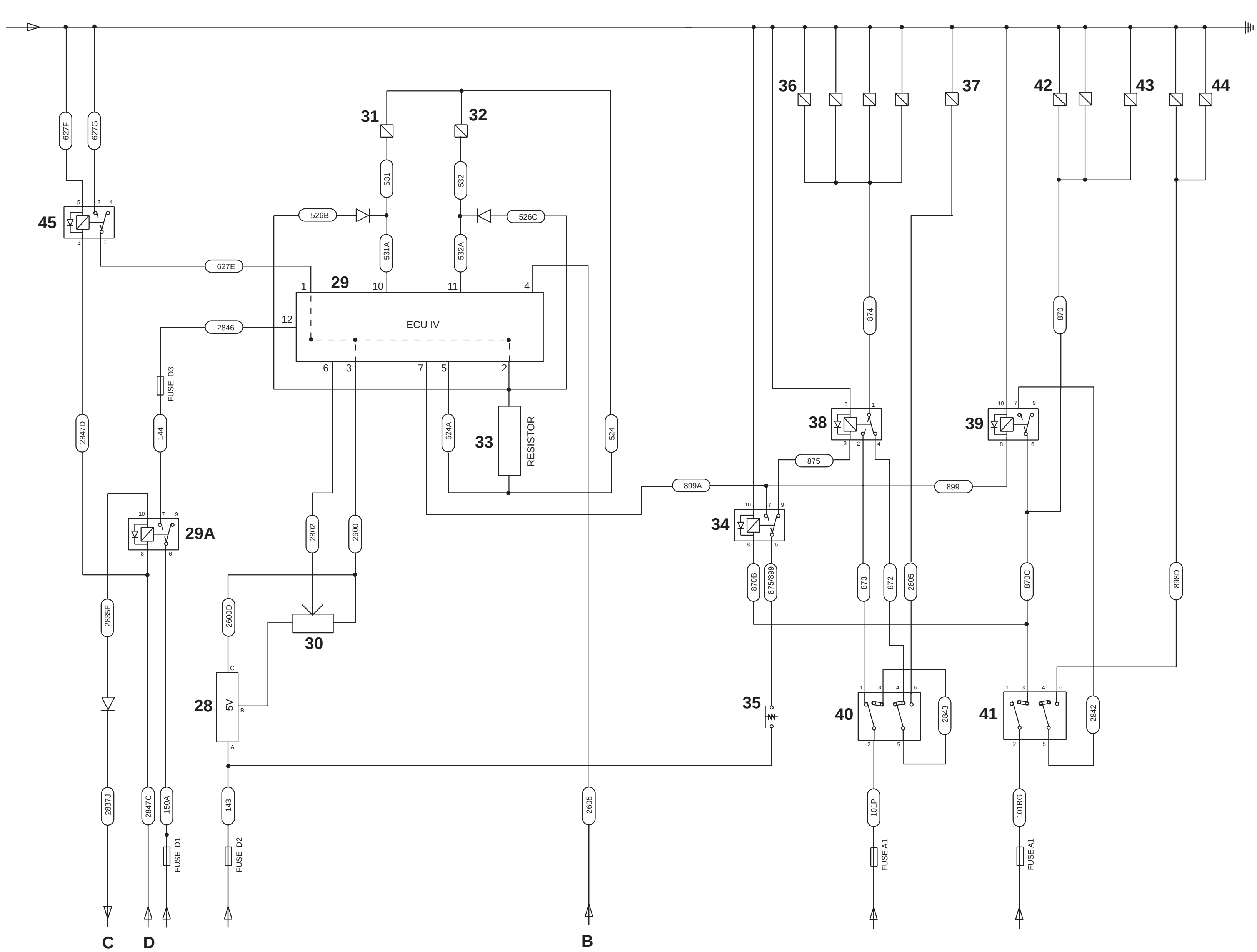


Fig 19. Sheet 2 of 3

Component Key: Sheet 3 of 3 ⇨ *Fig 20. (L-27)*

50 Shovel Reset Selector Switch
51 Ram Proximity Switch
52 Shovel Reset Relay
53 Shovel Reset Solenoid

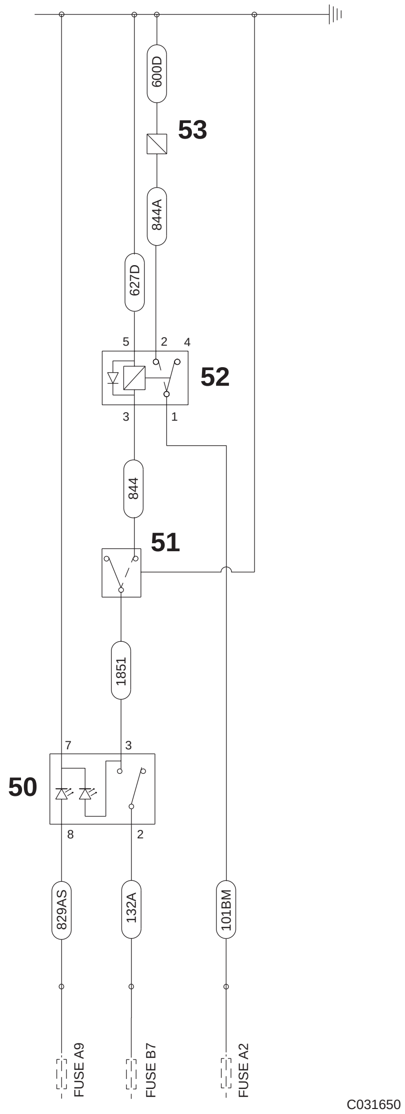


Fig 20. Shovel Reset, Sheet 3 of 3

Advanced EasyControl Machines - From May 2009 (Digital Instruments)

Component Key: Sheet 1 of 18
⇒ *Fig 21.* (L-29)

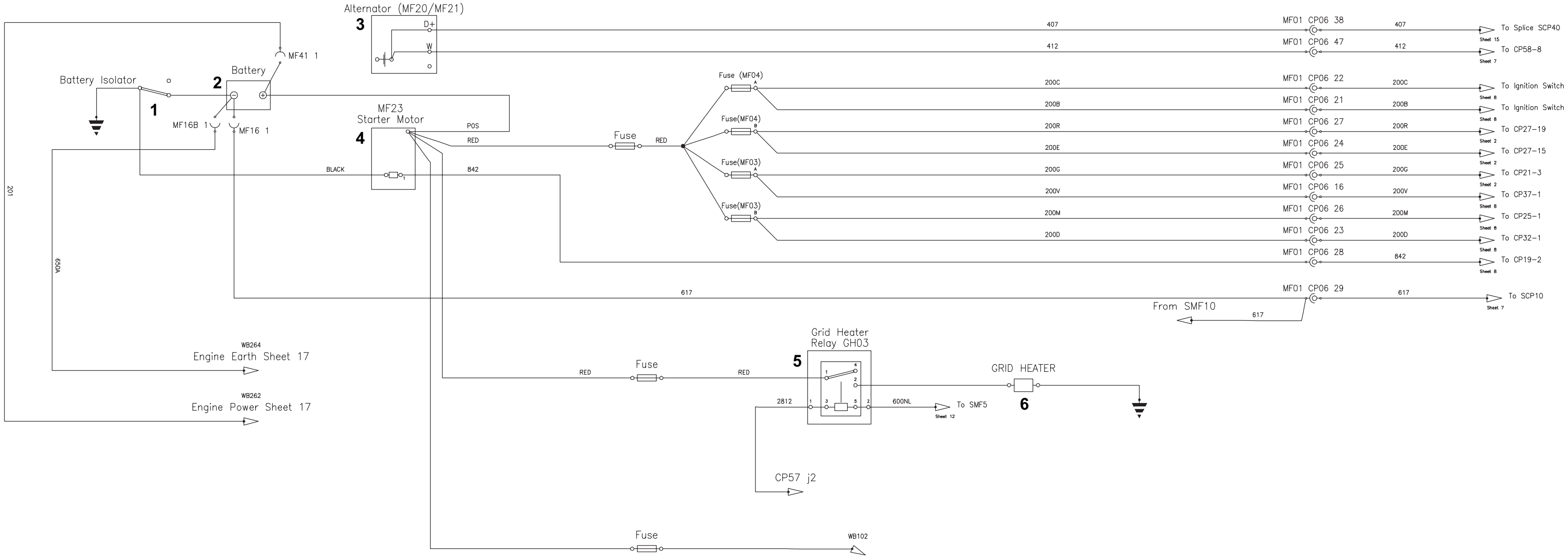
1 Battery Isolator
2 Battery
3 Alternator
4 Starter Motor
5 Grid Heater Relay - Cold Start
6 Grid Heater - Cold Start

Component Key: Sheet 2 of 18
⇒ *Fig 22.* (L-30)

1 Steer Proximity Switch - Front Axle
2 Coolant Level Switch - if fitted
3 Cold Start Advance Switch
4 Cold Start Solenoid
5 Water in Fuel Sensor
6 Air Conditioning Compressor Clutch Solenoid
7 Coolant Temperature Switch
8 Engine Shut-off Solenoid (ESOS)
9 Fuel Level Sender
10 Rear Washer Motor
11 Front Washer Motor
12 Horn
13 Air Filter ‘Blocked’ Switch
14 Engine Oil Pressure Switch
15 Shovel Reset Proximity Switch
16 Hydraulic Speed Control (HSC) Solenoid
17 SRS Solenoid
18 SRS Solenoid

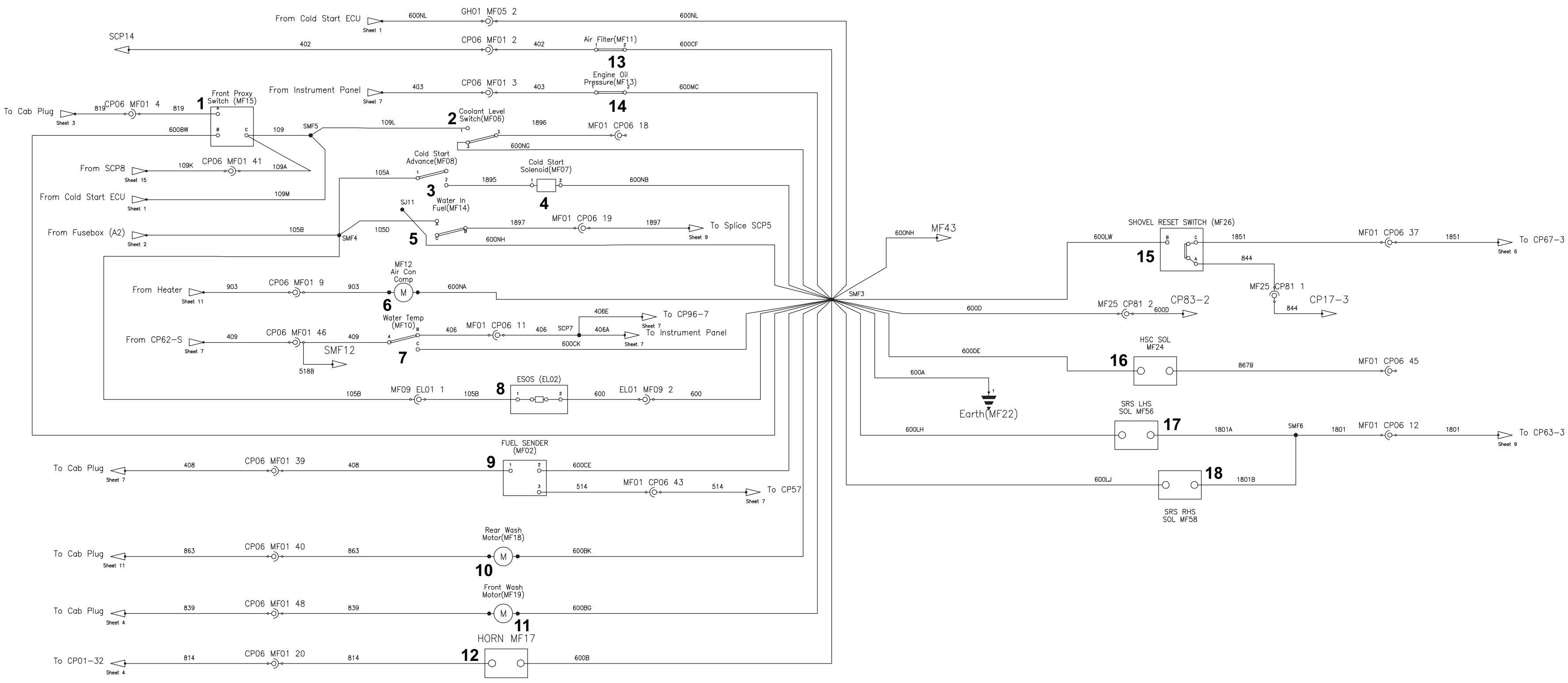
Component Key: Sheet 3 of 18
⇒ *Fig 23.* (L-31)

1 Diode Pack
2 Steer Mode Relay
3 Brake Mode Selector Switch
4 2/4WD Selector Switch
5 Footbrake Switch
6 Steer Mode ECU
7 Steer Mode Selector Switch
8 Brake Lights Relay
9 Hydraulic Speed Control (HSC) Cut-out Relay
10 Auto 2WB Relay
11 Transmission ECU
12 CANbus Terminator Resistor



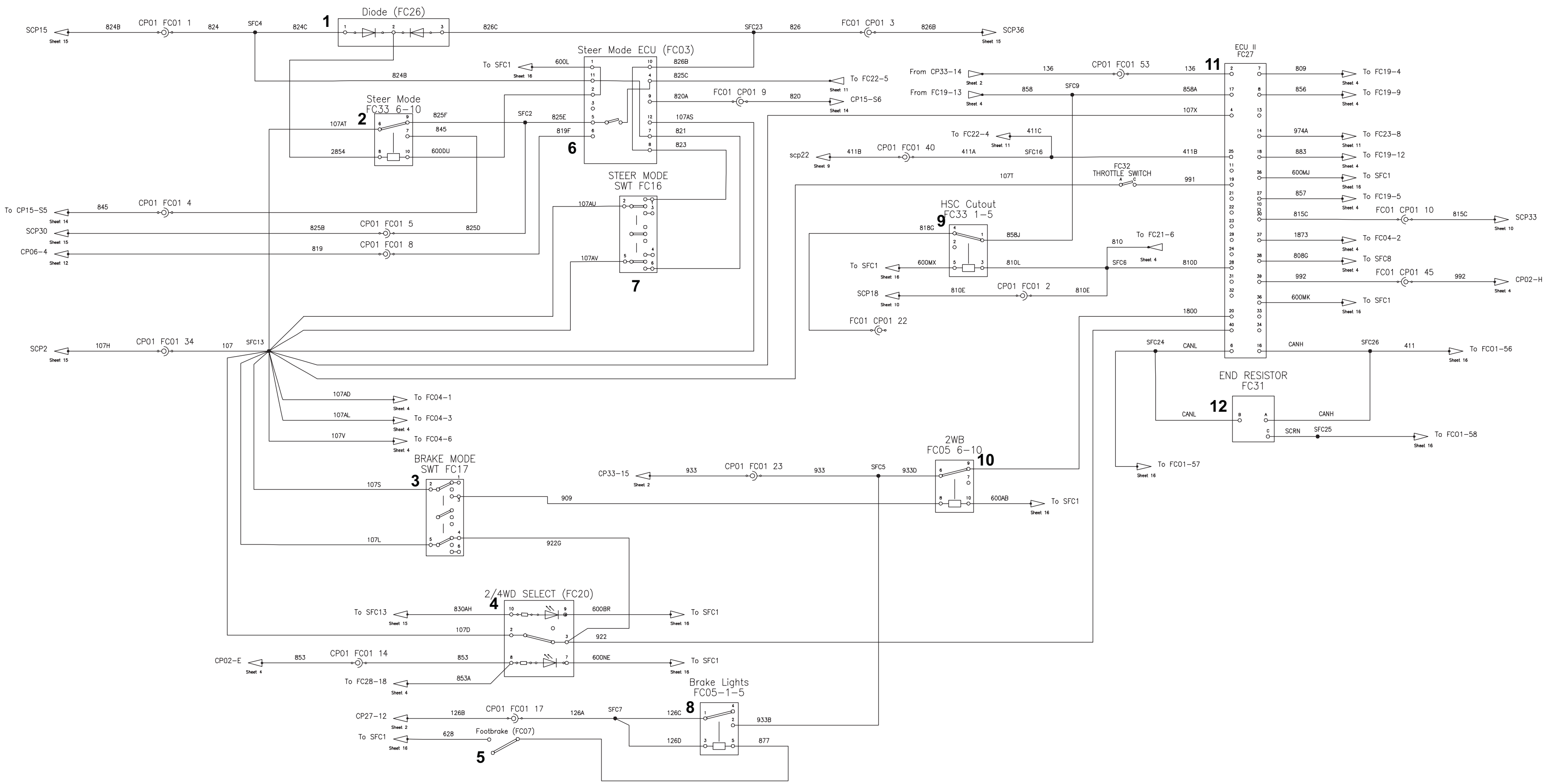
C090450APC-sht1

Fig 21. Sheet 1 of 18



C090450APC-sht2

Fig 22. Sheet 2 of 18



C090450APC-sht3

Fig 23. Sheet 3 of 18

Component Key: Sheet 4 of 18

⇨ *Fig 24. (L-33)*

1	Column Switch - RH
2	Column Switch - LH
3	Hazard Lights Switch
4	Front Wiper Motor
5	Transmission Dump Relay
6	Reverse Alarm Relay
7	Front Warning Lights
8	Transmission ECU
9	Headlights Switch
10	Transmission Kick-down Switch
11	Torque Converter Lock-up Solenoid
12	Transmission Speed Sensor
13	Layshaft Solenoid
14	Forward High Solenoid
15	Transmission Oil Pressure Switch
16	6-Speed Solenoid
17	Engine Speed Sensor
18	Mainshaft Solenoid
19	Reverse High Solenoid
20	Reverse Low Solenoid
21	Forward Low Solenoid
22	Transmission Oil Temperature Switch
23	Forward Solenoid

Component Key: Sheet 5 of 18

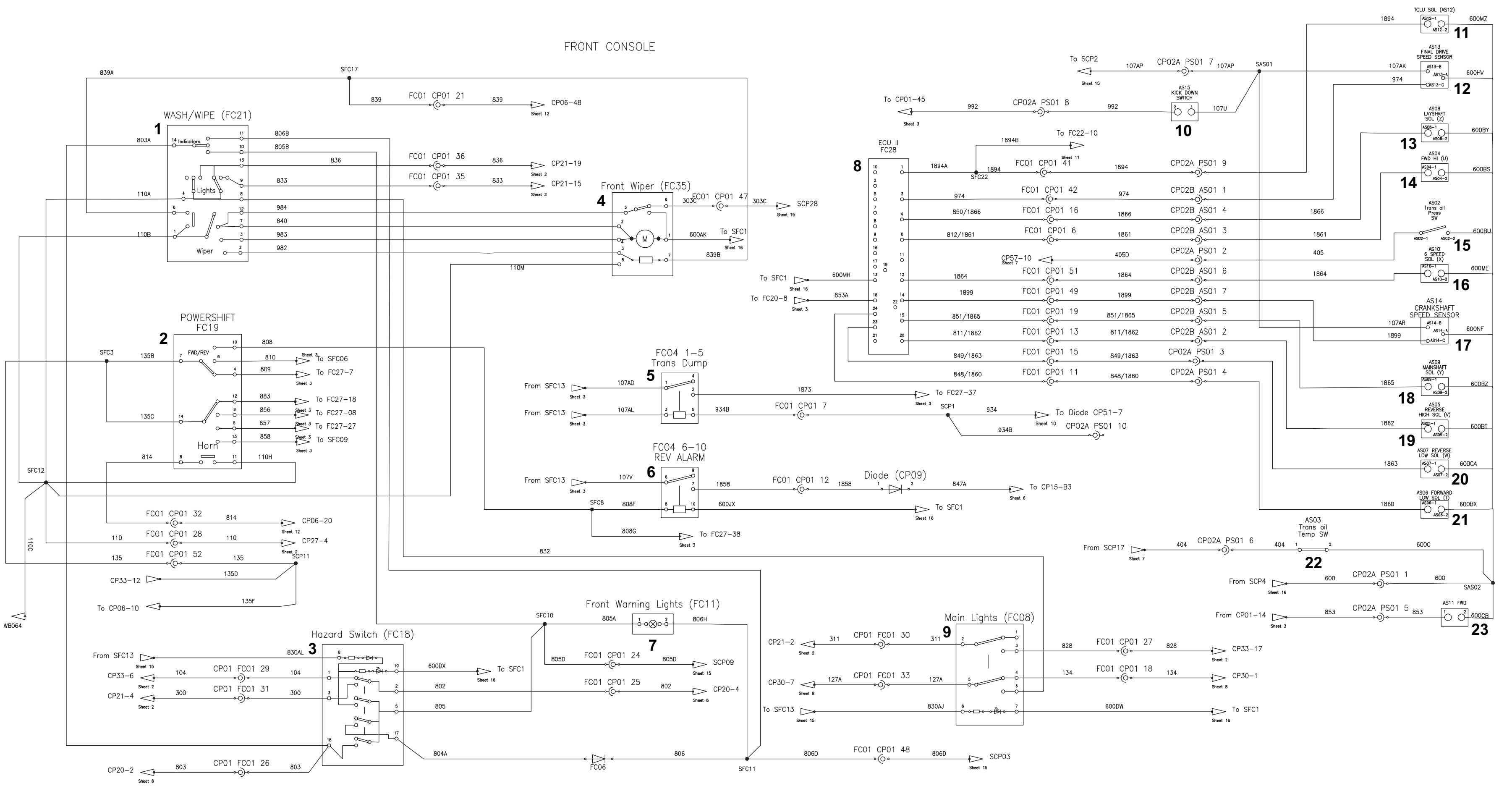
⇨ *Fig 25. (L-34)*

1	Low Stabiliser Leg Alarm Relay
2	Low Stabiliser Leg Alarm Relay
3	Stabiliser Leg Proximity Switch - RH
4	Stabiliser Leg Proximity Switch - LH

Component Key: Sheet 6 of 18

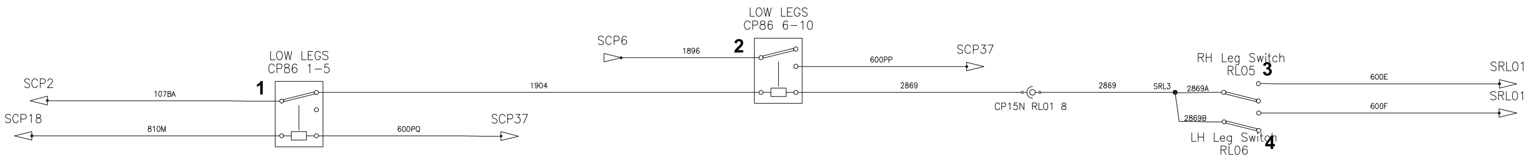
⇨ *Fig 26. (L-35)*

1	Beacon Switch
2	Front Worklights - LH
3	Front Worklights - RH
4	Rear Worklight - RH Outer
5	Rear Worklight - RH Inner
6	Rear Worklight - LH Inner
7	Rear Worklight - LH Outer
8	Beacon
9	Auxiliary Beacon
10	Auxiliary Beacon
11	Front Headlight - LH
12	Rear Lights - LH (USA)
13	Front Headlight - RH
14	Rear Lights - RH (USA)
15	Front Direction Indicators - LH (USA)
16	Front Direction Indicators - RH (USA)



C090450APC-sht4

Fig 24. Sheet 4 of 18



C090450APC-sht5

Fig 25. Sheet 5 of 18

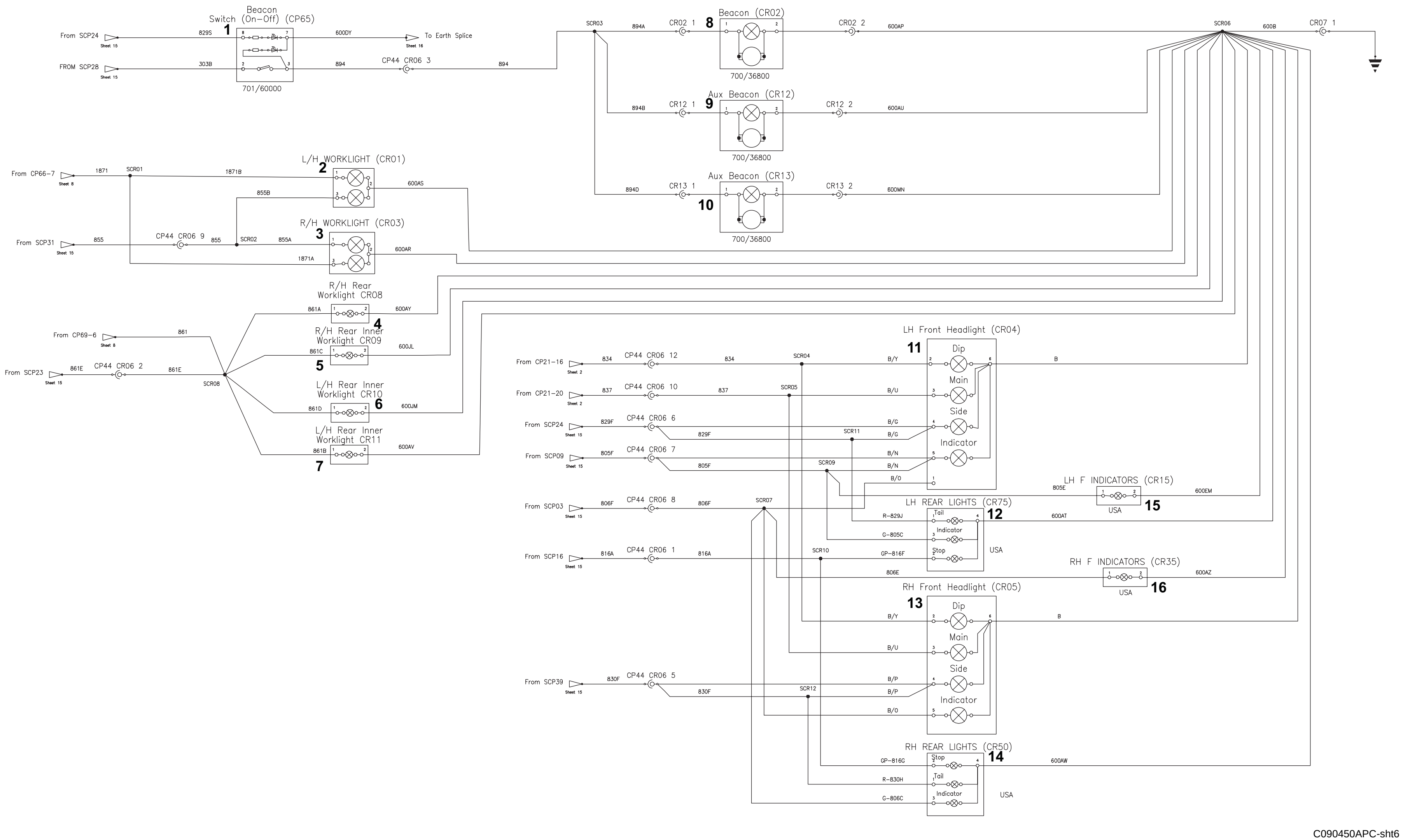


Fig 26. Sheet 6 of 18

Component Key: Sheet 7 of 18
⇒ Fig 27. (L-37)

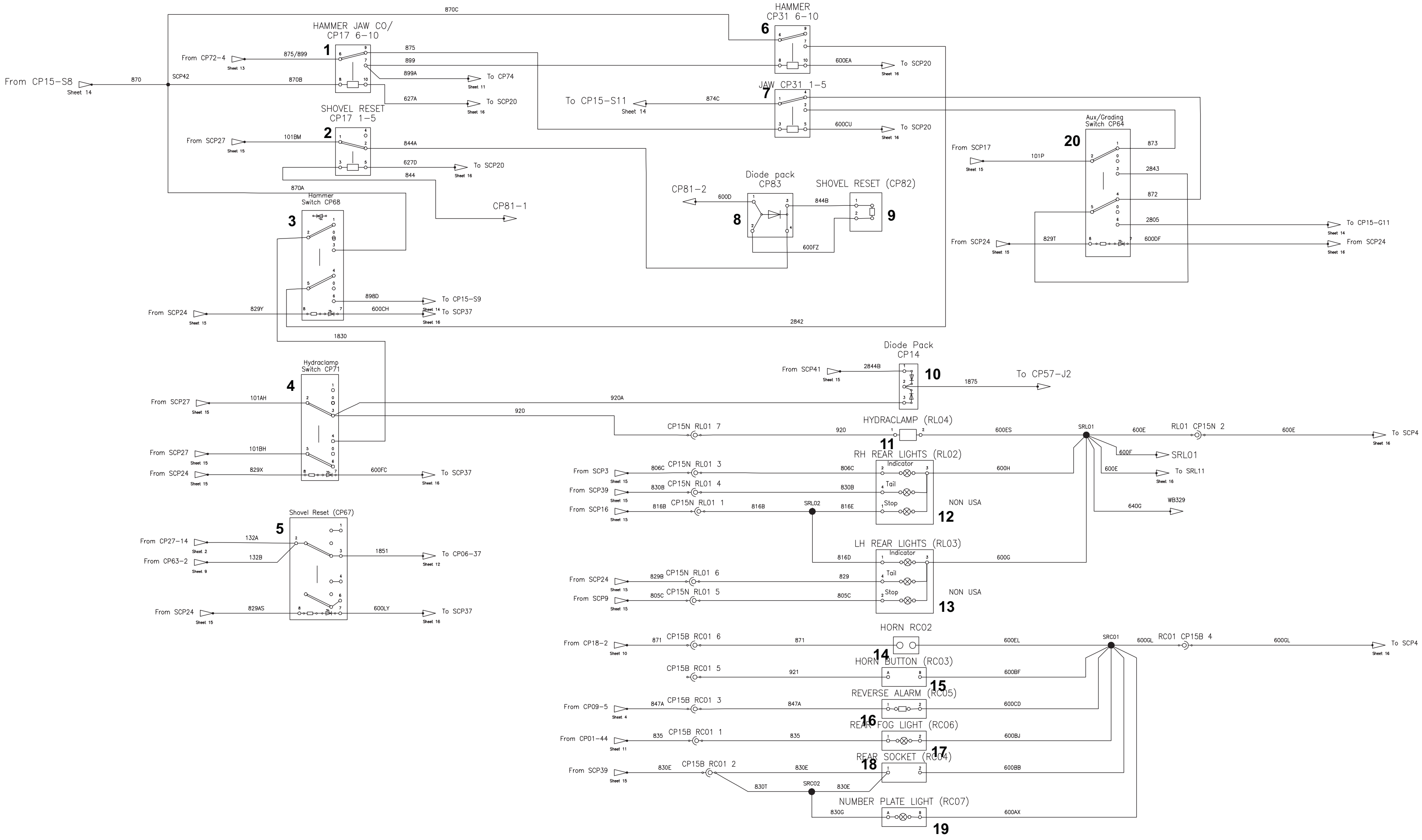
1	Hammer/Jaw Changeover Relay
2	Shovel Reset Relay
3	Hammer Selector Switch
4	Hydraclamps Selector Switch
5	Shovel Reset Selector Switch
6	Hammer Relay
7	Jaw Relay
8	Diode Pack
9	Shovel Reset Solenoid
10	Diode Pack
11	Hydraclamps Solenoid
12	Rear Lights - RH (Not USA)
13	Rear Lights - LH (Not USA)
14	Horn
15	Horn Pushbutton
16	Reverse Alarm
17	Rear Fog Light
18	Rear Socket
19	Number Plate Light
20	Auxiliary/Grading Mode Selector Switch

Component Key: Sheet 8 of 18
⇒ Fig 28. (L-38)

1	Instrument Panel (Side Console)
2	Air Filter'Blocked' Indicator Light
3	High Transmission Oil Temperature Indicator Light
4	Battery 'No Charge' Indicator Light
5	Park Brake Indicator Light
6	2WS Indicator Light
7	Panel Illumination
8	Grid Heater Indicator Light
9	Crab Steer Indicator Light
10	4WS Indicator Light
11	Warning Buzzer 1
12	Warning Buzzer 2

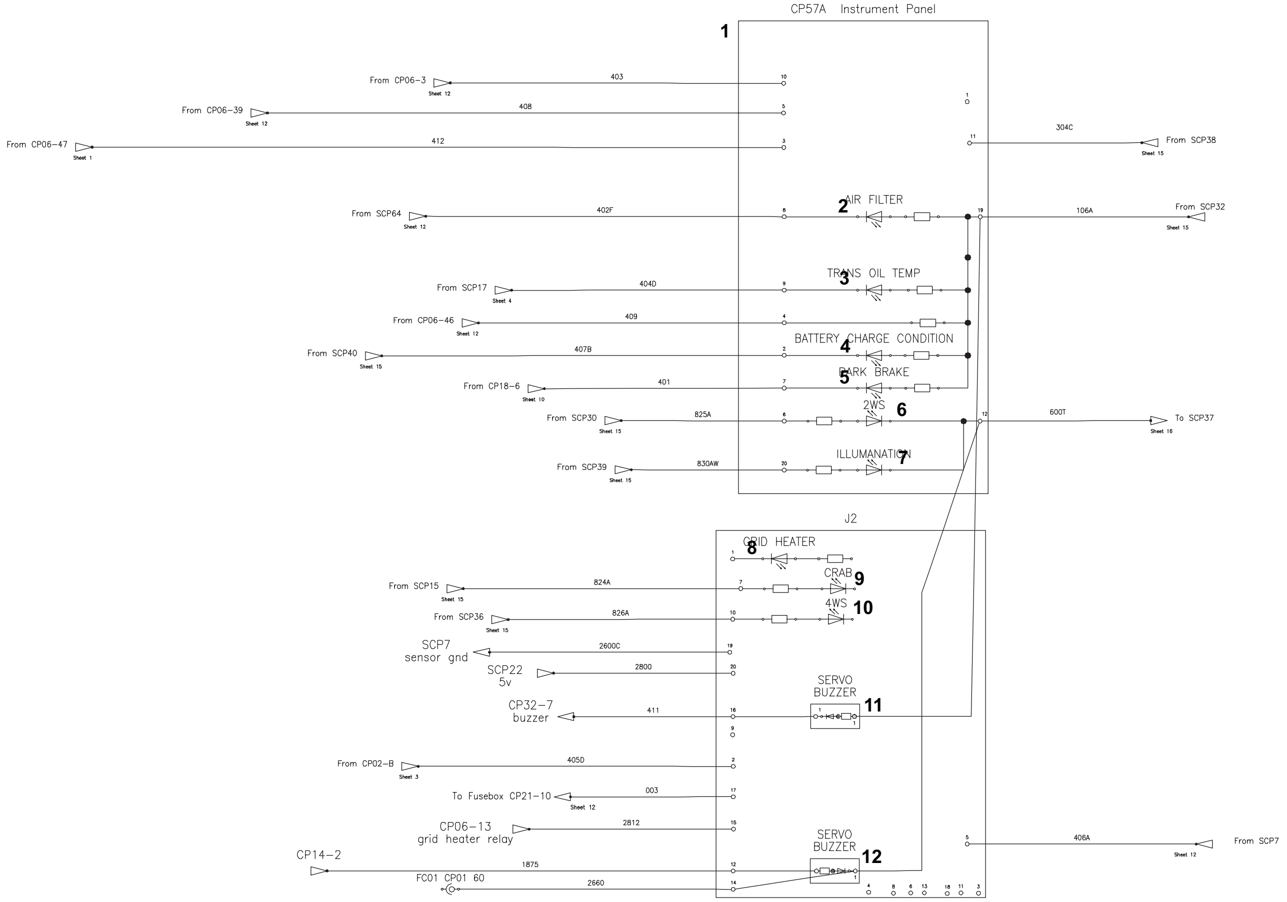
Component Key: Sheet 9 of 18
⇒ Fig 29. (L-39)

1	Engine Run Relay
2	Ignition Switch
3	Ignition 3 Relay
4	Ignition 1 Relay
5	Ignition 2 Relay
6	Lights Relay
7	Front Worklights Relay
8	Rear Worklights Relay
9	Front Worklights Selector Switch
10	Rear Worklights Selector Switch
11	Neutral Start Relay
12	Flasher
13	Cigar Lighter



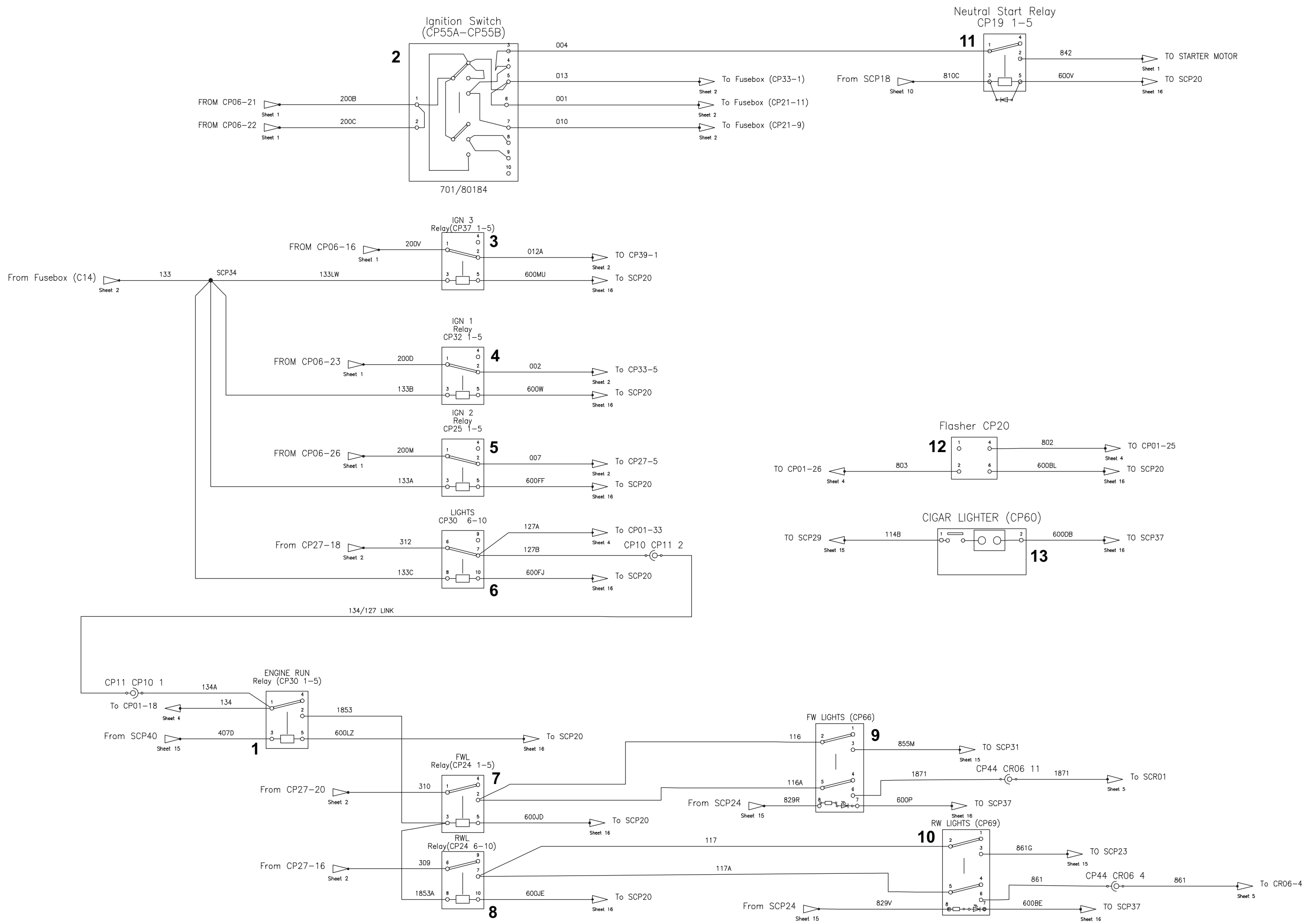
C090450APC-sht7

Fig 27. Sheet 7 of 18



C090450APC-sht8

Fig 28. Sheet 8 of 18



C090450APC-sht9

Fig 29. Sheet 9 of 18

Component Key: Sheet 10 of 18

⇨ *Fig 30. (L-41)*

1	Speaker - RH
2	Speaker - LH
3	Cab Interior Light
4	Warning Lights Relay
5	Diode Pack
6	ECU Cut-out Relay
7	Smooth Ride System (SRS) Selector Switch
8	ECU Power Relay
9	Radio
10	Boom Overload Warning Selector Switch
11	Park Brake Relay
12	Quickhitch Harness Connector
13	Pressure Switch (Excavator Boom Ram)
14	Park Brake Switch
15	Boom Overload Alarm Relay

Component Key: Sheet 11 of 18

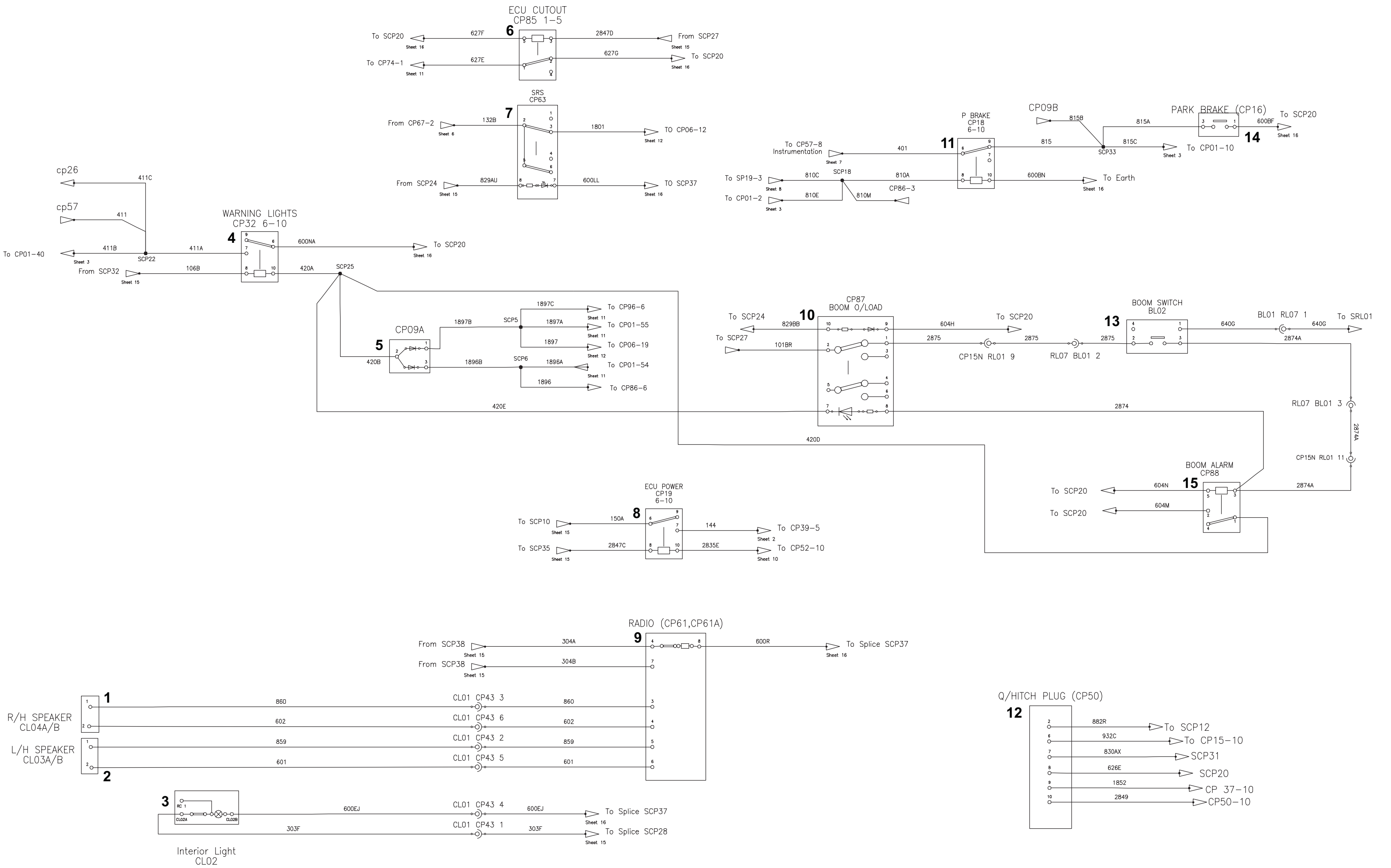
⇨ *Fig 31. (L-42)*

1	Horn Relay
2	Diode Pack
3	Diode Pack
4	Loader/Excavator Changeover Relay
5	PWM Changeover Relay
6	Servo Pilot Relay - LH Joystick
7	Servo Pilot Relay - RH Joystick
8	Transmission Dump Control Relay
9	Relay
10	Diode Pack
11	Diode Pack
12	Relay
13	Joysticks Enable Relay
14	Seat Forward Relay
15	Seat Rear Relay
16	Diode Pack
17	Diode Pack
18	Joysticks Enable Relay (Latching)
19	Diode Pack

Component Key: Sheet 12 of 18

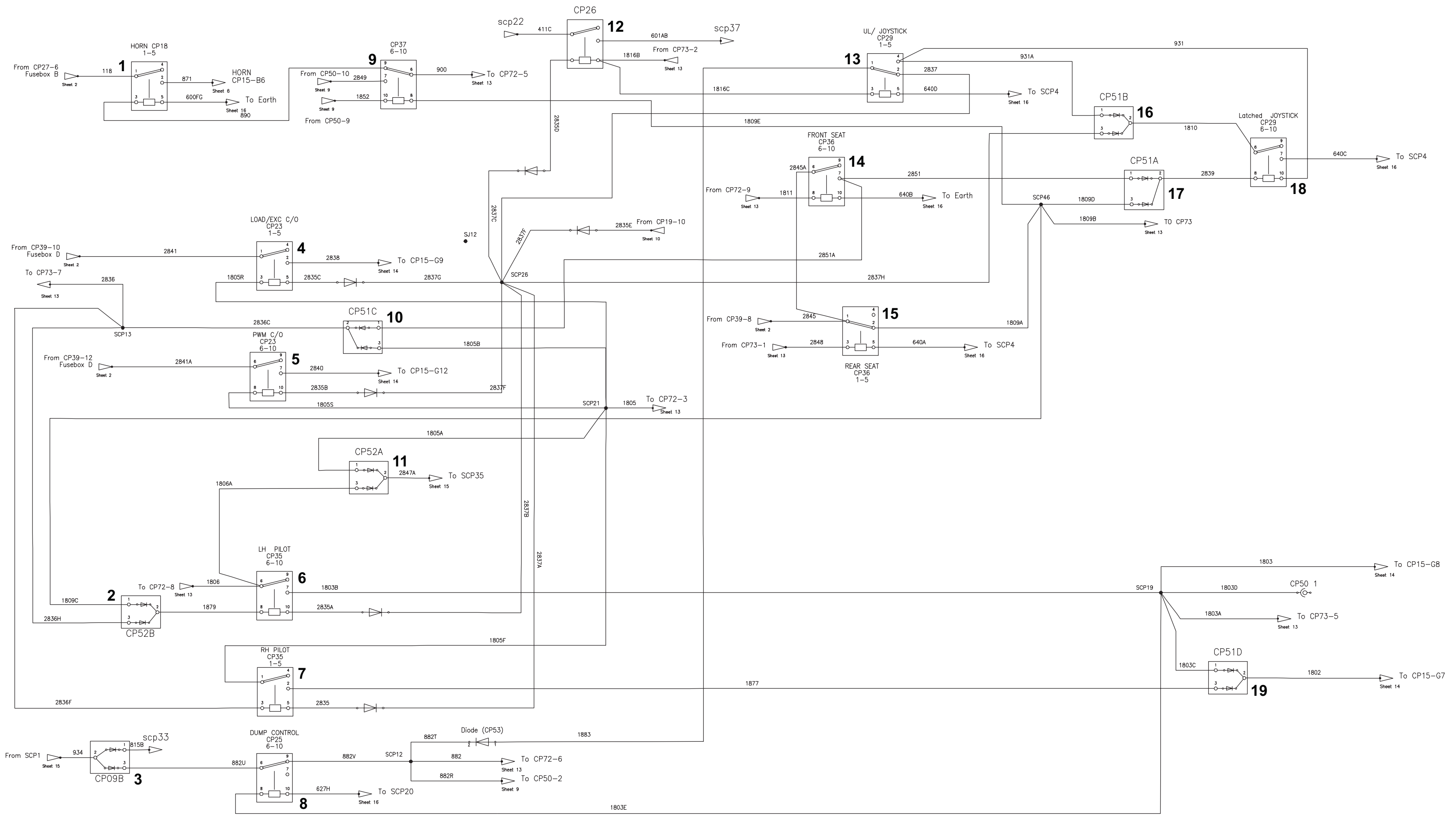
⇨ *Fig 32. (L-43)*

1	Rear Wash/Wipe Selector Switch
2	Heater Blower Motor
3	HTC & Front Quickhitch Harness Connector
4	Rear Wiper Motor
5	Resistor
6	Instrument Panel (Front Console)
7	Low Stabiliser Legs Indicator Lamp
8	Water in Fuel Indicator Lamp
9	Master Warning Indicator Lamp
10	2WS Indicator Lamp
11	Fog Light Indicator Lamp
12	Rear Worklights Indicator Lamp
13	Front Worklights Indicator Lamp
14	Main Beam Indicator Lamp
15	Torque Converter Lock-up Indicator Lamp
16	Engine Check Indicator Lamp
17	Engine Malfunction Indicator Lamp
18	Fog Light Selector Switch
19	PWM Controller ECU
20	Speedo
21	Speedo Illumination
22	Speedo Illumination



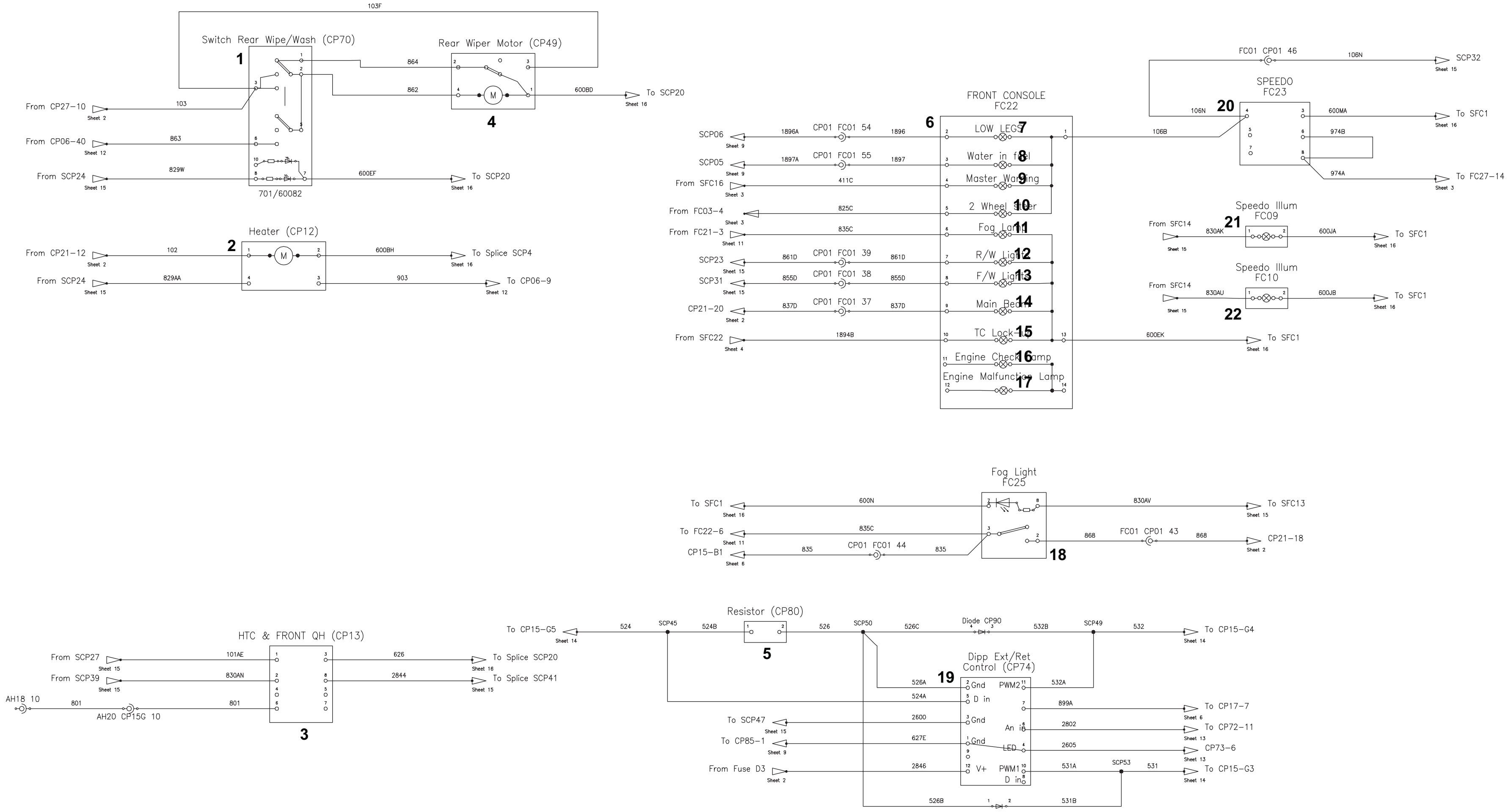
C090450APC-sht10

Fig 30. Sheet 10 of 18



C090450APC-sht11

Fig 31. Sheet 11 of 18



C090450APC-sht12

Fig 32. Sheet 12 of 18

Component Key: Sheet 13 of 18

⇨ *Fig 33. (L-45)*

1	Fusebox
2	Fusebox
3	Fusebox
4	Fusebox

Component Key: Sheet 14 of 18

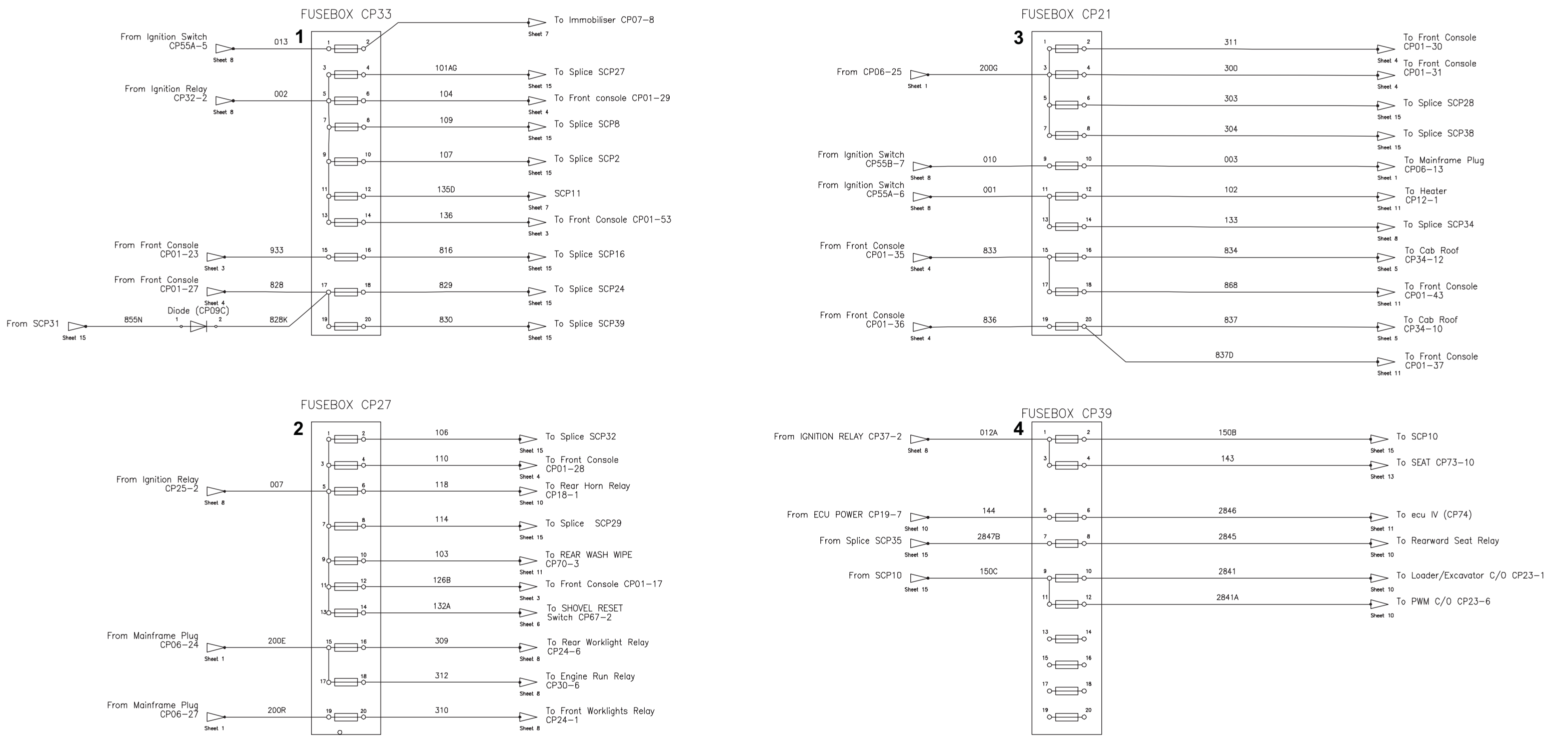
⇨ *Fig 34. (L-46)*

1	RH Joystick
2	Joystick Enable/Transmission Dump Pushbutton
3	Thumbwheel Switch - Extending Dipper/ Clam (PWM)
4	Float Mode Switch
5	Excavator/Loader Selector Switch
6	Seat Forward/Rear Switch
7	Heated Seat
8	LH Joystick
9	Max. Retract Pushbutton (Extending Dipper)
10	Rear Horn/Quickhitch Pushbutton

Component Key: Sheet 15 of 18

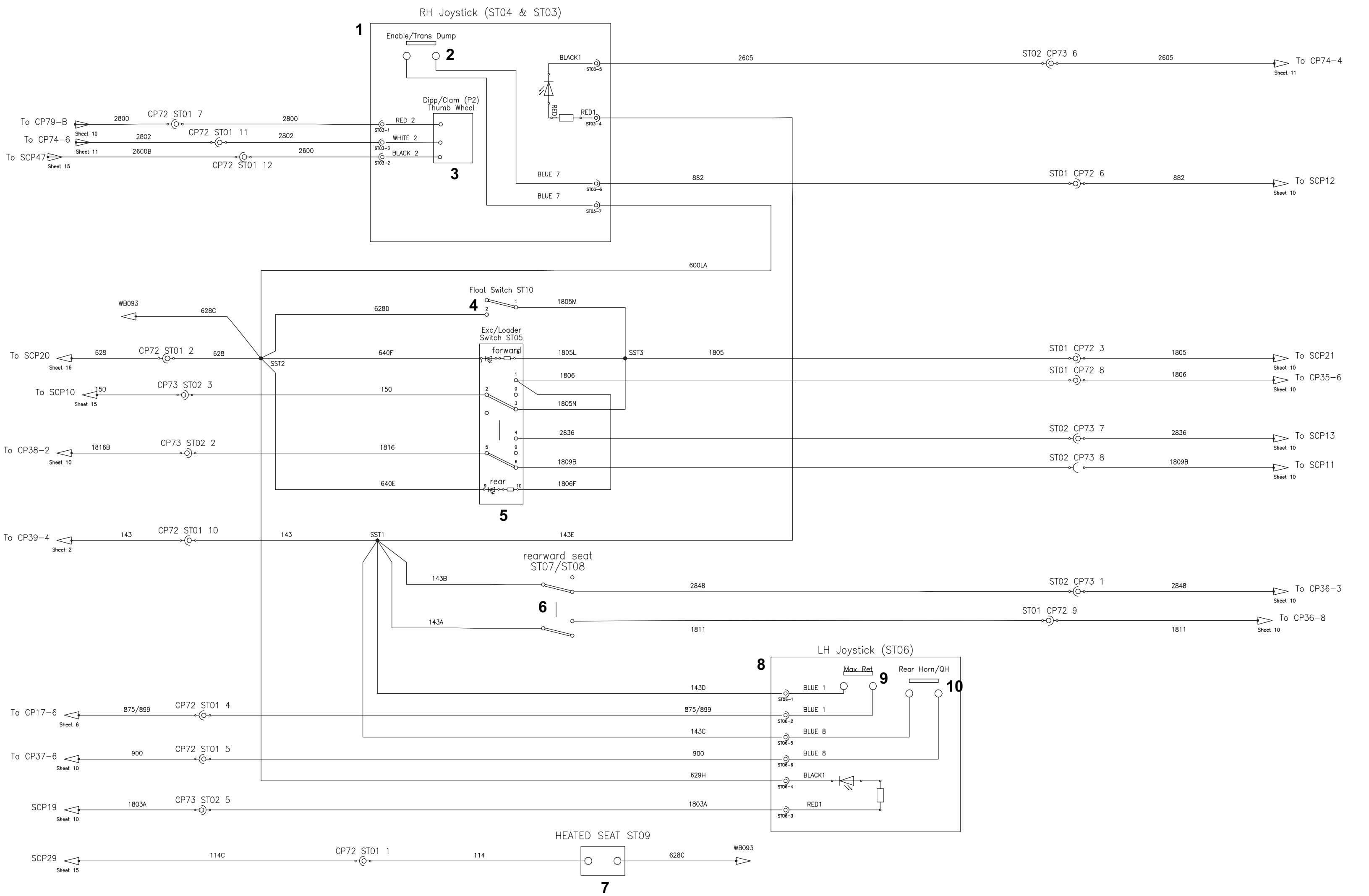
⇨ *Fig 35. (L-47)*

1	Extend Proportional Solenoid (PWM)
2	Retract Proportional Solenoid (PWM)
3	Jaw Changeover Solenoid
4	Quickhitch Solenoid
5	Hammer Solenoid 1
6	Hammer Solenoid 2
7	Hammer Cooling Solenoid
8	Hammer/Extending Dipper Changeover Solenoid
9	Grading Mode Solenoid
10	Changeover Solenoid - Extend (PWM)
11	Changeover Solenoid - Retract (PWM)
12	Changeover Solenoid - Lift
13	Changeover Solenoid - Lower
14	Changeover Solenoid - Crowd
15	Changeover Solenoid - Dump
16	Pump Solenoid -if fitted
17	Servo Pilot Solenoid - RH Joystick
18	Servo Pilot Solenoid - LH Joystick
19	Steer Proximity Switch - Rear Axle
20	4WS Solenoid
21	Crab Steer Solenoid
22	2WS Solenoid
23	4WS Solenoid



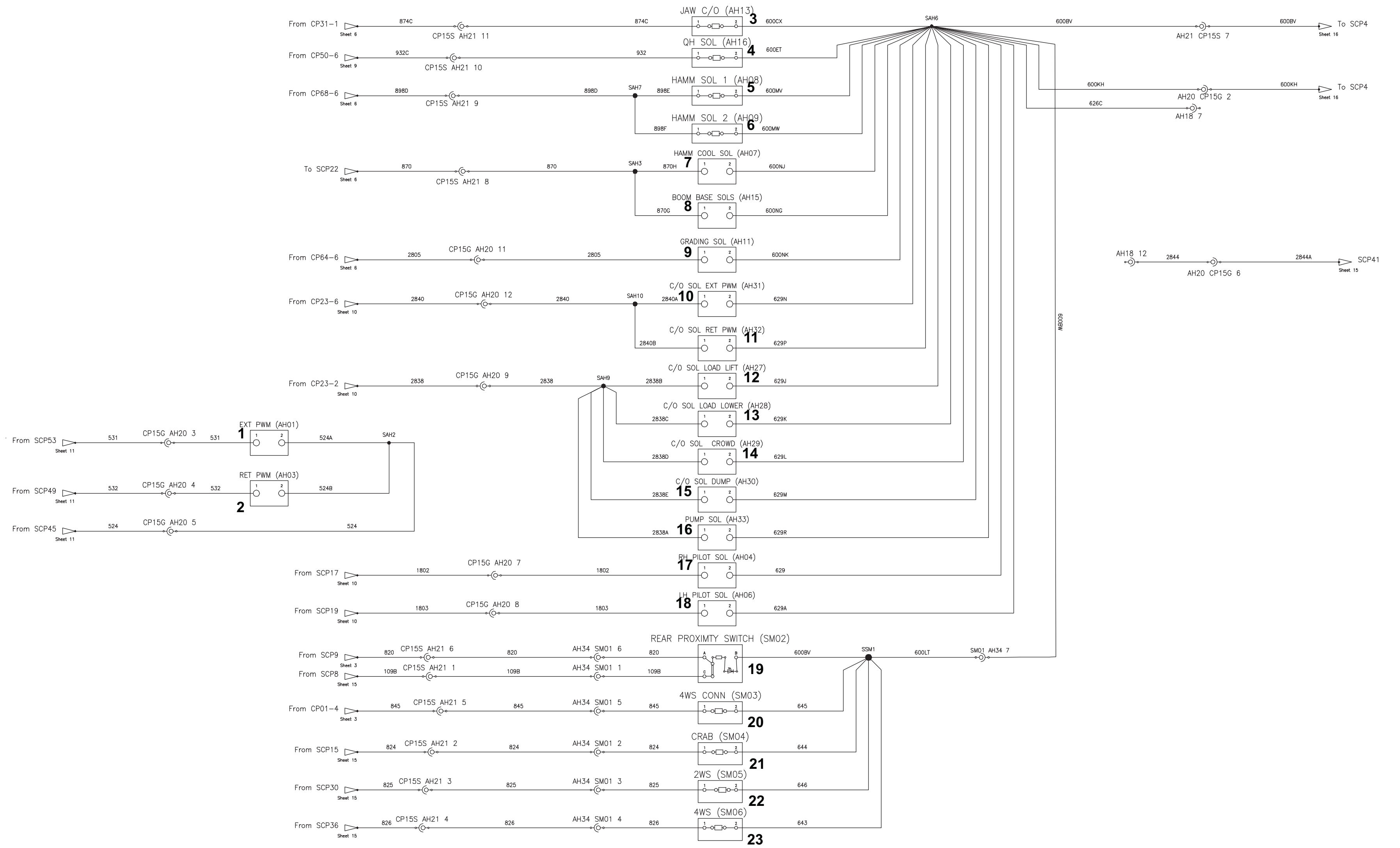
C090450APC-sht13

Fig 33. Sheet 13 of 18



C090450APC-sht14

Fig 34. Sheet 14 of 18



C090450APC-sht15

Fig 35. Sheet 15 of 18

Component Key: Sheet 17 of 18

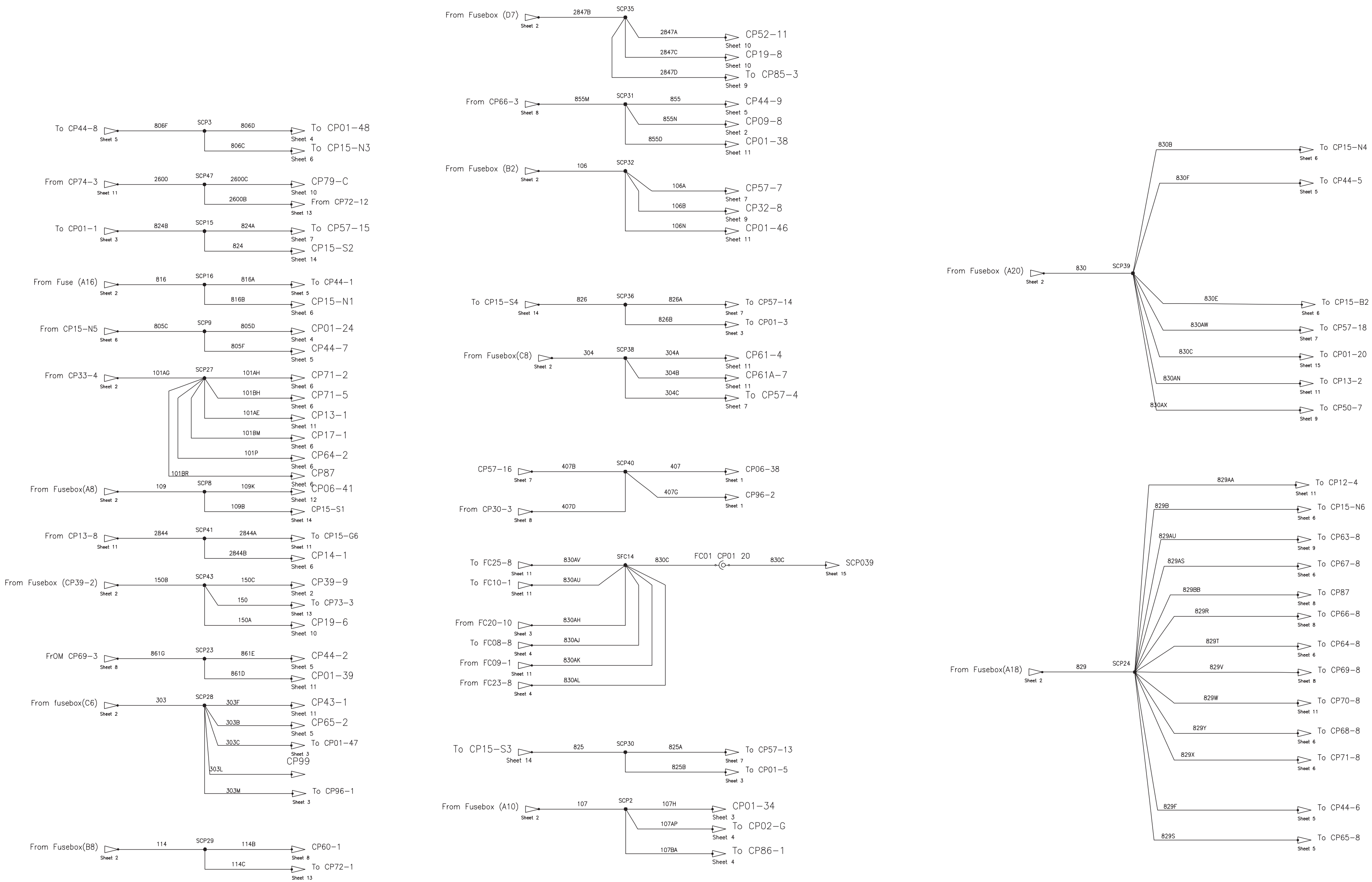
⇨ *Fig 37. (L-50)*

1	Earth Point
2	Earth Point
3	Earth Point
4	Earth Point

Component Key: Sheet 18 of 18

⇨ *Fig 38. (L-51)*

1	Diagnostics Connector
2	Serial Connector
3	CANbus Terminator Resistor
4	CANbus Terminator Resistor
5	Live Link Connector



C090450APC-sht16

Fig 36. Sheet 16 of 18

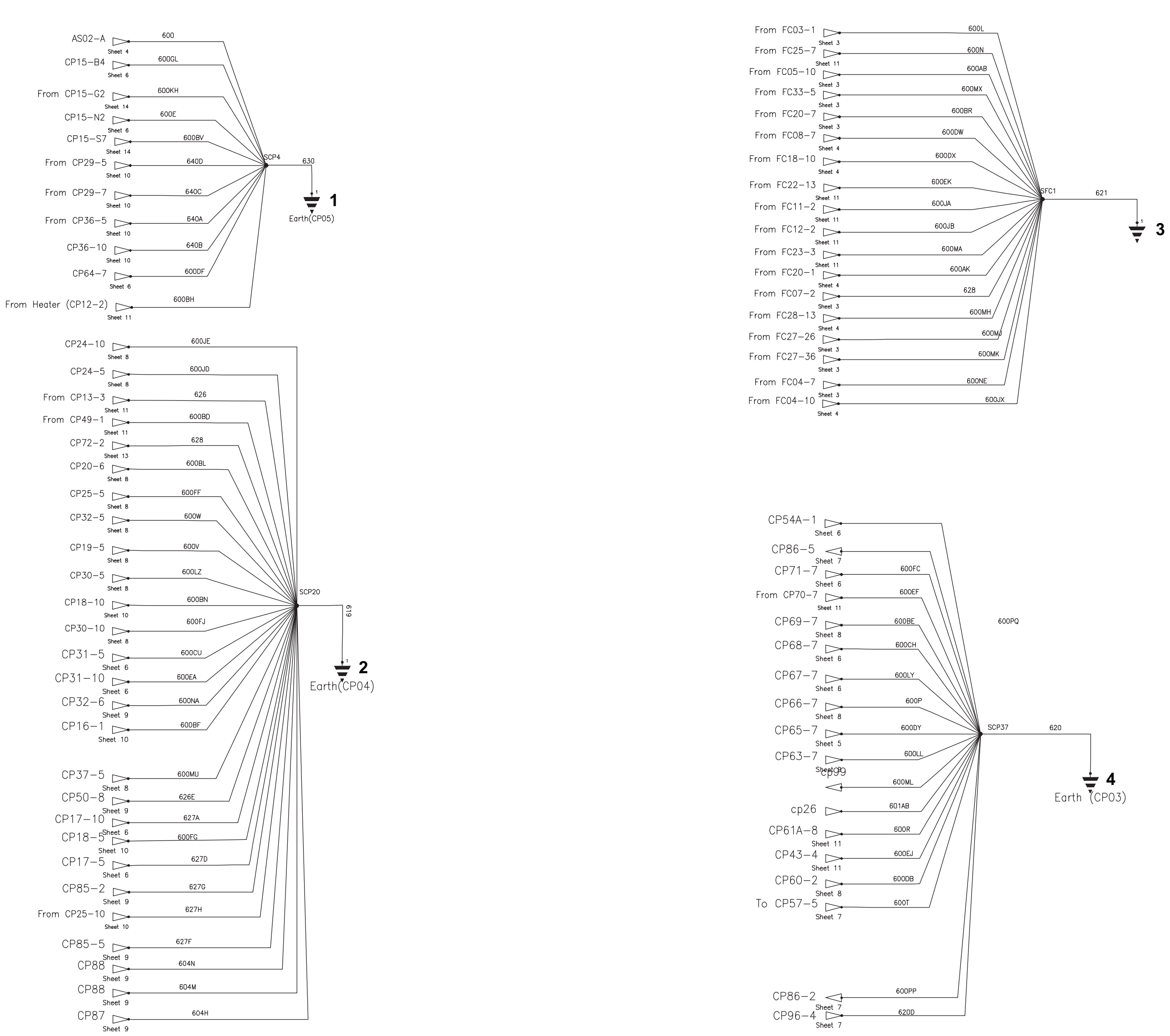
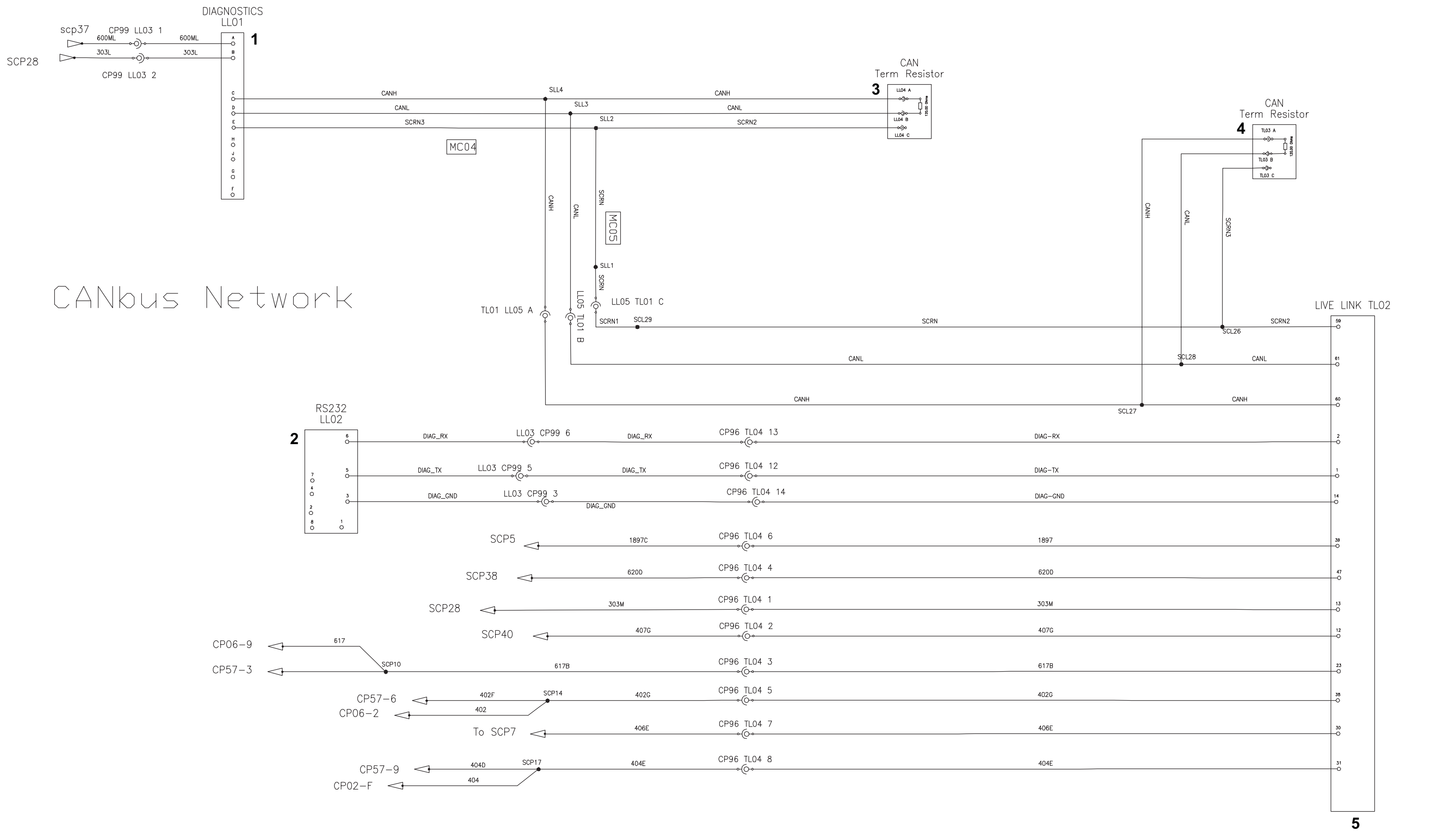


Fig 37. Sheet 17 of 18



C090450APC-sht18

Fig 38. Sheet 18 of 18

EasyControl Machines - To May 2009 (Analog Instruments)

Component Key: Sheet 1 of 17
⇨ *Fig 39. (L-53)*

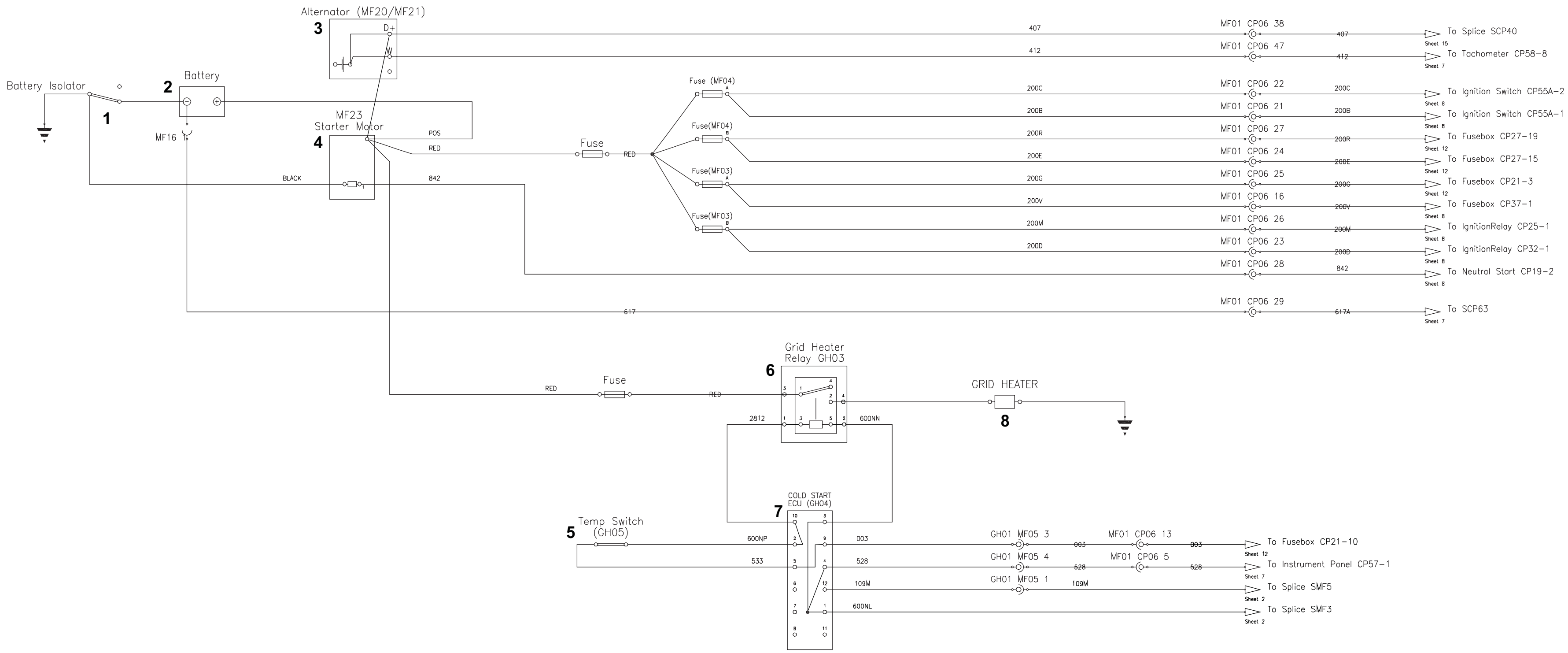
1 Battery Isolator
2 Battery
3 Alternator
4 Starter Motor
5 Ambient Temperature Switch - Cold Start
6 Grid Heater Relay - Cold Start
7 Cold Start ECU
8 Grid Heater - Cold Start

Component Key: Sheet 2 of 17
⇨ *Fig 40. (L-54)*

1 Steer Proximity Switch - Front Axle
2 Coolant Level Switch
3 Cold Start Advance Switch
4 Cold Start Solenoid
5 Water in Fuel Sensor
6 Coolant Temperature Switch
7 Engine Shut-off Solenoid (ESOS)
8 Fuel Level Sender
9 Rear Washer Motor
10 Front Washer Motor
11 Horn
12 Air Filter ‘Blocked’ Switch
13 Engine Oil Pressure Switch
14 Shovel Reset Proximity Switch
15 SRS Solenoid
16 SRS Solenoid
17 Shovel Reset Selector Switch
18 Shovel Reset Solenoid
19 Smooth Ride System (SRS) Selector Switch

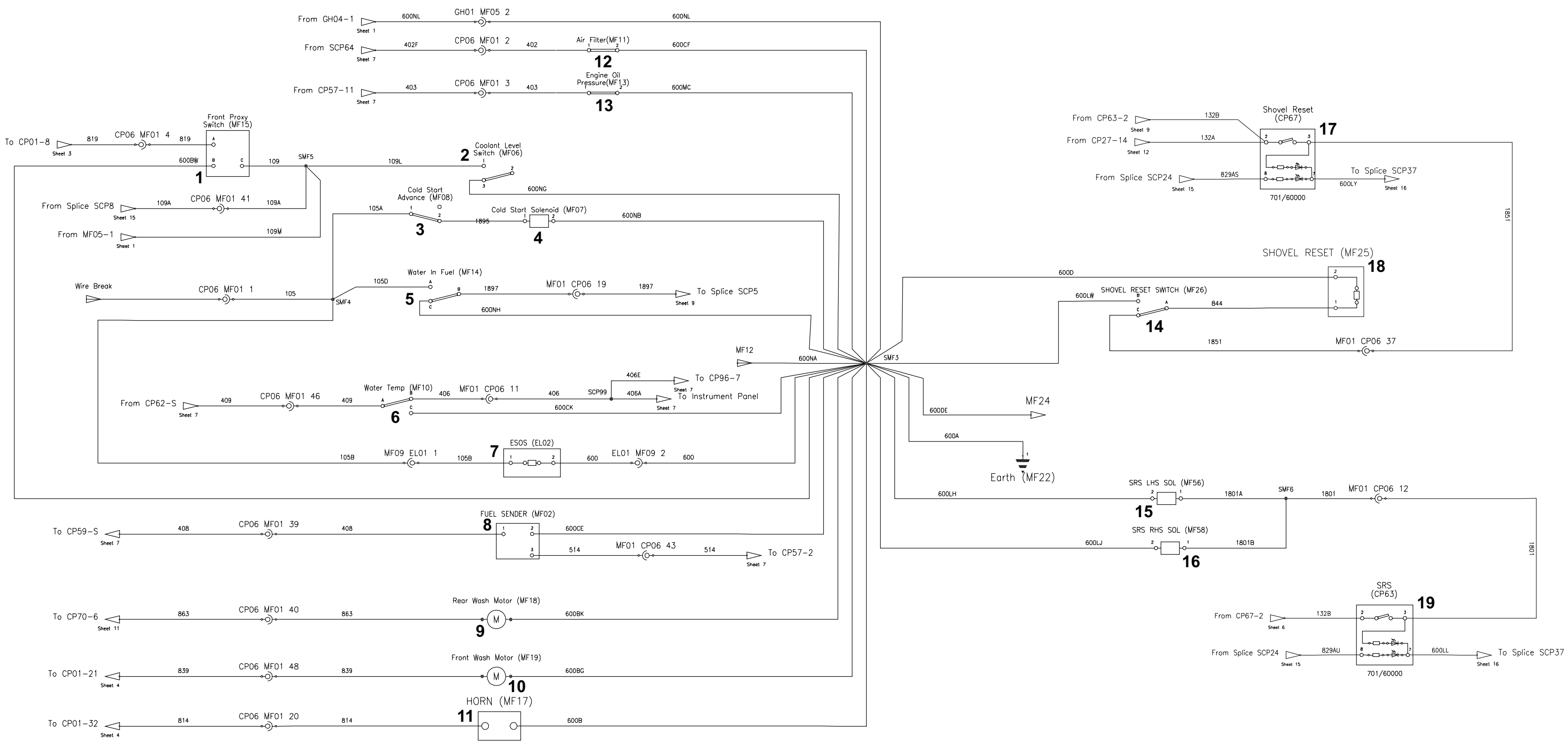
Component Key: Sheet 3 of 17
⇨ *Fig 41. (L-55)*

1 Footbrake Switch
2 Brake Mode Selector Switch
3 2/4WD Selector Switch
4 Auto 4WB Relay
5 Reverse Relay
6 Forward Relay
7 Interlock Relay
8 Transmission Dump Relay
9 Auto 2WB Relay
10 Forward Hi/Lo Relay
11 Drive Relay
12 Diode Pack
13 Steer Mode Relay



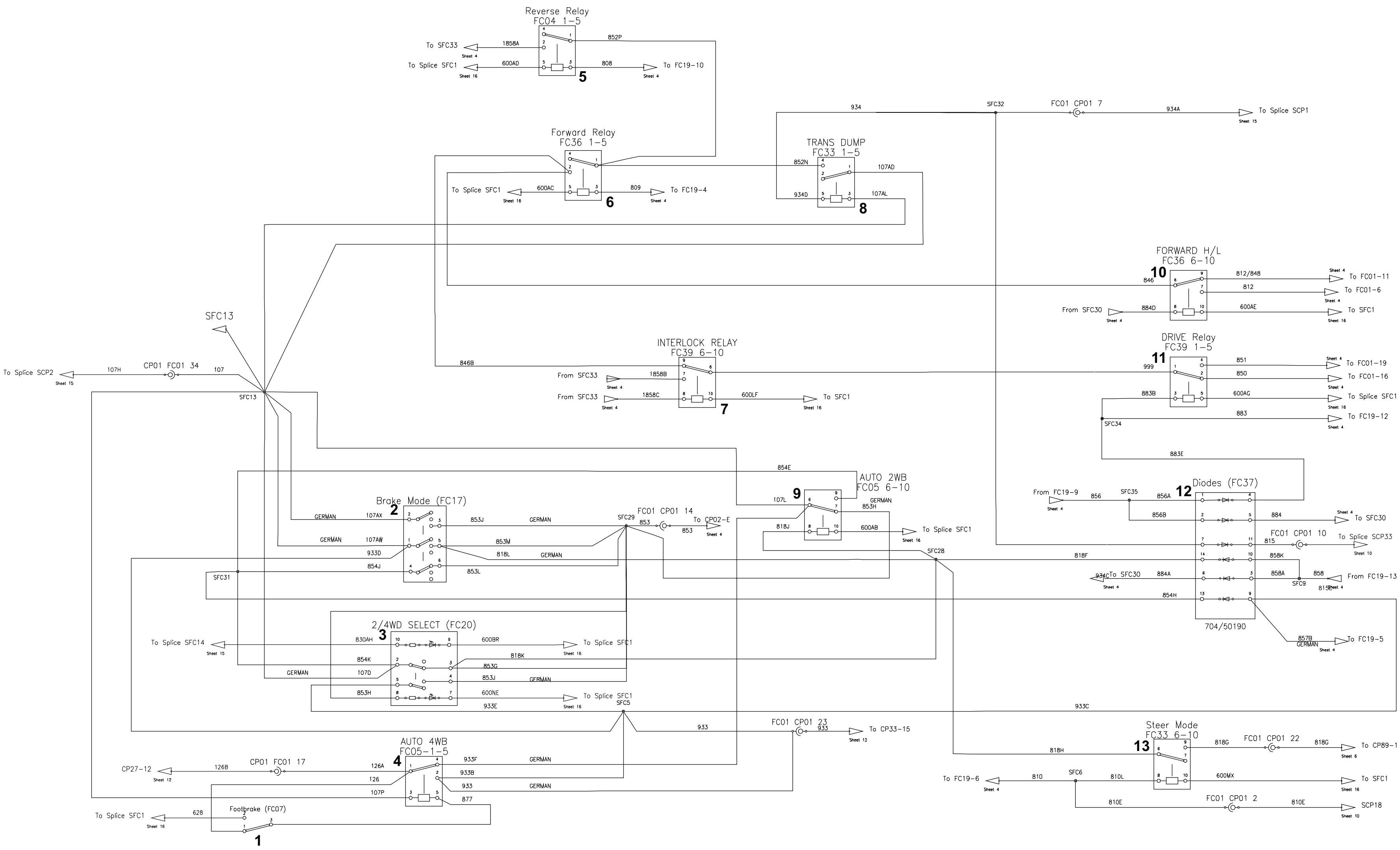
332-D2396sht1

Fig 39. Sheet 1 of 17



332-D2396sht2

Fig 40. Sheet 2 of 17



332-D2396sht3

Fig 41. Sheet 3 of 17

Component Key: Sheet 4 of 17

⇒ Fig 42. (L-57)

1	Column Switch - RH
2	Column Switch - LH
3	Hazard Lights Switch
4	Front Wiper Motor
5	Reverse Alarm Relay
6	Front Warning Lights
7	Flasher
8	Headlights Switch
9	Transmission Oil Temperature Switch
10	Transmission Oil Pressure Switch
11	Transmission Dump Switch
12	Layshaft Solenoid
13	6-Speed Solenoid
14	Mainshaft Solenoid
15	Reverse Low Solenoid
16	Reverse High Solenoid
17	Forward Low Solenoid
18	Forward Solenoid

Component Key: Sheet 5 of 17

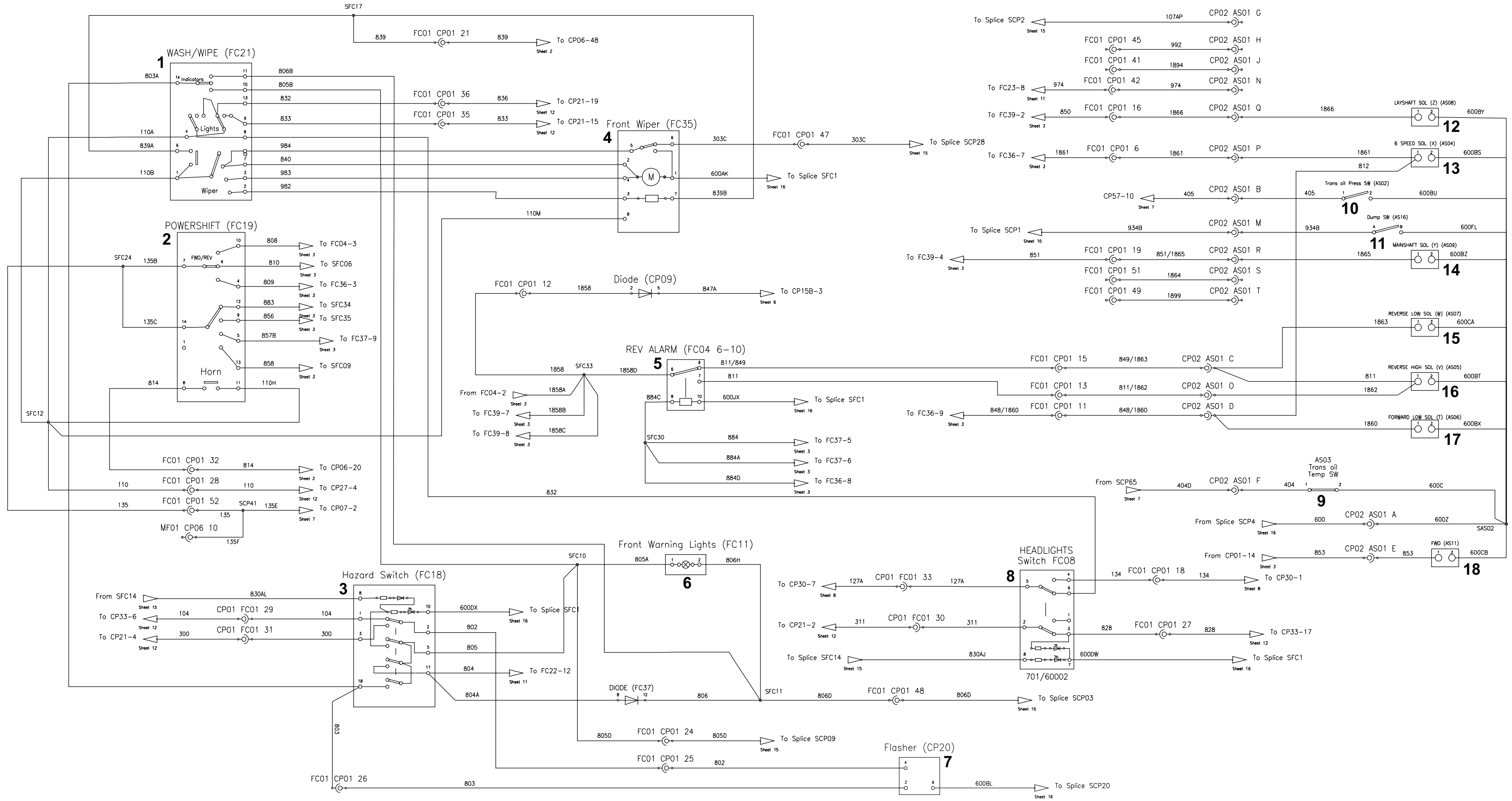
⇒ Fig 43. (L-58)

1	Front Worklights - LH
2	Front Worklights - RH
3	Rear Worklight - RH Outer
4	Rear Worklight - RH Inner
5	Rear Worklight - LH Inner
6	Rear Worklight - LH Outer
7	Cab Interior Light
8	Beacon Switch
9	Beacon
10	Auxiliary Beacon
11	Auxiliary Beacon
12	Front Headlight - LH
13	Rear Lights - LH (USA)
14	Front Headlight - RH
15	Rear Lights - RH (USA)
16	Front Direction Indicators - LH (USA)
17	Front Direction Indicators - RH (USA)

Component Key: Sheet 6 of 17

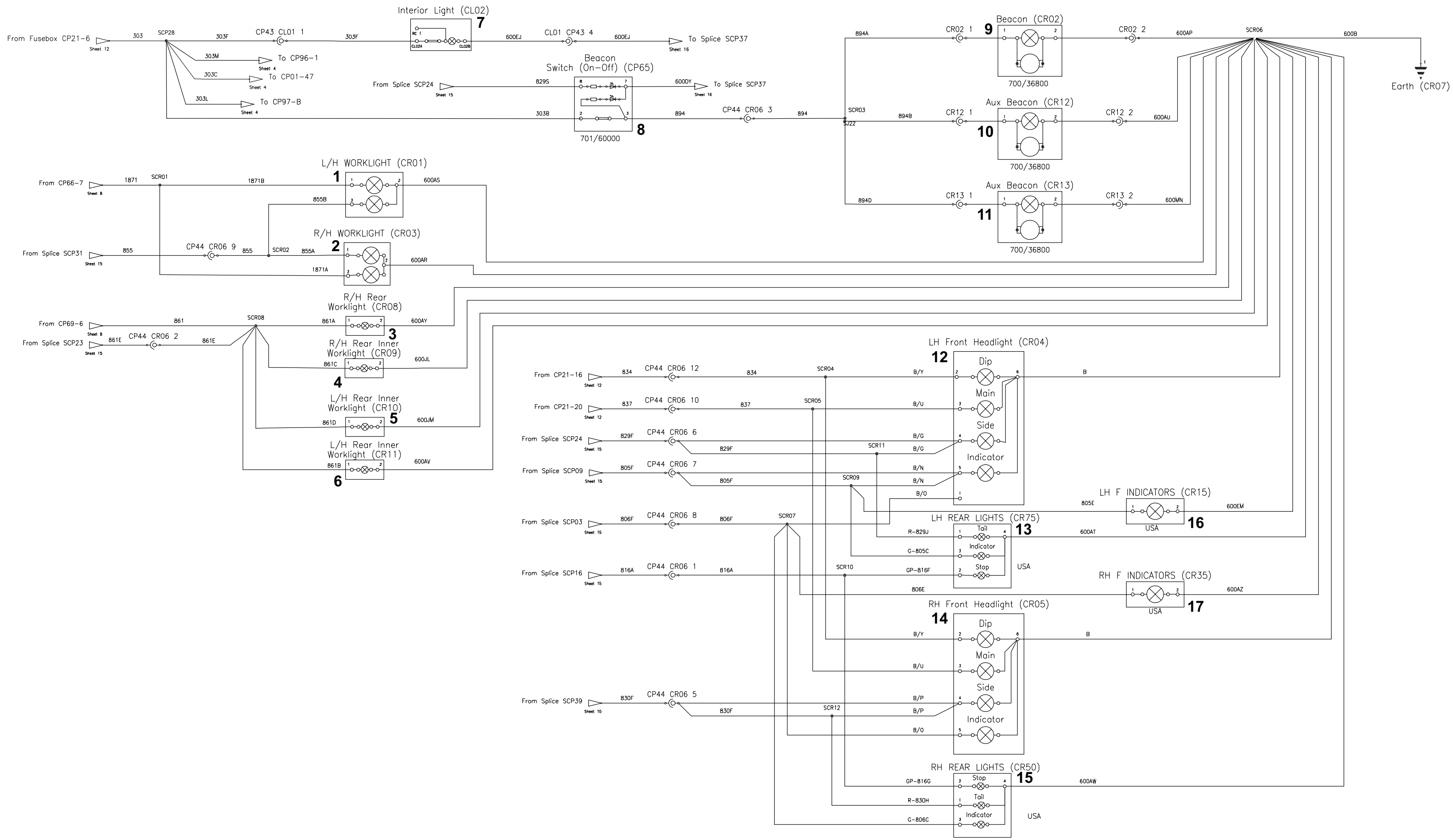
⇒ Fig 44. (L-59)

1	Hydraulic Speed Control (HSC) Solenoid
2	Hammer Selector Switch
3	Hydraclamps Selector Switch
4	Hammer Switch (Foot Switch)
5	Diode Pack
6	Hammer/Jaw Changeover Relay
7	Jaw Relay
8	Hammer Relay
9	Warning Buzzer
10	Hydraclamps Solenoid
11	Hammer Solenoid
12	HSC Pushbutton
13	Hydraulic Speed Control (HSC) Selector Switch
14	Jaw Changeover Solenoid
15	Jaw Changeover Solenoid
16	Jaw Changeover Solenoid
17	Jaw Changeover Solenoid



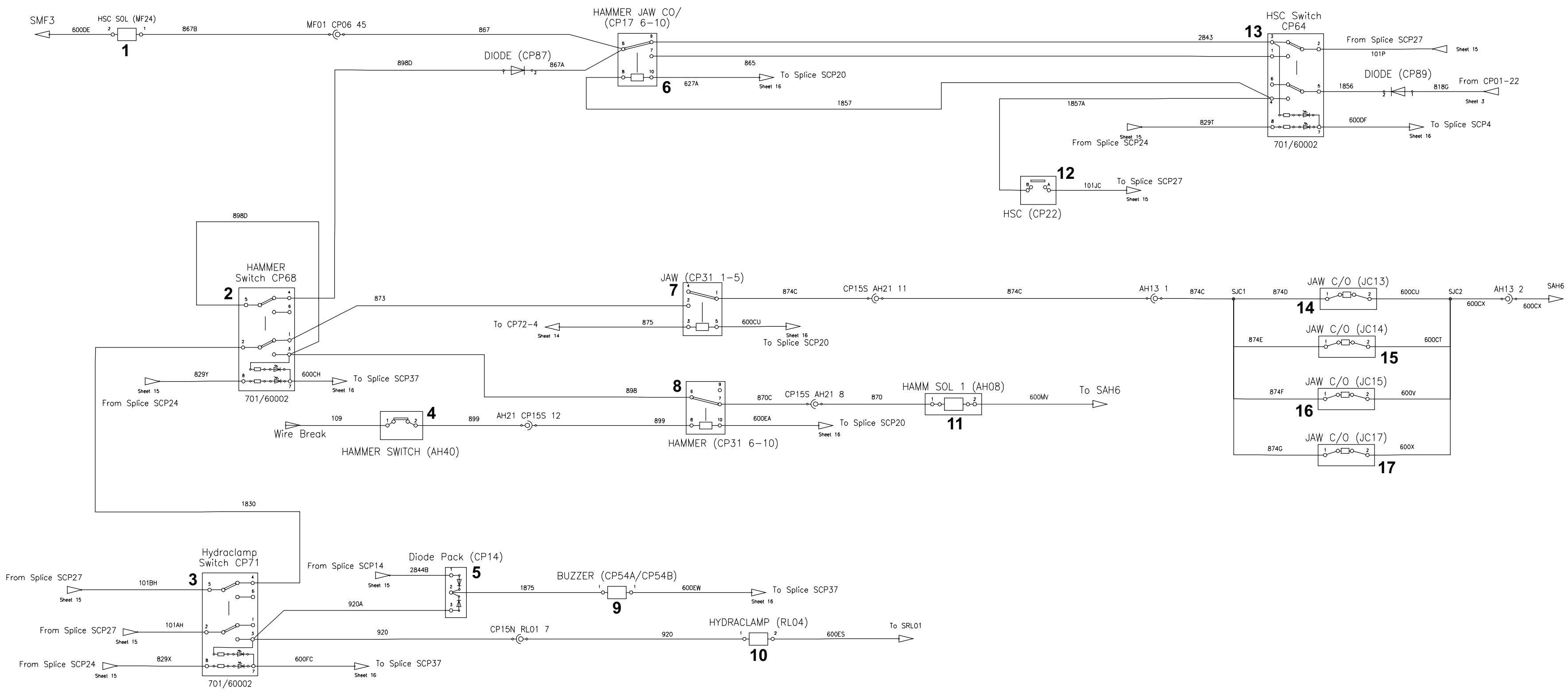
332-D2396sht4

Fig 42. Sheet 4 of 17



332-D2396sht5

Fig 43. Sheet 5 of 17



332-D2396sht6

Fig 44. Sheet 6 of 17

Component Key: Sheet 7 of 17

⇒ Fig 45. (L-61)

1	Warning Buzzer
2	Warning Lights Relay
3	Coolant Temperature Gauge
4	Coolant Temperature Gauge Illumination
5	Fuel Level Gauge
6	Fuel Level Gauge Illumination
7	Horn
8	Horn Pushbutton
9	Reverse Alarm
10	Rear Fog Light
11	Rear Socket
12	Number Plate Light
13	Boom Overload Warning Selector Switch
14	Pressure Switch (Excavator Boom Ram)
15	Boom Overload Alarm Relay

Component Key: Sheet 8 of 17

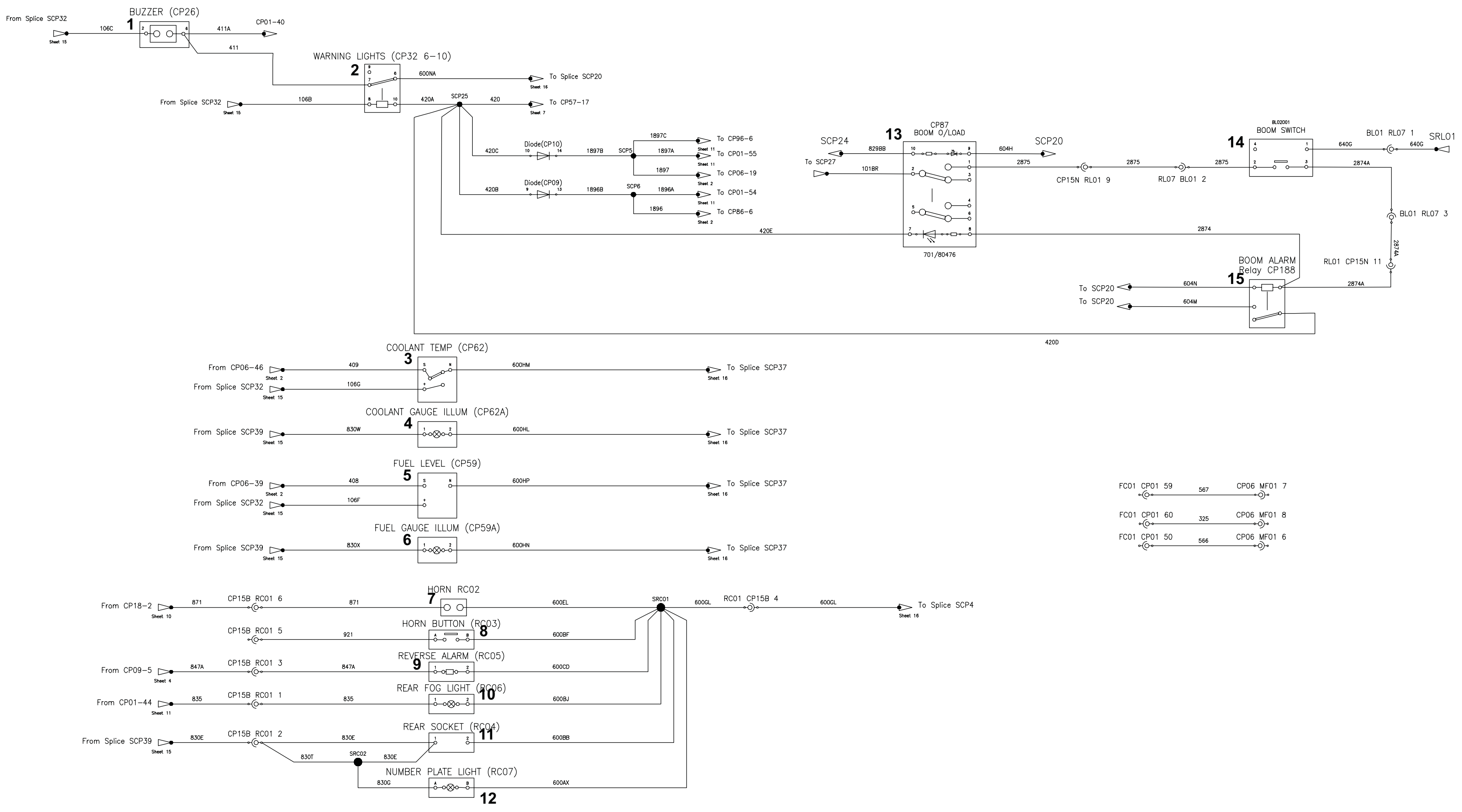
⇒ Fig 46. (L-62)

1	Engine Run Relay
2	Ignition Switch
3	Ignition 3 Relay
4	Ignition 1 Relay
5	Ignition 2 Relay
6	Lights Relay
7	Front Worklights Relay
8	Rear Worklights Relay
9	Front Worklights Selector Switch
10	Rear Worklights Selector Switch
11	Neutral Start Relay
12	Park Brake Relay
13	Rear Lights - RH (Not USA)
14	Rear Lights - LH (Not USA)
15	Cigar Lighter
16	Park Brake Switch

Component Key: Sheet 9 of 17

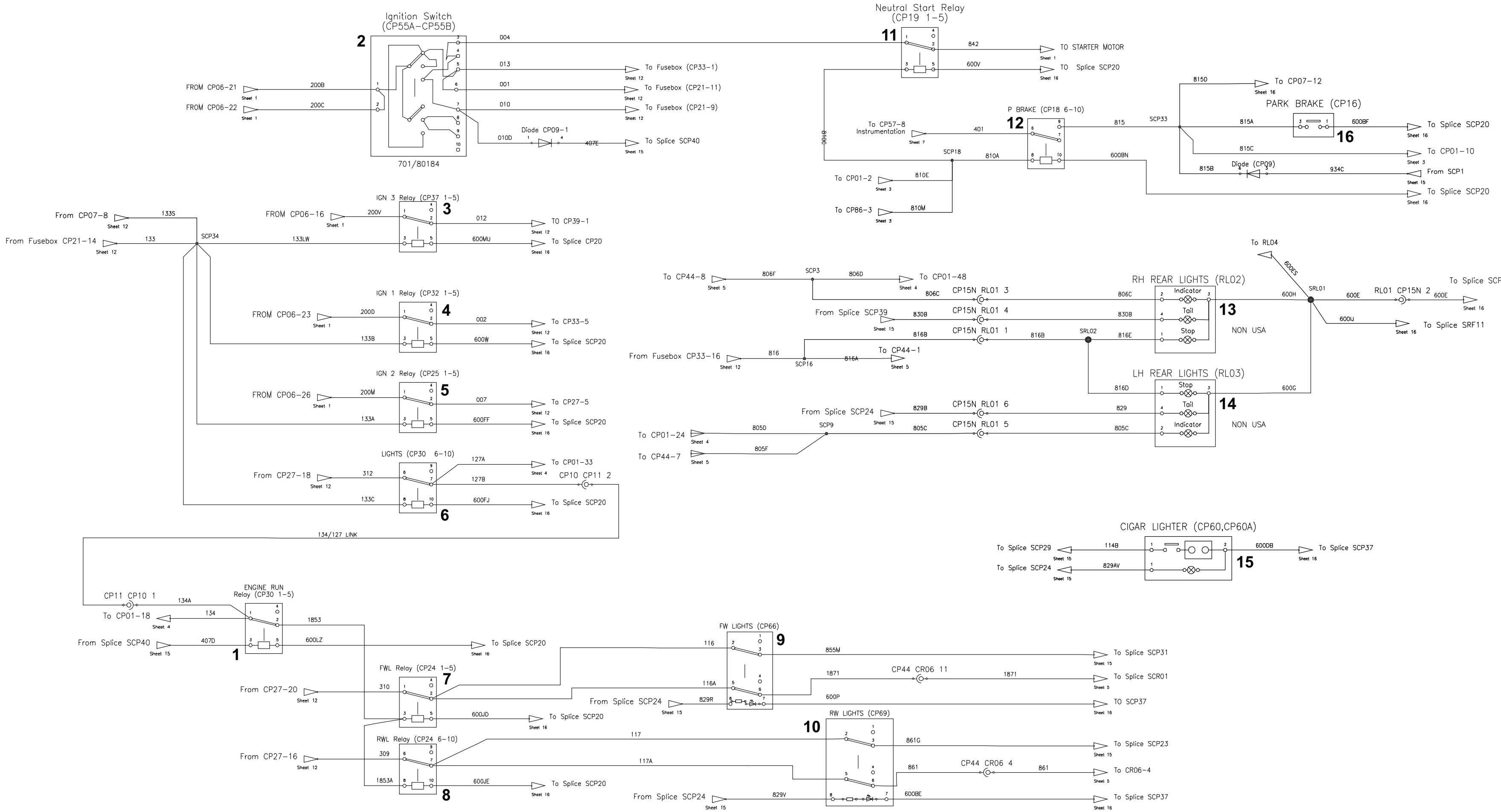
⇒ Fig 47. (L-63)

1	Speaker - RH
2	Speaker - LH
3	Tachometer
4	Tachometer Illumination
5	Tachometer Illumination
6	Radio
7	Instrument Panel (Side Console)
8	Low Transmission Oil Pressure Indicator Lamp
9	Clock
10	Cold Start Grid Heater Indicator Lamp
11	Air Filter ‘Blocked’ Indicator Lamp
12	Low Engine Oil Pressure Indicator Lamp
13	High Transmission Oil Temperature Indicator Lamp
14	High Engine Coolant Temperature Indicator Lamp
15	Alternator ‘No Charge’ Indicator Lamp
16	Park Brake Indicator Lamp
17	Low Fuel Level Indicator Lamp
18	Crab Steer Indicator Lamp
19	4WS Indicator Lamp
20	2WS Indicator Lamp
21	Panel Illumination



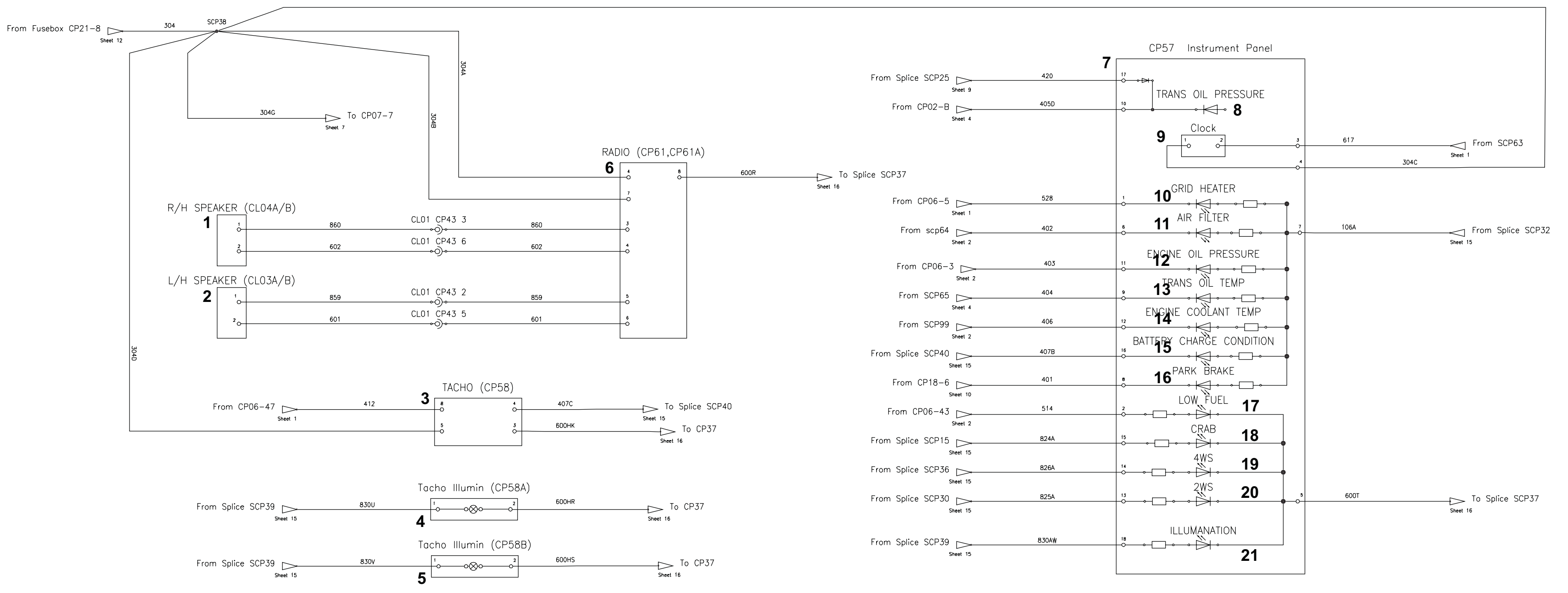
332-D2396sht7-C1

Fig 45. Sheet 7 of 17



332-D2396sht8

Fig 46. Sheet 8 of 17



332-D2396sht9

Fig 47. Sheet 9 of 17

Component Key: Sheet 10 of 17

⇒ Fig 48. (L-65)

1 Transmission Dump Control Relay
2 Loader/Excavator Changeover Relay
3 ECU Power Relay
4 Loader/Excavator Auxiliary Changeover Relay
5 Servo Pilot Relay - LH Joystick
6 Servo Pilot Solenoid - LH Joystick
7 Servo Pilot Solenoid - RH Joystick
8 Warning Buzzer (Servo)
9 Seat Forward Relay
10 Seat Rear Relay
11 Joysticks Enable Relay
12 Joysticks Enable Relay (Latching)
13 Horn Relay
14 Rear Horn/Quickhitch Changeover Relay

Component Key: Sheet 11 of 17

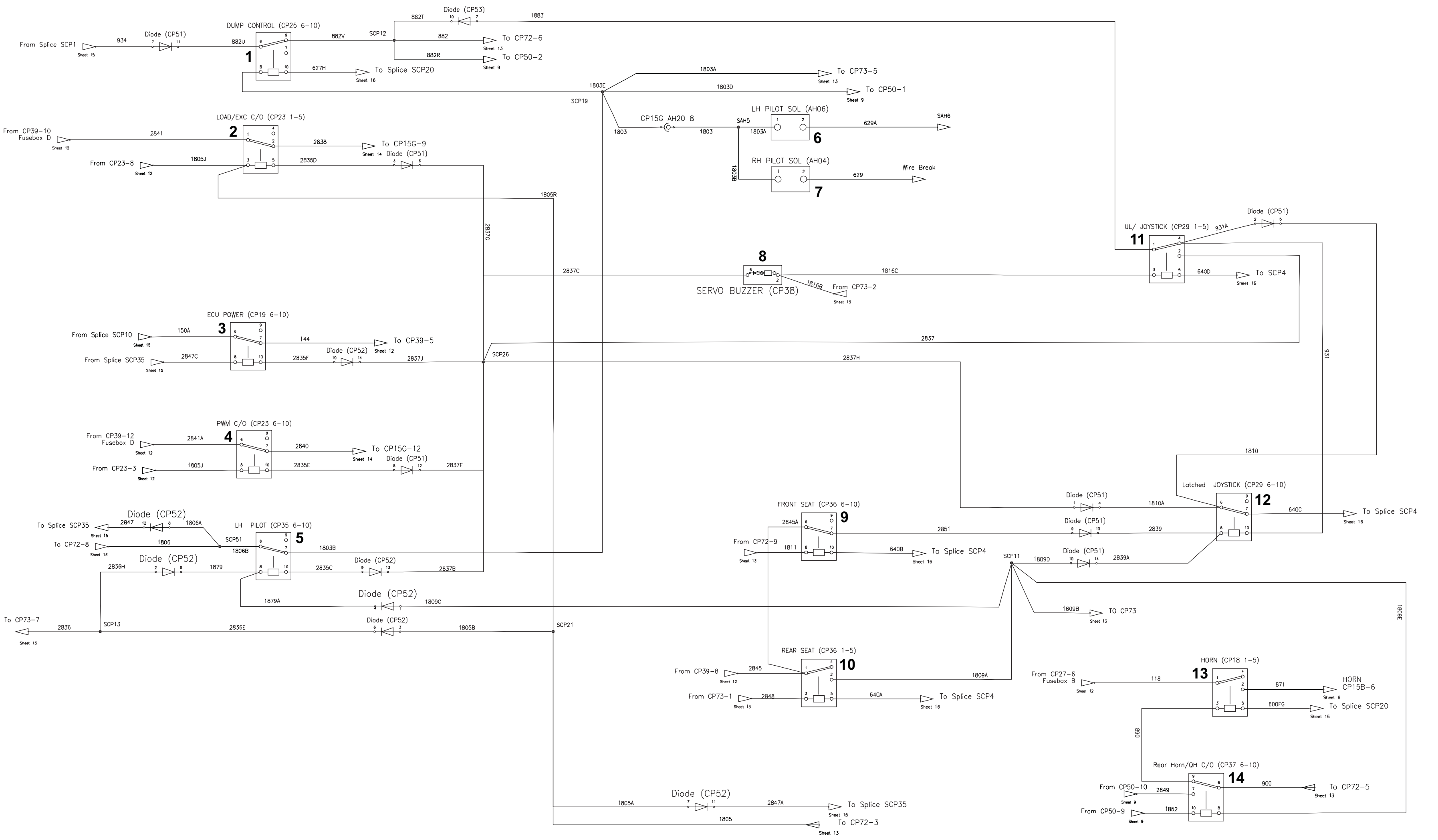
⇒ Fig 49. (L-66)

1 Rear Wash/Wipe Selector Switch
2 Heater Blower Motor
3 HTC and Front Quickhitch Harness Connector
4 Rear Wiper Motor
5 Air Conditioning Compressor Clutch Solenoid
6 Instrument Panel (Front Console)
7 Low Stabiliser Legs Indicator Lamp
8 Water in Fuel Indicator Lamp
9 Master Warning Indicator Lamp
10 2WS Indicator Lamp
11 Fog Light Indicator Lamp
12 Rear Worklights Indicator Lamp
13 Front Worklights Indicator Lamp
14 Main Beam Indicator Lamp
15 Torque Converter Lock-up Indicator Lamp
16 Sidelights Indicator Lamp
17 Hazards Indicator Lamp
18 Fog Light Selector Switch
19 Loader/Excavator Auxiliary Changeover Relay
20 Speedo
21 Speedo Illumination
22 Speedo Illumination

Component Key: Sheet 12 of 17

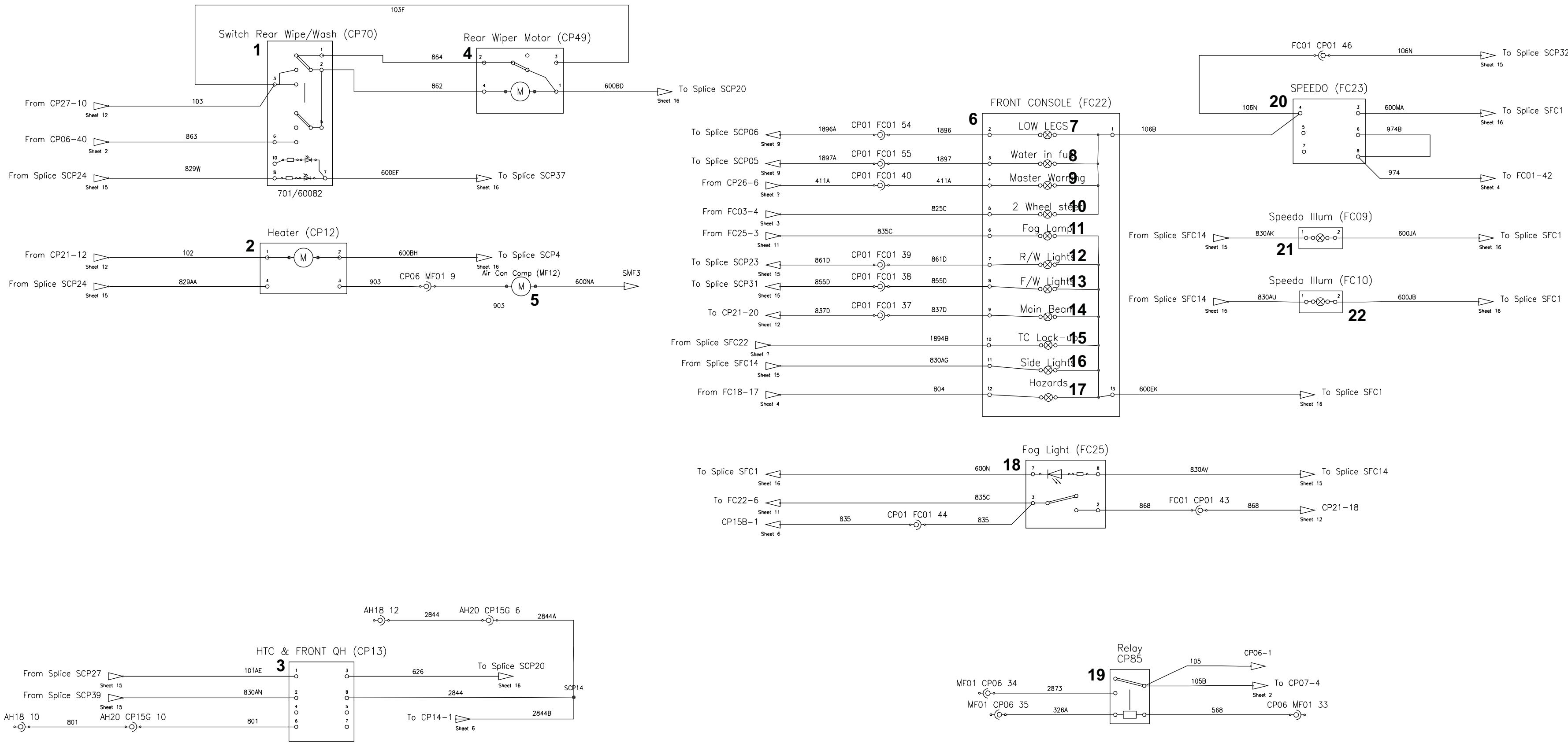
⇒ Fig 50. (L-67)

1 Fusebox A
2 Fusebox B
3 Fusebox C
4 Fusebox D



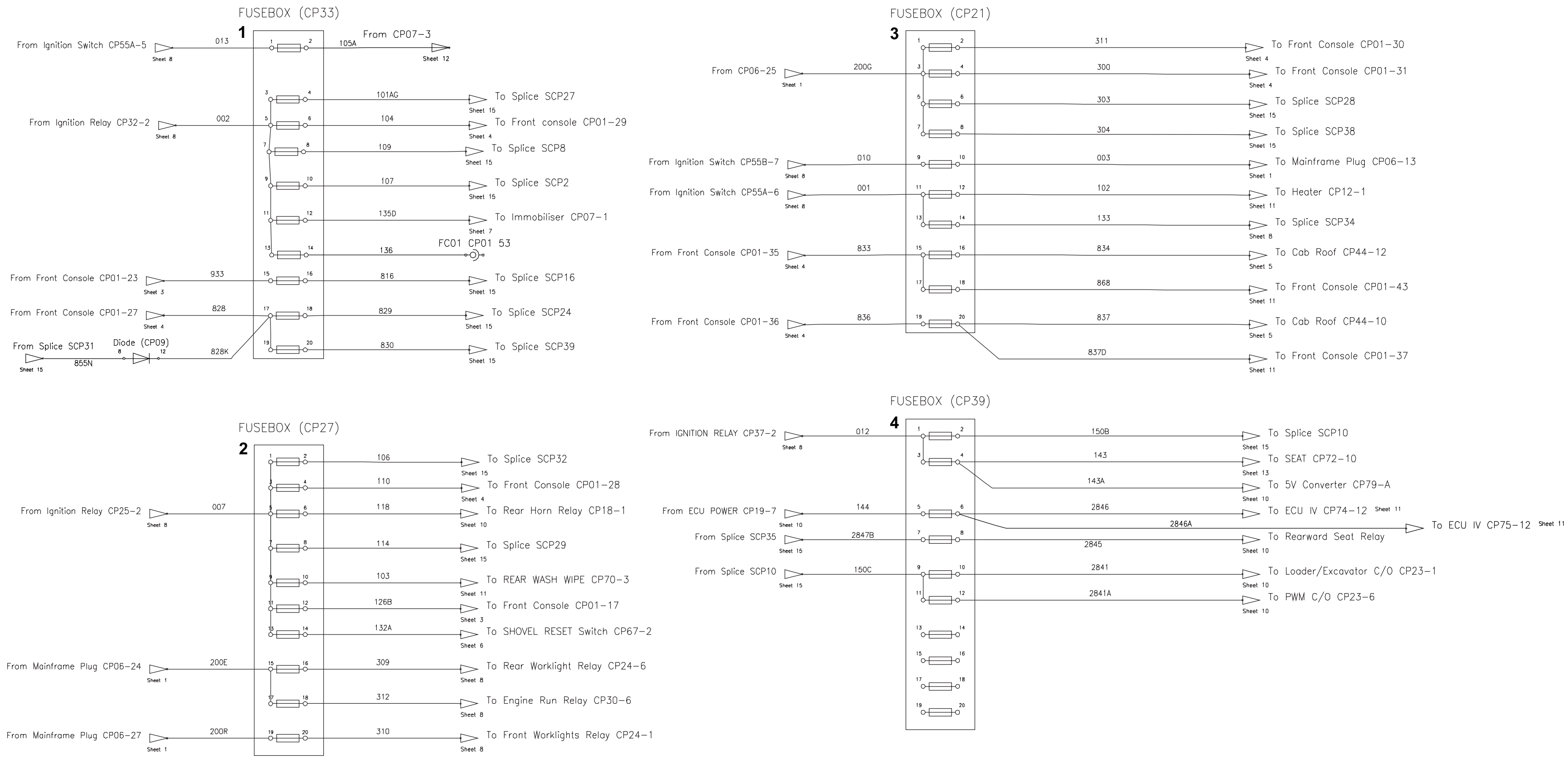
332-D2396sht10

Fig 48. Sheet 10 of 17



332-D2396sht11

Fig 49. Sheet 11 of 17



332-D2396sht12

Fig 50. Sheet 12 of 17

Component Key: Sheet 13 of 17

⇒ *Fig 51. (L-69)*

1	Heated Seat
2	ECU Cut-Out Relay
3	Extend Proportional Solenoid - Auxiliary Service Ram (PWM)
4	Resistor
5	Transmission Dump Pushbutton
6	Excavator/Loader Selector Switch
7	Seat Forward/Rear Switch
8	Retract Proportional Solenoid - Auxiliary Service Ram (PWM)
9	PWM Controller ECU - Loader/Excavator Auxiliary Service Ram
10	Loader/Excavator Auxiliary Changeover Relay
11	Thumbwheel Switch - Clam Shovel Ram (PWM)
12	RH Joystick
13	Joystick Enable/Transmission Dump Pushbutton
14	Thumbwheel Switch - Extending Dipper Ram (PWM)
15	5 volt Converter

Component Key: Sheet 14 of 17

⇒ *Fig 52. (L-70)*

1	Quickhitch
2	Diode Pack
3	Steer Mode Changeover Relay
4	Loader/Excavator Auxiliary Changeover Valve Solenoid
5	Loader/Excavator Auxiliary Changeover Valve Solenoid
6	Quickhitch Solenoid
7	Steer Proximity Switch - Rear Axle
8	4WS Solenoid
9	Crab Steer Solenoid
10	2WS Solenoid
11	4WS Solenoid
12	Steer Mode ECU
13	Steer Mode Selector Switch

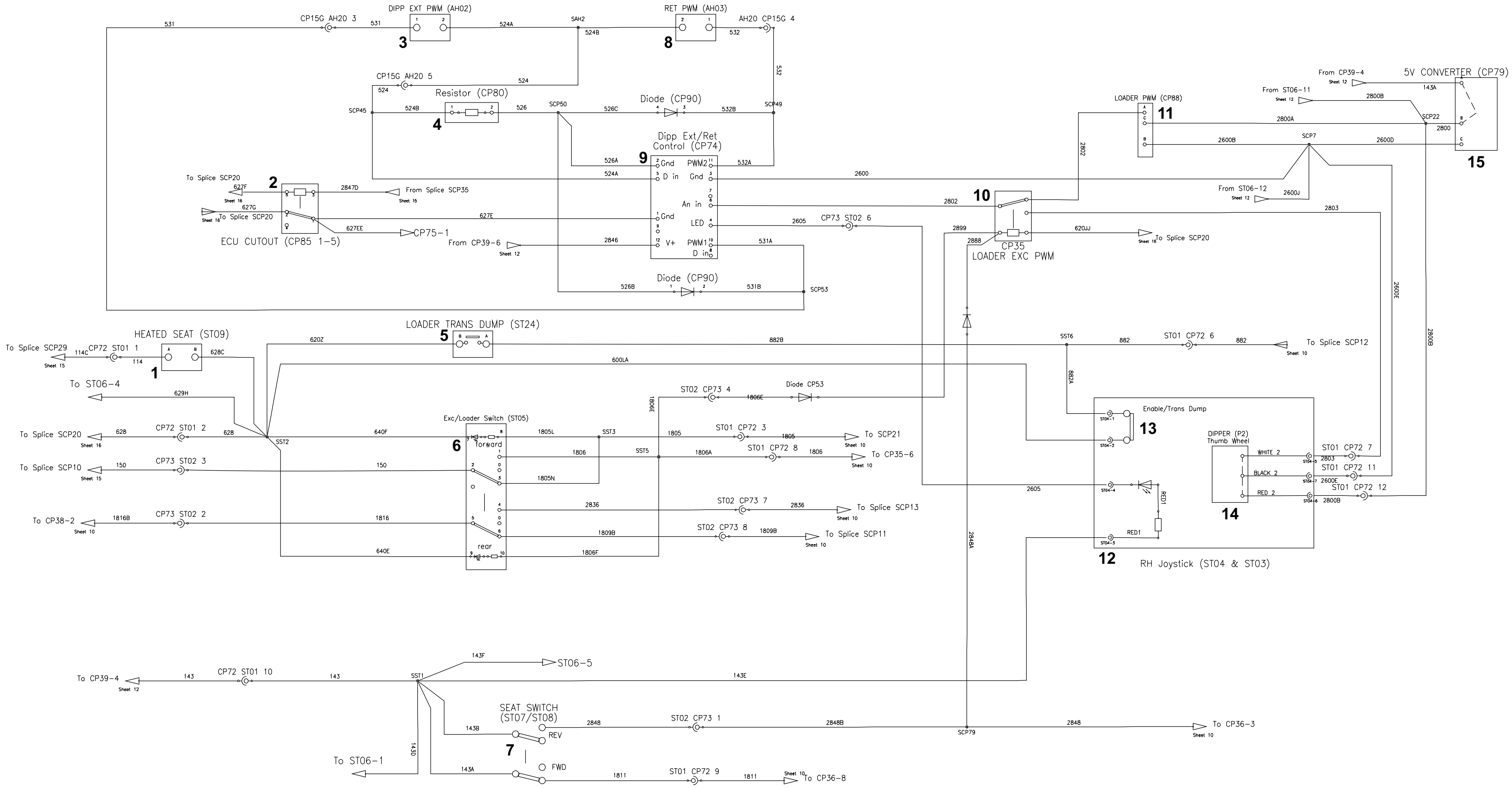
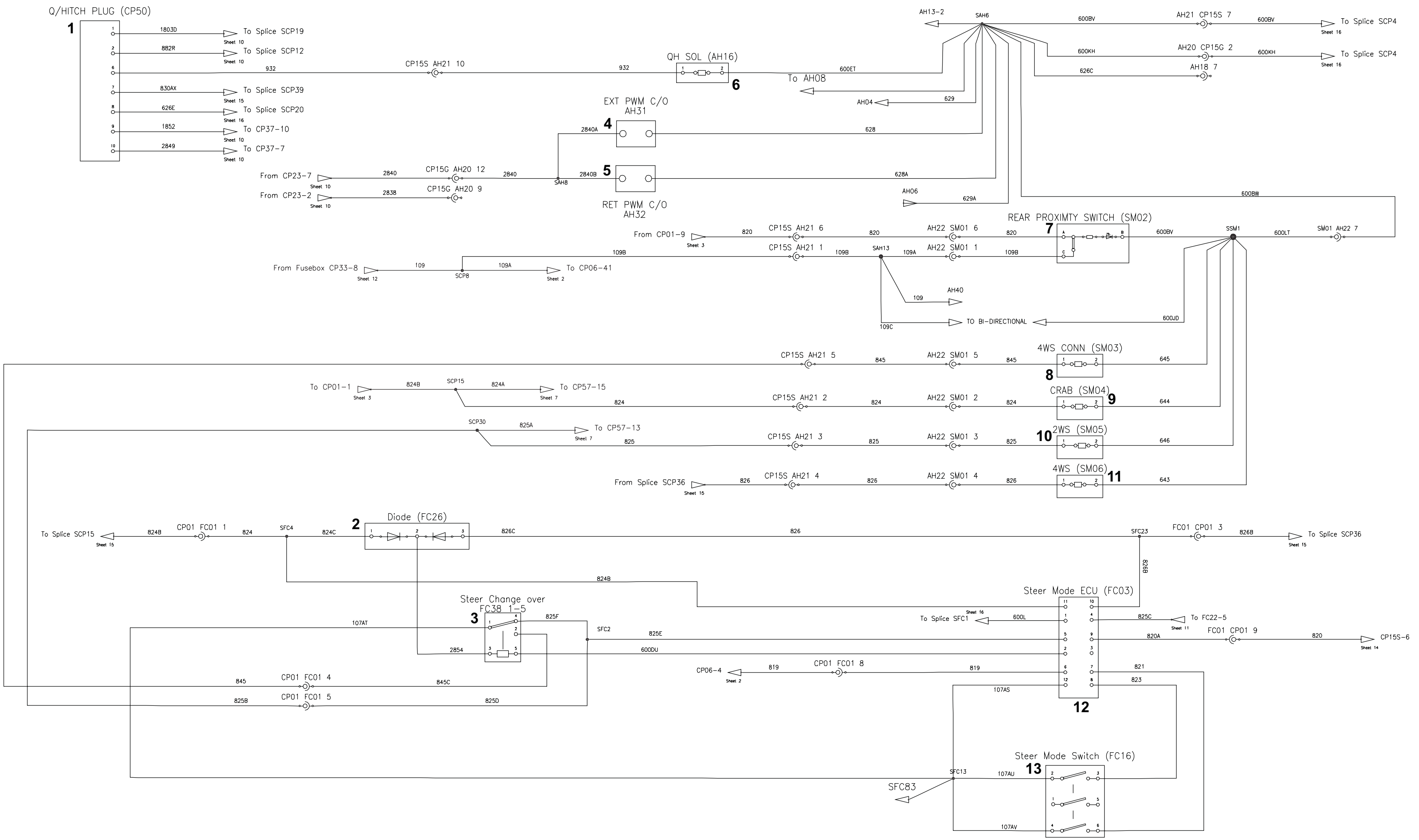
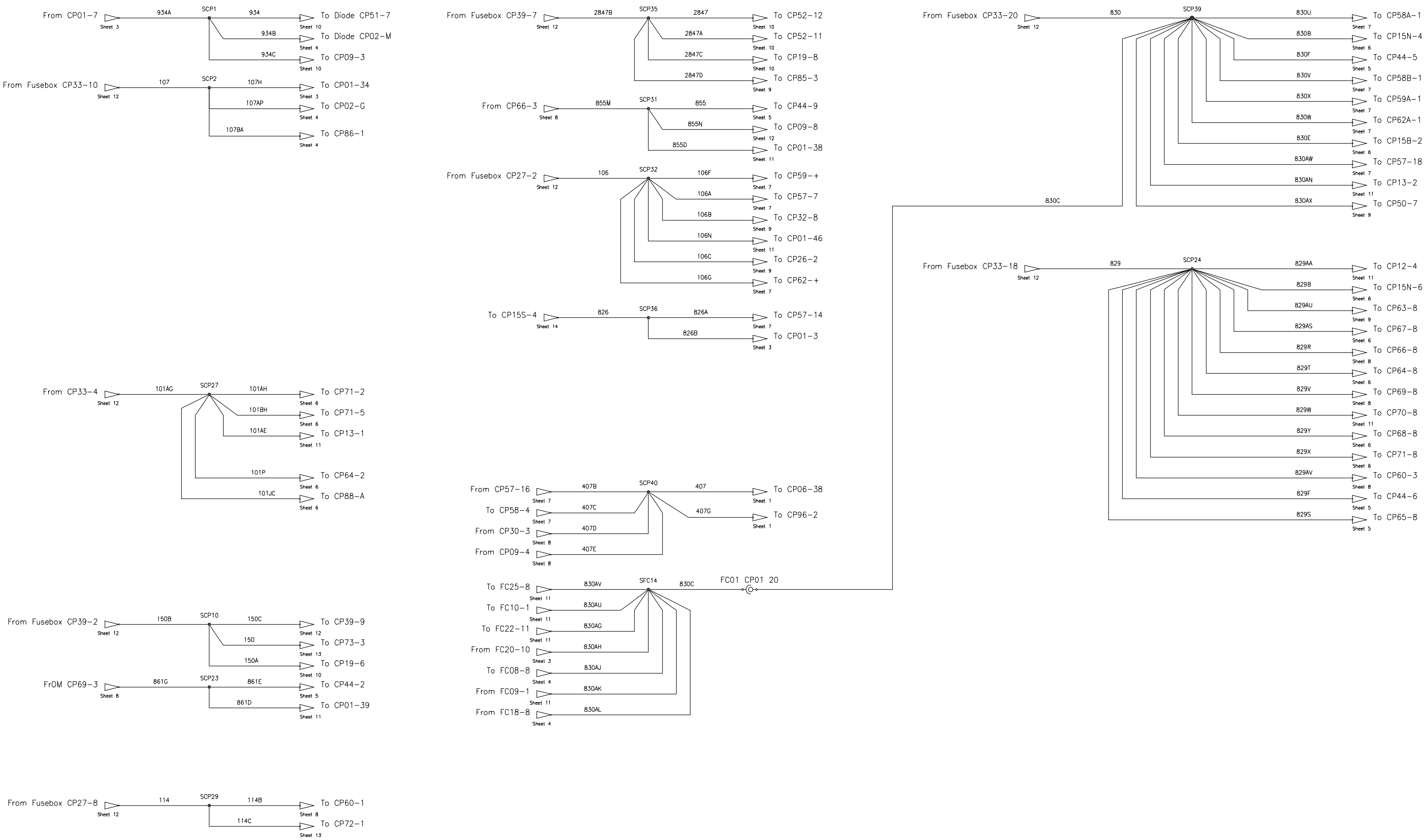


Fig 51. Sheet 13 of 17



332-D2396sht14

Fig 52. Sheet 14 of 17



332-D2396sht15

Fig 53. Sheet 15 of 17

Component Key: Sheet 16 of 17
⇨ Fig 54. (L-73)

1	Earth Point
2	Earth Point
3	Earth Point
4	Earth Point

Component Key: Sheet 17 of 17
⇨ Fig 55. (L-74)

1	LH Joystick
2	Rear Horn/Quickhitch Pushbutton
3	Jaw Pushbutton
4	Thumbwheel Switch - Bucket Thumb Ram (PWM)
5	Extend Proportional Solenoid - Bucket Thumb Ram (PWM)
6	Resistor
7	Retract Proportional Solenoid - Bucket Thumb Ram (PWM)
8	PWM Controller ECU - Bucket Thumb Ram

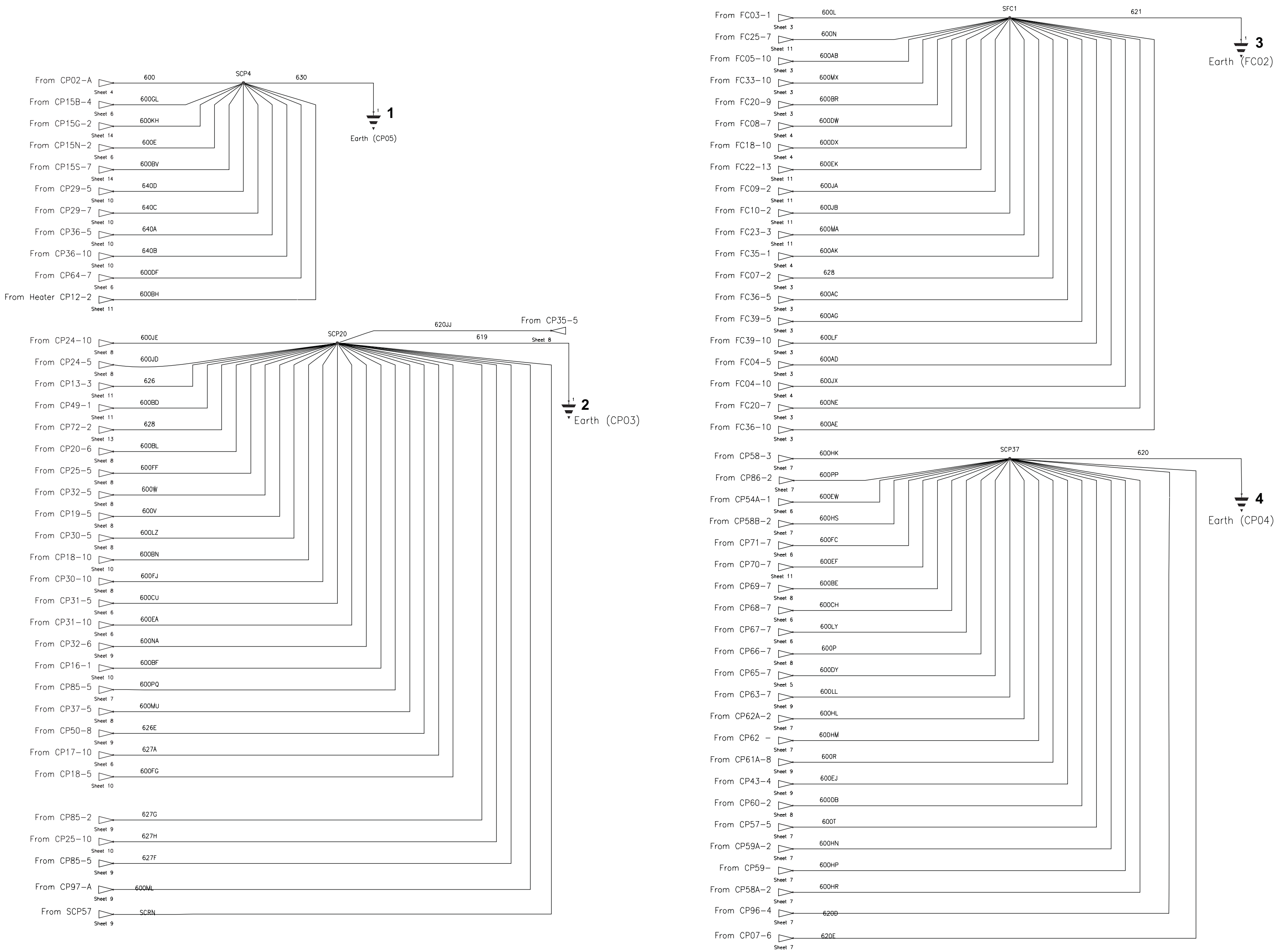
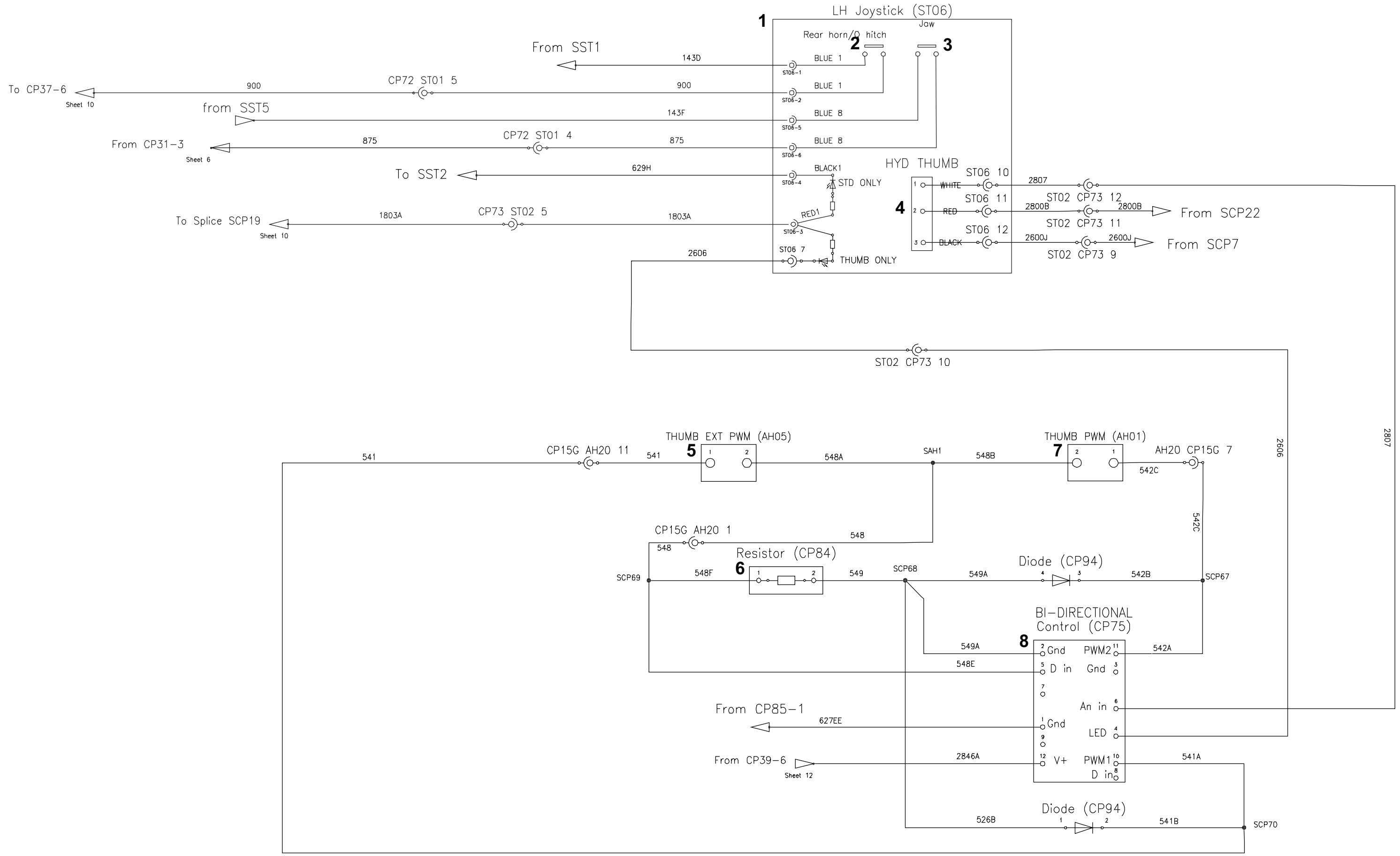


Fig 54. Sheet 16 of 17



332-D2396sht17

Fig 55. Sheet 17 of 17

EasyControl Machines - From May 2009 (Digital Instruments)

Component Key: Sheet 1 of 18

⇨ *Fig 56.* (L-76)

1	Battery Isolator
2	Battery
3	Alternator
4	Starter Motor
5	Grid Heater Relay - Cold Start
6	Grid Heater - Cold Start

Component Key: Sheet 2 of 18

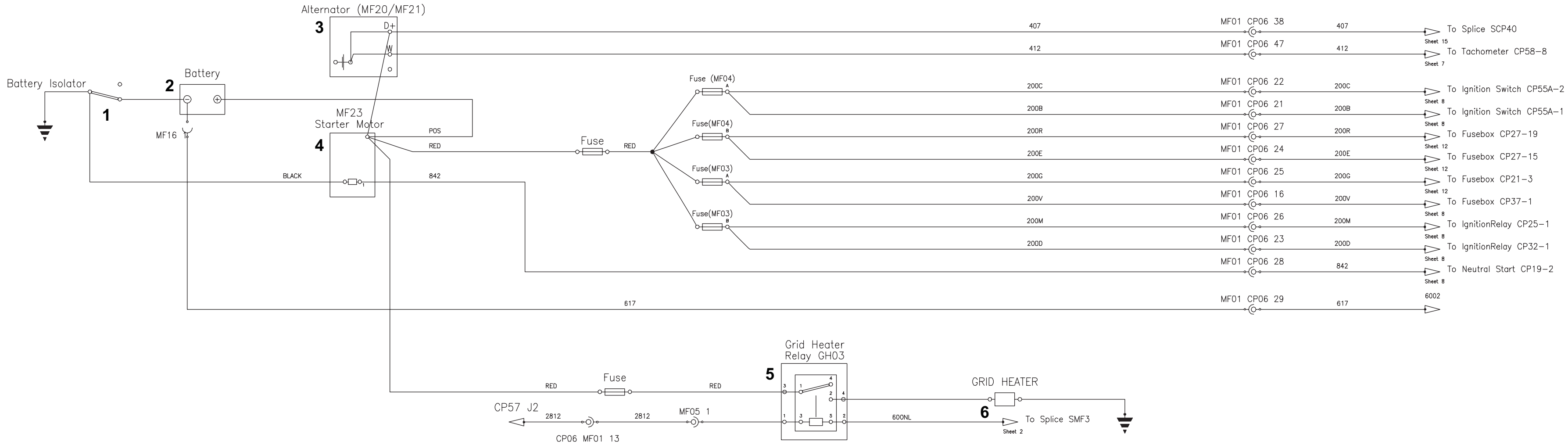
⇨ *Fig 57.* (L-77)

1	Steer Proximity Switch - Front Axle
2	Cold Start Advance Switch
3	Cold Start Solenoid
4	Water in Fuel Sensor
5	Coolant Temperature Switch
6	Engine Shut-off Solenoid (ESOS)
7	Fuel Level Sender
8	Rear Washer Motor
9	Front Washer Motor
10	Horn
11	Air Filter ‘Blocked’ Switch
12	Engine Oil Pressure Switch
13	Shovel Reset Proximity Switch
14	SRS Solenoid
15	SRS Solenoid
16	Shovel Reset Selector Switch
17	Shovel Reset Solenoid
18	Smooth Ride System (SRS) Selector Switch

Component Key: Sheet 3 of 18

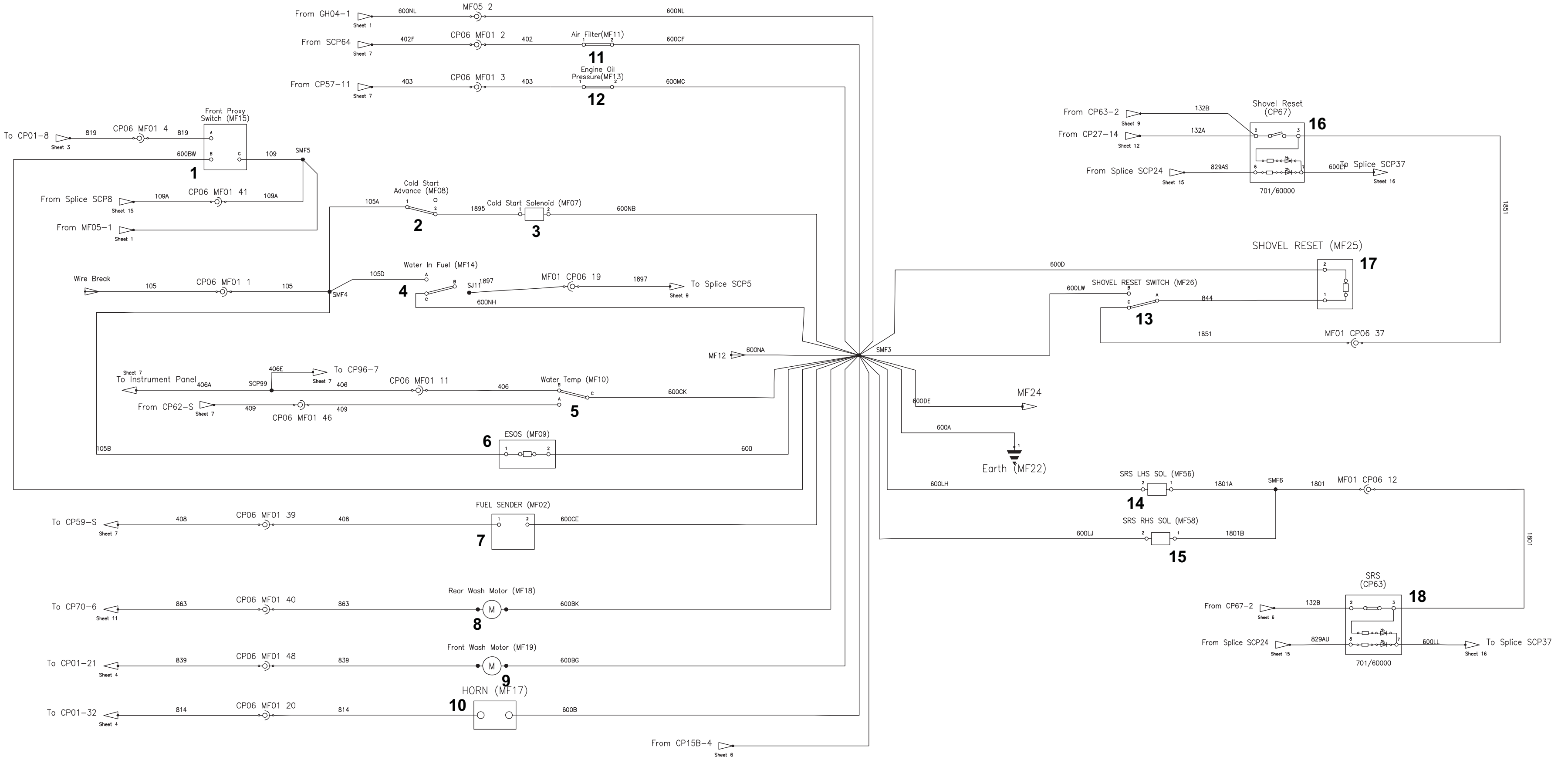
⇨ *Fig 58.* (L-78)

1	Footbrake Switch
2	Brake Mode Selector Switch
3	Auto 2WB Relay
4	Auto 4WB Relay
5	Reverse Relay
6	Forward Relay
7	Interlock Relay
8	Transmission Dump Relay
9	2/4WD Selector Switch
10	Transmission Dump Pushbutton
11	Forward Hi/Lo Relay
12	Drive Relay
13	Diode Pack
14	Hydraulic Speed Control (HSC) Relay



C090440PCH-sht1

Fig 56. Sheet 1 of 18



C090440PCH-sht2

Fig 57. Sheet 2 of 18

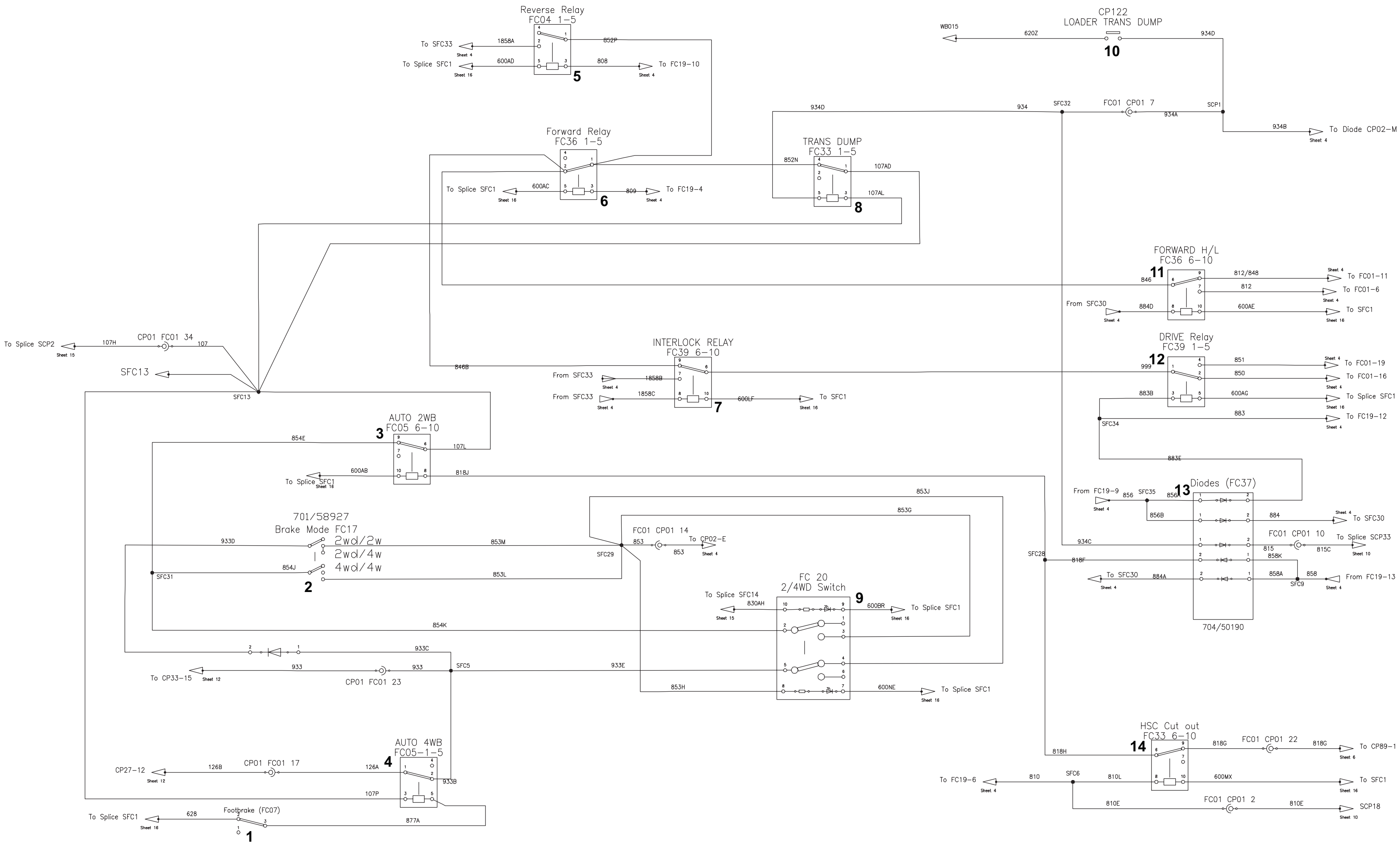


Fig 58. Sheet 3 of 18

Component Key: Sheet 4 of 18

⇨ *Fig 59. (L-80)*

1	Column Switch - RH
2	Column Switch - LH
3	Hazard Lights Switch
4	Front Wiper Motor
5	Reverse Alarm Relay
6	Front Warning Lights
7	Flasher
8	Headlights Switch
9	Transmission Oil Temperature Switch
10	Transmission Oil Pressure Switch
11	Transmission Dump Switch
12	Layshaft Solenoid
13	6-Speed Solenoid
14	Mainshaft Solenoid
15	Reverse Low Solenoid
16	Reverse High Solenoid
17	Forward Low Solenoid
18	Forward Solenoid

Component Key: Sheet 5 of 18

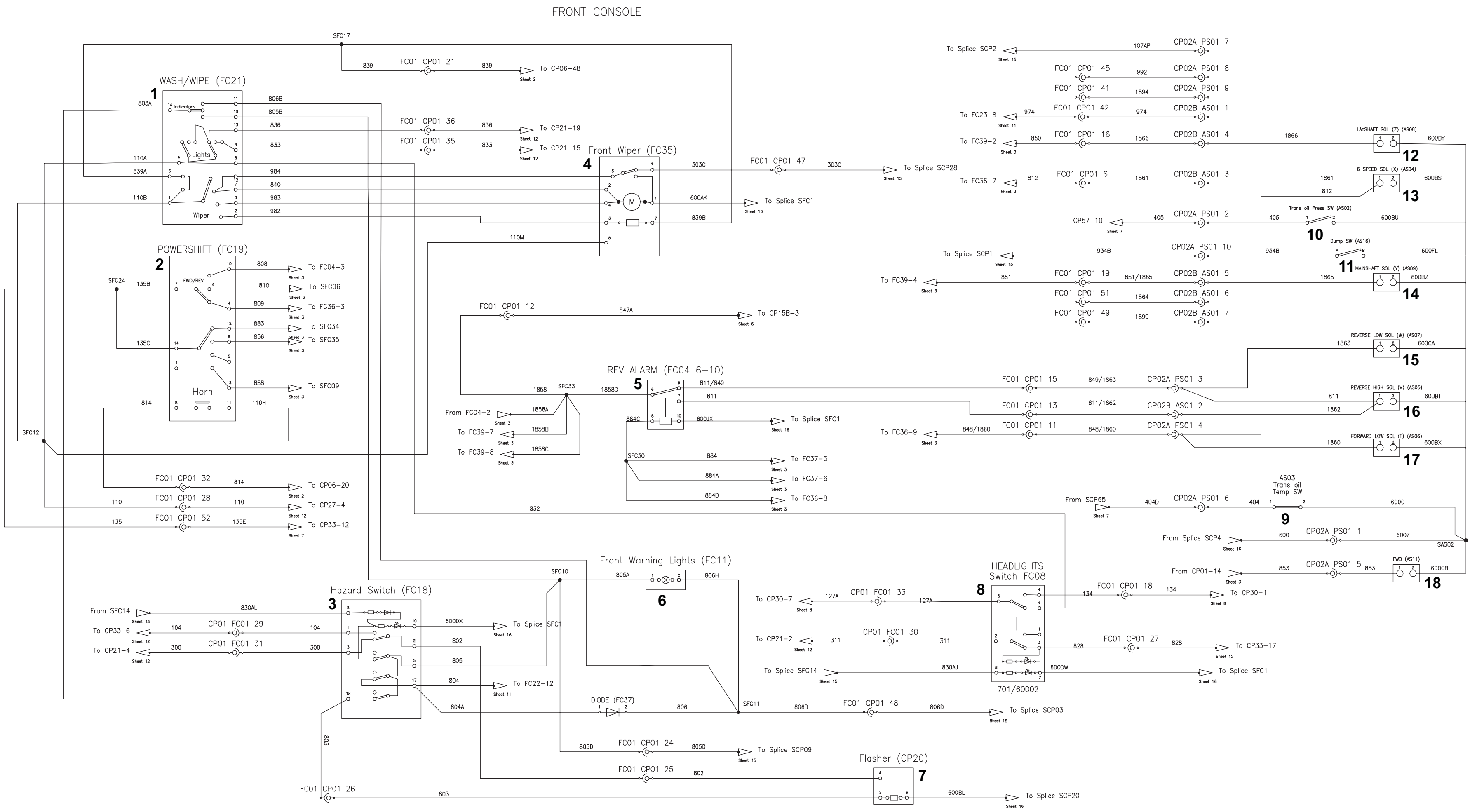
⇨ *Fig 60. (L-81)*

1	Diagnostics Connector
2	Serial Connector
3	Stabiliser Leg Proximity Switch - RH
4	Stabiliser Leg Proximity Switch - LH
5	CANbus Terminator Resistor
6	CANbus Terminator Resistor
7	Low Stabiliser Leg Alarm Relay
8	Low Stabiliser Leg Alarm Relay
9	Live Link Connector

Component Key: Sheet 6 of 18

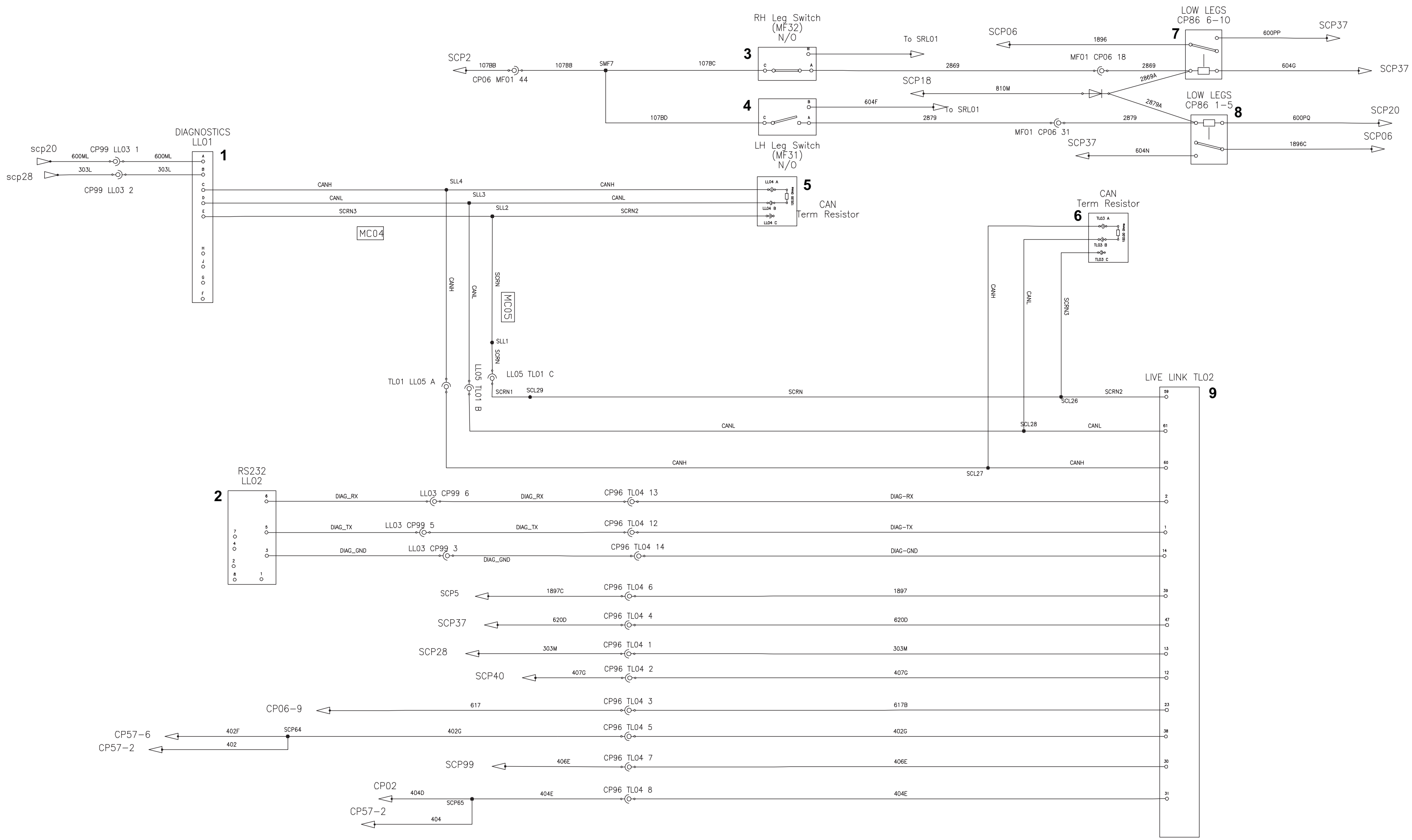
⇨ *Fig 61. (L-82)*

1	Front Worklights - LH
2	Front Worklights - RH
3	Rear Worklight - RH Outer
4	Rear Worklight - RH Inner
5	Rear Worklight - LH Inner
6	Rear Worklight - LH Outer
7	Cab Interior Light
8	Beacon Switch
9	Beacon
10	Auxiliary Beacon
11	Auxiliary Beacon
12	Front Headlight - LH
13	Rear Lights - LH (USA)
14	Front Headlight - RH
15	Rear Lights - RH (USA)
16	Front Direction Indicators - LH (USA)
17	Front Direction Indicators - RH (USA)



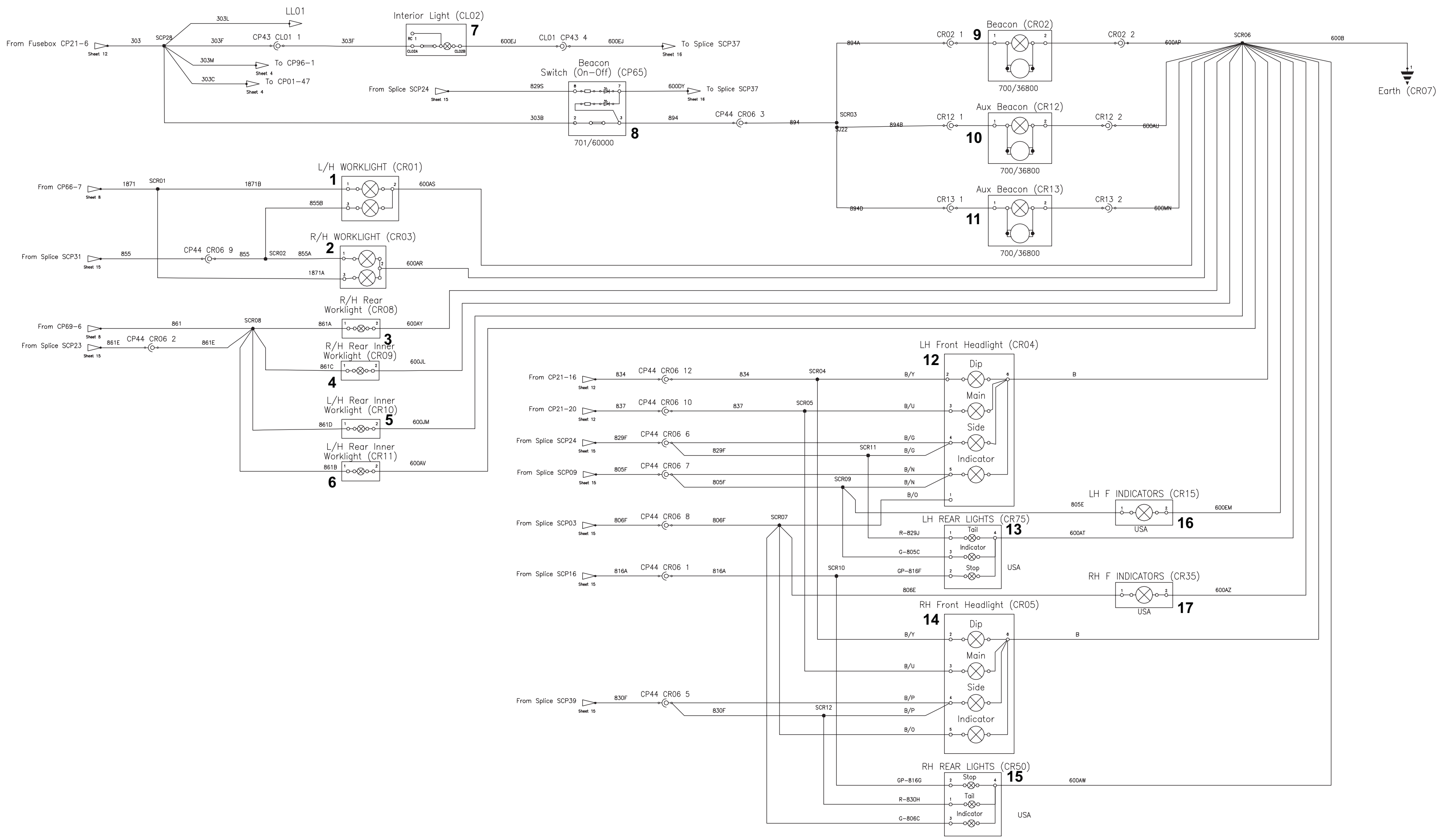
C090440PCH-sht4

Fig 59. Sheet 4 of 18



C090440PCH-sht5

Fig 60. Sheet 5 of 18



C090440PCH-sht6

Fig 61. Sheet 6 of 18

Component Key: Sheet 7 of 18

⇨ Fig 62. (L-84)

1 Hydraulic Speed Control (HSC) Solenoid
2 Hammer Selector Switch
3 Hydraclamps Selector Switch
4 Hammer Switch (Foot Switch)
5 Diode Pack
6 Hammer/Jaw Changeover Relay
7 Jaw Relay
8 Hammer Relay
9 Hydraclamps Solenoid
10 Hammer Solenoid
11 HSC Pushbutton
12 Hydraulic Speed Control (HSC) Selector Switch
13 Jaw Changeover Solenoid
14 Jaw Changeover Solenoid
15 Jaw Changeover Solenoid
16 Jaw Changeover Solenoid

Component Key: Sheet 8 of 18

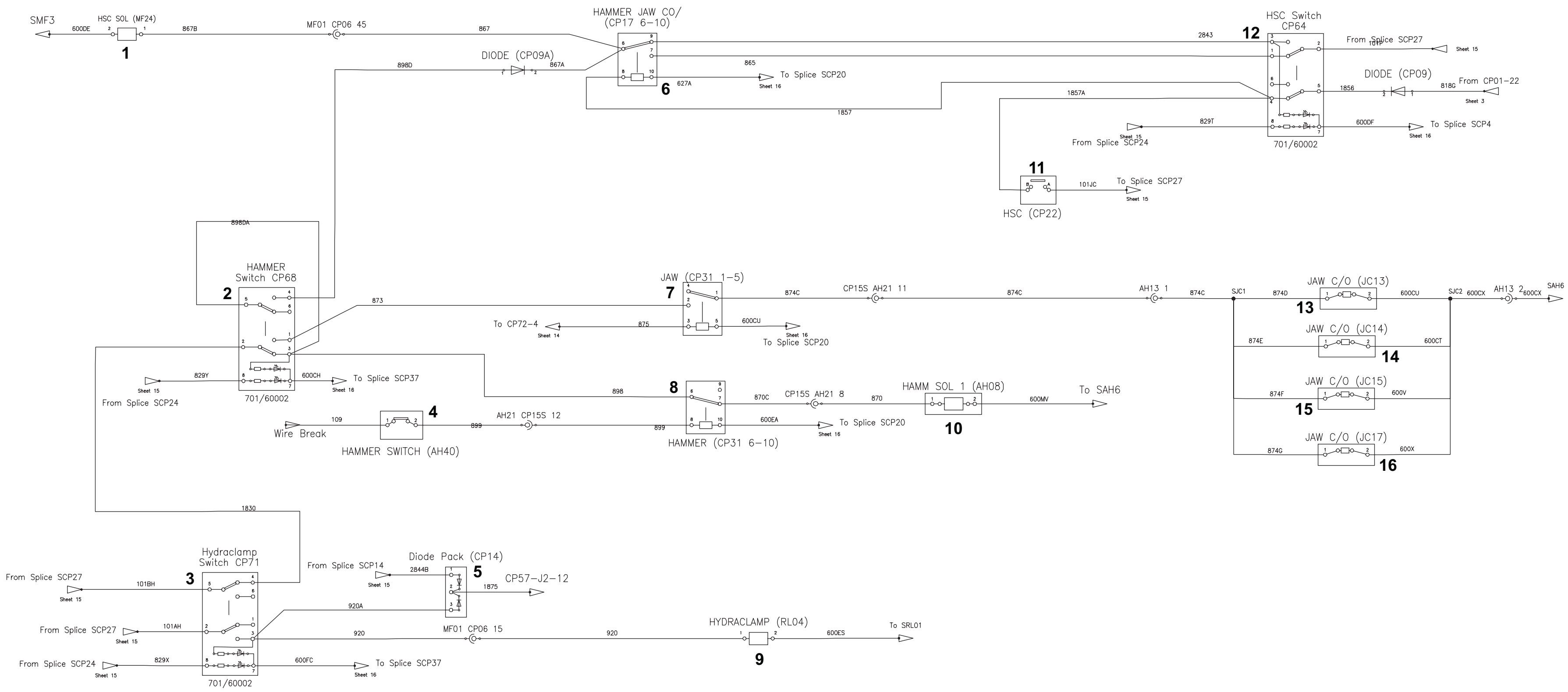
⇨ Fig 63. (L-85)

1 Warning Lights Relay
2 Horn
3 Horn Pushbutton
4 Reverse Alarm
5 Rear Fog Light
6 Rear Socket
7 Number Plate Light
8 Boom Overload Warning Selector Switch
9 Pressure Switch (Excavator Boom Ram)
10 Boom Overload Alarm Relay

Component Key: Sheet 9 of 18

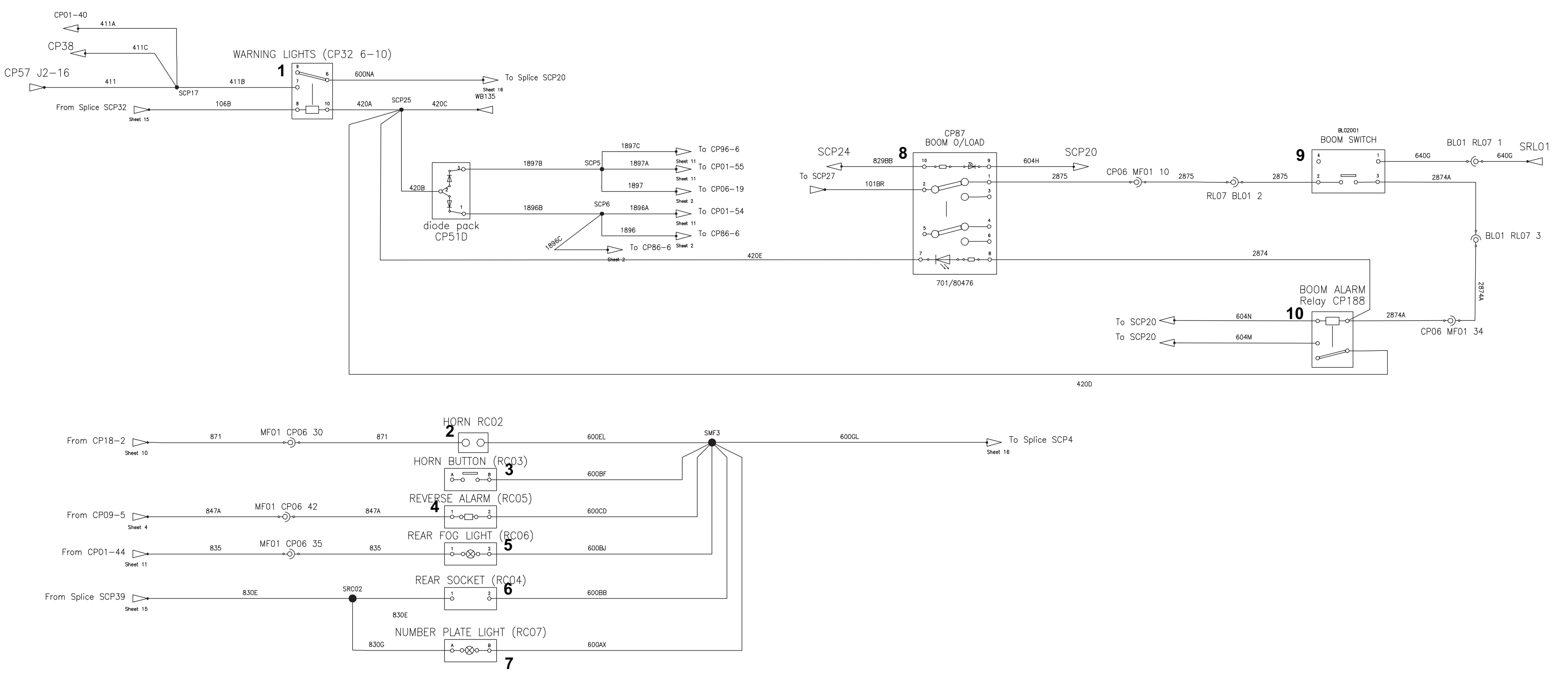
⇨ Fig 64. (L-86)

1 Ignition Switch
2 Engine Run Relay
3 Ignition 3 Relay
4 Ignition 1 Relay
5 Ignition 2 Relay
6 Lights Relay
7 Front Worklights Relay
8 Rear Worklights Relay
9 Front Worklights Selector Switch
10 Rear Worklights Selector Switch
11 Neutral Start Relay
12 Park Brake Relay
13 Rear Lights - RH (Not USA)
14 Rear Lights - LH (Not USA)
15 Park Brake Switch



C090440PCH-sht7

Fig 62. Sheet 7 of 18



C090440PCH-sht8

Fig 63. Sheet 8 of 18

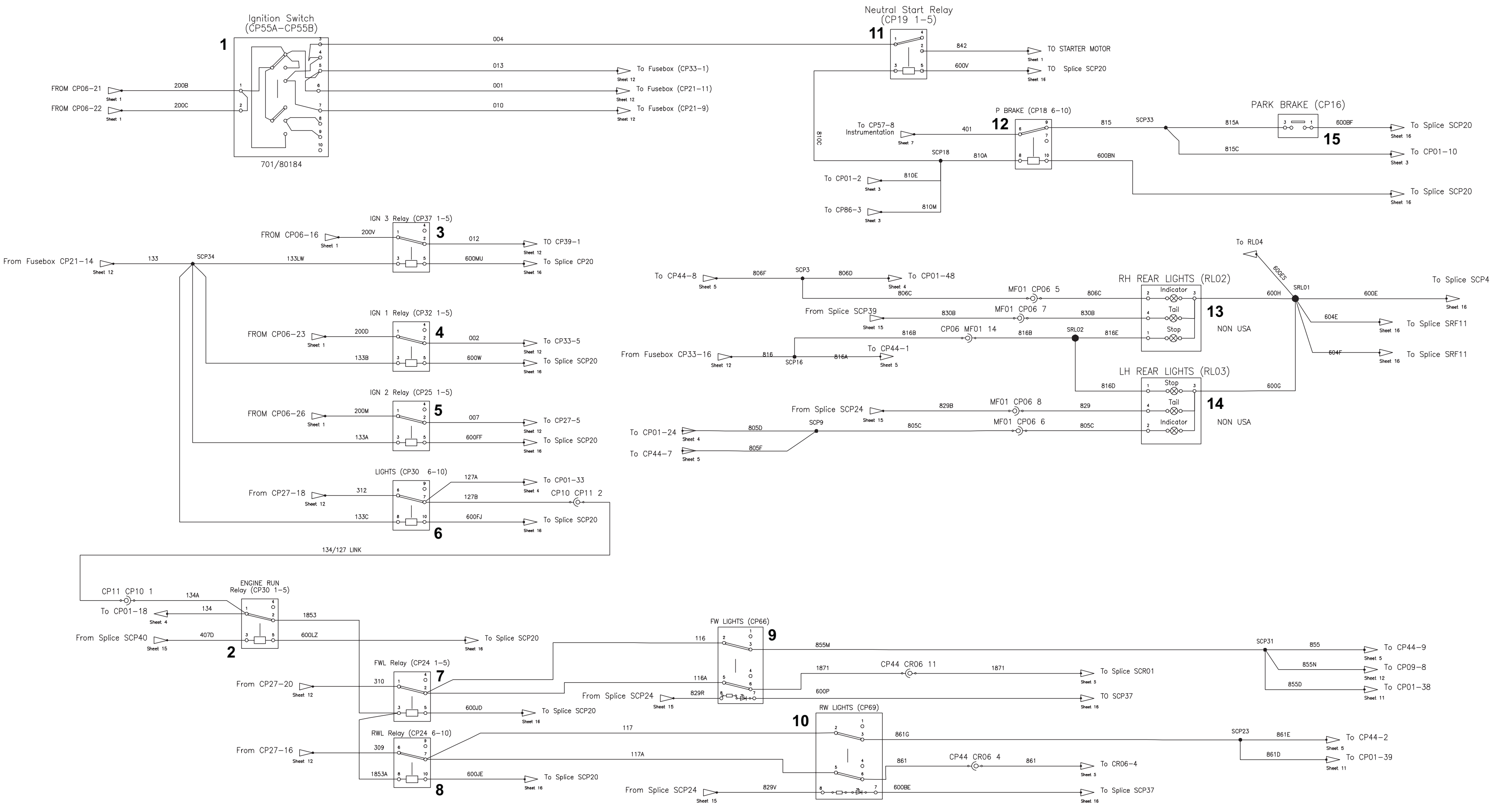


Fig 64. Sheet 9 of 18

Component Key: Sheet 10 of 18

⇒ Fig 65. (L-88)

1 LH Joystick

2 Rear Horn/Quickhitch Pushbutton

3 Jaw Pushbutton

4 Thumbwheel Switch - Bucket Thumb Ram (PWM)

5 Extend Proportional Solenoid - Bucket Thumb Ram (PWM)

6 Resistor

7 Retract Proportional Solenoid - Bucket Thumb Ram (PWM)

8 PWM Controller ECU - Bucket Thumb Ram

9 Fuel Pump Relay - if fitted

Component Key: Sheet 11 of 18

⇒ Fig 66. (L-89)

1 Speaker - RH

2 Speaker - LH

3 Radio

4 Instrument Panel (Side Console)

\- Low Transmission Oil Pressure Indicator Lamp

\- Clock

\- Cold Start Grid Heater Indicator Lamp

\- Air Filter ‘Blocked’ Indicator Lamp

\- Low Engine Oil Pressure Indicator Lamp

\- High Transmission Oil Temperature Indicator Lamp

\- High Engine Coolant Temperature Indicator Lamp

5 Alternator ‘No Charge’ Indicator Lamp

6 Park Brake Indicator Lamp

\- Low Fuel Level Indicator Lamp

\- Crab Steer Indicator Lamp

\- 4WS Indicator Lamp

7 2WS Indicator Lamp

8 Panel Illumination

9 Warning Buzzer 1

10 Warning Buzzer 2

Component Key: Sheet 12 of 18

⇒ Fig 67. (L-90)

1 Loader/Excavator Changeover Relay

2 ECU Power Relay

3 Loader/Excavator Auxiliary Changeover Relay

4 Servo Pilot Relay - LH Joystick

5 Diode Pack

6 Diode Pack

7 Servo Pilot Solenoid - LH Joystick

8 Servo Pilot Solenoid - RH Joystick

9 Warning Buzzer Relay

10 Loader Relay

11 Seat Forward Relay

12 Seat Rear Relay

13 Diode Pack

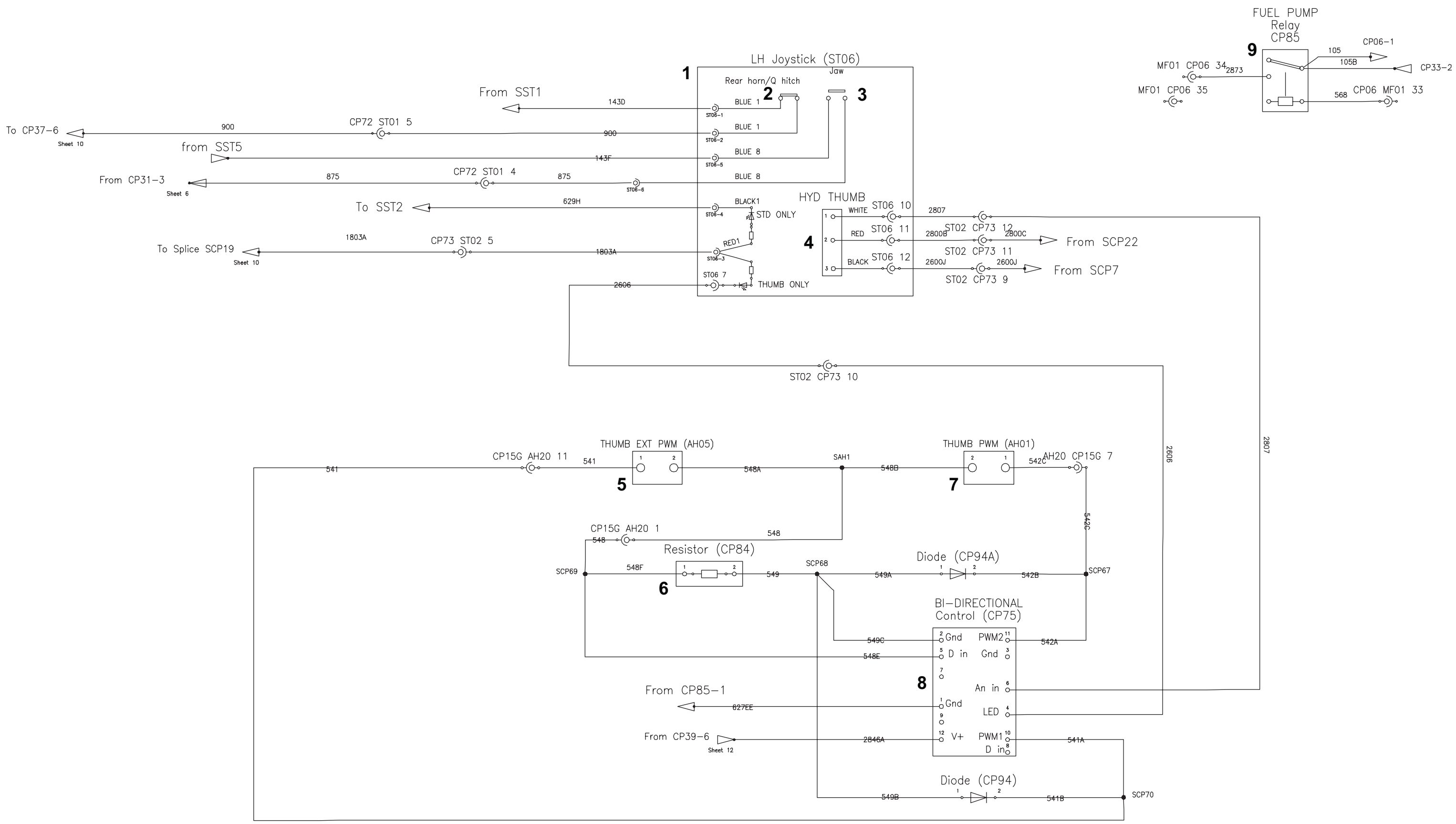
14 Diode Pack

15 Joysticks Enable Relay

16 Joysticks Enable Relay (Latching)

17 Horn Relay

18 Rear Horn/Quickhitch Changeover Relay



C090440PCH-sht10

Fig 65. Sheet 10 of 18

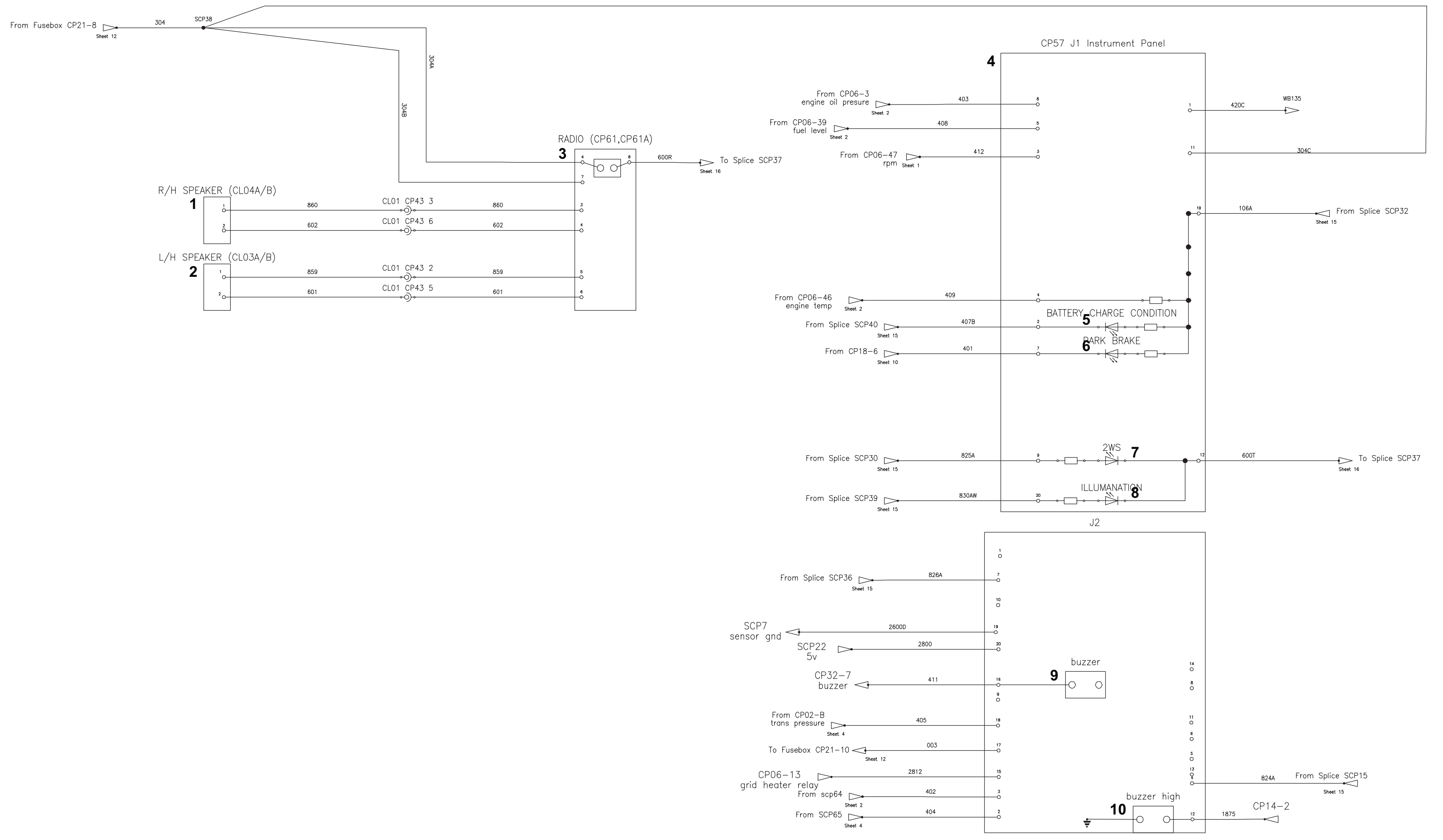
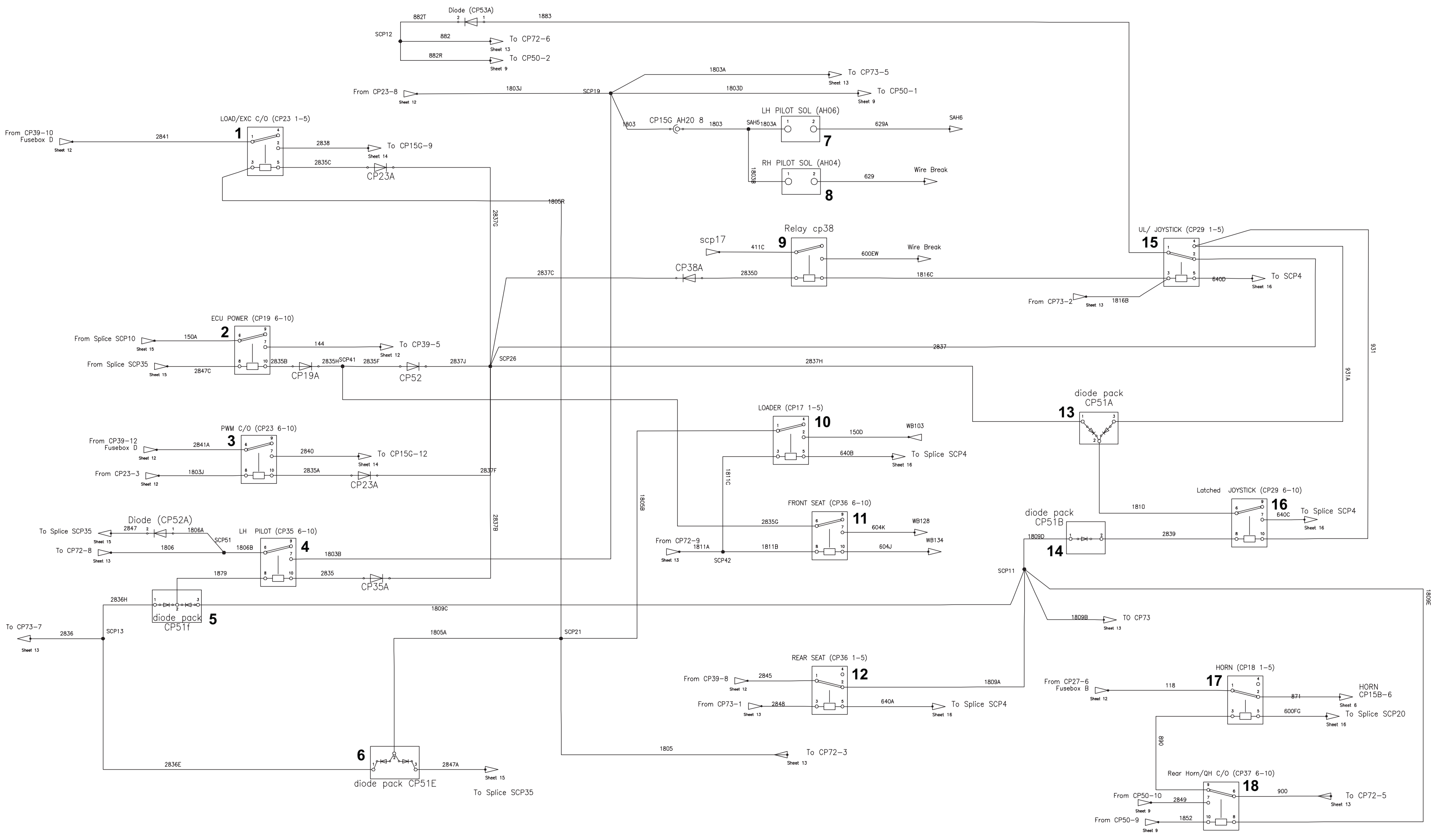


Fig 66. Sheet 11 of 18



C090440PCH-sht12

Fig 67. Sheet 12 of 18

Component Key: Sheet 13 of 18
⇒ Fig 68. (L-92)

1	Instrument Panel (Front Console)
2	Low Stabiliser Legs Indicator Lamp
3	Water in Fuel Indicator Lamp
4	Master Warning Indicator Lamp
5	2WS Indicator Lamp
6	Fog Light Indicator Lamp
7	Rear Worklights Indicator Lamp
8	Front Worklights Indicator Lamp
9	Main Beam Indicator Lamp
10	Torque Converter Lock-up Indicator Lamp
11	Engine Check Indicator Lamp
12	Engine Malfunction Indicator Lamp
13	Fog Light Selector Switch
14	Rear Wash/Wipe Selector Switch
15	Rear Wiper Motor
16	Heater Blower Motor
17	Air Conditioning Compressor Clutch Solenoid
18	Speedo
19	Speedo Illumination
20	Speedo Illumination

Component Key: Sheet 14 of 18
⇒ Fig 69. (L-93)

1	Fusebox
2	Fusebox
3	Cigar Lighter
4	Fusebox
5	Fusebox

Component Key: Sheet 15 of 18
⇒ Fig 70. (L-94)

1	Heated Seat
2	ECU Cut-Out Relay
3	Extend Proportional Solenoid - Auxiliary Service Ram (PWM)
4	Resistor
5	Excavator/Loader Selector Switch
6	Seat Forward/Rear Switch
7	Retract Proportional Solenoid - Auxiliary Service Ram (PWM)
8	PWM Controller ECU - Loader/Excavator Auxiliary Service Ram
9	Diode Pack
10	Loader/Excavator Auxiliary Changeover Relay
11	Thumbwheel Switch - Clam Shovel Ram (PWM)
12	RH Joystick
13	Joystick Enable/Transmission Dump Pushbutton
14	Thumbwheel Switch - Extending Dipper Ram (PWM)

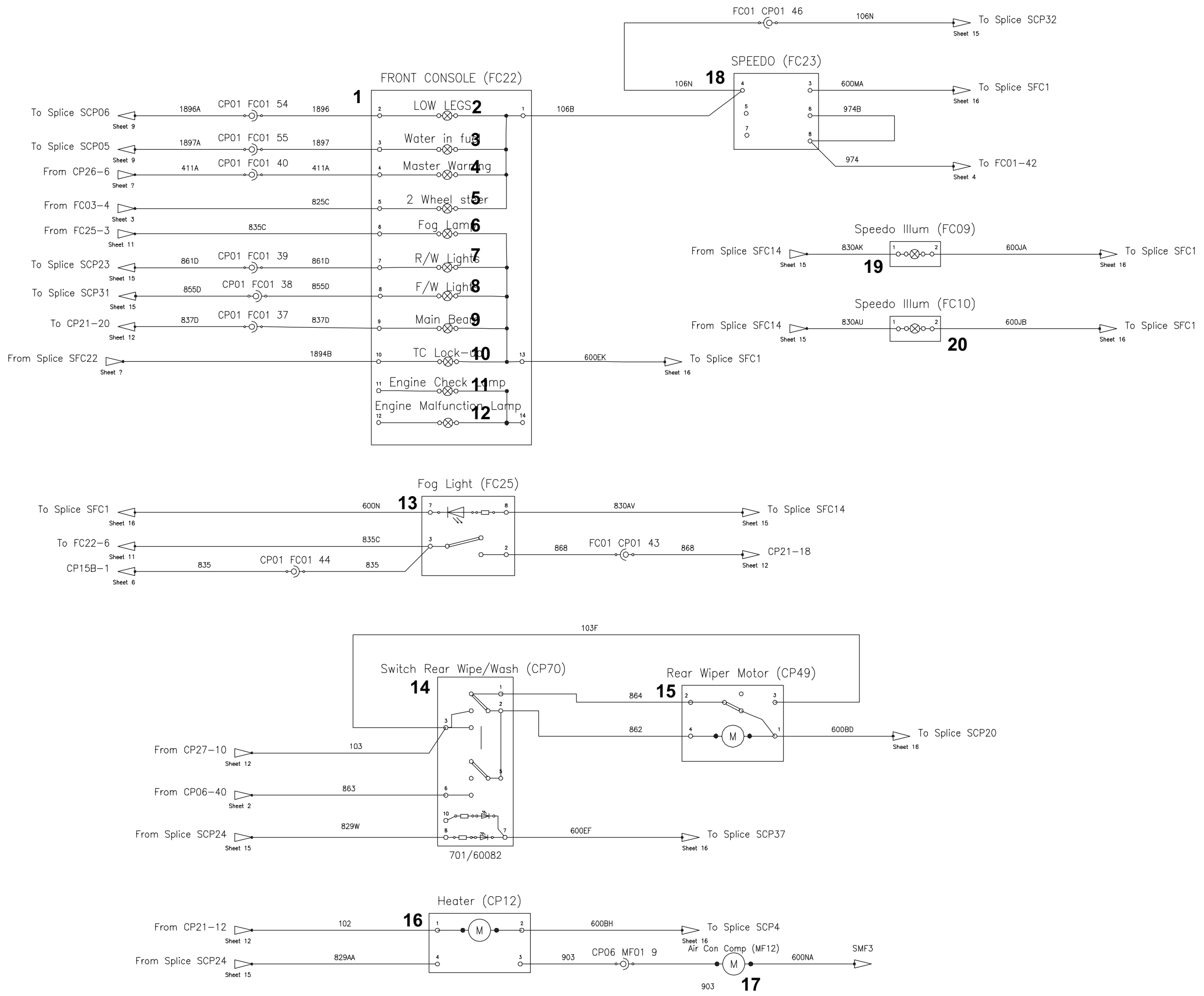


Fig 68. Sheet 13 of 18

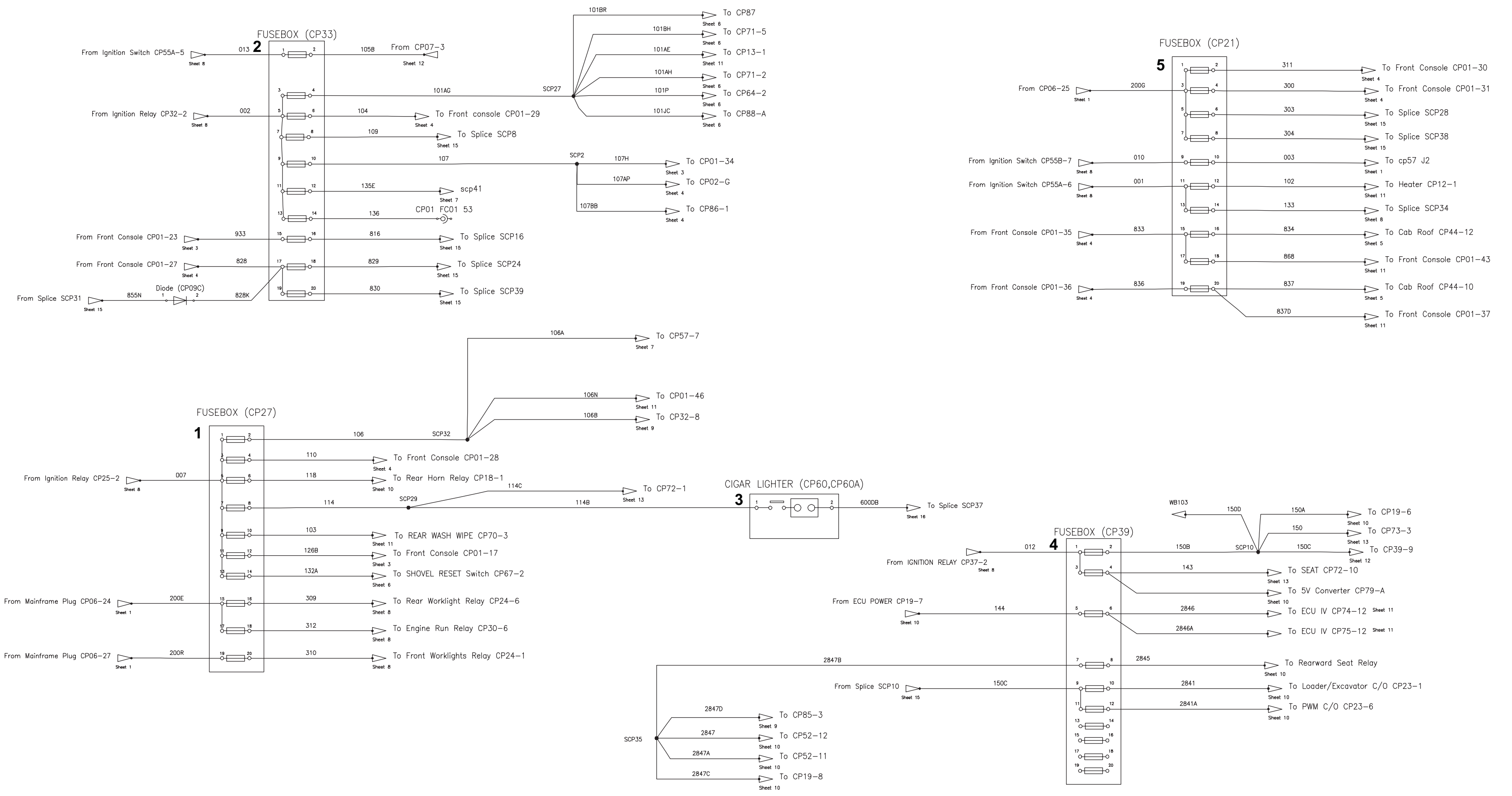
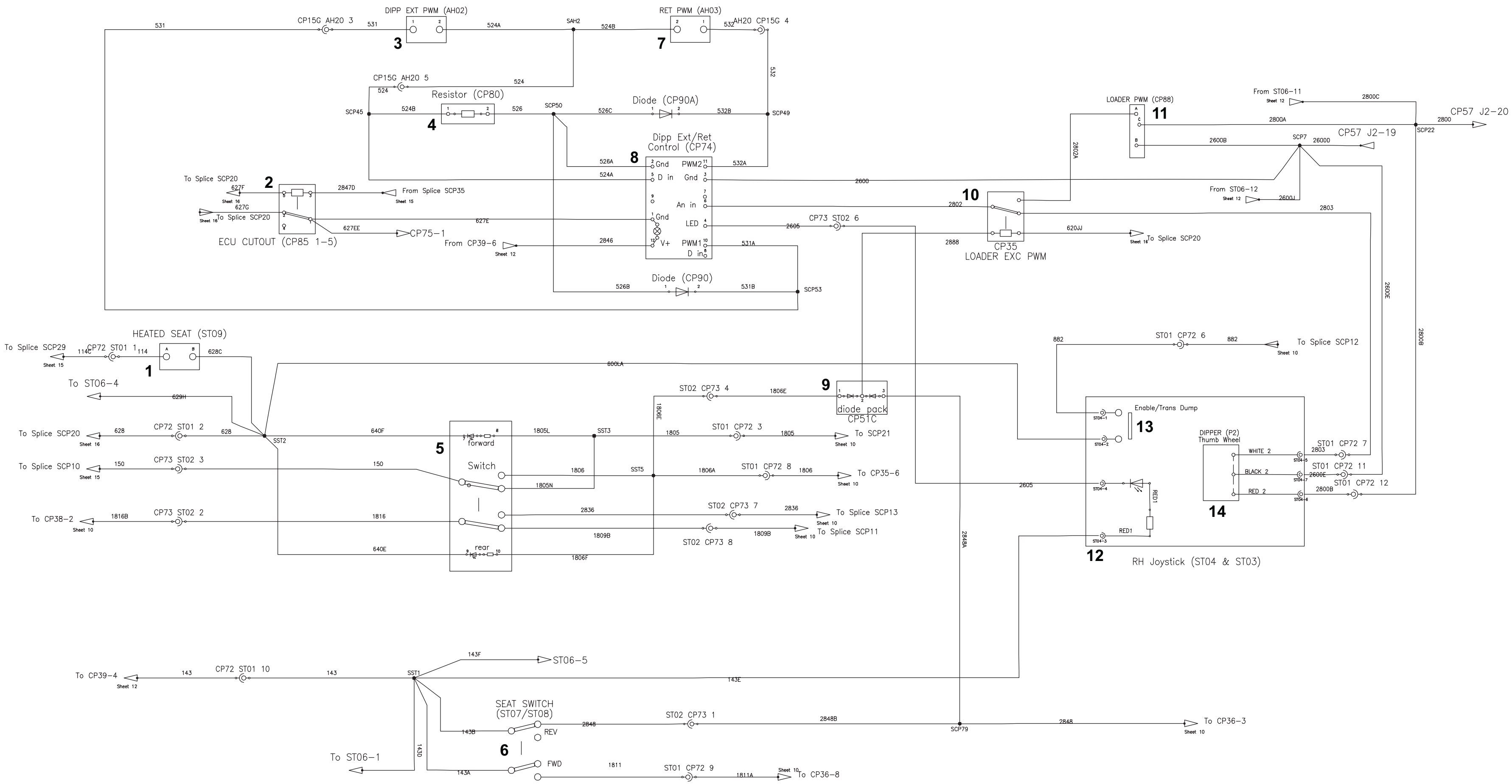


Fig 69. Sheet 14 of 18



C090440PCH-sht15

Fig 70. Sheet 15 of 18

Component Key: Sheet 16 of 18
⇨ Fig 71. (L-96)

1	Quickhitch Connector
2	Diode Pack
3	Steer Mode Changeover Relay
4	Loader/Excavator Auxiliary Changeover Valve Solenoid
5	Loader/Excavator Auxiliary Changeover Valve Solenoid
6	Quickhitch Solenoid
7	Steer Proximity Switch - Rear Axle
8	4WS Solenoid
9	Crab Steer Solenoid
10	2WS Solenoid
11	4WS Solenoid
12	Steer Mode ECU
13	Steer Mode Selector Switch

Component Key: Sheet 17 of 18
⇨ Fig 72. (L-97)

1	HTC & Front Quickhitch Connector
2	Earth Point

Component Key: Sheet 18 of 18
⇨ Fig 73. (L-98)

1	Earth Point
2	Earth Point
3	Earth Point

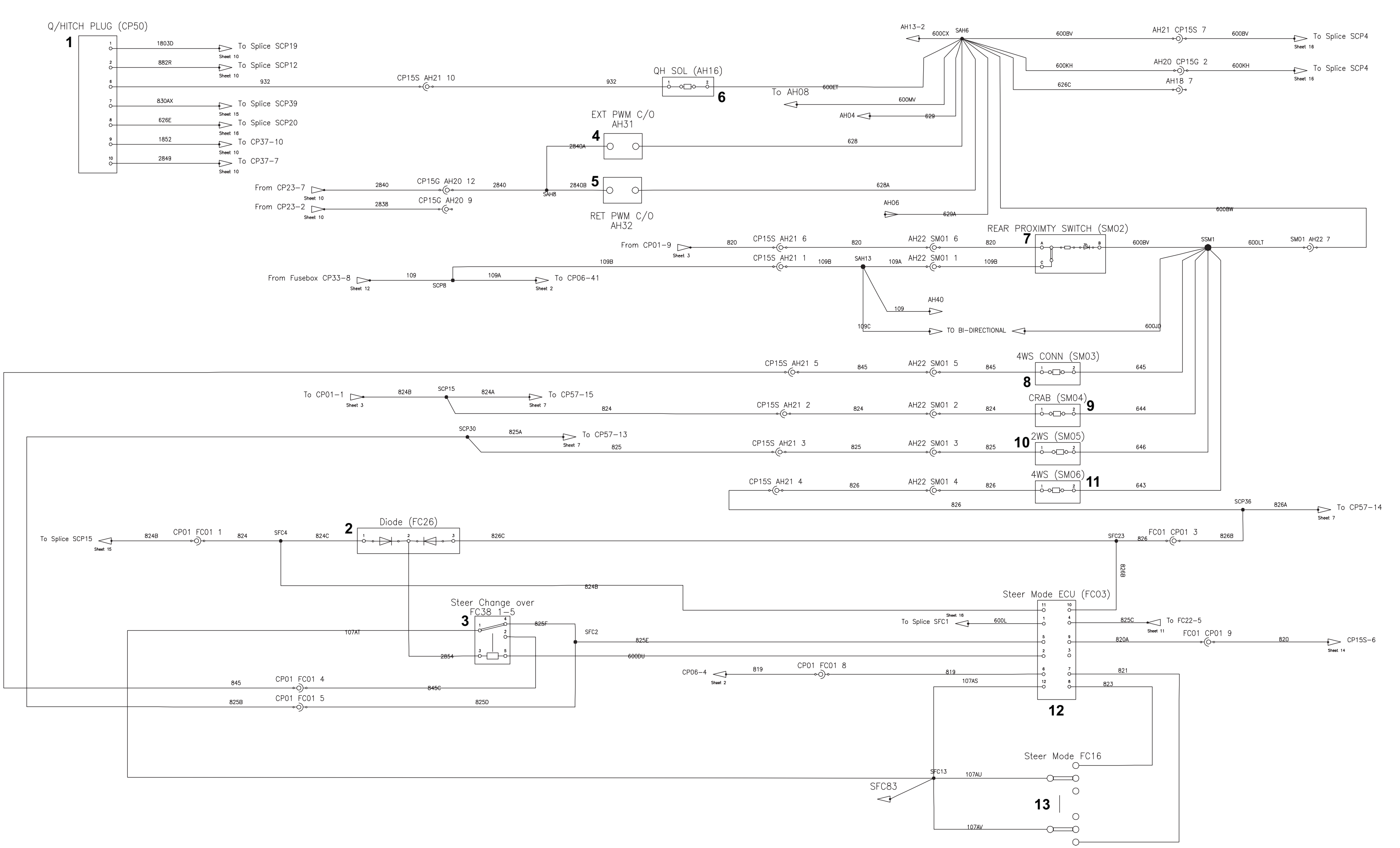


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Fig 71. Sheet 16 of 18

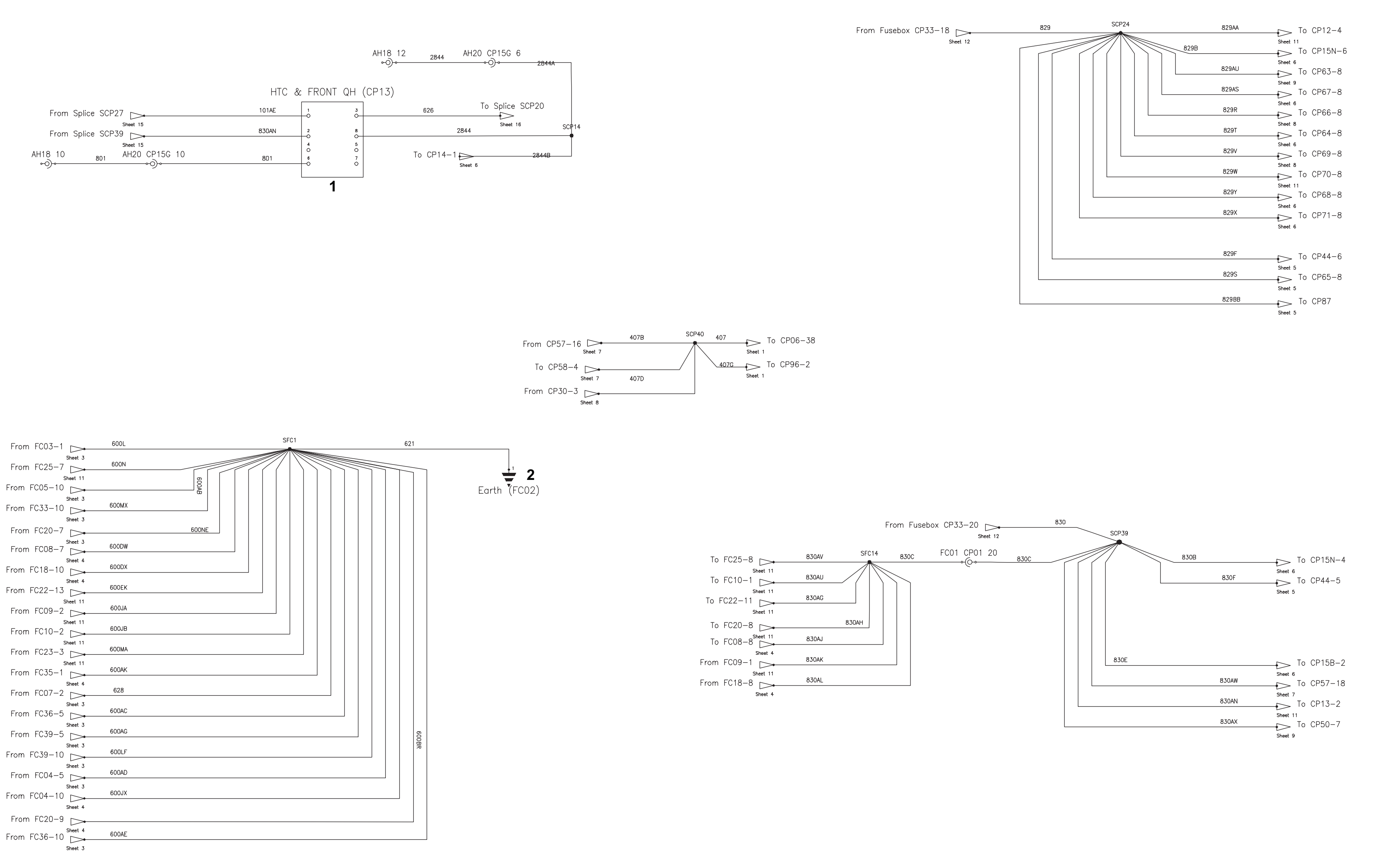
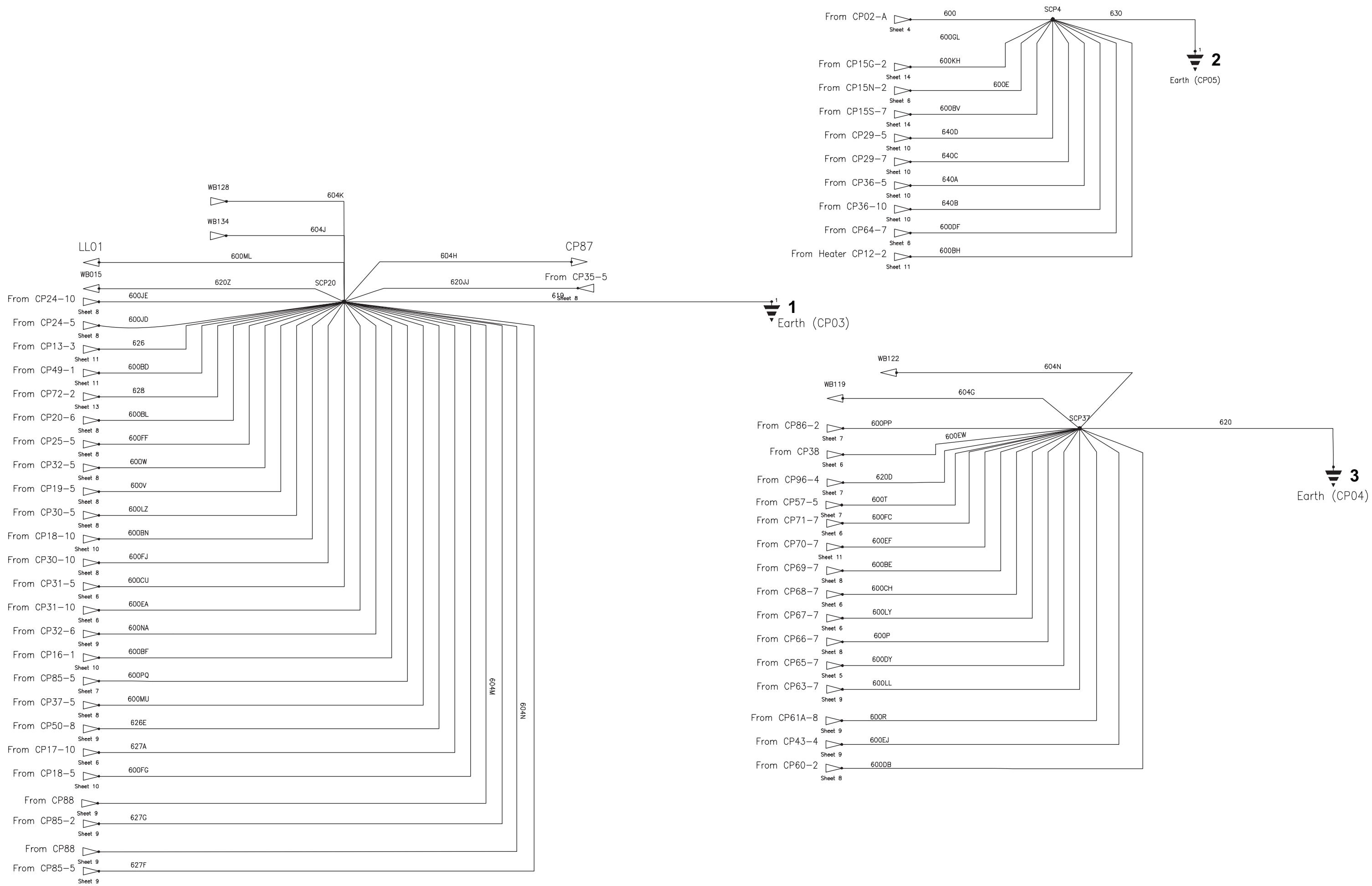


Fig 72. Sheet 17 of 18



C090440PCH-sht18

Fig 73. Sheet 18 of 18

Schematic Circuits - Hydraulics

Precision Control Machines

Small letters on the schematic indicate port markings. Ports `A' and `B' are always identified as service ports (feed and return from respective ram).

Component Key: Sheet 1 of 7 ⇨ *Fig 1. (L-100)*

1	Tank
1A	Return Filter
1B	Suction Strainer
2	Pump, Main Section (P1)
2A	Pump, Secondary Section (P2)
3	Loader Valve Block
3A	Loader Lift Ram Spool
3B	Shovel Ram Spool
3C	Auxiliary Spool (Clam Shovel)
3D	Shovel Ram Head Side A.R.V.
3E	Shovel Ram Rod Side A.R.V.
3F	Flushing Valve
3G	Flow Regulator Valve
3H	Load Sense Relief Valve
4	Excavator Valve Block
4A	Slew Spool
4B	Boom Spool
4C	Stabiliser Spool R.H.
4D	Stabiliser Spool L.H.
4E	Dipper Spool
4F	Bucket Spool
4G	Auxiliary Spool - Extending Dipper
4H	Hydraclamp Valve - Sideshift Only
4J	Slew A.R.V.
4K	Slew A.R.V.
4L	Boom Ram Rod Side A.R.V.
4M	Boom Ram Head Side A.R.V.
4N	Dipper Ram Head Side A.R.V.
4P	Dipper Ram Rod Side A.R.V.
4Q	Bucket Ram Head Side A.R.V.
4S	Extending Dipper Ram Rod Side A.R.V.
4T	Extending Dipper Ram Head Side A.R.V.
5	Clam Shovel Ram
6	Shovel Ram
7	Loader Lift Ram
8	Hydraulic Oil Cooler
9	Anti Cavitation Check Valve
10	Inloader Valve (HSC)
11	Priority Valve
12	Servo Pressure Supply Valve
12A	Dipper `Extend' Valve
12B	Dipper `Retract' Valve
12C	Clam Shovel `Open' Valve
12D	Clam Shovel `Close' Valve
12E	Servo Pressure Isolation Valve - Joysticks
12F	Servo Pressure Regulating Valve
13	Slew Rams
14	Boom Ram
15	Stabiliser Ram R.H.
16	Stabiliser Ram L.H.
17	Dipper Ram
18	Bucket Ram
19	Hydraclamps - Sideshift Only
20	Extending Dipper Ram
21	Hydraclamp Valve - Sideshift Only (Chassis mounted) (1)
X1	Pressure Test Point (Pump P1 Pressure)
X2	Pressure Test Point (Pump P2 Pressure)
X3	Pressure Test Point (Servo Pressure)
X4	Pressure Test Point (Load Sense Pressure)

(1) Machines from May 2008.

Hammer Option:

30	Hammer Selector Valve
31	Hammer Selector Valve
32	Hammer Return Coupling QR
33	Hammer Feed Coupling QR
34	Hi-Flow Cooling Selector Valve
35	Flow Regulator Valve (Cooling)

Power Sideshift Option:

36	Power Sideshift Selector Valve
37	Power Sideshift Ram

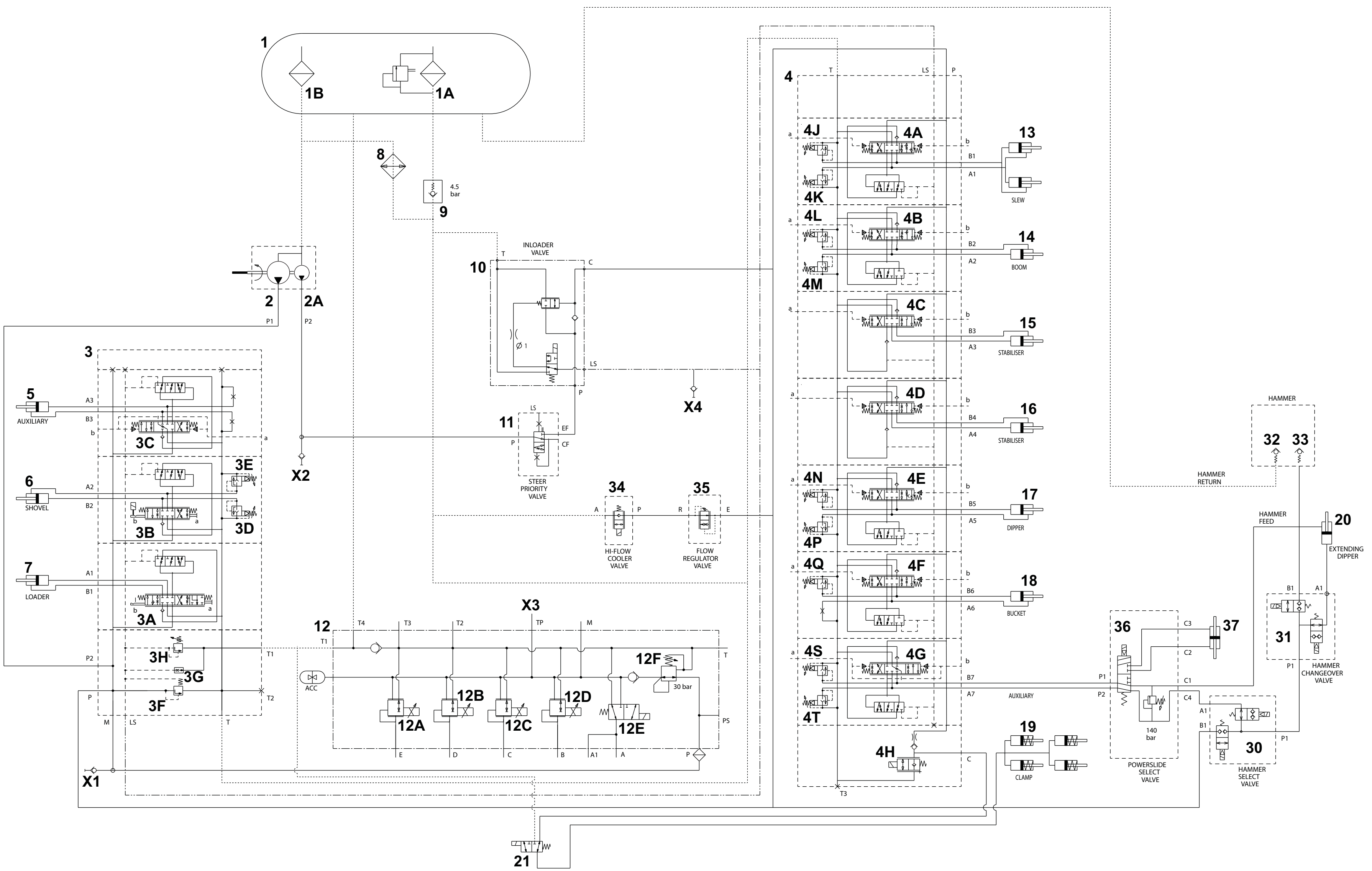


Fig 1. Main Circuit (with inloader valve), Sheet 1 of 7

Component Key: Sheet 2 of 7 ⇒ *Fig 2. (L-102)*

1	Tank
1A	Return Filter
1B	Suction Strainer
2	Pump, Main Section (P1)
2A	Pump, Secondary Section (P2)
3	Loader Valve Block
3A	Loader Lift Ram Spool
3B	Shovel Ram Spool
3C	Auxiliary Spool (Clam Shovel)
3D	Shovel Ram Head Side A.R.V.
3E	Shovel Ram Rod Side A.R.V.
3F	Flushing Valve
3G	Flow Regulator Valve
3H	Load Sense Relief Valve
4	Excavator Valve Block
4A	Slew Spool
4B	Boom Spool
4C	Stabiliser Spool R.H.
4D	Stabiliser Spool L.H.
4E	Dipper Spool
4F	Bucket Spool
4G	Auxiliary Spool - Extending Dipper
4H	Hydraclamp Valve - Sideshift Only
4J	Slew A.R.V.
4K	Slew A.R.V.
4L	Boom Ram Rod Side A.R.V.
4M	Boom Ram Head Side A.R.V.
4N	Dipper Ram Head Side A.R.V.
4P	Dipper Ram Rod Side A.R.V.
4Q	Bucket Ram Head Side A.R.V.
4S	Extending Dipper Ram Rod Side A.R.V.
4T	Extending Dipper Ram Head Side A.R.V.
5	Clam Shovel Ram
6	Shovel Ram
7	Loader Lift Ram
8	Hydraulic Oil Cooler
9	Anti Cavitation Check Valve
10	Unloader Valve (HSC)
11	Priority Valve
12	Servo Pressure Supply Valve
12A	Dipper `Extend' Valve
12B	Dipper `Retract' Valve
12C	Clam Shovel `Open' Valve
12D	Clam Shovel `Close' Valve
12E	Servo Pressure Isolation Valve - Joysticks
12F	Servo Pressure Regulating Valve
13	Slew Rams
14	Boom Ram
15	Stabiliser Ram R.H.
16	Stabiliser Ram L.H.
17	Dipper Ram
18	Bucket Ram
19	Hydraclamps - Sideshift Only
20	Extending Dipper Ram
21	Hydraclamp Valve - Sideshift Only (Chassis mounted) (1)
X1	Pressure Test Point (Pump P1 Pressure)
X2	Pressure Test Point (Pump P2 Pressure)
X3	Pressure Test Point (Servo Pressure)
X4	Pressure Test Point (Load Sense Pressure)

(1) *Machines from May 2008.*

Hammer Option:

30	Hammer Selector Valve
31	Hammer Selector Valve
32	Hammer Return Coupling QR
33	Hammer Feed Coupling QR
34	Hi-Flow Cooling Selector Valve
35	Flow Regulator Valve (Cooling)

Power Sideshift Option:

36	Power Sideshift Selector Valve
37	Power Sideshift Ram

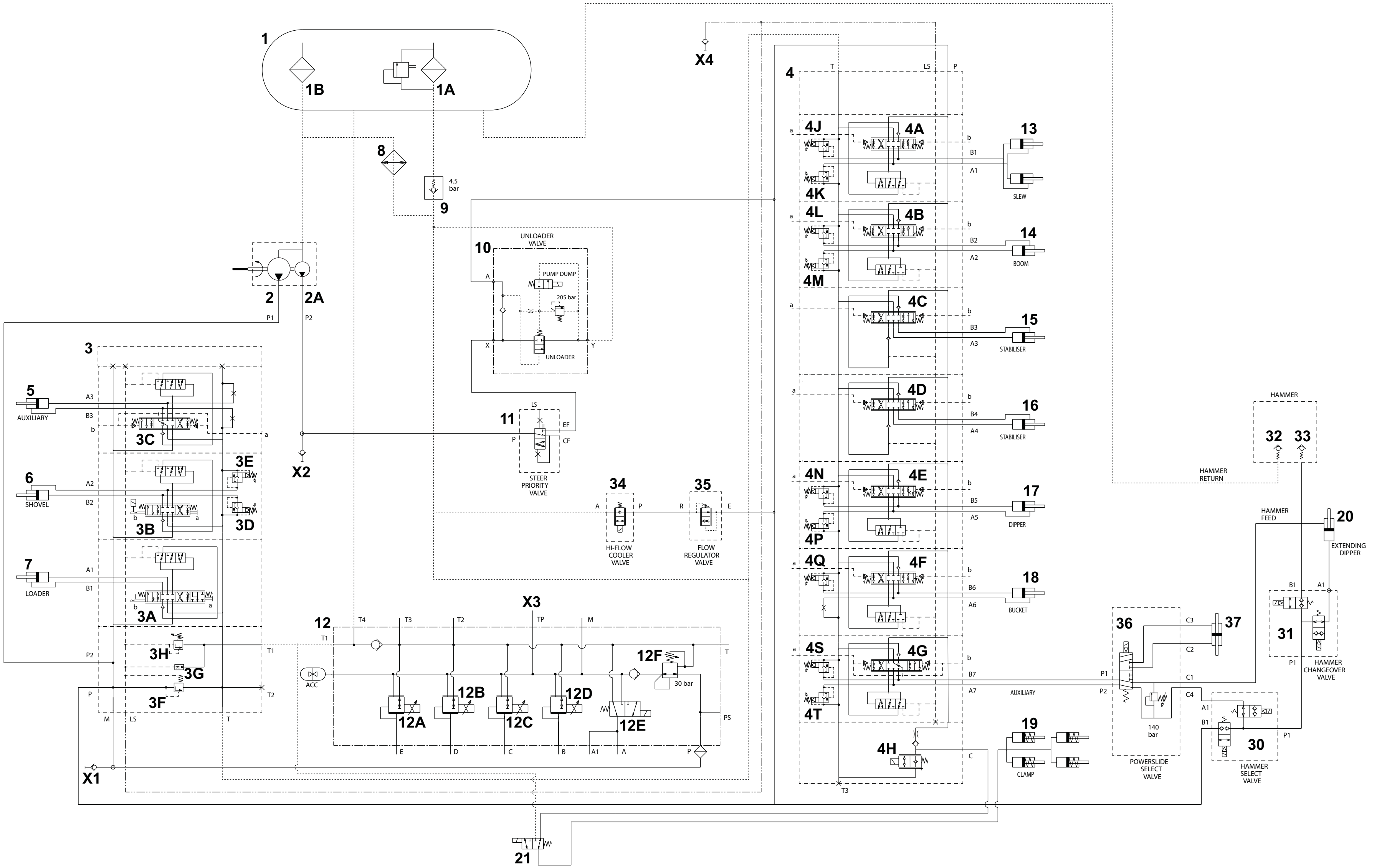


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Fig 2. Main Circuit (with unloader valve modification), Sheet 2 of 7

Component Key: Sheet 3 of 7 *⇨ Fig 3. (L-104)*

3 Loader Valve Block

4 Excavator Valve Block

12 Servo Pressure Supply Valve

40 Excavator Joystick Controller L.H.

41 Excavator Joystick Controller R.H.

42 Stabiliser Controls

43 Grading Mode Solenoid Valve - Dipper service operation

X3 Pressure Test Point (Servo Pressure)

Note: *From October 2006, the grading mode solenoid valve **43** is connected to operate with the boom service.*

Component Key: Sheet 4 of 7 *⇨ Fig 4. (L-105)*

3 Loader Valve Block

4 Excavator Valve Block

12 Servo Pressure Supply Valve

40 Excavator Joystick Controller L.H.

41 Excavator Joystick Controller R.H.

42 Stabiliser Controls

43 Grading Mode Solenoid Valve - Dipper service operation

44 Pilot Bypass Valve

X3 Pressure Test Point (Servo Pressure)

L-103

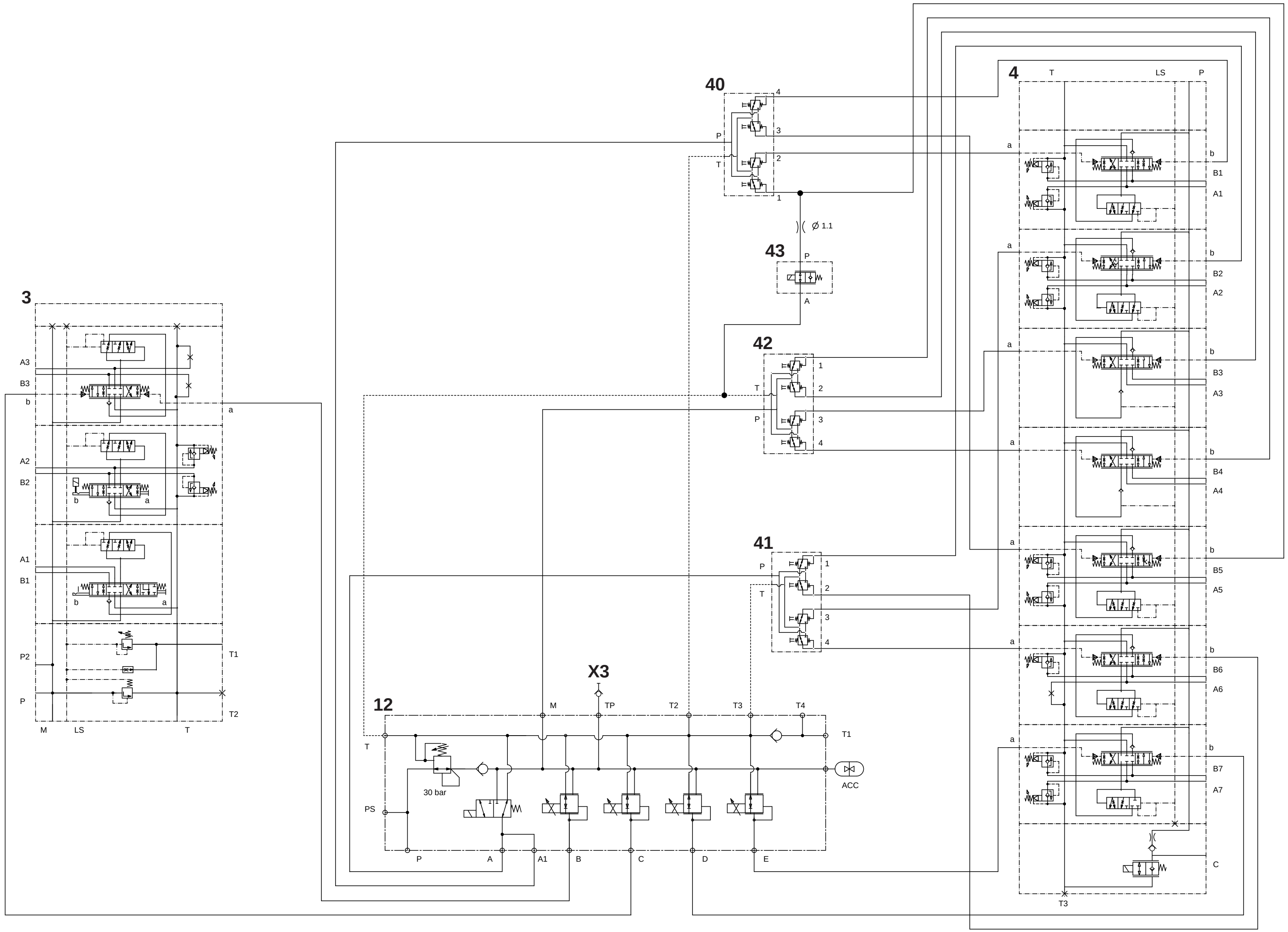


Fig 3. Pilot Circuit ISO Control Pattern - Machines without Hammer Circuit, Sheet 3 of 7

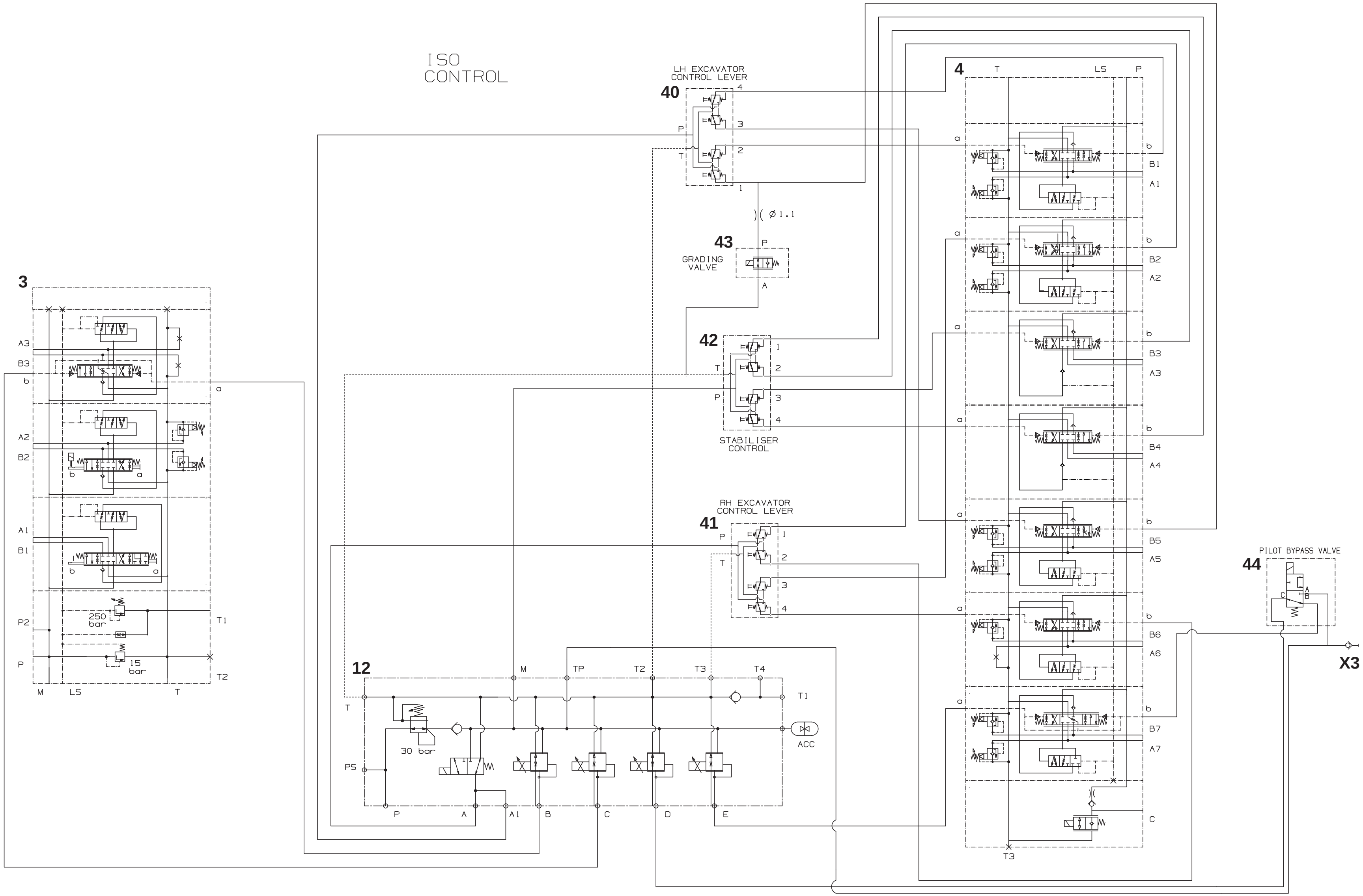


Fig 4. Pilot Circuit ISO Control Pattern - Machines with Hammer Circuit, Sheet 4 of 7

Component Key: Sheet 5 of 7 ⇨ *Fig 5. (L-107)*

4 Excavator Valve Block

40 Excavator Joystick Controller L.H.

41 Excavator Joystick Controller R.H.

42 Stabiliser Controls

43 Grading Mode Solenoid Valve - Dipper service operation

45 ISO/SAE Control Pattern Changeover Valve

Note: *From October 2006, the grading mode solenoid valve* ***43*** *is connected to operate with the boom service.*

Component Key: Sheet 6 of 7 ⇨ *Fig 6. (L-108)*

4 Excavator Valve Block

20 Extending Dipper Ram

50 Hammer Selector Valve

51 Couplings QR - Hammer

52 Auxiliary Changeover Solenoid Valve (Boom)

53 Couplings QR - Jaw Bucket/Grab

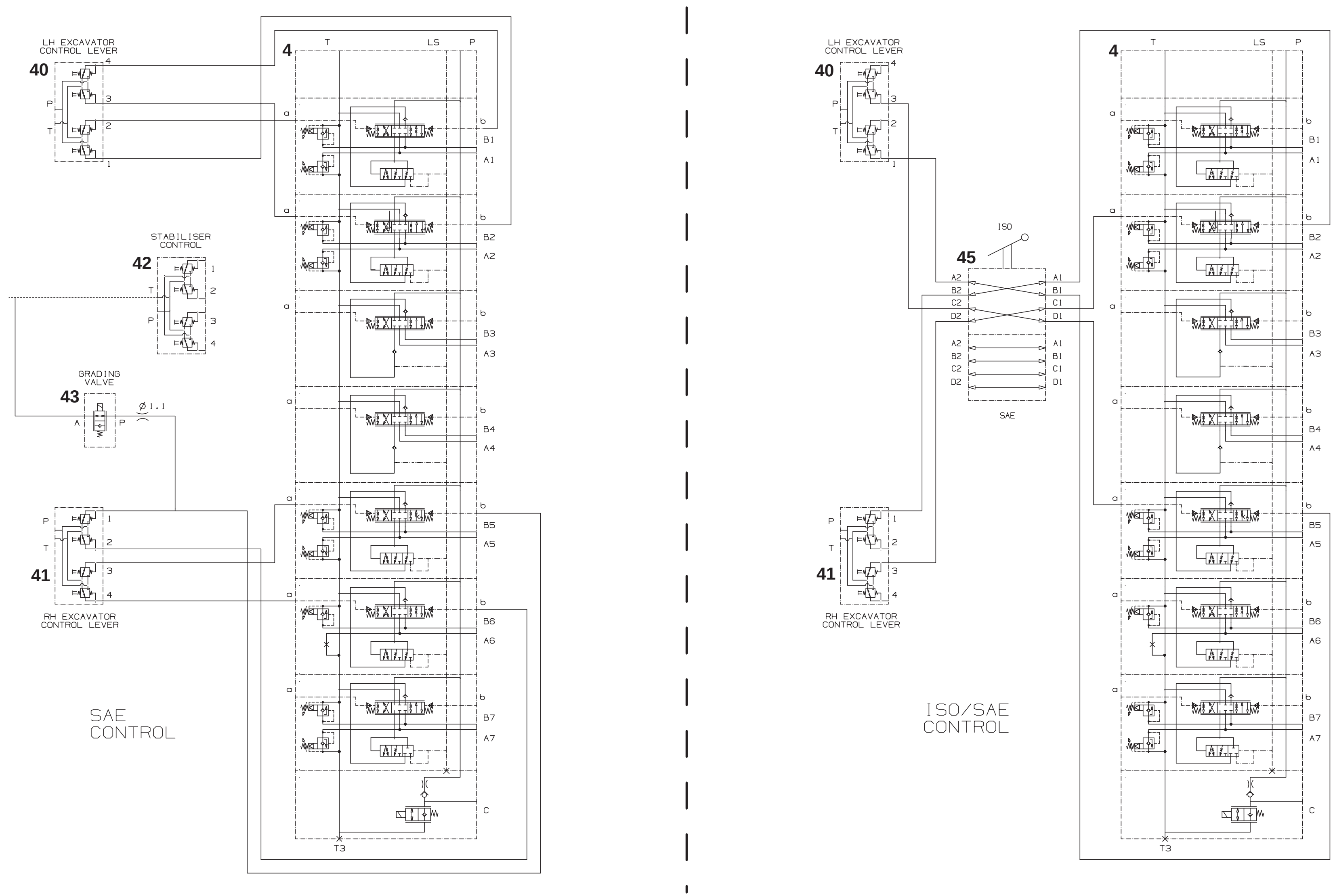
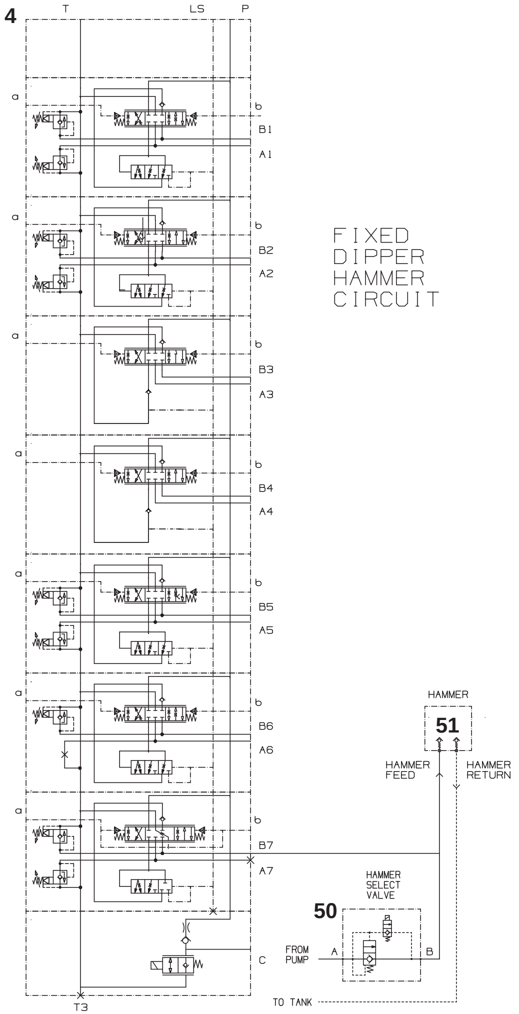


Fig 5. Pilot Circuit SAE Control Pattern and ISO/SAE Control Pattern Changeover, Sheet 5 of 7



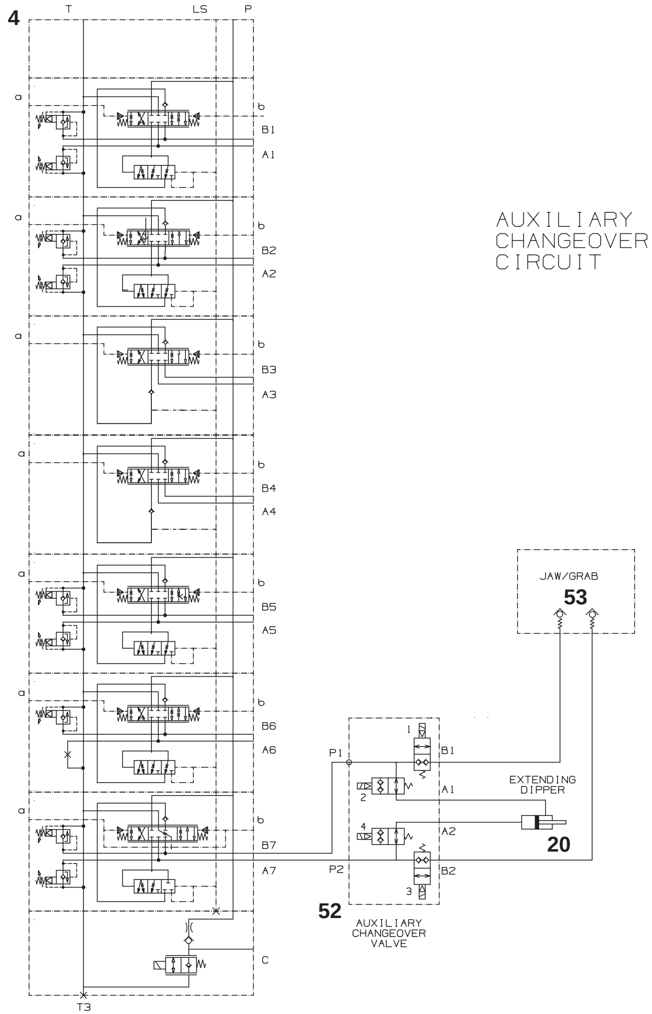


Fig 6. Fixed Dipper Hammer and Excavator Auxiliary Changeover, Sheet 6 of 7

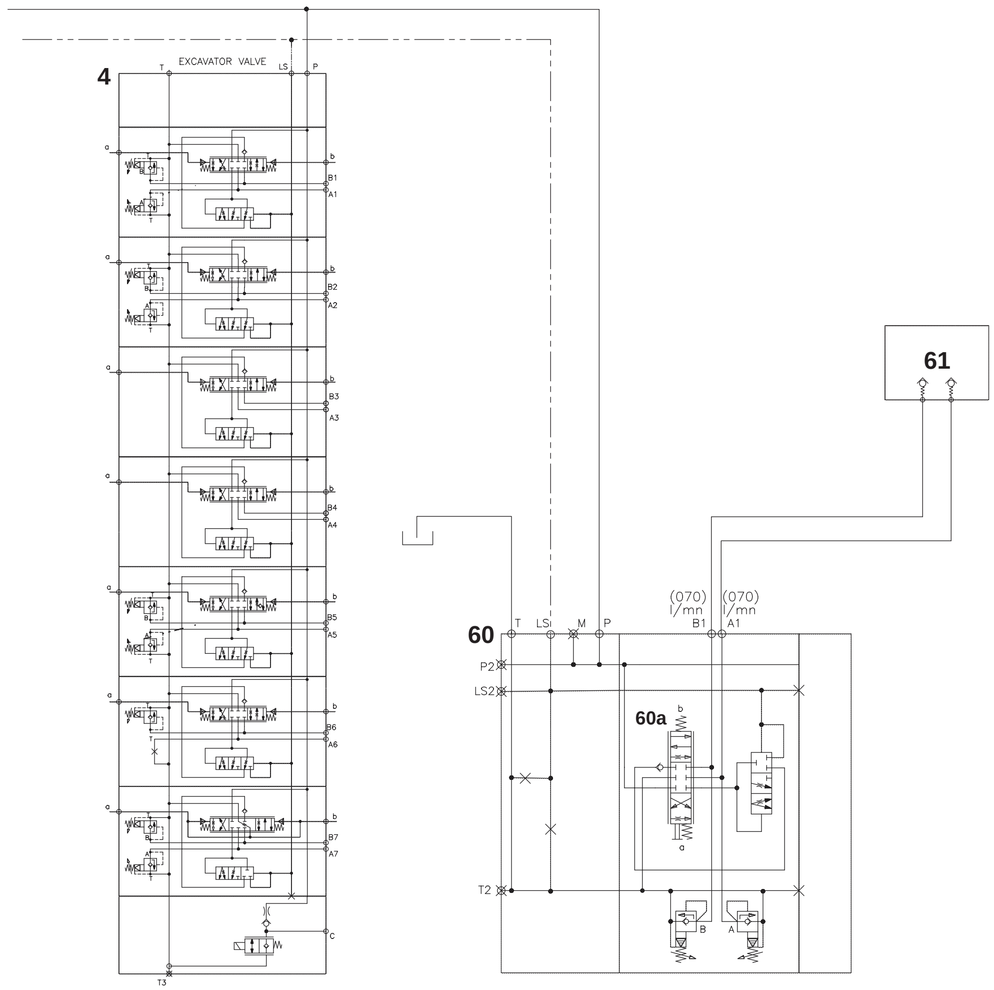


Fig 7. Excavator Second Auxiliary (Option), Sheet 7 of 7

Component Key:

4	Excavator Valve Block
60	Auxiliary Valve Block (Chassis mounted)
60a	Second Auxiliary Spool (Footpedal Operated)
61	Quick Release Couplings

Advanced EasyControl Machines

Small letters on the schematic indicate port markings. Ports `A' and `B' are always identified as service ports (feed and return from respective ram).

Component Key: Sheet 1 of 6 *⇨ Fig 8. (L-111)*

1	Tank
1A	Return Filter
1B	Suction Strainer
2	Pump - Variflow
3	Loader Valve Block
3A	Loader Lift Ram Spool (175 - 190 litres/min)
3B	Shovel Ram Spool (150 litres/min)
3C	Auxiliary Spool - Clam (80 - 110 litres/min)
3D	Shovel Ram Head Side A.R.V.
3E	Shovel Ram Rod Side A.R.V.
3F	Flushing Valve (27 bar)
3G	Flow Regulator Valve
3H	Load Sense Relief Valve (250 bar)
4	Excavator Valve Block
4A	Slew Spool
4B	Boom Spool (120 - 135 litres/min)
4C	Stabiliser Spool R.H. (60 litres/min)
4D	Stabiliser Spool L.H. (60 litres/min)
4E	Dipper Spool (120 - 135 litres/min)
4F	Bucket Spool
4G	Auxiliary Spool - Extending Dipper (80 - 120 litres/min)
4H	Hydraclamp Valve - Sideshift Only (up to May 2008)
4J	Slew A.R.V.
4K	Slew A.R.V.
4L	Boom Ram Rod Side A.R.V.
4M	Boom Ram Head Side A.R.V.
4N	Dipper Ram Head Side A.R.V.
4P	Dipper Ram Rod Side A.R.V.
4Q	Bucket Ram Head Side A.R.V.
4S	Ext. Dipper Ram Rod Side A.R.V.
4T	Ext. Dipper Ram Head Side A.R.V.
5	Clam Shovel Ram
6	Shovel Ram
7	Loader Lift Ram
8	Hydraulic Oil Cooler
8A	Anti Cavitation Check Valve
9	Oil Filter - Pilot Feed Line
10	Accumulator - Return Line
11	Priority Valve
12	Servo Pressure Supply Valve
12A	Auxiliary Service `Extend' Valve
12B	Auxiliary Service `Retract' Valve
12C	Servo Pressure Isolation Valve - RH Joystick
12D	Servo Pressure Isolation Valve - LH Joystick
12E	Servo Pressure Regulating Valve (35 bar)
13	Slew Rams
14	Boom Ram
15	Stabiliser Ram R.H.
16	Stabiliser Ram L.H.
17	Dipper Ram
18	Bucket Ram
19	Hydraclamps - Sideshift Only
20	Hydraclamp Valve - Sideshift Only (Chassis mounted - from May 2008)
X1	Pressure Test Point (Pump Pressure)
X3	Pressure Test Point (Servo Pressure)
X4	Pressure Test Point (Load Sense Pressure)
X5	Pressure Test Point (Load Sense Pressure)

Hammer Option:

34	Hi-Flow Cooling Selector Valve
35	Flow Regulator Valve (Cooling)

Connections:

A	To Steer Valve (load sense feed), see ***Section H, Steering***.
B	To Steer Valve (main feed), see ***Section H, Steering***.
C	To C *⇨ Fig 12. (L-117)*

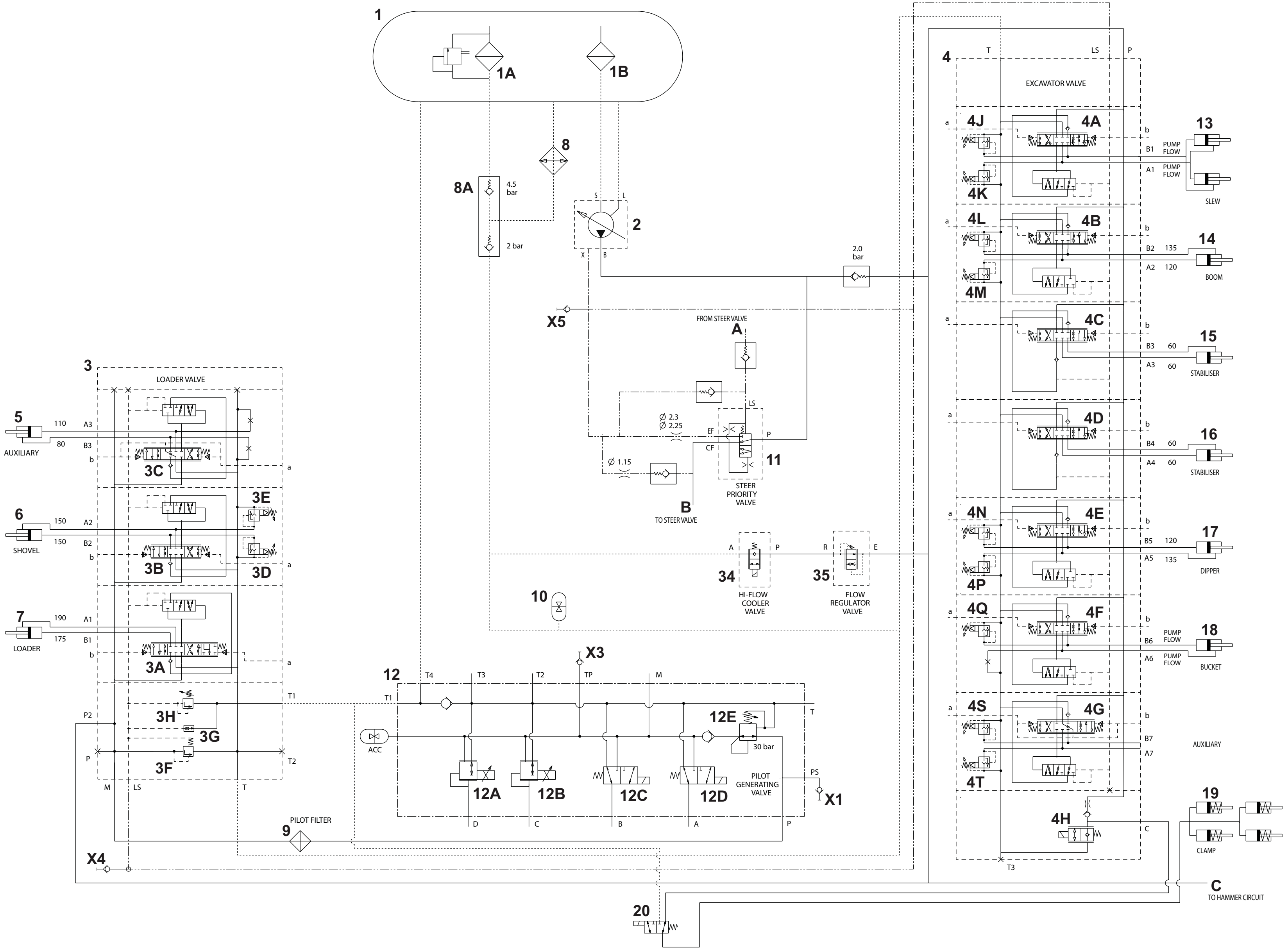


Fig 8. Main Circuit, Sheet 1 of 6

Component Key: Sheet 2 of 6 ⇨ *Fig 9. (L-113)*

3	Loader Valve Block
4	Excavator Valve Block
12	Servo Pressure Supply Valve
40	Joystick Controller L.H.
41	Joystick Controller R.H.
42	Boom Service or Loader Lift Service Changeover Solenoid Valve (Offside)
43	Bucket Service or Shovel Service Changeover Solenoid Valve (Middle)
51	Shuttle Valve
52	Shovel Reset Solenoid Valve
X1	Pressure Test Point (Pump Pressure)
X3	Pressure Test Point (Servo Pressure)

Connections:

D	To D ⇨ *Fig 10. (L-114)*

Component Key: Sheet 3 of 6
⇨ *Fig 10. (L-114)*

3	Loader Valve Block
4	Excavator Valve Block
12	Servo Pressure Supply Valve
44	Grading Mode Solenoid Valve - Dipper service operation
45	Excavator Auxiliary Service or Loader Auxiliary Service Changeover Solenoid Valve (Nearside)
46	Stabiliser Controls
X1	Pressure Test Point (Pump Pressure)
X3	Pressure Test Point (Servo Pressure)

Connections:

D	From D ⇨ *Fig 9. (L-113)*
E	**ISO Pattern:** To Joystick Controller L.H.
	ISO/SAE Pattern: To Control Pattern Changeover Valve

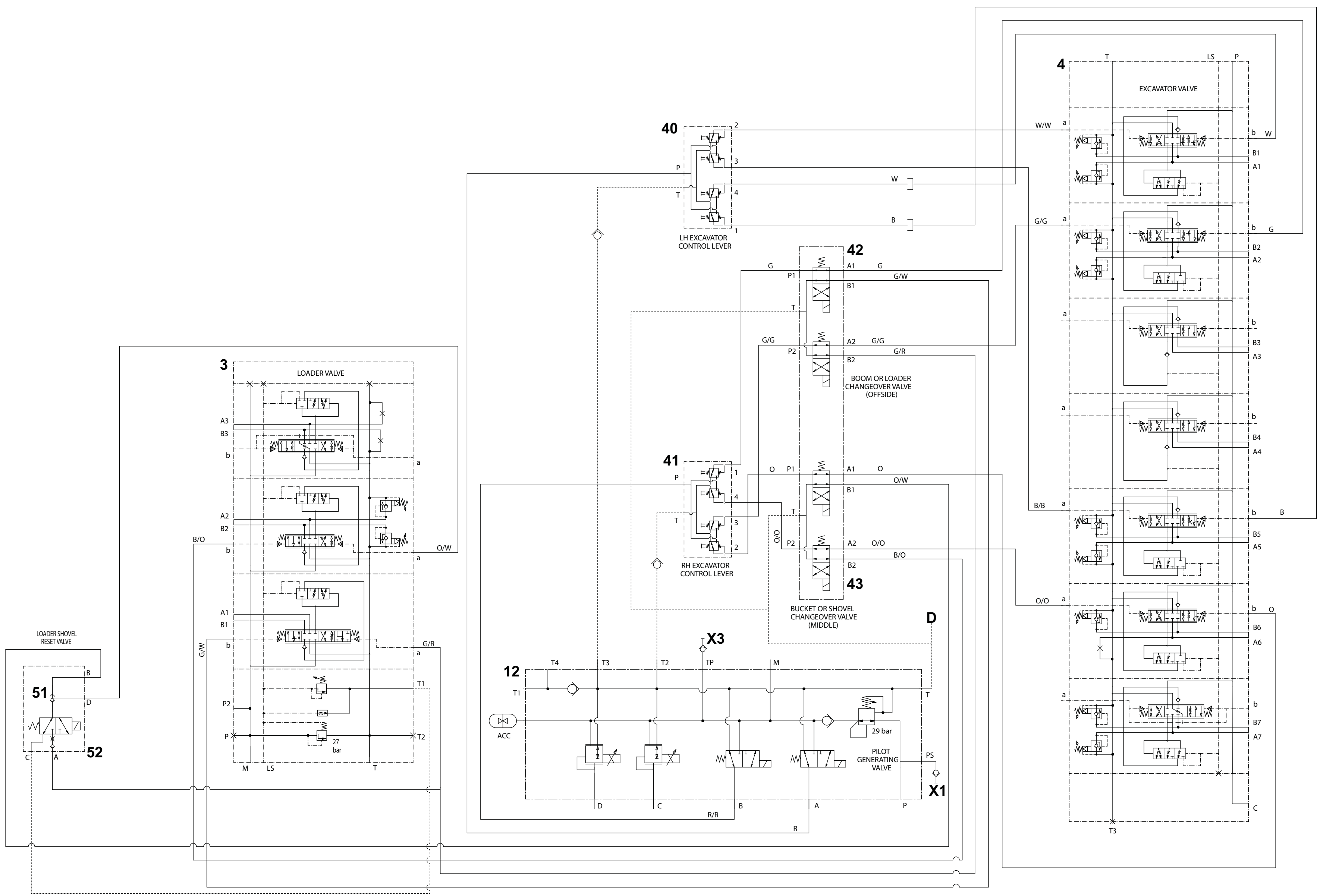


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Fig 9. Pilot Circuit ISO Pattern, Loader Control Changeover and Shovel Reset, Sheet 2 of 6

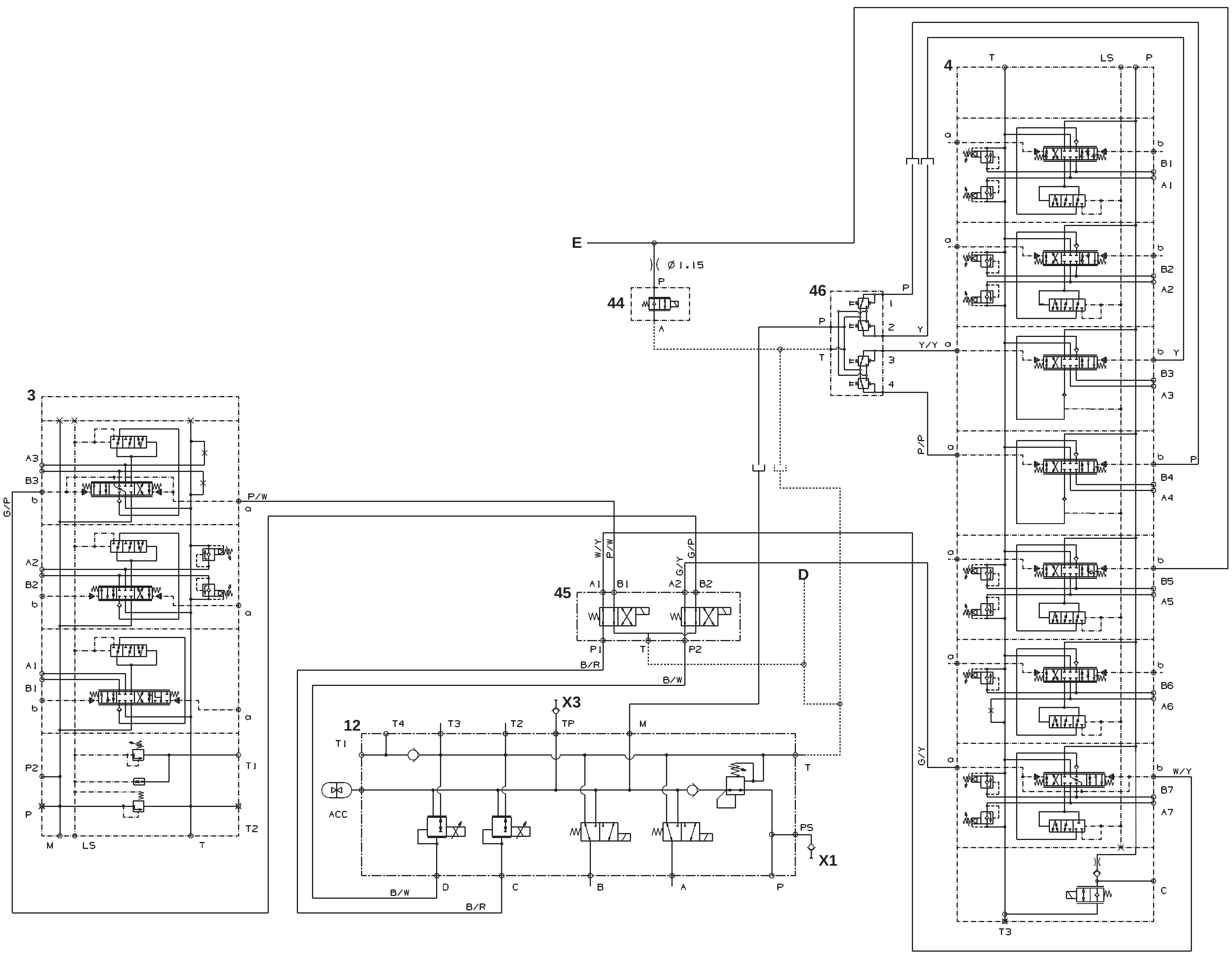

Fig 10. Auxiliary Service Changeover, Stabiliser Controls and Grading Mode, Sheet 3 of 6

Component Key: Sheet 4 of 6 ⇒ *Fig 11. (L-116)*

ISO/SAE Control Pattern Changeover:

4	Excavator Valve Block
40	Joystick Controller L.H.
41	Joystick Controller R.H.
42	Boom/Dipper Service or Loader Lift Service Changeover Solenoid Valve (Offside)
43	Bucket Service or Shovel Service Changeover Solenoid Valve (Middle)
47	ISO/SAE Control Pattern Changeover Valve

Excavator Auxiliary Changeover:

4	Excavator Valve Block
29	Extending Dipper Ram
48	Auxiliary Changeover Solenoid Valve (Boom)
49	Coupling QR - Jaw Bucket/Grab
50	Coupling QR - Jaw Bucket/Grab

Component Key: Sheet 5 of 6 ⇒ *Fig 12. (L-117)*

Extending Dipper Options:

4	Excavator Valve Block
4R	Bucket Ram Rod Side A.R.V.
29	Extending Dipper Ram
30	Hammer Changeover Valve
31	Hammer Selector Valve
32	Hammer Return Coupling QR
33	Hammer Feed Coupling QR
36	Power Sideshift Selector Valve
37	Power Sideshift Ram
38	Accumulator - Hammer Return Line
38A	Oil Filter - Hammer Return Line

Fixed Dipper Options:

4	Excavator Valve Block
4R	Bucket Ram Rod Side A.R.V.
31	Hammer Selector Valve
32	Hammer Return Coupling QR
33	Hammer Feed Coupling QR
38	Accumulator - Hammer Return Line
38A	Oil Filter - Hammer Return Line

Connections:

C	From C ⇒ *Fig 8. (L-111)*

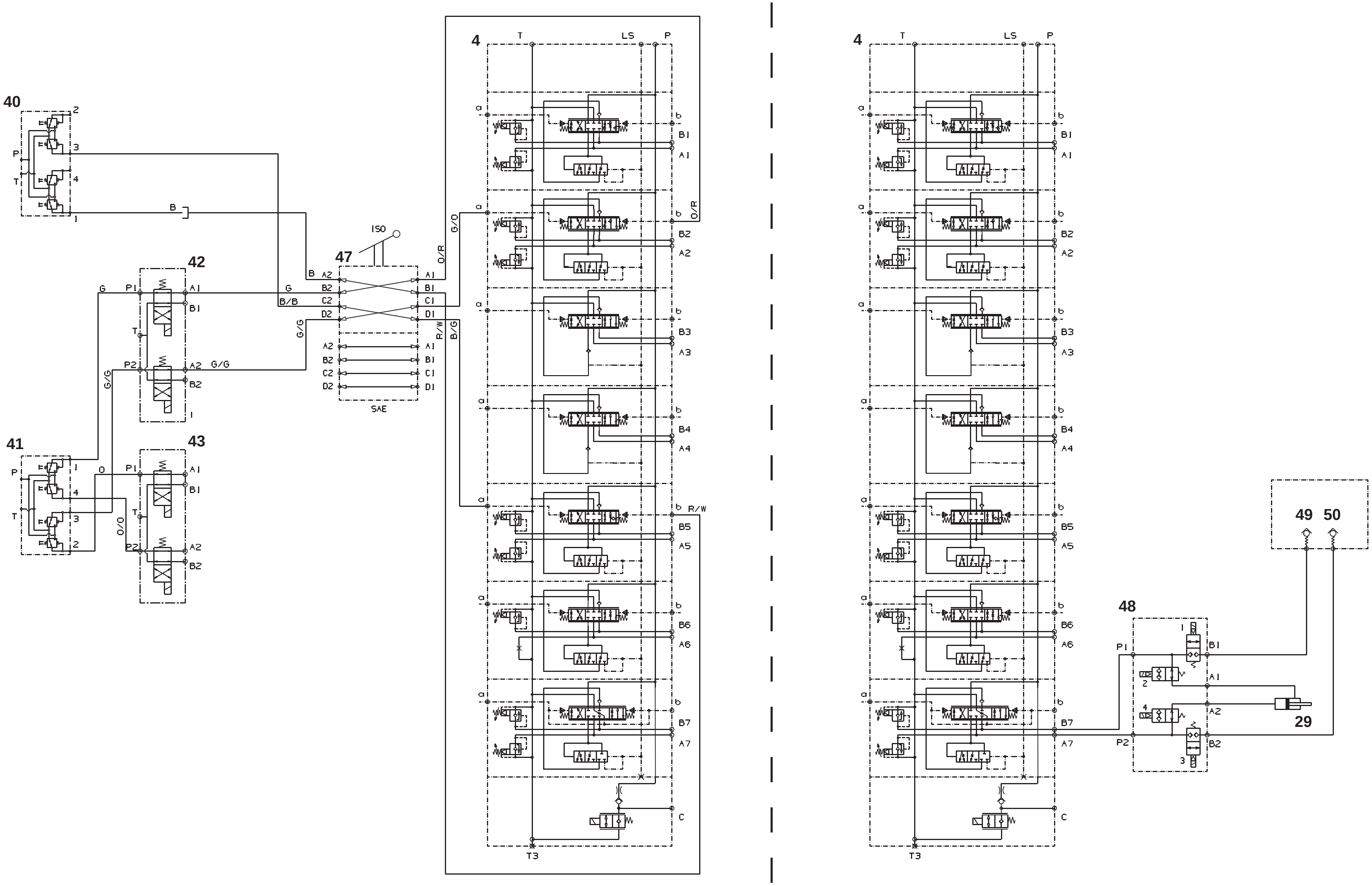

Fig 11. ISO/SAE Control Pattern Changeover and Excavator Auxiliary Changeover, Sheet 4 of 6

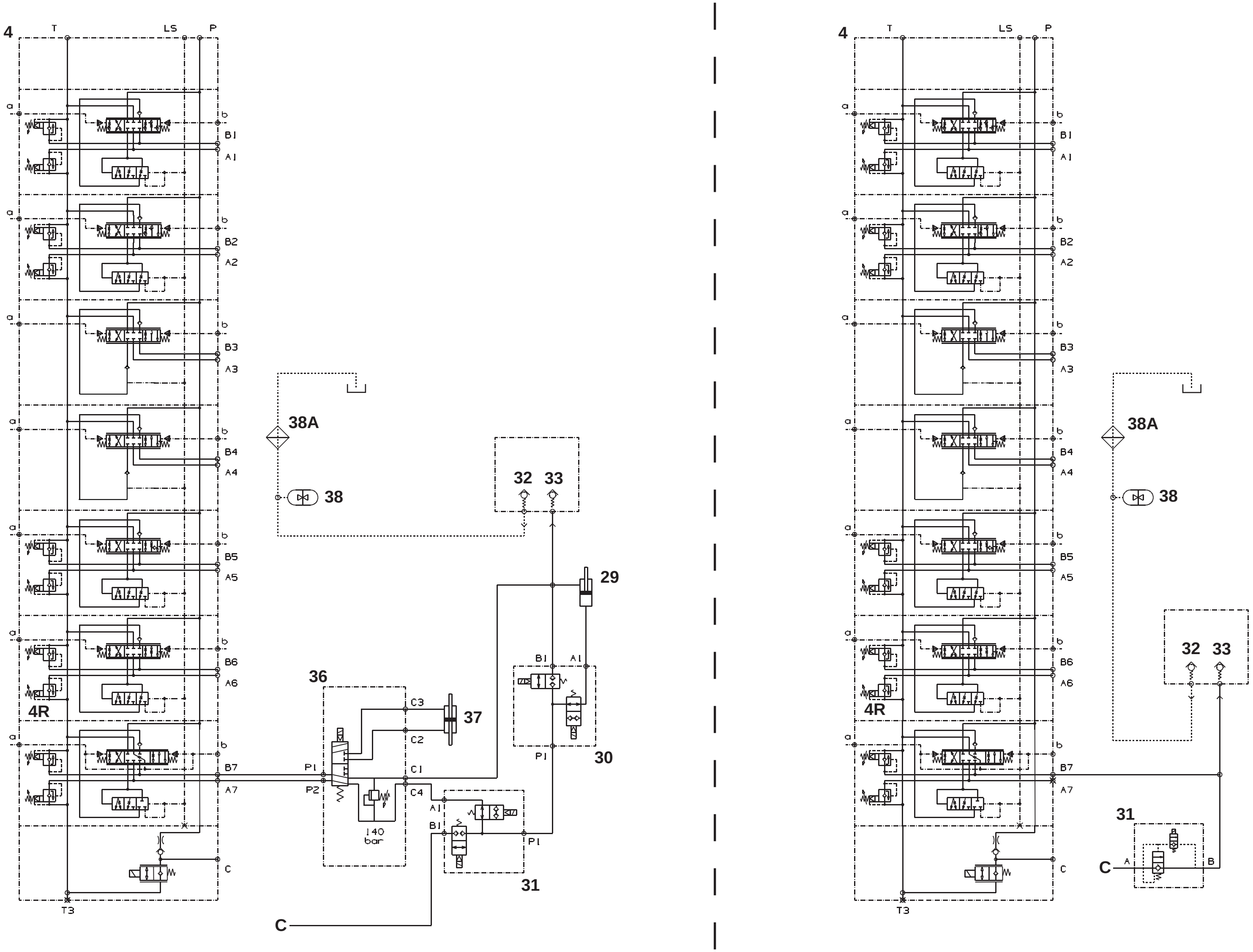

Fig 12. Extending Dipper and Fixed Dipper Options, Sheet 5 of 6

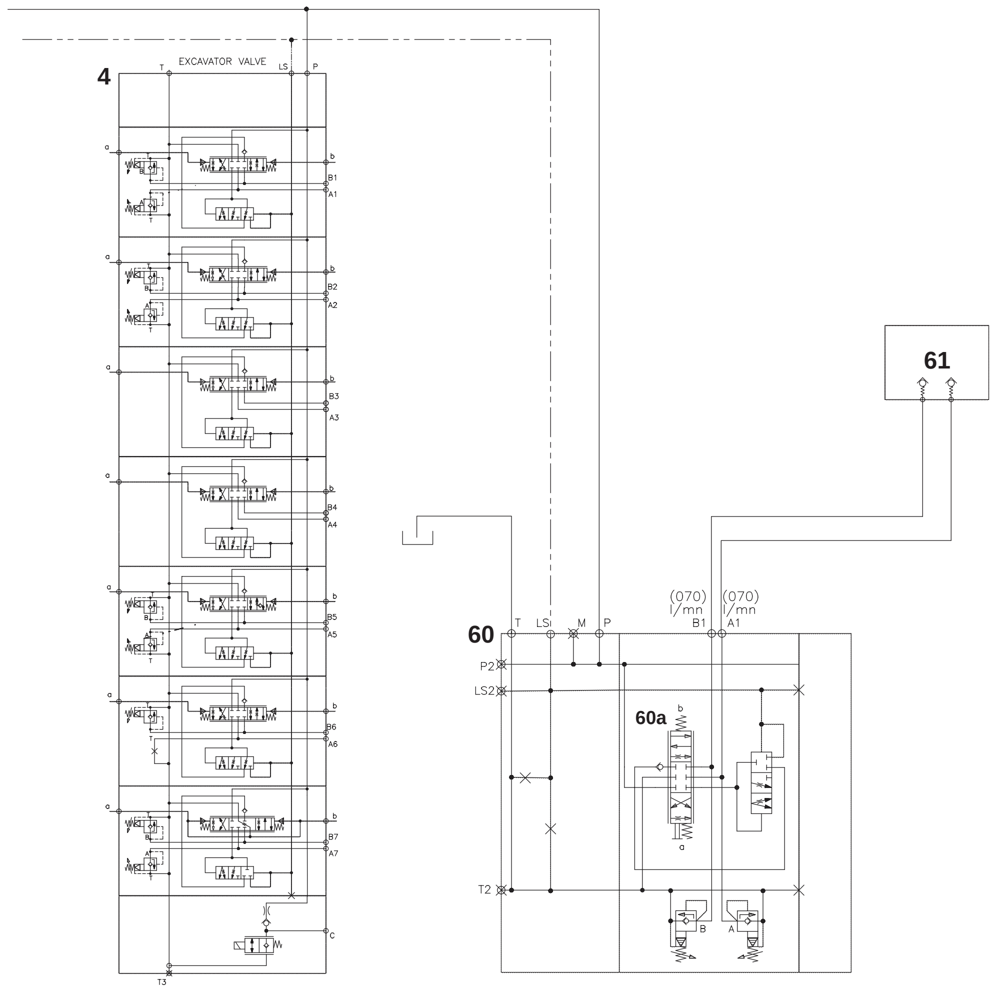

Fig 13. Excavator Second Auxiliary (Option), Sheet 6 of 6

Component Key:

4	Excavator Valve Block
60	Auxiliary Valve Block (Chassis mounted)
60a	Second Auxiliary Spool (Footpedal Operated)
61	Quick Release Couplings

Variflow Pump Internal Circuit

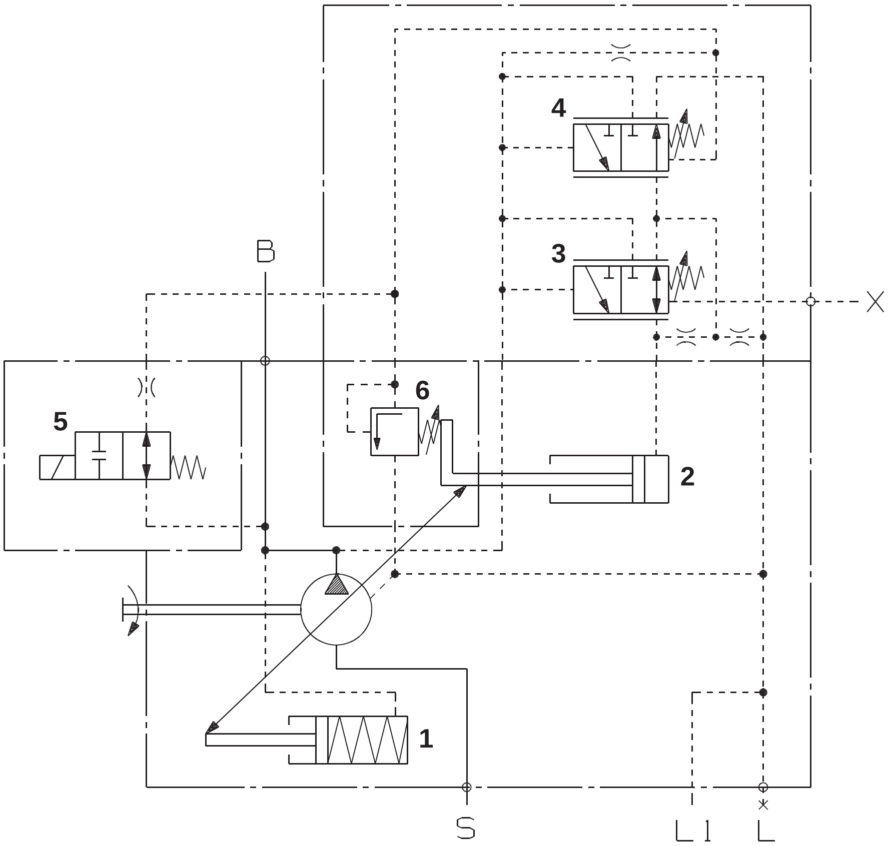

Fig 14.

Component Key: *⇒ Fig 14. (L-119)*

1 Stroking Piston

2 Flow Control Piston

3 Flow Control Spool

4 Power Limiting Spool

5 Dual Horsepower Solenoid Valve - if fitted (1)

6 Power Valve (Torque Control)

Connection Ports:

B Discharge (Outlet)

L Case Drain

S Suction (Inlet)

X Load Sense

(1) No longer fitted on machines from serial no. 975289.

EasyControl Machines

Small letters on the schematic indicate port markings. Ports `A' and `B' are always identified as service ports (feed and return from respective ram).

Component Key: Sheet 1 of 4
⇒ Fig 15. (L-121)

1	Tank
1a	Return Filter
1b	Suction Strainer
2	Pump - Main Section (P1)
2a	Pump - Secondary Section (P2)
3	Loader Valve Block
3a	Loader Lift Ram Spool
3b	Shovel Ram Spool
3c	Auxiliary Spool - Clam Shovel
3d	Shovel Ram Head Side A.R.V.
3e	Shovel Ram Rod Side A.R.V.
3f	Hydraulic Speed Control Solenoid (HSC)
3g	Main Relief Valve (MRV)
3h	Unloader Pilot Valve
3j	Unloader Valve Spool
3k	Constant Pressure Valve (Servo Feed)
3l	High Pressure Relief Valve (Secondary)
4	Excavator Valve Block
4a	Slew Spool
4b	Boom Spool
4c	Stabiliser Spool R.H.
4d	Stabiliser Spool L.H.
4e	Dipper Spool
4f	Bucket Spool
4h	Hydraclamp Valve - Sideshift
4j	Slew A.R.V.
4k	Slew A.R.V.
4l	Boom Ram Rod Side A.R.V.
4m	Boom Ram Head Side A.R.V.
4n	Dipper Ram Head Side A.R.V.
4p	Dipper Ram Rod Side A.R.V.
4q	Bucket Ram Head Side A.R.V.
5	Clam Shovel Ram
6	Shovel Ram
7	Loader Lift Ram
8	Smooth Ride System (SRS) Solenoid Valve Assembly
8a	Smooth Ride System Accumulator
9	Hydraulic Oil Cooler
10	Anti-Cavitation Check Valve
11	Steer Priority Valve
12	Servo Pressure Supply Valve
12a	Clam Shovel/Ext. Dipper `Open' Valve
12b	Clam Shovel/Ext. Dipper `Close' Valve
12c	Servo Pressure Isolation Valve - LH Joystick
12d	Servo Pressure Isolation Valve - RH Joystick
12e	Servo Pressure Regulating Valve (35 bar)
13	Oil Filter (Servo Feed)
14	Front Power Trackrod Ram - AWS Only
15	Rear Power Trackrod Ram - AWS Only
16	Steer Mode Control Solenoid Valve - AWS Only
17	Steer Unit
18	Front Power Trackrod Ram - 2WS
19	Slew Rams
20	Boom Ram
20a	Hose Burst Protection Valve - Boom
21	Stabiliser Ram R.H.
22	Stabiliser Ram L.H.
23	Dipper Ram
24	Bucket Ram
25	Hydraclamps - Sideshift
26	Anti-Reaction Valve - Centremount
27	Auxiliary Valve Block
28	Extending Dipper Ram
X1	Pressure Test Point (Pump P1 Pressure)
X2	Pressure Test Point (Pump P2 Pressure)
X3	Pressure Test Point (Servo Pressure)

Connections:

A To A ⇒ Fig 16. (L-123)

Hammer Option:

31	Diverter Solenoid Valve
32	Quick Release Couplings

Power Sideshift Option:

34	Power Sideshift Solenoid Valve Assembly
35	Power Sideshift Ram

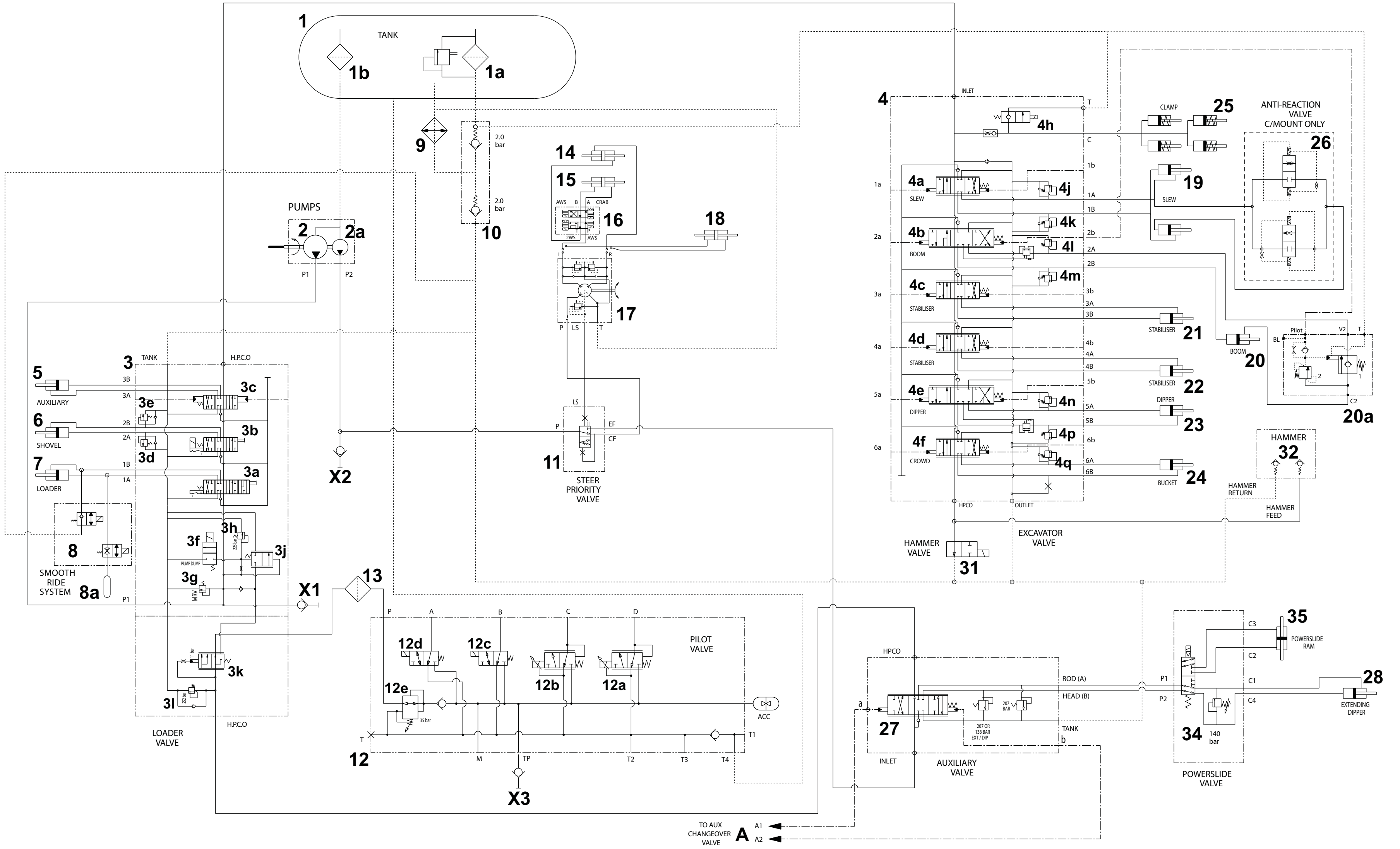

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Fig 15. Main Circuit, Sheet 1 of 4

Component Key: Sheet 2 of 4

⇒ Fig 16. (L-123)

3	Loader Valve Block
4	Excavator Valve Block
12	Servo Pressure Supply Valve
13	Oil Filter (Servo Feed)
40	Joystick Controller L.H.
41	Joystick Controller R.H.
42	Stabiliser Controls
43	Loader/Excavator Auxiliary Changeover Solenoid Valve
X1	Pressure Test Point (Pump P1 Pressure)
X3	Pressure Test Point (Servo Pressure)

Connections:

A From A ⇒ Fig 15. (L-121)

Component Key: Sheet 3 of 4

⇒ Fig 17. (L-124)

4	Excavator Valve Block
28	Extending Dipper Ram
40	Joystick Controller L.H.
41	Joystick Controller R.H.
44	ISO/SAE Control Pattern Selector Valve

Jaw Bucket Option:

37	Excavator Auxiliary Changeover Solenoid Valve
38	Quick Release Couplings

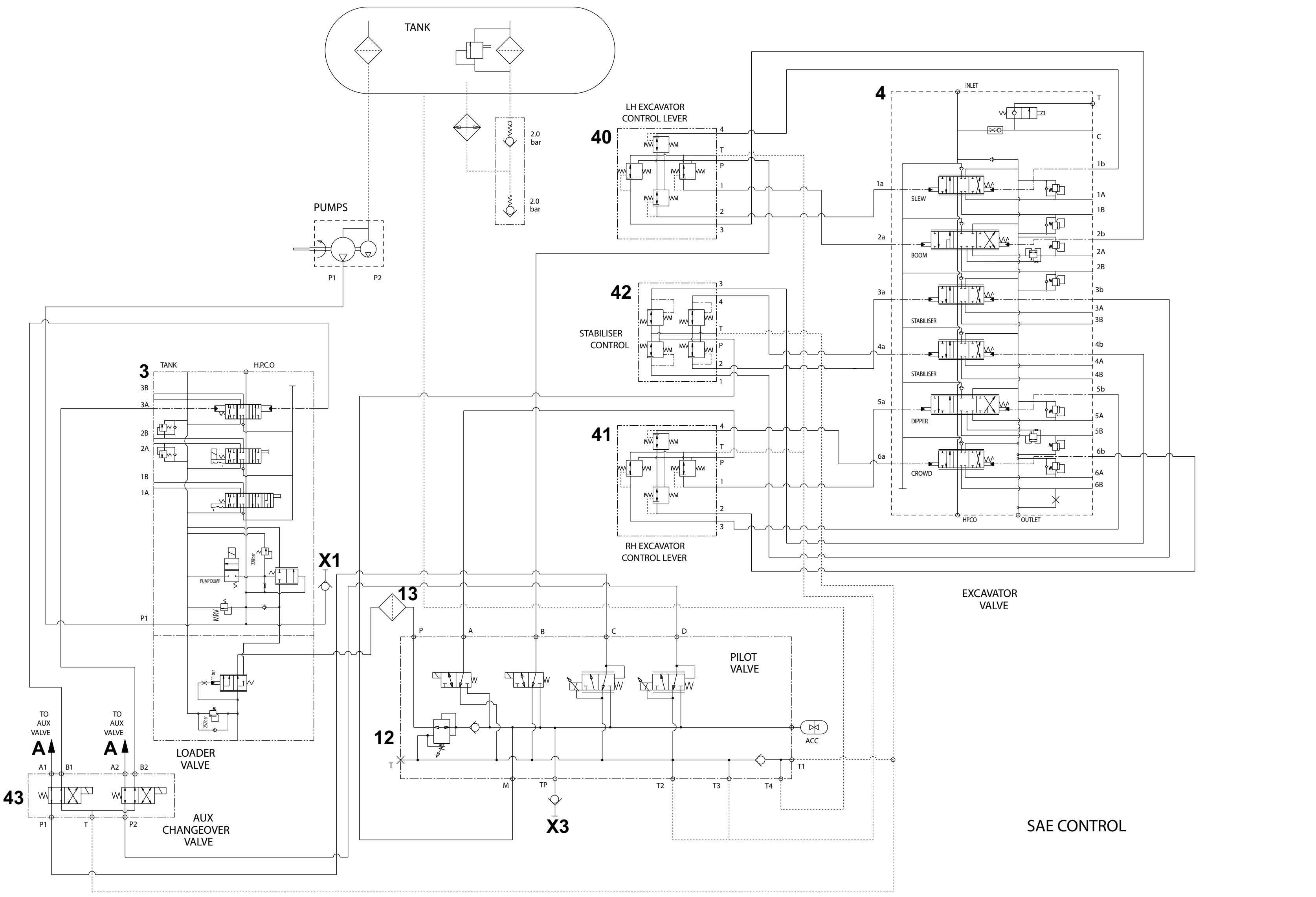

Fig 16. Pilot Circuit SAE Control Pattern, Sheet 2 of 4

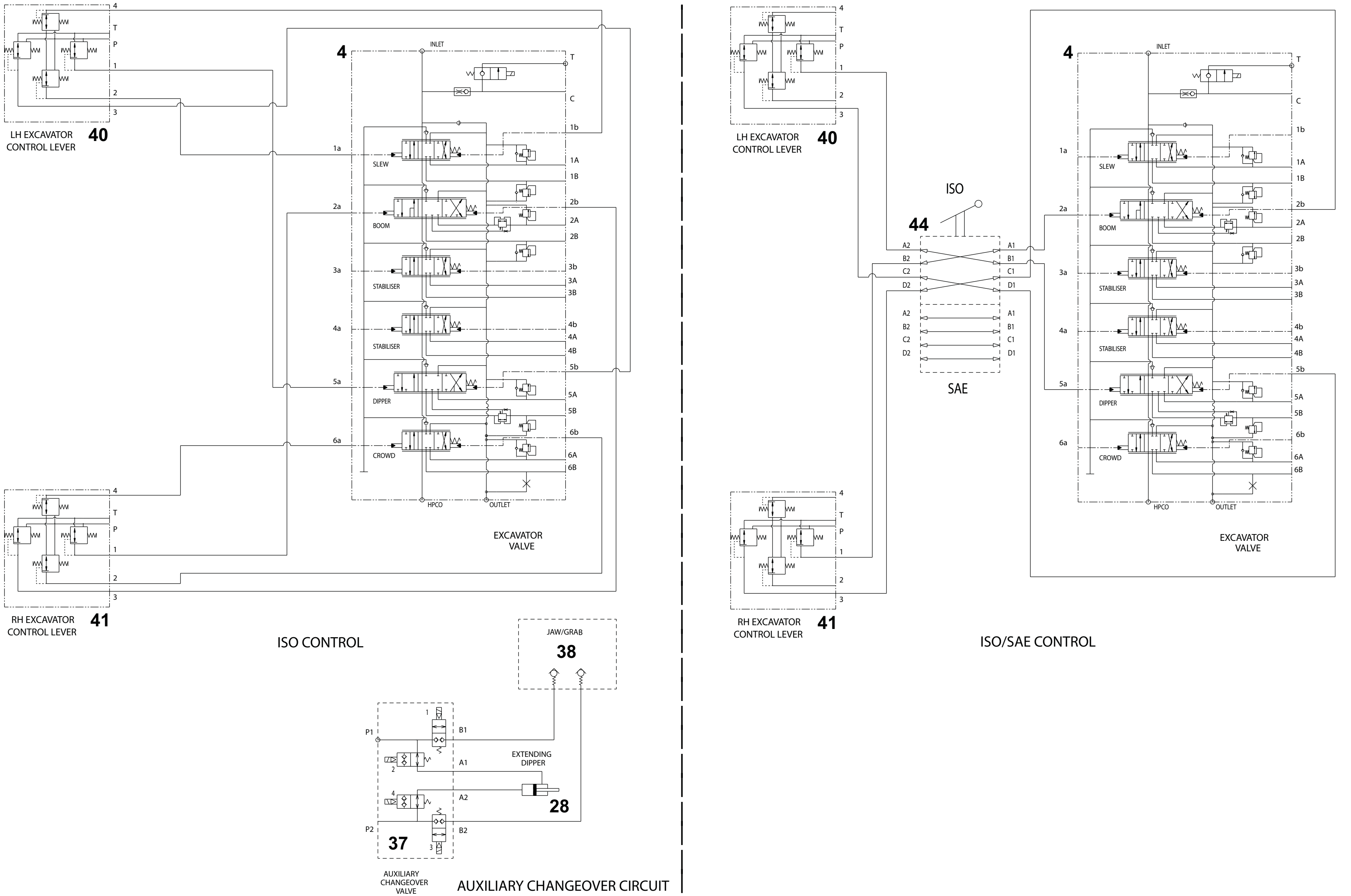

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Fig 17. Pilot Circuit ISO Control Pattern and ISO/SAE Control Pattern Changeover, Sheet 3 of 4

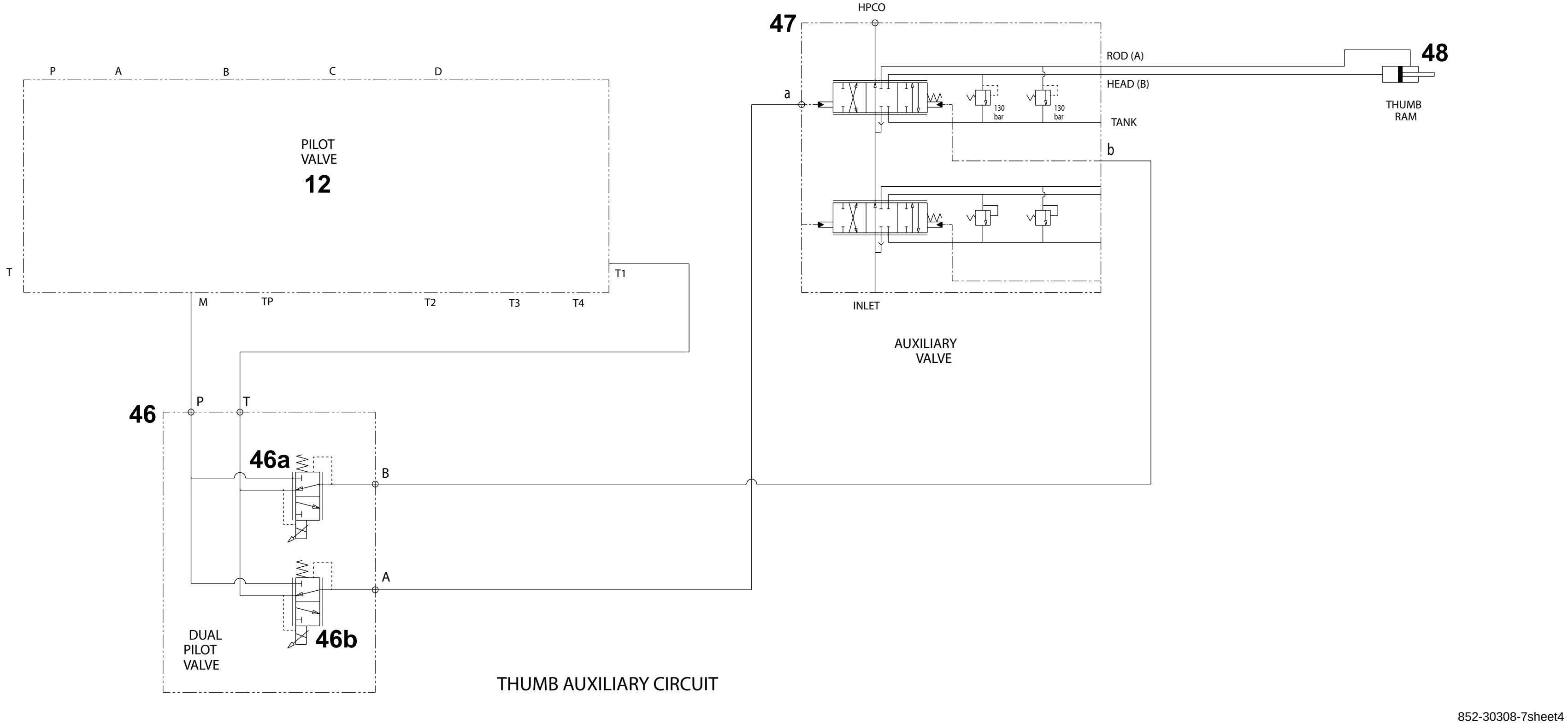


Fig 18. Thumb Auxiliary Circuit, Sheet 4 of 4

Component Key:

12	Servo Pressure Supply Valve
46	Dual Pilot Control Valve Block
46a	Thumb ‘Open’ Proportional Solenoid Valve
46b	Thumb ‘Close’ Proportional Solenoid Valve
47	Auxiliary Valve Block (2 spool shown)
48	Thumb Ram

Precision Control SYSTEM

Related Topics

The table lists other topics in the section that contain information related to this topic. Refer to the applicable topics to complete your procedures. Where applicable the text contains cross-references to help you find the correct information.

Topic Titles:
⇨ *Joystick and Stabiliser Controls (L-232)*
⇨ *Loader Lever Controls (L-239)*
⇨ *Servo Pressure Supply Valve (L-241)*
⇨ *Inloader Valve (L-258)*
⇨ *Hydraulic Pump (Gearpumps) (L-266)*
⇨ *Loader Valve (Sectional Type) (L-277)*
⇨ *Excavator Valve (Sectional Type) (L-312)*
⇨ *Auxiliary Valve Block (Sectional Type) (L-336)*
⇨ *Cab Seat (L-342)*

System Overview

***Note:** This hydraulic system differs in many important aspects to the normal hydraulic system. Before attempting to service or fault find the system ensure that you read and understand all the descriptions in this section. **The following descriptions make some comparisons to the normal hydraulic system. `Normal system' refers to standard non-servo machines** described in Section E Hydraulics.*

The combined effect of the features described below ensure a precise and predictable response of the hydraulic services to operator input, and at the same time, maximises machine operating efficiency.

Excavator Servo Controls

⇨ ***Fig 1. (L-129)***. The Precision Control system facilitates operation of the backhoe (excavator) via joystick controllers **A** and **B** mounted in the arms of the seat, and operation of the stabilisers via levers **C** mounted in the side console.

The joysticks and stabiliser controls each directly operate proportional pilot control valve capsules **D**. These valves in turn operate the excavator valve **E** service spools via hydraulic pilot pressure. The pilot control valve capsules direct servo pilot oil at a pressure proportional to the amount the operator moves the applicable joystick. The interconnecting servo pilot hoses to and from the excavator joystick controllers are routed through the central seat support pillar and then through the cab floor. **There are no mechanical linkages between the control levers and the excavator service spools as used in the normal system**.

Servo Pilot Oil Supply: A servo pressure supply valve **F** provides a constant supply of oil at servo pressure to the joystick controllers and stabiliser controls. Note that if the operator's seat is not in the correct operating position, or the joysticks cut-out pushbutton is pressed, the servo pressure supply valve isolates the servo pilot oil supply and the joystick controllers are disabled. ⇨ ***Joystick Enable and Seat Interlock Switches (L-128)***

Load Sense and Pressure Compensator Function

Load Sensing: All the hydraulic services are connected to a hydraulic load sense circuit. When no services are operated, there is no demand for flow from the hydraulic system, the oil from the gearpump flows to the inlet-outlet section of the loader valve **G** and directly back to tank. Note that the service spools are closed-centre. **There is no `neutral circuit' as defined in the normal system**.

When a service is operated, the system senses the demand, and the pump operating pressure adjusts to a value sufficient to operate the service. The load sense feature also incorporates the main pressure relief function, which is controlled by the load sense relief valve **H**. **This replaces the Main Relief Valve (MRV) used in the normal system**. ⇨ ***Hydraulic Operation and Schematics (L-130)***.

Pressure Compensation: Each service spool incorporates a pressure compensator valve **J**. When services are operated simultaneously, the system ensures consistent operating speed for all services, even when the limit of the hydraulic pump performance is approached.

***Note:** Pressure compensator valves are not fitted at the excavator valve stabiliser spools from October 2005.*

Inloader Valve and Hydraulic Speed Control (HSC) Function

The output flow from the secondary hydraulic pump **K** (pump P2) is automatically controlled by an inloader valve **L**. The valve responds to the hydraulic load sense pressure and main system pressure, connecting the flow from pump P2 into the main hydraulic system only when it is required. The precision control system normally operates with pump P2 output isolated. **This differs to the normal system (Unloader operation) where pump P2 is always connected unless the operator presses the HSC switch in the cab**. ⇨ ***Hydraulic Operation and Schematics (L-130)***.

Note:** On some machines the original inloader valve has been replaced with a new unloader valve.* ⇨ ***Unloader Valve Variant (L-136)

The hydraulic operation of the inloader valve can be overridden electrically by energising solenoid **M**. While the solenoid remains energised, the additional flow available from the hydraulic pump P2 cannot be connected into the main hydraulic system, and is permanently dumped to tank.

The inloader solenoid **M** is energised by the operator pressing the HSC switch **N** in the side console or the pushbutton in the loader lever. Dumping the pump P2 output flow to tank in this way reduces the load on the engine, and ensures that more of the engine power is available for traction when the machine is entering a stock pile during loading operations. For more details of the electrical circuit and connections, ⇨ ***Electrical Operation and Schematics (L-137)***.

System Pressure Switch: When the seat is facing forward, a system pressure switch housed in the servo pressure supply valve block **F**, prevents HSC operation when the main hydraulic system pressure is above 230 bar (3350 lb/in^2).

Note: *The system pressure switch is no longer fitted on machines from serial no. 976693.*

Grading Mode

On some machine variants the HSC switch **N** has an additional mode function to select `grading bucket' mode. This feature gives the operator greater control when precise positioning of the grading bucket is required. ⇨ ***Hydraulic Operation and Schematics (L-130)***.

Auxiliary Service Thumbwheel Controls

The RH joystick incorporates a thumbwheel switch **P** to operate the excavator auxiliary service. The loader lever knob also incorporates a thumbwheel switch **Q** to operate the loader auxiliary service.

The thumbwheels control four electro-hydraulic proportional solenoid valves housed in the servo pressure supply valve block **F**.

Central to the control of the proportional solenoids is the PWM controller electronic control unit (ECU) **R** mounted to the loader lever tower. The ECU receives analogue electrical inputs from the thumbwheel switches **P** and **Q**, and supplies a modulated output signal (PWM) to the relevant proportional solenoid valve.

The proportional solenoid valves work as separate pressure reducing valves, and direct servo pilot oil to move the auxiliary service spool at a pressure proportional to the amount the operator moves the thumbwheel switch. For a detailed description of proportional solenoid valve operation, see ***Servo Pressure Supply Valve - Descriptions***.

Joystick Enable and Seat Interlock Switches

To make the joystick controls active, the solenoid operated isolation valve housed in the servo pressure supply valve block **F** must be energised. The solenoid is energised via relays, by sensor switches **S** and **T** on the seat.

Typically, to energise the isolation valve solenoid the seat must first be locked in the rear facing position, thereby activating the `seat rear' sensor switch **T** on the base of the seat. The operator must then press and release the joysticks enable pushbutton on the RH joystick. The green LED's **U** on both joysticks will then illuminate to indicate that the joysticks are active.

To disable the joysticks the operator must either press the cut-out pushbutton on the RH seat pod or unlock and move the seat from the rear facing position. This will cause the the isolation valve solenoid to de-energise, and the servo pilot oil supply to the joysticks will be isolated.

Note that the excavator joysticks can be enabled by the operator when the seat is locked in the forward facing position if required. This activates the `seat forward' sensor switch **S** on the base of the seat. The operator must then press and hold the pushbutton on the RH joystick. The warning buzzer will sound to alert the operator that the joysticks are active. When the operator releases the pushbutton, the joysticks become disabled and the warning buzzer will cease. For more details of the electrical circuit and connections, ⇨ ***Electrical Operation and Schematics (L-137)***.

The LH joystick houses a pushbutton to operate the rear horn. On some machine variants the joysticks may have additional mode pushbuttons, for example to operate a hydraulic quickhitch, or an auxiliary changeover valve, typically to select between jaw bucket and extending dipper operation.

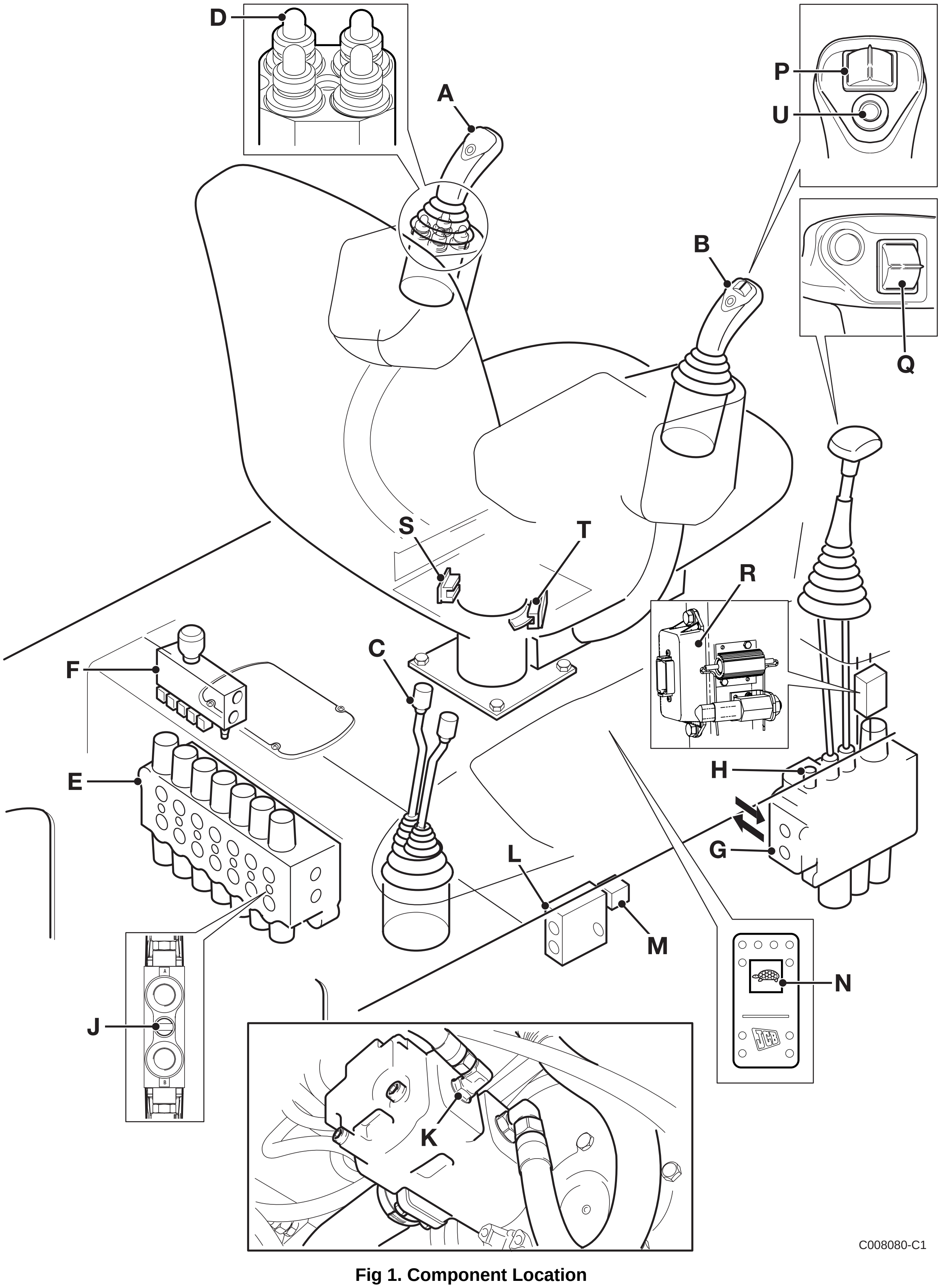


Fig 1. Component Location

Hydraulic Operation and Schematics

***Note:** To make the description as clear as possible the diagram shows only part of the complete hydraulic system. For the complete hydraulic schematics, see **Schematic Circuits**.*

No Services Operated: ⇒ *Fig 2. (L-132)*.

Note that the service spools are closed-centre. Oil from primary pump **P1** flows to the inlet-outlet section of the loader valve **3** and to the inlet port of the excavator valve **6**. When the main system pressure reaches around 15 bar the spring **3a** in flushing valve **3b** is overcome and oil is returned back to tank.

Note that oil from secondary pump **P2** supplies the steer circuit via steer priority valve **1** as normal, but is not connected to the main hydraulic system. Its flow is dumped to tank via inloader valve **2**.

Oil from pump **P1** also flows to the servo pressure supply valve **8**. The valve supplies servo pilot oil pressure regulated at 30 bar to the joystick controllers **4** and stabiliser controls.

Service Operation: ⇒ *Fig 3. (L-133)*.

When a service is operated, boom lift for example, movement of the applicable joystick controller **4** supplies pilot oil to actuate the service spool **6a**. The controller supplies pilot oil at a pressure proportional to the joystick movement, thus controlling how far the service spool is displaced. Oil passes across the service spool to the applicable pressure compensator valve **6c**. The valve opens and diverts oil to the load sense gallery and load hold check valve **6b**. Pressure in the load sense gallery increases and the flushing valve **3b** begins to close. Main system pressure continues to rise until load hold check valve **6b** opens and the boom lift ram **7** operates.

The main system pressure will now be equal to the load sense pressure (load from the boom lift ram) + the force of flushing valve spring **3a** (around 15 bar).

Oil from the other side of the ram **7** flows across the service spool and back to tank in the normal way.

Inloader Operation: ⇒ *Fig 3. (L-133)*.

When high flow operation is required, if operating multiple hydraulic services simultaneously at full speed for example, the inloader valve **2** operates to connect the output from pump **P2**. The valve operates when the pressure difference between the load sense and service galleries reduces. This causes the inloader valve spool **2a** to close, directing the oil from pump **P2** into the main hydraulic system.

***Note:** On some machines the original inloader valve has been replaced with a new unloader valve.* ⇒ *Unloader Valve Variant (L-136)*

Multiple Service Operation: In the normal hydraulic system the services are connected in parallel, this means that when multiple services are operated simultaneously, the speed of one service can be affected by the operating pressure of another service. This is not the case with precision control.

The pressure compensator valves for each service react to the differing load pressures. For example, when a pressure compensator valve is subjected to a higher load sense pressure from another service, it reacts to reduce the flow to its service, ensuring that the associated ram operates at a constant speed, regardless of the increase in the main system pressure.

Main System Pressure Relief: ⇒ *Fig 4. (L-134)*.

The maximum main system pressure is controlled by limiting the maximum load sense pressure.

When a service ram reaches the end of its stroke, or the service meets resistance and generates pressure above 235 bar in the load sense line, the load sense relief valve **3c** opens and load sense oil is dumped to tank, preventing further pressure rise. The flushing valve **3b** operates as normal. Since the main system pressure required to open the flushing valve is around 15 bar above the load sense pressure it follows that the main system pressure will be limited to 235 bar + 15 bar, a total of 250 bar.

***Note:** The pressure values given are examples for the purpose of explanation only. Actual values may be different depending on the machine variant. All pressure relief valves are factory set. No adjustment is normally required.* ⇒ *Checking the Main System Pressures (L-159)*.

Grading Mode: ⇒ *Fig 5. (L-135)*.

The grading mode circuit is activated by operating the selector switch in the cab.

When grading mode is selected, the grading mode solenoid valve **43** is energised. The valve spool connects port (P) to port (A) allowing a small amount of oil from the dipper `raise' pilot line to leak back to tank **T** via the drain line from the stabiliser controls **42** and the servo pressure supply valve **12**.

The volume of oil leaking to tank is controlled by the integral restrictor orifice **Y**.

The constant leak to tank reduces proportionally the pilot pressure available to actuate the dipper service spool **4E** in the raise direction, this has the effect of slowing the rate of movement of the dipper ram **17** in the raise direction, and overall making the dipper operate more slowly in response to raise demands from the joystick **40**.

This feature gives the operator greater control when precise positioning of the grading bucket is required.

Note: *From October 2006, the grading mode solenoid valve* ***43*** *is connected to operate with the boom service.*

Table 1. Colour Key to Oil Flow and Pressure

	Full Pressure
	Load Sense Line
	Servo
	Neutral
	Exhaust

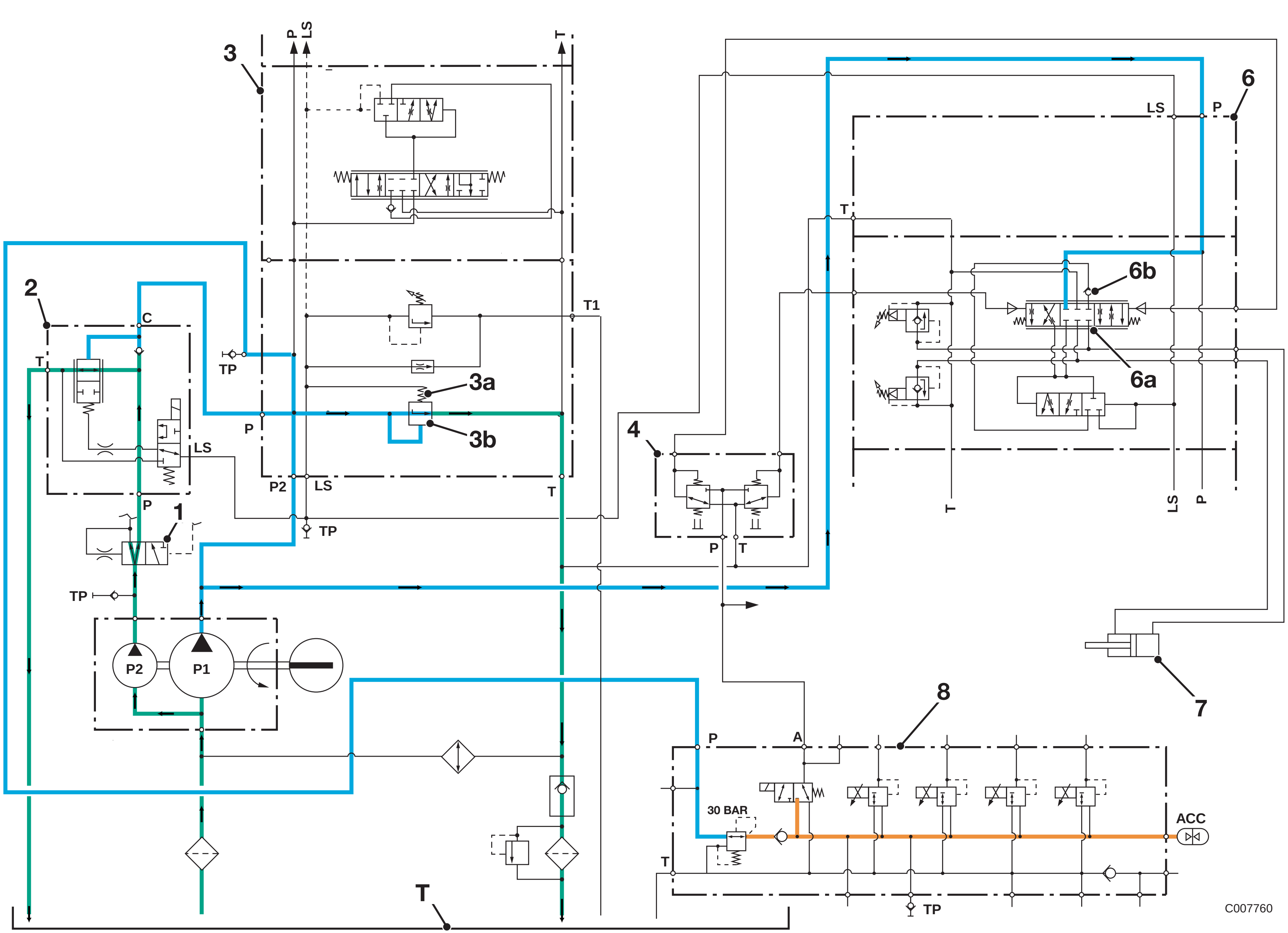


Fig 2. No Services Operated (Neutral)

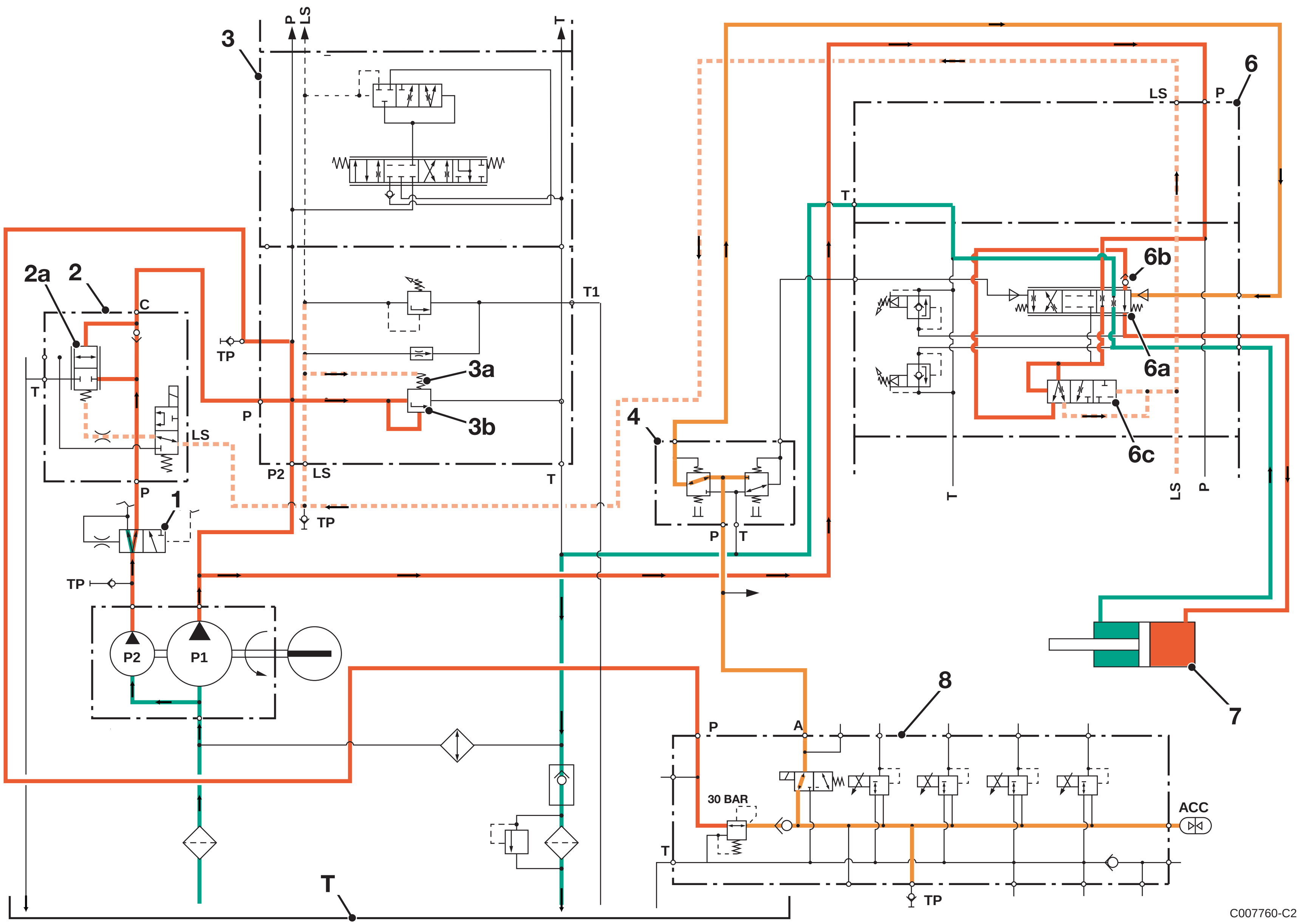


Fig 3. Service Operation and Inloader Operation

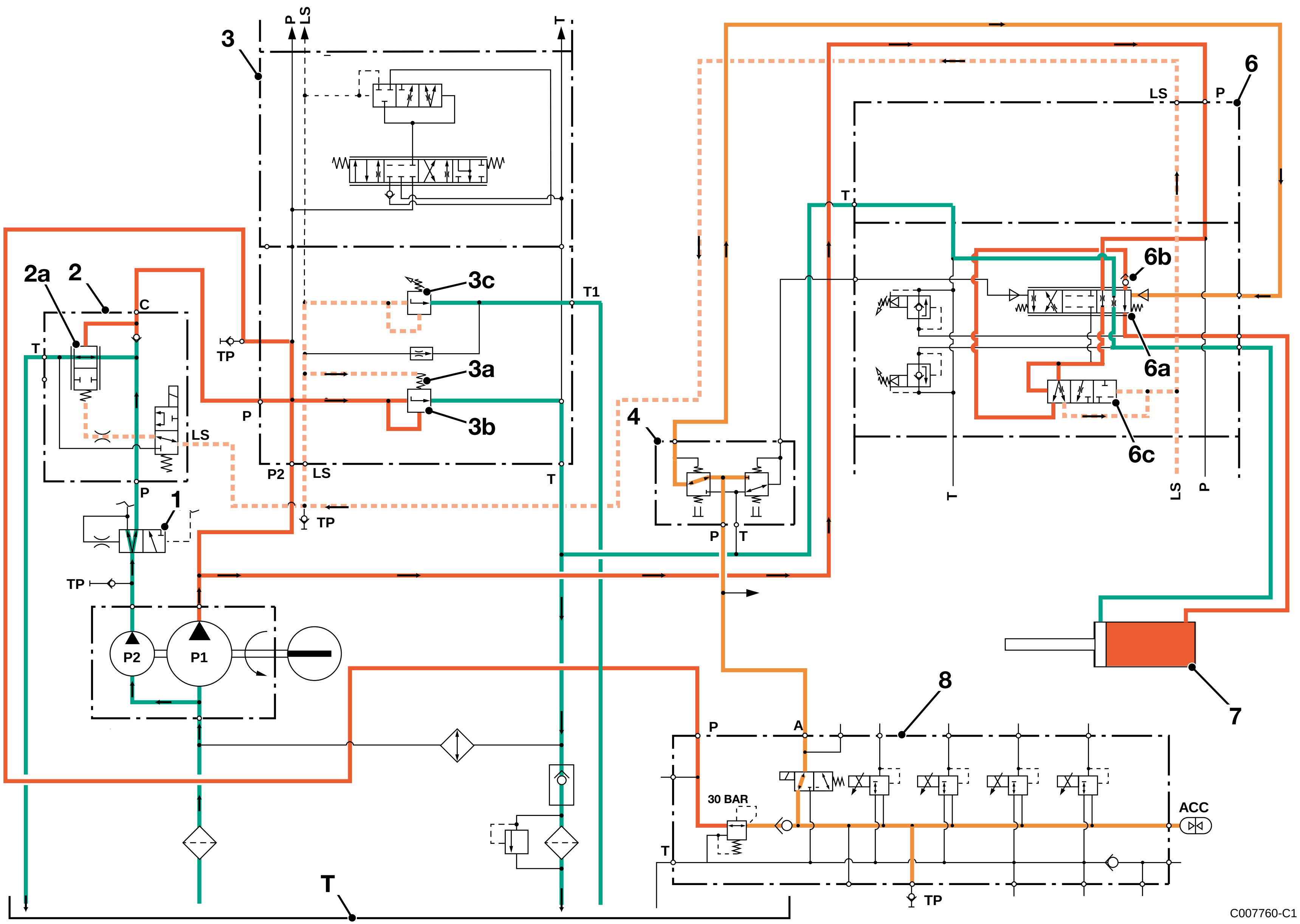


Fig 4. Main System Pressure Relief

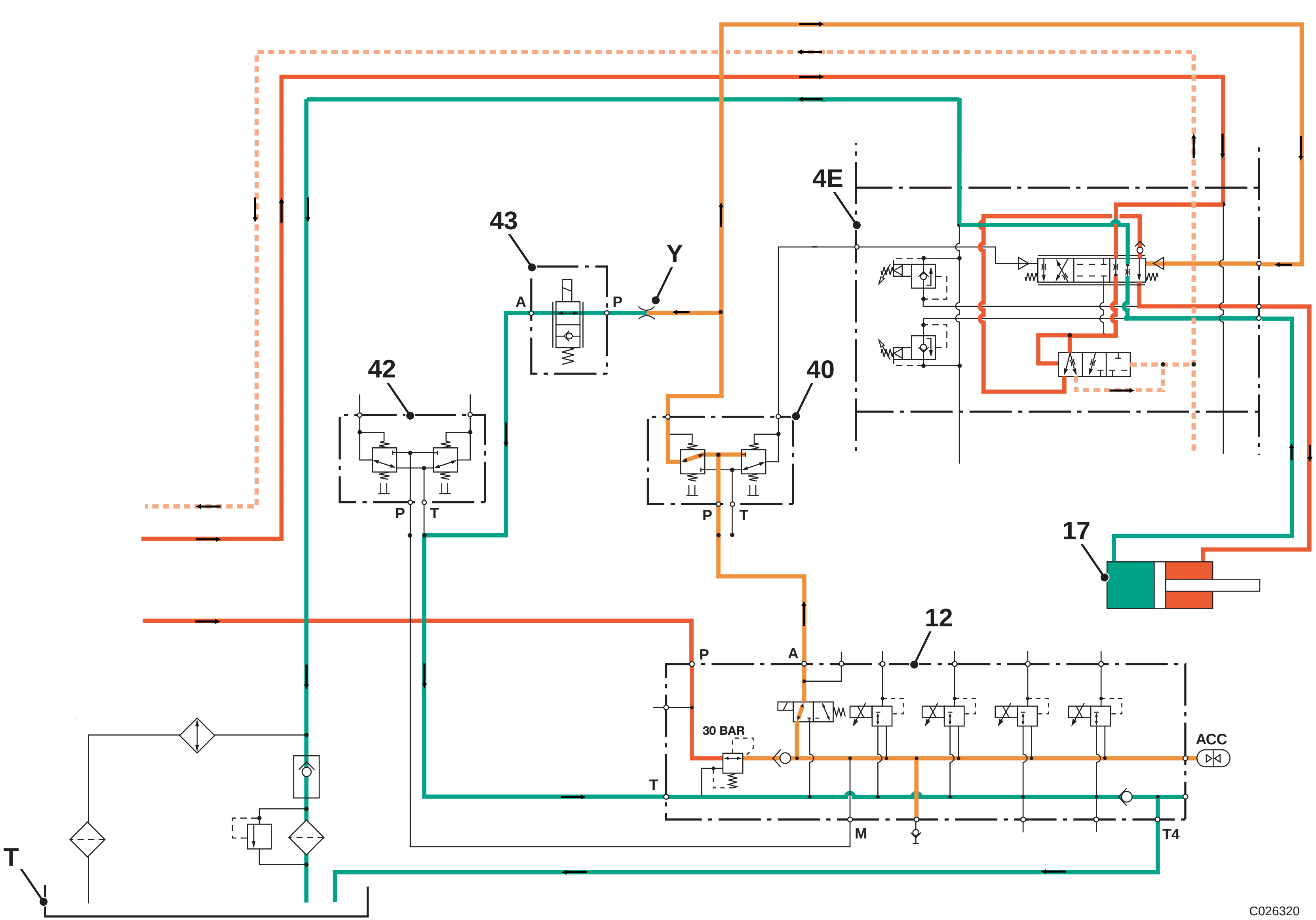


Fig 5. Grading Mode Operation

Unloader Valve Variant

On some machines the original inloader valve has been replaced with a new unloader valve.

This means that on machines that have been modified, the flow from the secondary pump P2 is normally always in circuit, and is 'unloaded' back to tank via an unloader spool. This is the same operation as the unloader (located in the loader valve) on standard non-servo machines described in Section E.

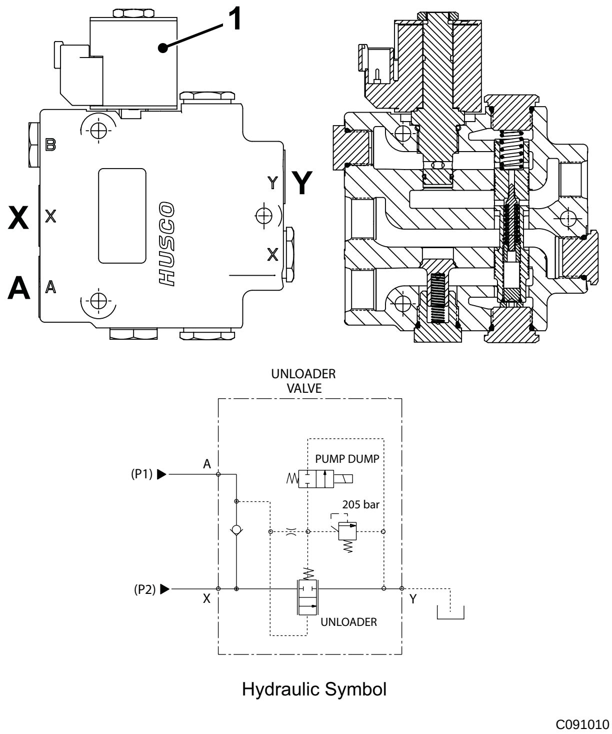


Fig 6. Unloader Valve

Key:

1 Pump dump solenoid (HSC)

A Pump P1 port

X Pump P2 port (via steer priority valve)

Y Tank port

Note: *For the complete machine hydraulic circuit, see* ***Schematic Circuits - Hydraulics****.*

Electrical Operation and Schematics

Joysticks Enable Circuit

The diagrams in this section are intended to show how the electrical circuits work when different functions are operated.

The wire numbers and colours, where appropriate, are shown as an aid to identification while fault finding. The wires coloured red show the electrical live feeds. The wires coloured green show the electrical returns to earth.

Before fault finding make sure that you understand how the electrical circuits work. Most potential faults can be traced using a multimeter to carry out continuity checks on wires, switches and solenoids.

Seat Facing Rear: ⇨ *Fig 7. (L-138)*.

Pressing the joystick enable pushbutton **9** energises the seat rear/servo pilot relay **12**. The servo pilot valve solenoid **15** then energises, which allows servo pilot pressure to be directed the joystick controllers. The joystick controllers become active.

Seat Facing Rear and Latched: ⇨ *Fig 8. (L-139)*.

The seat rear/servo pilot relay **12** latches when the joysticks enable pushbutton **9** is released. The Joystick controllers remain active until either the joysticks cut-out pushbutton **13** is pressed or the seat is moved from the rear facing position.

Joysticks Cut-out Button Pressed: ⇨ *Fig 9. (L-140)*.

Pressing the joysticks cut-out pushbutton **13** momentarily de-energises the seat rear/servo pilot relay **12**. The relay unlatches. The servo pilot valve solenoid **15** then de-energises isolating the servo pilot pressure to the joystick controllers.

Seat Facing Forward: ⇨ *Fig 10. (L-141)*.

With the seat facing forward, the servo pilot valve solenoid **15** is energised only while the joystick enable pushbutton **9** is `held' pressed. The joysticks enable warning buzzer **18** will sound to alert the operator that the joysticks are active.

Component Key:

9 Joysticks Enable Pushbutton (RH Joystick)
10 Joysticks Enabled LED (LH Joystick)
11 Joysticks Enabled LED (RH Joystick)
12 Seat Rear/Servo Pilot Latching Relay
13 Joysticks Cut-out Pushbutton
14 Seat Rear Sensor Switch (Vane Type)
15 Servo Pilot Valve Solenoid
16 Seat Forward/Servo Pilot Relay
17 Seat Forward Sensor Switch (Vane Type)
18 Joysticks Enable Warning Buzzer (Seat Forward)
A To PWM Controller (ECU)

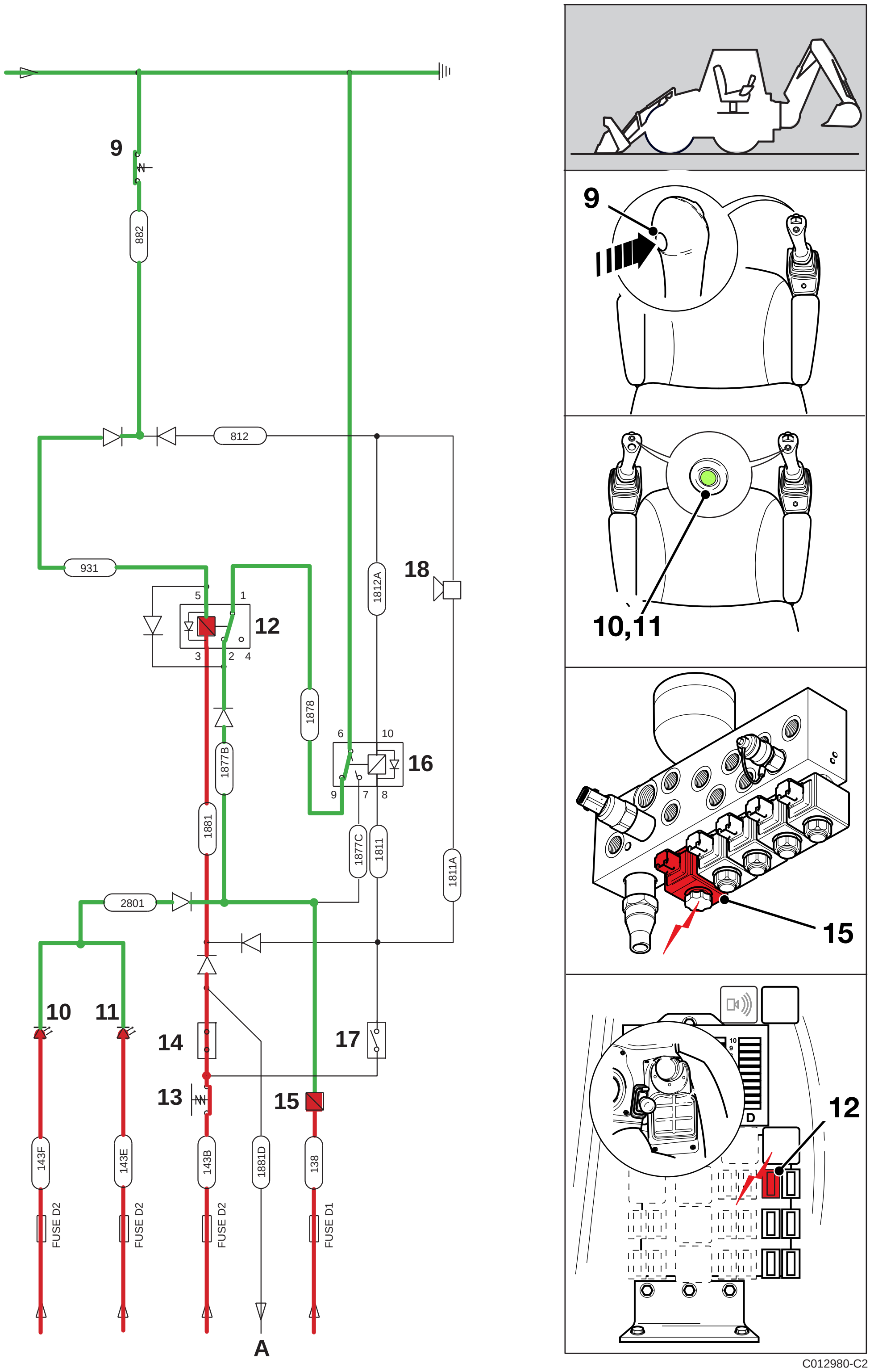


Fig 7. Joysticks Enable Circuit - Seat Facing Rear

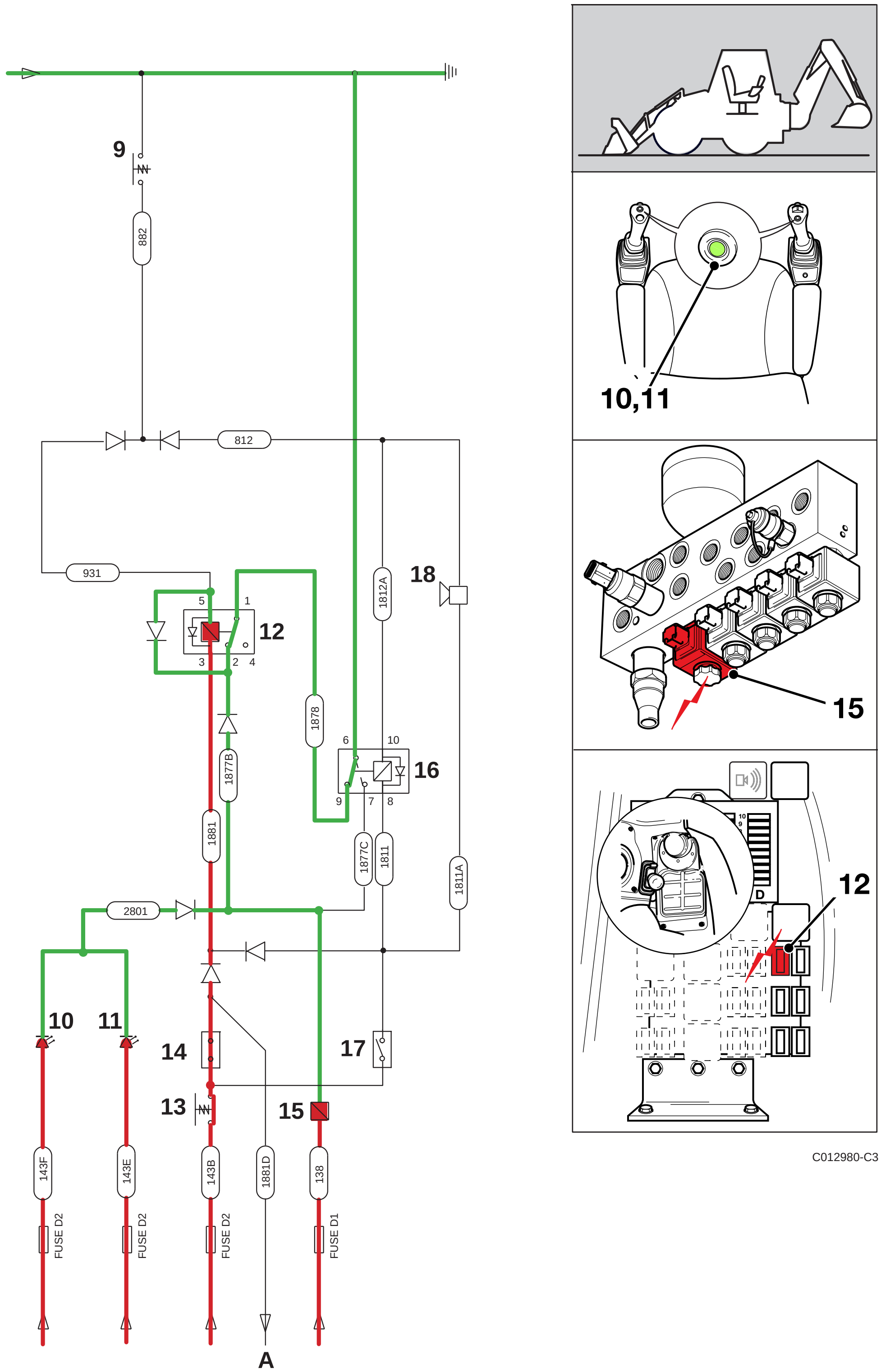
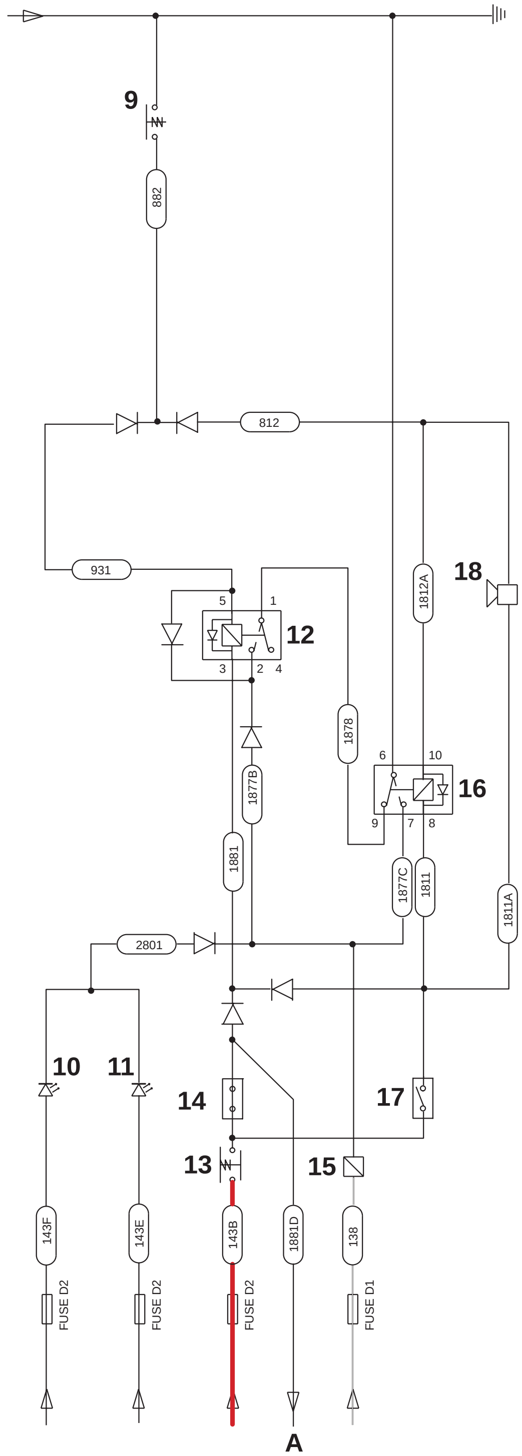


Fig 8. Joysticks Enable Circuit - Seat Facing Rear and Latched



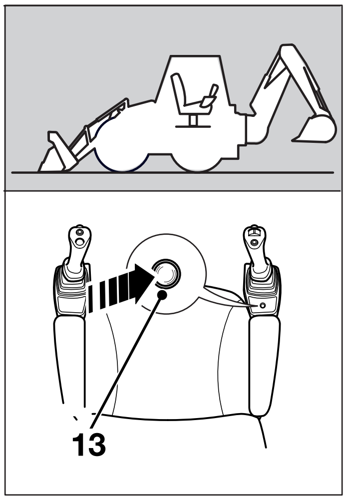


Fig 9. Joysticks Enable Circuit - Joysticks Cut-out Button Pressed

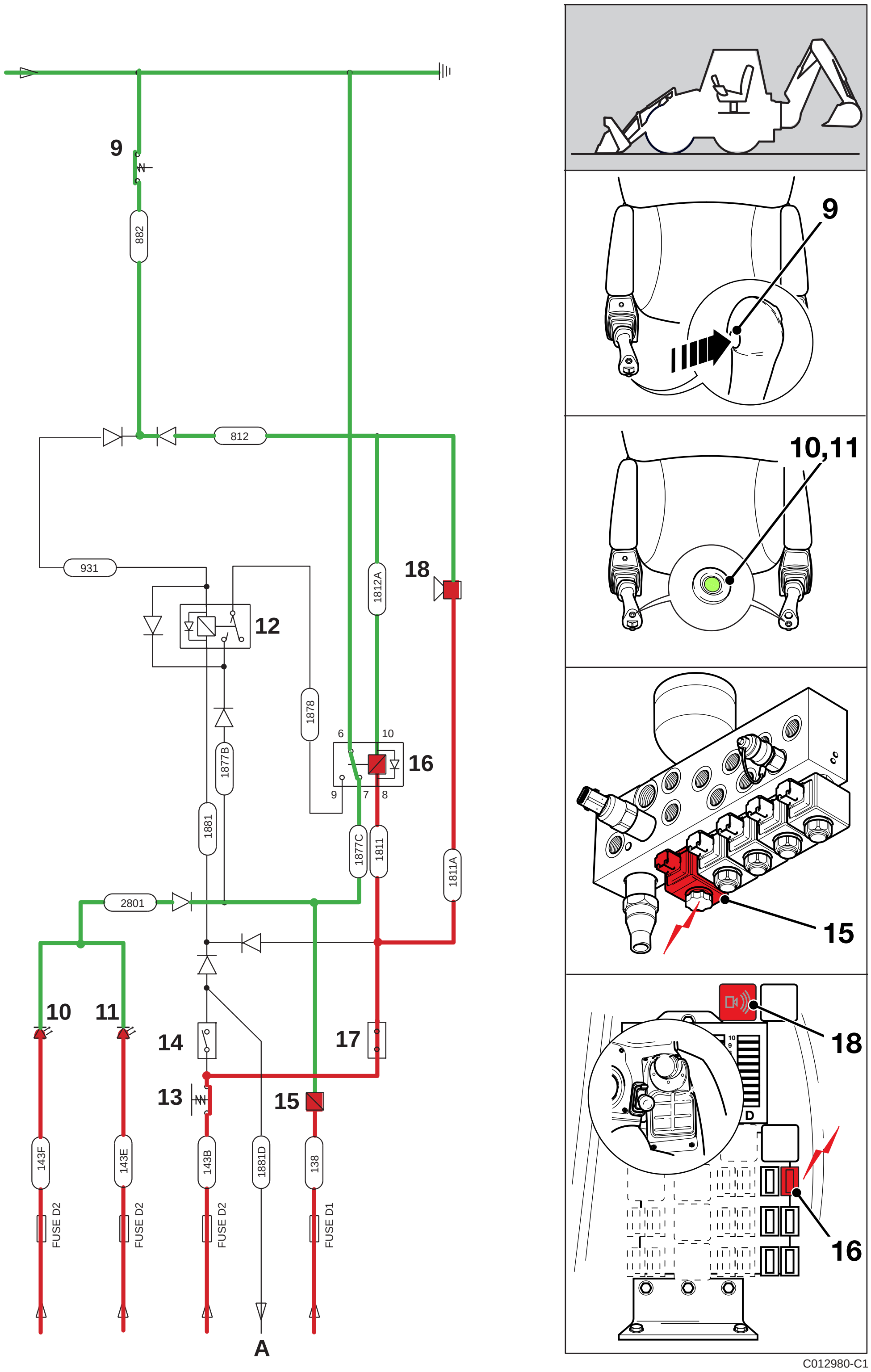


Fig 10. Joysticks Enable Circuit - Seat Facing Forward

Hydraulic Speed Control (HSC) Inloader Override Circuit

The diagrams in this section are intended to show how the electrical circuits work when different functions are operated.

The wire numbers and colours, where appropriate, are shown as an aid to identification while fault finding. The wires coloured red show the electrical live feeds. The wires coloured green show the electrical returns to earth.

Before fault finding make sure that you understand how the electrical circuits work. Most potential faults can be traced using a multimeter to carry out continuity checks on wires, switches and solenoids.

HSC Selector Switch `ON' (Joysticks NOT Enabled): ⇨ *Fig 11. (L-143)*.

Pressing the HSC selector switch **24** energises the inloader valve solenoid **19** (via the HSC relay **22**). The hydraulic operation of the inloader is thus electrically overridden. I.e. While the solenoid remains energised, the additional flow available from the hydraulic pump secondary section P2 cannot be connected into the main hydraulic system, and is dumped to tank.

HSC Selector Switch `ON' and Main Hydraulic System Pressure Above 230 Bar (Joysticks NOT Enabled): ⇨ *Fig 12. (L-144)*.

When the pressure in the main hydraulic system reaches 230 bar, the system pressure switch **21** energises the inloader relay **20**, which de-energises the inloader valve solenoid **19**. The hydraulic operation of the inloader will then function normally. I.e. While the solenoid remains de-energised, the additional flow available from the hydraulic pump secondary section P2 will be connected into the main hydraulic system automatically, should the flow demanded by a service or multiple services begin to exceed the flow available.

Note: *The system pressure switch is no longer fitted on machines from serial no. 976693.*

Loader Lever HSC Pushbutton Pressed (Joysticks NOT Enabled): ⇨ *Fig 13. (L-145)*.

Pressing the loader lever HSC pushbutton **23** energises the HSC relay **22**, which then energises the inloader valve solenoid **19**. The hydraulic operation of the inloader is thus electrically overridden. I.e. While the solenoid remains energised, the additional flow available from the hydraulic pump secondary section P2 cannot be connected into the main hydraulic system, and is dumped to tank.

Component Key:

9 Joysticks Enable Pushbutton (RH Joystick)
12 Seat Rear/Servo Pilot Latching Relay
13 Joysticks Cut-out Pushbutton
14 Seat Rear Sensor Switch (Vane Type)
15 Servo Pilot Valve Solenoid
16 Seat Forward/Servo Pilot Relay
17 Seat Forward Sensor Switch (Vane Type)
19 Inloader Valve Solenoid
20 Inloader Relay
21 System Pressure Switch (Servo Pilot Valve) (1)
22 HSC Relay
23 HSC Pushbutton (Loader Lever)
24 HSC/Grading Mode Selector Switch
44 HSC Cut-out Relay
B From 4th Gear Selector (Column Gear Switch)
C From Neutral Selector (Column Fwd/Rev Switch)

(1) No longer fitted on machines from serial no. 976693.

For a summary of the different hydraulic speed control (HSC) inloader override conditions, ⇨ *Table 2. HSC Inloader Override Status Table (L-146)*

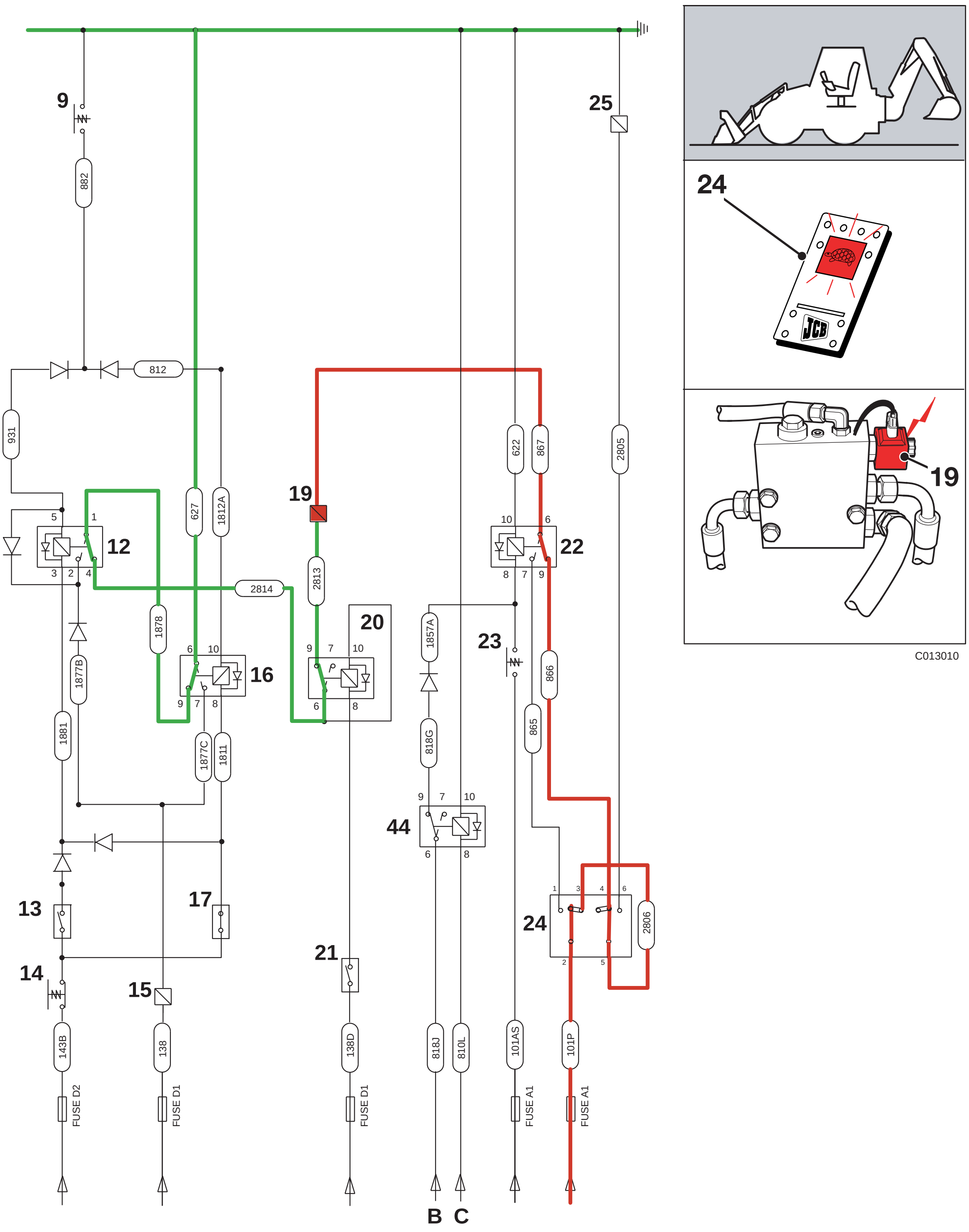


Fig 11. HSC Override Circuit - Switch `ON' (Joysticks NOT Enabled)

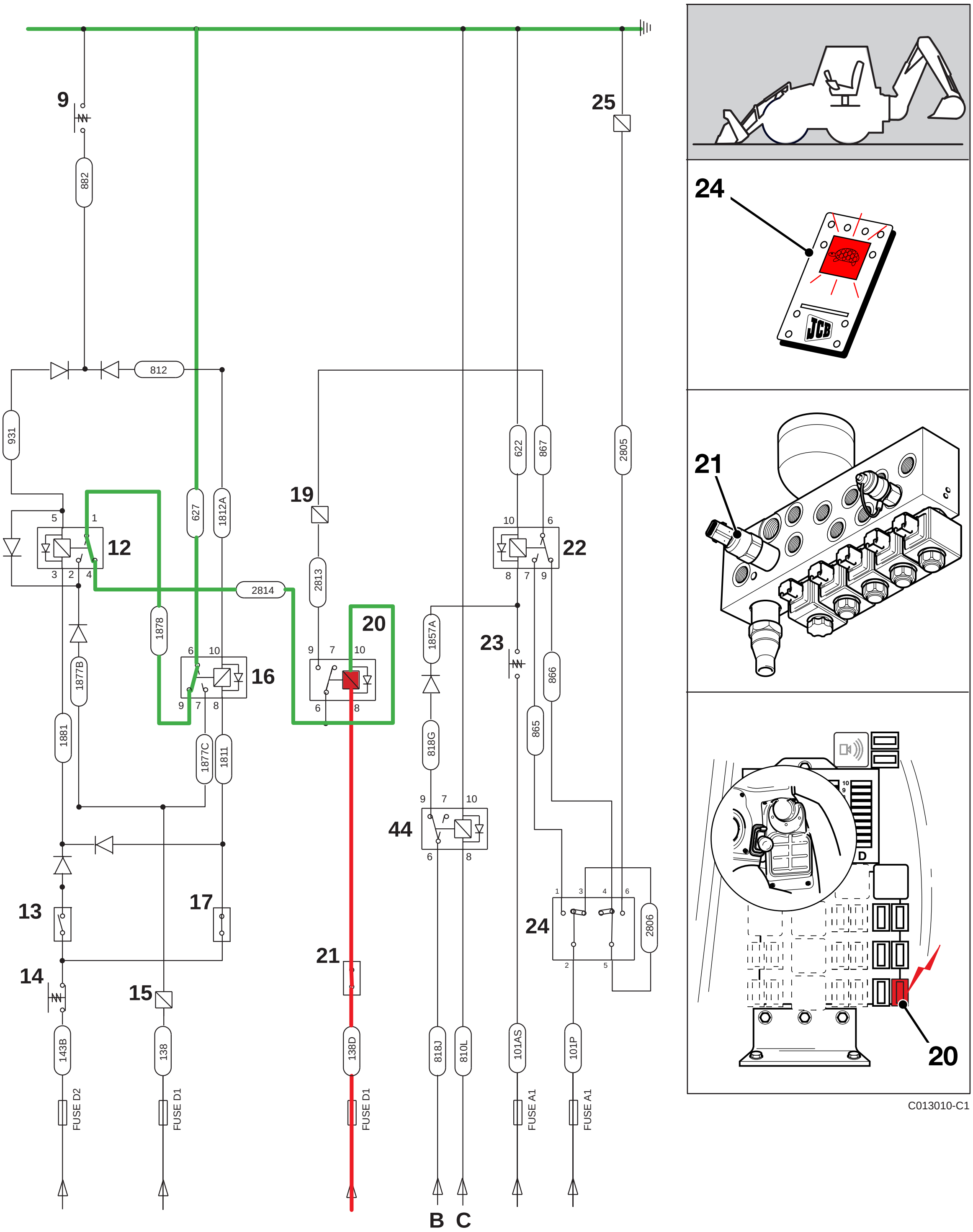


Fig 12. HSC Override Circuit - Switch `ON' and System Pressure Above 230 Bar (Joysticks NOT Enabled)

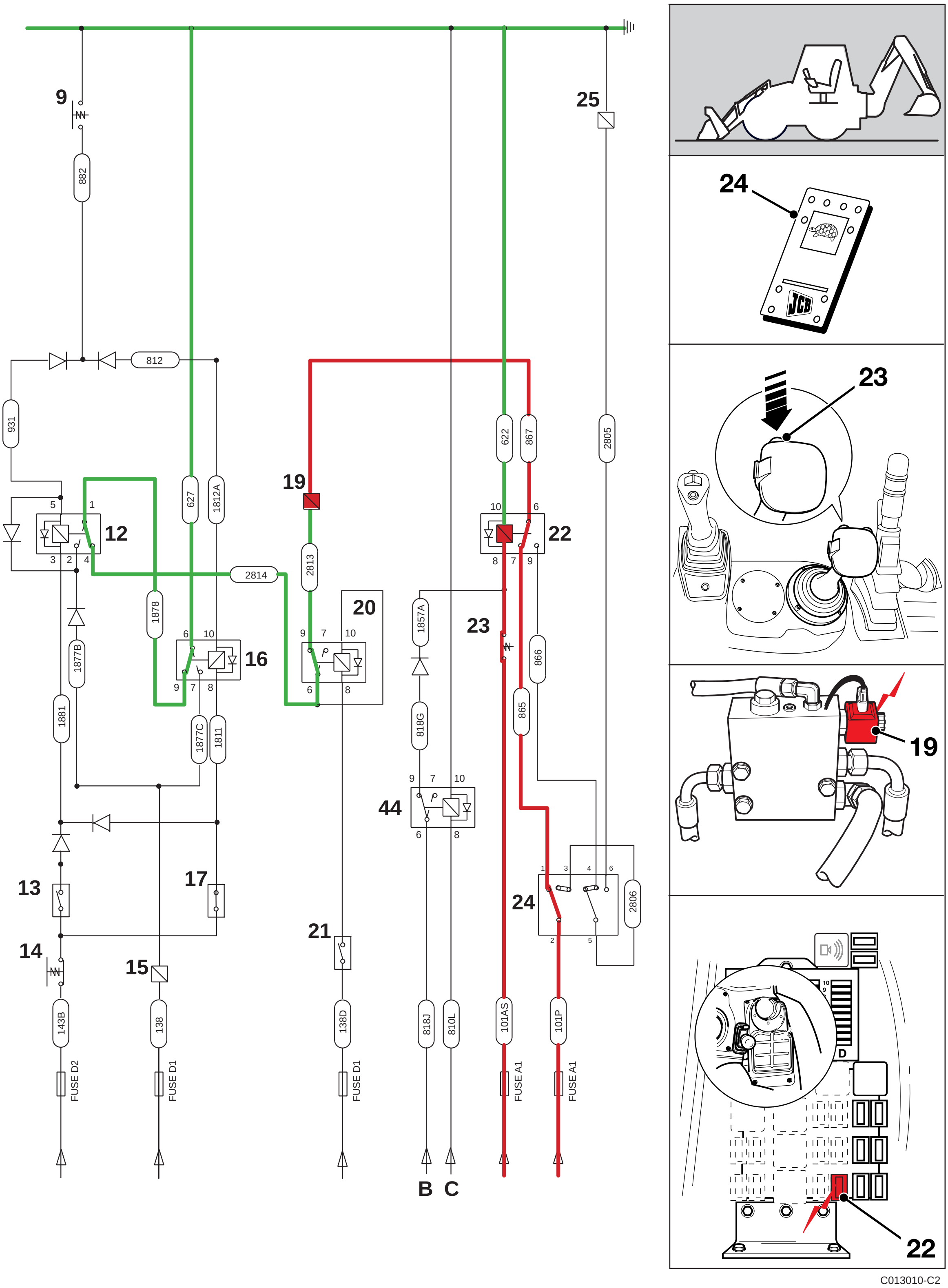


Fig 13. HSC Override Circuit - Loader Lever Button Pressed (Joystick NOT Enabled)

Table 2. HSC Inloader Override Status Table

System Configuration:						Status:
Joysticks Enabled ?	HSC Selector Switch Position ?	Loader Lever HSC Pushbutton Position ?	Hydraulic System Pressure Above 230 Bar ? (1)	4th/Auto Gear Selected ?	Neutral Selected ?	Inloader Valve Solenoid `Energised'
YES	ON or OFF	ON or OFF	NO	YES & NO	YES & NO	NO
YES	ON or OFF	ON or OFF	YES	YES & NO	YES & NO	NO
NO	OFF	ON or OFF	NO	YES	NO	YES
NO	OFF	ON or OFF	NO	YES	YES	NO
NO	ON	OFF	NO	YES & NO	YES & NO	YES
NO	ON	ON	NO	YES & NO	YES & NO	NO
NO	ON or OFF	ON or OFF	YES	YES & NO	YES & NO	NO

(1) The system pressure switch is no longer fitted on machines from serial no. 976693.

The above table shows the status of the inloader valve solenoid (either Energised or De-energised) for various system configurations.

Clam Shovel and Extending Dipper Circuit

The diagrams in this section are intended to show how the electrical circuits work when different functions are operated.

The wire numbers and colours, where appropriate, are shown as an aid to identification while fault finding. The wires coloured red show the electrical live feeds. The wires coloured green show the electrical returns to earth.

Before fault finding make sure that you understand how the electrical circuits work. Most potential faults can be traced using a multimeter to carry out continuity checks on wires, switches and solenoids.

Extending Dipper Controls: ⇨ *Fig 14. (L-148)*.

Pressing the joystick enable pushbutton **9** energises the clam shovel/ext. dipper isolator relay **43**. The relay latches and enables the PWM controller (ECU) **28** to function.

The ECU has a live feed on pin 8, indicating that the seat is facing rear. The changeover relay **34** is not energised, therefore the relay contacts connect the return circuit for the extending dipper proportional valve solenoids **30**.

The extending dipper thumbwheel **29** is fed from a separate 5 volt regulated supply **26**. When the thumbwheel is moved by the operator, the ECU converts the thumbwheel voltage (input) into a corresponding valve current signal (PWM output) to the relevant extending dipper solenoid valve coil **30**.

The ECU controls the valve current signal by varying the duty cycle of the PWM output.

A series of diodes are connected at the solenoid coils to prevent feedback from one coil to another, and also condition the circuit so that the duty cycle/valve current relationship functions correctly.

Connected in series with the solenoid coil return circuit is a 2.2 ohm, 150 Watt current sense resistor **33**. The resistor enables the ECU to measure the amount of current flowing through the coil being operated.

Clam Shovel Controls: ⇨ *Fig 15. (L-149)*.

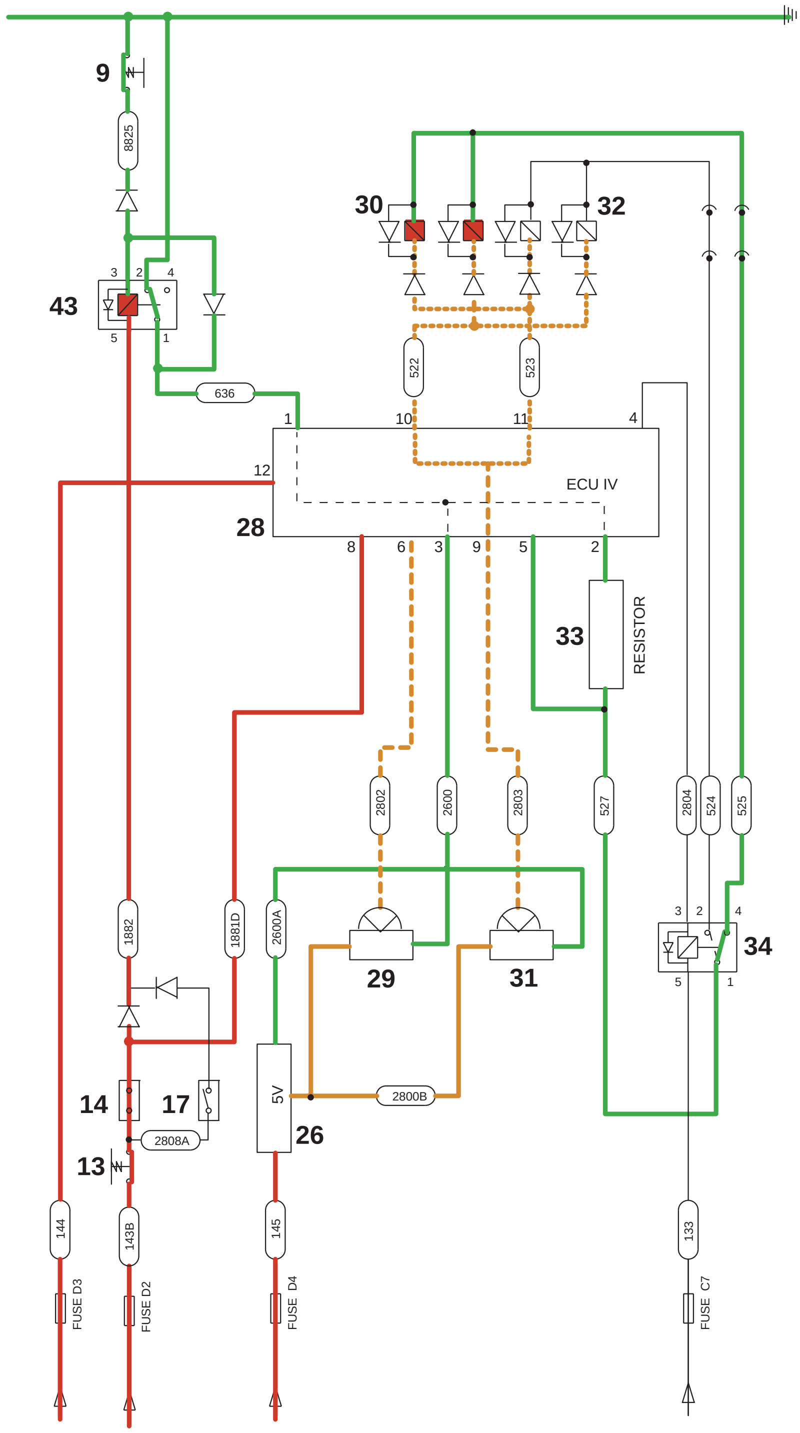
The clam shovel circuit works in the same way as the extending dipper circuit, except:

The ECU does not have a live feed on pin 8, indicating that the seat is facing forward. The changeover relay **34** energises, the relay contacts connect the return circuit for the clam shovel proportional valve solenoids **32**.

When the clam shovel thumbwheel **31** is moved by the operator, the ECU converts the thumbwheel voltage (input) into a corresponding valve current signal (PWM output) to the relevant clam shovel solenoid valve coil **32**.

Component Key:

9	Joysticks Enable Pushbutton (RH Joystick)
13	Joysticks Cut-out Pushbutton
14	Seat Rear Sensor Switch (Vane Type)
17	Seat Forward Sensor Switch (Vane Type)
26	5V Voltage Regulator
28	PWM Controller (ECU)
29	Ext. Dipper Thumbwheel (RH Joystick)
30	Ext. Dipper Proportional Solenoids (Servo Pilot Valve)
31	Clam Shovel Thumbwheel (Loader Lever)
32	Clam Shovel Proportional Solenoids (Servo Pilot Valve)
33	2.2 ohm, 150 Watt Resistor
34	Clam Shovel/Ext. Dipper C/O Relay
43	Clam Shovel/Ext. Dipper Isolator Latching Relay



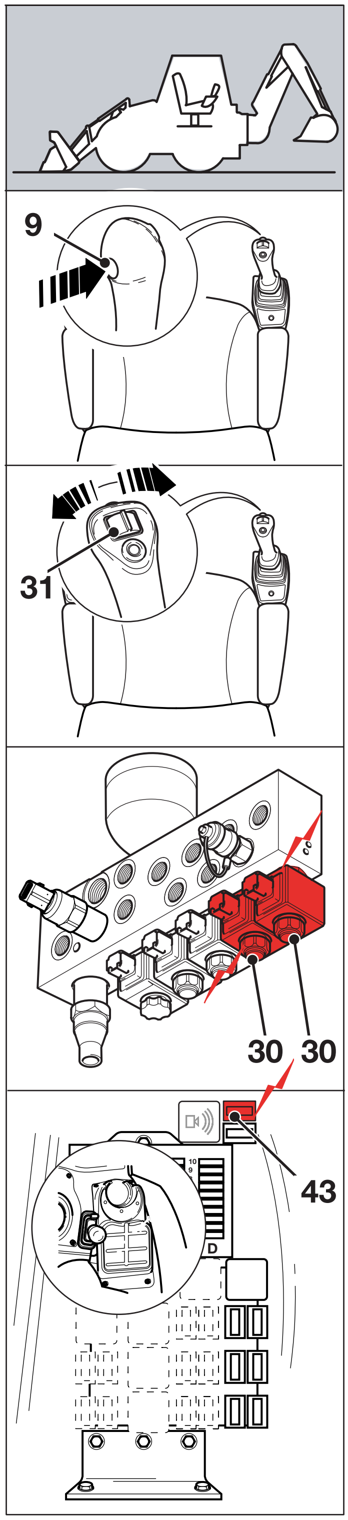


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Fig 14. Extending Dipper Controls

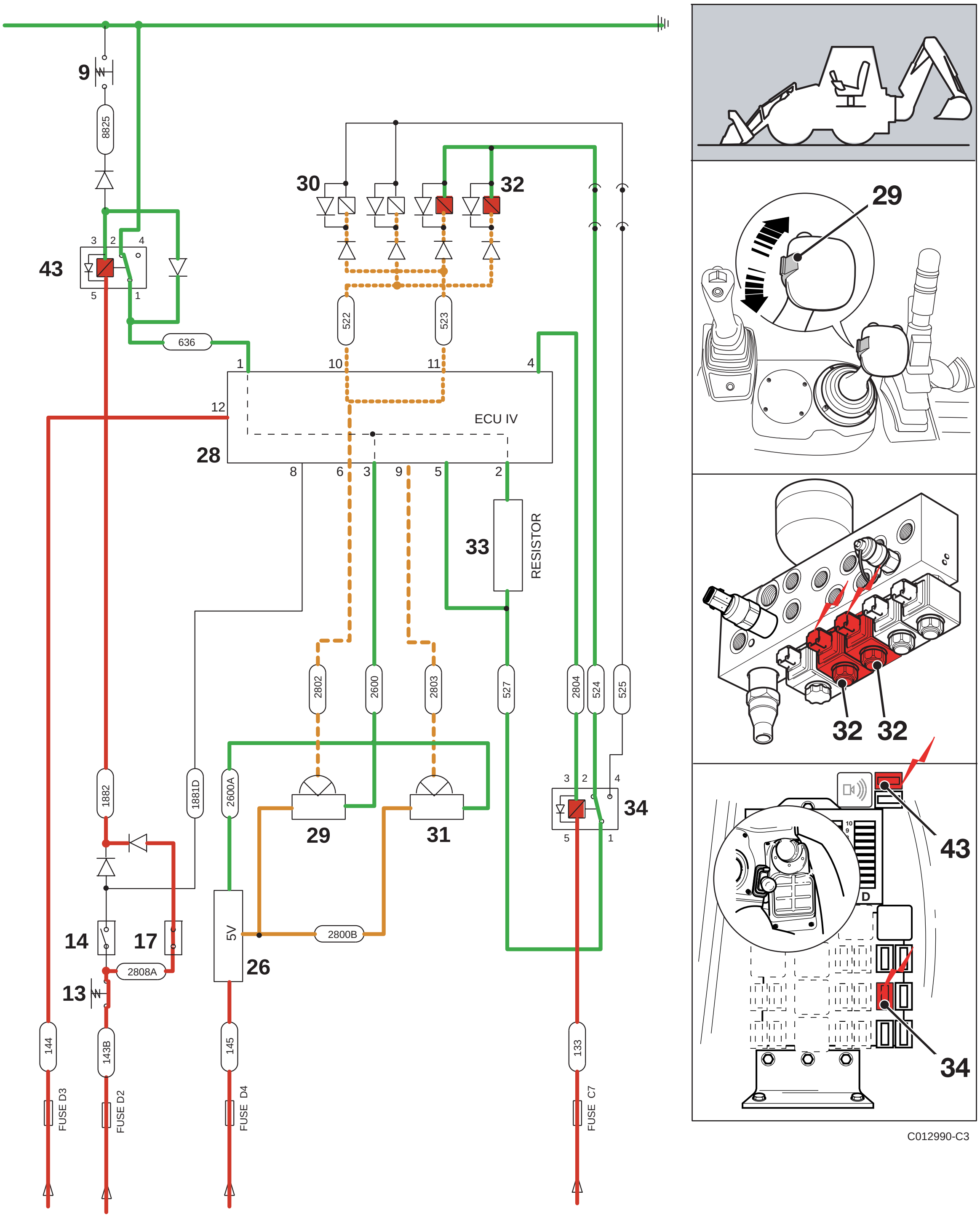


Fig 15. Clam Shovel Controls

Fault Finding

The purpose of this section is to help you trace a particular fault. The tables identify possible causes and give a suggested action with specific tests where applicable.

To help identify the hydraulic and electrical components mentioned in the fault finding tables, refer to the hydraulic and electrical schematic diagrams (near the beginning of this section).

1 Before you begin fault finding, read the safety information at the beginning of this manual.

2 Make any relevant electrical checks before moving on to the hydraulics.

3 Make simple checks before say, stripping a major hydraulic component.

4 Make sure that the hydraulic fluid is at the correct working temperature (50 °C, 122 °F).

5 If hydraulic contamination is found be sure to remove ALL debris, and if possible identify its origin. It may be part of a component from elsewhere in the hydraulic circuit.

6 What ever the fault, check the condition of the hydraulic fluid. Drain and replace if necessary.

7 Renew any seals such as `O' rings when re-assembling hydraulic components.

Fault Finding Tables

Fault Descriptions:		
1	No servo controls, the joysticks do not function.	⇒ Table 3. (L-151).
2	ALL services slow to operate (Particularly noticeable when operating the loader arms).	⇒ Table 4. (L-152).
3	ALL services lack power, the machine is unable to lift.	⇒ Table 5. (L-153).
4	One service operates correctly, but slows down when a second service is selected.	⇒ Table 6. (L-154).
5	One service fails or is slow to operate.	⇒ Table 7. (L-155).
6	Clam shovel or extending dipper service does not operate.	⇒ Table 8. (L-156).

Electronic Fault Codes

The thumbwheel PWM contollers (ECU's) will generate a blink code for some fault conditions. ⇒ Thumbwheel Diagnostic `Blink' Codes (L-157).

Table 3.

Fault	Possible Cause	Action
No servo controls, the joysticks do not function.	**1** Fault in electrical interlock circuit wiring, or operation of electrical interlock switches.	Check the condition of the associated electrical wiring for damage and that the fuses are intact. For details of the electrical circuit and connections ⇒ ***Joysticks Enable Circuit (L-137)***.
	a Seat sensor switch defective.	Check the seat is locked in the rear facing position and that the seat sensor switch is operating.
	b Enable pushbutton defective.	Check the function of the joystick enable pushbutton.
	c Solenoid at the servo pressure supply valve not energised.	Check the condition of the associated electrical wiring for damage and that the fuses are intact.
	d Solenoid coil faulty.	Check the solenoid for open or short circuits. Measure the solenoid coil resistance.
	2 Servo pilot pressure too low.	Measure the servo pilot pressure. ⇒ ***Checking the Servo Pressure (L-158)***.
	a Due to faulty servo regulating valve.	Renew the servo pressure supply valve. Refer to ***Servo Pressure Supply Valve - Removal and Replacement***.

⇒ ***Fault Finding Tables (L-150)***.

Table 4.

Fault	Possible Cause	Action
ALL services slow to operate. (Indicates lack of flow in the hydraulic circuit)	**1** Insufficient hydraulic fluid.	Check for leaks and top up as required.
	2 Servo pilot pressure too low.	Measure the servo pilot pressure. ⇨ ***Checking the Servo Pressure (L-158)***.
	a Due to faulty servo regulating valve.	Renew the servo pressure supply valve. Refer to ***Servo Pressure Supply Valve - Removal and Replacement***.
	3 Flushing valve piston within the loader valve inlet section sticking open due to contamination.	Dismantle and inspect the flushing valve piston. Refer to ***Loader Valve (Sectional Type) - Dismantle and Assemble***.
ALL services slow to operate (Particularly noticeable when operating the loader arms).	**4** Flow from P2 pump not in circuit because the inloader valve is not receiving the correct load sense pressure.	Test the inloader valve. ⇨ ***Testing the Inloader Valve (L-164)***.
	a Due to load sense relief valve out of adjustment or defective.	Check and adjust as required. ⇨ ***Checking the Main System Pressures (L-159)***.
	b Due to internal leakage fault in the load sense circuit.	Measure the load sense pressure. ⇨ ***Checking for Internal Leakage Fault in Load Sense Line (L-162)***.
	5 Flow from P2 pump not in circuit because the inloader valve solenoid is permanently energised.	
	a Due to Hydraulic Speed Control (HSC) switch selected.	Check the function of the HSC selector switch.
	b Due to faulty system pressure switch. (1)	Check the function of the pressure switch at the servo pressure supply valve.

(1) No longer fitted on machines from serial no. 976693.

⇨ ***Fault Finding Tables (L-150)***.

Table 5.

Fault	Possible Cause	Action
ALL services lack power, the machine is unable to lift. (Indicates lack of pressure in the hydraulic circuit)	**1** Insufficient hydraulic fluid.	Check for leaks and top up as required.
	2 Servo pilot pressure too low.	Measure the servo pilot pressure. ⇨ ***Checking the Servo Pressure (L-158)***.
	a Due to faulty servo regulating valve.	Renew the servo pressure supply valve. Refer to ***Servo Pressure Supply Valve - Removal and Replacement***.
	3 Load sense relief valve out of adjustment or defective.	Check and adjust as required. ⇨ ***Checking the Main System Pressures (L-159)***.
	4 Internal leakage fault in the load sense circuit.	Measure the load sense pressure. ⇨ ***Checking for Internal Leakage Fault in Load Sense Line (L-162)***.

⇨ ***Fault Finding Tables (L-150)***.

Table 6.

Fault	Possible Cause	Action
One service operates correctly, but slows down when a second service is selected.	**1** Flow from P2 pump not in circuit because the inloader valve is not receiving the correct load sense pressure.	Test the inloader valve. ⇨ ***Testing the Inloader Valve (L-164)***.
	a Due to internal leakage fault in the load sense circuit.	Measure the load sense pressure. ⇨ ***Checking for Internal Leakage Fault in Load Sense Line (L-162)***.
	2 Flow from P2 pump not in circuit because the inloader valve solenoid is permanently energised.	
	a Due to Hydraulic Speed Control (HSC) switch selected.	Check the function of the HSC selector switch.
	b Due to faulty system pressure switch. [1]	Check the function of the pressure switch at the servo pressure supply valve.
	3 Flushing valve piston within the loader valve inlet section sticking open due to contamination.	Dismantle and inspect the flushing valve piston. Refer to ***Loader Valve (Sectional Type) - Dismantle and Assemble***.

(1) No longer fitted on machines from serial no. 976693.

⇨ ***Fault Finding Tables (L-150)***.

Table 7.

Fault	Possible Cause	Action
One service fails or is slow to operate.	**1** Associated hoses damaged, trapped or kinked.	Check hoses and replace as required.
	2 Associated ram leaking.	Carry out ram leakage checks, renew seals as required.
	3 Auxiliary relief valve (ARV) out of adjustment or defective.	Renew the associated auxiliary relief valve.
	4 Pressure compensator piston sticking due to contamination.	Test pressure compensator operation. ⇒ ***Pressure Compensator Network - Testing (L-166)***. Dismantle and inspect the associated pressure compensator piston. Refer to ***Excavator Valve (Sectional Type)*** or ***Loader Valve (Sectional Type) - Dismantle and Assemble***.
	5 Service spool or associated load hold check valves damaged or sticking due to contamination.	Dismantle and inspect the service spool and load hold check valves. Refer to ***Excavator Valve (Sectional Type)*** or ***Loader Valve (Sectional Type) - Dismantle and Assemble***.

⇒ ***Fault Finding Tables (L-150)***.

Table 8.

Fault	Possible Cause	Action
Clam shovel or extending dipper service does not operate. ***Note:*** *For certain fault conditions, the PWM Controller (ECU) will generate a blink code,* ***⇒ Thumbwheel Diagnostic `Blink' Codes (L-157)****.*	**1** Fault in electrical circuit wiring, or operation of PWM Controller (ECU).	Check the condition of the associated electrical wiring for damage and that the fuses are intact. For details of the electrical circuit and connections ***⇒ Clam Shovel and Extending Dipper Circuit (L-147)***.
	a Thumbwheel switch defective.	Check the function of the applicable thumbwheel switch. See ***Servo Pressure Supply Valve - Descriptions***.
	b Solenoid at the servo pressure supply valve not energising.	Check the condition of the associated electrical wiring for damage and that the fuses are intact.
	c Solenoid coil faulty.	Check the applicable solenoid coil for open or short circuits. Measure the solenoid coil resistance. Renew the solenoid coil.
	d Faulty PWM Controller (ECU).	Renew the PWM Controller (ECU). (1)
	2 Servo pilot pressure too low.	Measure the servo pilot pressure. ***⇒ Checking the Servo Pressure (L-158)***.
	a Due to faulty servo regulating valve.	Renew the servo pressure supply valve. Refer to ***Servo Pressure Supply Valve - Removal and Replacement***.
	b Due to proportional solenoid valve cartridge damaged or sticking due to contamination.	Renew the servo pressure supply valve. Refer to ***Servo Pressure Supply Valve - Removal and Replacement***.

(1) The ECU is a non-serviceable part. The ECU is NOT programmable.

⇒ Fault Finding Tables (L-150).

Thumbwheel Diagnostic `Blink' Codes

If an electrical fault condition is detected while operating an auxiliary service, the PWM Controller (ECU) will generate a blink code. In order to read the code however, it is necessary to access the relays in the side console as described below:

1 Park the machine on firm level ground, engage the parking brake and set the transmission to neutral. Lower the loader arms and backhoe to the ground. Switch OFF the engine.

2 Remove cover **A** to gain access to the fuses and relays beneath. Remove the clam shovel/extending dipper changeover relay **21**, and in its place fit a test relay (see ***Service Tools***).

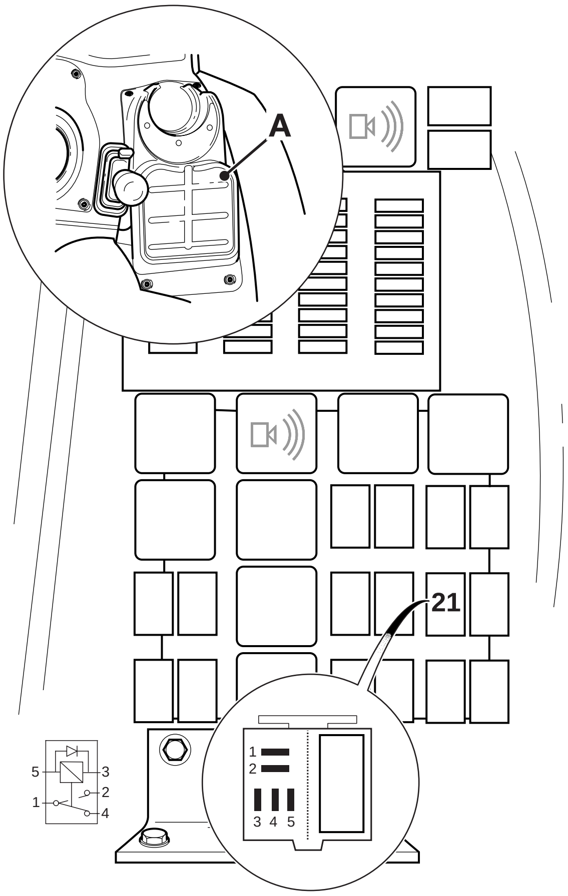


Fig 16.

3 With the operator seat locked in the forward facing position, switch the ignition key to ON (but do not start the engine), then press the joysticks enable pushbutton on the RH joystick to activate the system.

If there is a fault, the test relay LED will indicate the blink code. The blink code sequence consists of the LED being switched ON for 1.5 seconds followed by a number of flashes (the code) of 0.5 second ON, 0.5 second OFF, and is completed by the LED being switched OFF for 1.5 seconds. The sequence is repeated until the fault is cleared.

Note: *If a test relay is not available, place a solenoid tester pen (with an LED or bleeper) against the clam shovel/extending dipper changeover relay **21** to read the code.*

Blink Code:	Fault:
1 Flash	Extending dipper `Extend' valve solenoid coil, or its associated wiring faulty (open or short circuit).
2 Flashes	Extending dipper `Retract' valve solenoid coil, or its associated wiring faulty (open or short circuit).
3 Flashes	Clam shovel `Close' valve solenoid coil, or its associated wiring faulty (open or short circuit).
4 Flashes	Clam shovel `Open' valve solenoid coil, or its associated wiring faulty (open or short circuit).
5 Flashes	Extending dipper thumbwheel signal voltage too high (greater than 4.725 Volts).
6 Flashes	Extending dipper thumbwheel signal voltage too low (less than 0.275 Volts).
7 Flashes	Clam shovel thumbwheel signal voltage too high (greater than 4.725 Volts).
8 Flashes	Clam shovel thumbwheel signal voltage too low (less than 0.275 Volts).

For details of the electrical circuit and connections ⇨ ***Clam Shovel and Extending Dipper Circuit (L-147)***.

Service Procedures

Checking the Servo Pressure

WARNING

Make the machine safe before working underneath it. Park the machine on level ground, lower the attachments to the ground. Apply the park brake, put the transmission in neutral and stop the engine. Block both sides of all four wheels.

Disconnect the battery, to prevent the engine being started while you are beneath the machine.

GEN-4-1_1

Make sure that the hydraulic oil is at working temperature, i.e. 50°C (122°F).

1 Working under the LH side of the machine, connect a 0 - 70 bar (0 - 1000 lbf/in^2) pressure gauge to the servo pressure test point **A** (at the servo pressure supply valve as shown).

2 With the engine running at 1500 rpm, check the reading on the pressure gauge. The servo pressure should be as stated below:

30 bar (30.6 kgf/cm^2, 435 lbf/in^2)

Note: *The servo pressure regulating valve **B** is factory set and sealed with a plastic tamper proof cap. The system pressure switch **C** is no longer fitted on machines from serial no. 976693.*

Important: *The extent of permissible servicing is the renewal of the solenoid coils. Further dismantling of the valve is not recommended. If the valve is suspected as being faulty it must be renewed as a complete assembly. Note also that the pilot circuit accumulator is a non serviceable part and is sealed for life. It is not possible to recharge the accumulator with nitrogen.*

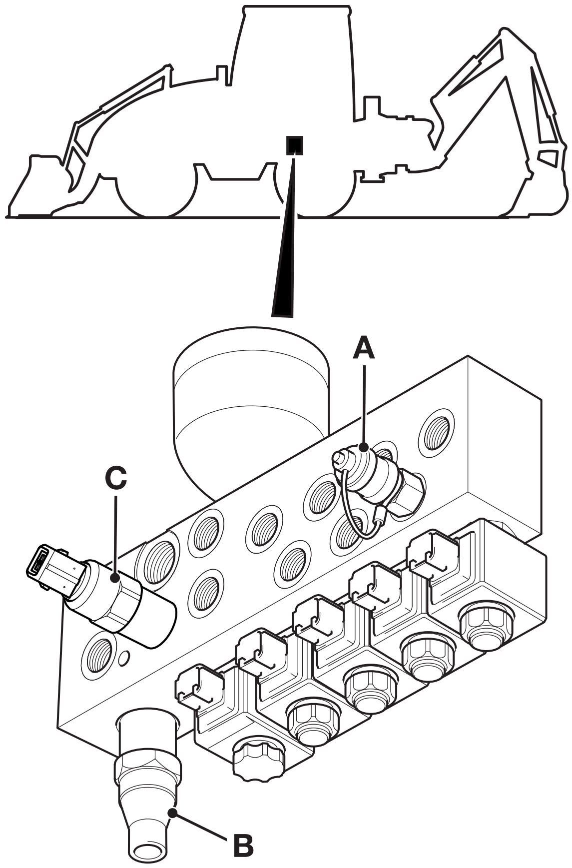


Fig 17.

Checking the Main System Pressures

Note: *This procedure describes the correct method to check the main system pressure, load sense pressure and standby pressure. A multi-channel digital pressure test set will be required to be able to measure the pressures accurately (see* ***Service Tools****).*

WARNING

Make the machine safe before working underneath it. Park the machine on level ground, lower the attachments to the ground. Apply the park brake, put the transmission in neutral and stop the engine. Block both sides of all four wheels.

Disconnect the battery, to prevent the engine being started while you are beneath the machine.

GEN-4-1_1

1 Lower the loader arms to the ground, then put the excavator into the travel position. Stop the engine.

2 Vent the hydraulic services and pilot circuit accumulator hydraulic pressure:

Switch the starter to ON without starting the engine. Activate the joystick controls, operate the joysticks several times to vent the hydraulic pressure from the servo system and service rams. Turn the starter switch to the OFF position and remove the key.

3 Working under the RH side of the machine, connect a 0 - 600 bar (0 - 8500 lbf/in^2) pressure transducer to the main system pressure test point **B** (at the loader valve block) and connect to `Channel 1' on the test set.

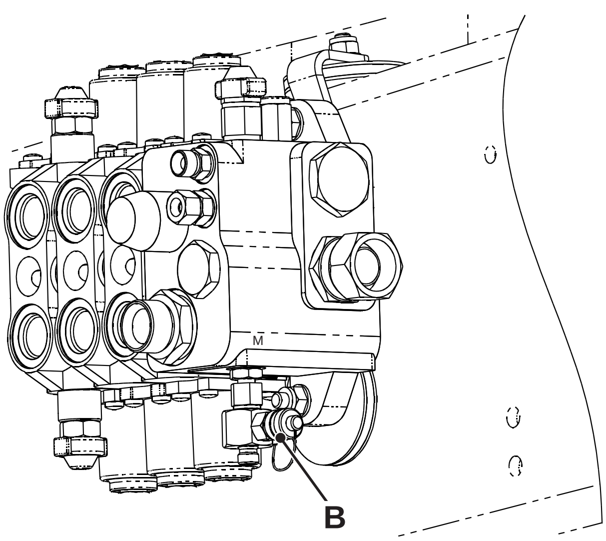


Fig 18.

4 Connect another 0 - 600 bar (0 - 8500 lbf/in^2) pressure transducer to the load sense pressure test point **C** (in the LS hose as shown) and connect to `Channel 2' on the test set.

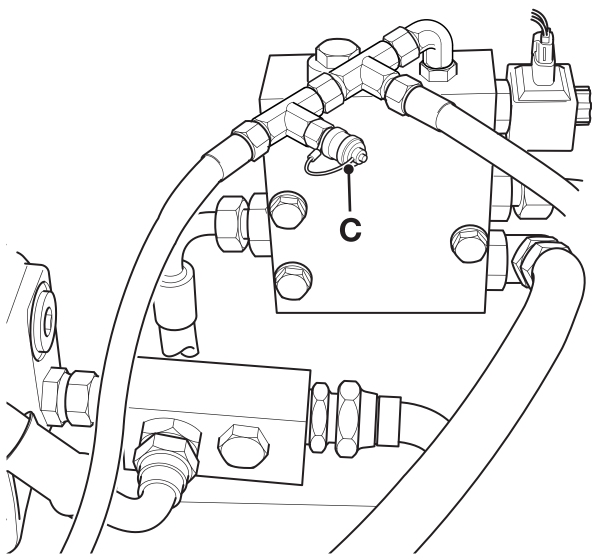


Fig 19.

5 Press button **D** to switch the test set ON, then press button **E** to set the screen to display delta-P between channels 1 and 2.

Service Procedures

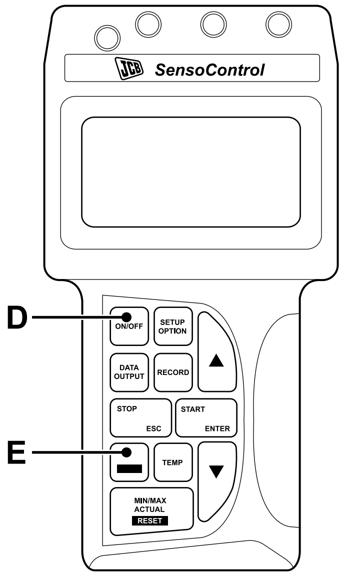


Fig 20.

6 Start the engine. Make sure that the hydraulic oil is at working temperature, i.e. 50°C (122°F).

7 Measure the **standby pressure**:

a With the seat locked in the rear facing position, activate the joystick controls.

b Set the engine speed to 1500 rpm.

c Note the pressure difference between the two pressure transducers on the test set. This is the standby pressure.

8 Measure the **main system pressure** and **load sense pressure**:

a Leave the seat in the rear facing position.

b Operate the joystick to fully crowd the excavator bucket, hold the joystick in this position to raise the main system pressure.

Note: *The pressure rise should be instantaneous. If the main system pressure rise is slow (laboured) to achieve maximum pressure, this indicates that there maybe an internal leakage fault in the load sense circuit.* ***⇒ Checking for Internal Leakage Fault in Load Sense Line (L-162)***.

c Note the pressures on the test set. `Channel 1' is the main system pressure and `Channel 2' is the load sense pressure.

9 Record the pressures in a table as shown below:

Table 9. Machines to serial no. 1336068

	Standby	Main System	Load Sense
Required:	15 - 17 bar	250 bar	235 bar
Recorded:			

Table 10. Machines from serial no. 1336069

	Standby	Main System	Load Sense
Required:	19 bar	252 bar	235 bar
Recorded:			

If required the pressures can be adjusted, but this must be done in the correct sequence. ***⇒ Pressure Adjustment (L-161)***.

Pressure Adjustment

If required the hydraulic system pressures can be adjusted, but this must be done in the correct sequence as described below:

1 Adjust the **standby pressure**:

To adjust the standby pressure, add shims to the flushing valve inside the loader valve block.

After adjustment also check the load sense pressure and main system pressure which may have changed slightly after adjusting standby.

2 Adjust the **load sense** and **main system pressure**:

Adjusting the load sense pressure alters the main system pressure.

To adjust the load sense pressure, remove the plastic cap from the load sense relief valve **Y** (at the loader valve block as shown). Loosen the locknut and turn the adjuster screw. Turn the adjuster screw clockwise to increase pressure and counter-clockwise to decrease the pressure.

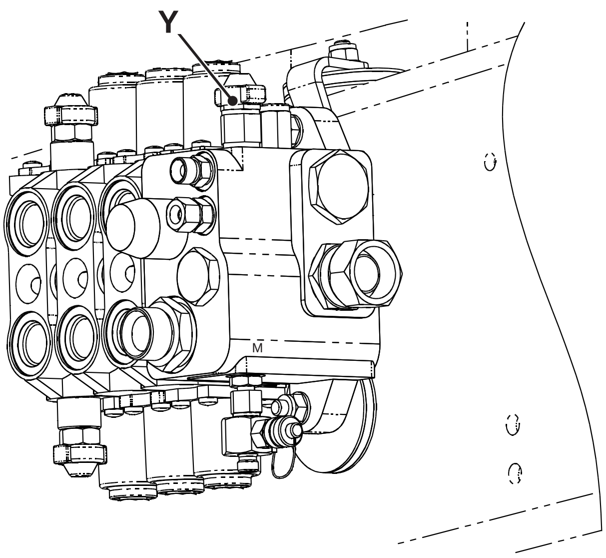


Fig 21.

Checking for Internal Leakage Fault in Load Sense Line

1 Check the hydraulic system pressures. ⇒ ***Checking the Main System Pressures (L-159)***.

Note: *If the main system pressure rise is slow (laboured) to achieve maximum pressure, this indicates that there may be an internal leakage fault in the load sense circuit.*

If an internal leakage fault is suspected in the load sense circuit, carry out the procedure described in the following steps to identify which valve assembly is at fault.

⚠ WARNING

Hydraulic Pressure

Hydraulic fluid at system pressure can injure you. Before connecting or removing any hydraulic hose, residual hydraulic pressure trapped in the service hose line must be vented. Make sure the hose service line has been vented before connecting or removing hoses. Make sure the engine cannot be started while the hoses are open.

INT-3-1-11_2

2 Before attempting to disconnect any hoses, vent the hydraulic services and pilot circuit accumulator hydraulic pressure:

Switch the starter to ON without starting the engine. Activate the joystick controls, operate the joysticks several times to vent the hydraulic pressure from the servo system and service rams. Turn the starter switch to the OFF position and remove the key.

3 ⇒ ***Fig 22. (L-163)***. Isolate the inloader valve **B** from the load sense circuit:

a Disconnect the tee adaptor from the load sense port **C**. Blank off the open port in the inloader valve block and in the tee adaptor using suitable high pressure blanking plugs and caps.

b Repeat step 1 and note if there is any improvement in the main system pressure on the test set.

c If the pressure rise is instantaneous to achieve maximum pressure, the fault must be within the inloader valve assembly. Renew the inloader valve.

If the pressure rise is still slow (laboured) to achieve maximum pressure, carry out step d.

d Isolate the excavator valve from the load sense circuit:

i Vent the hydraulic services and pilot circuit accumulator hydraulic pressure, see step 2.

ii Disconnect the hose at the tee adaptor port **D**. Blank off the open port in the tee adaptor and the open end of the hose using suitable high pressure blanking plugs and caps.

iii Repeat step 1 and note if there is any improvement in the main system pressure on the test set.

iv If the pressure rise is instantaneous to achieve maximum pressure, the fault must be within the excavator valve assembly. Dismantle and inspect the excavator valve block, see ***Excavator Valve (Sectional Type) - Dismantle and Assemble***.

If the pressure rise is still slow (laboured) to achieve maximum pressure, the fault must be within the loader valve assembly. Dismantle and inspect the loader valve block, see ***Loader Valve (Sectional Type) - Dismantle and Assemble***.

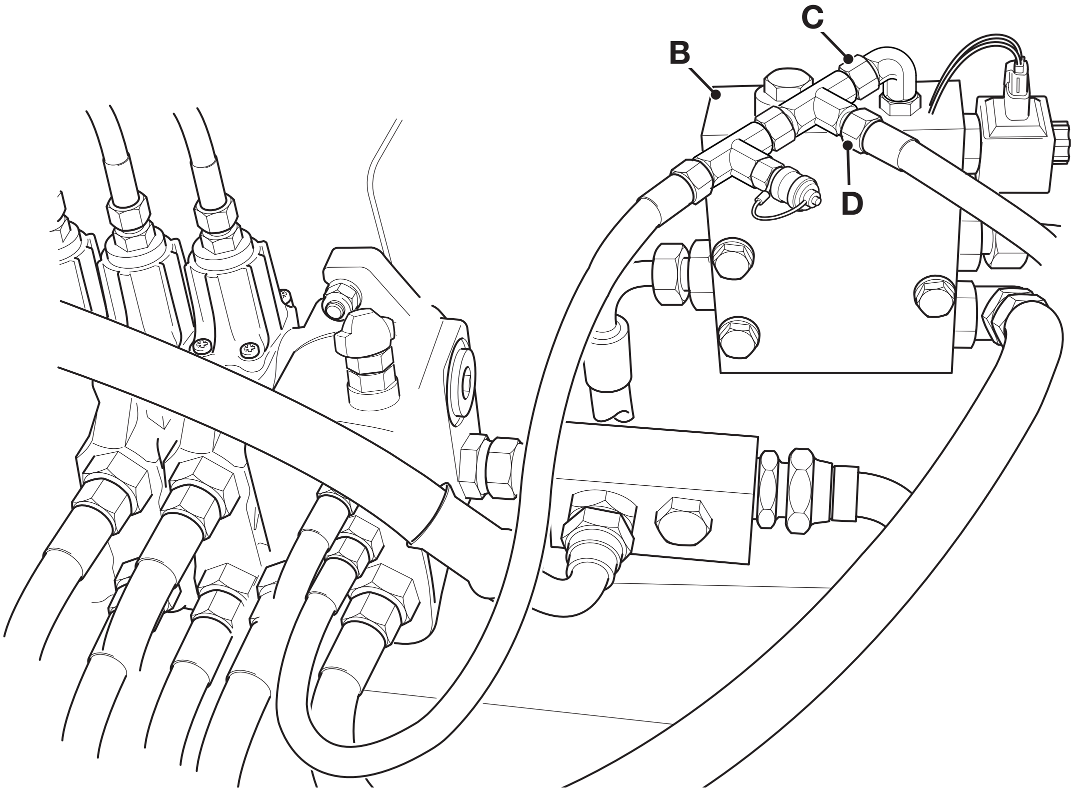


Fig 22. Checking for Internal Leakage Fault in Load Sense Line

Testing the Inloader Valve

Note: *On some machines the original inloader valve has been replaced with a new unloader valve.* *⇨ Unloader Valve Variant (L-136)*

WARNING

Make the machine safe before working underneath it. Park the machine on level ground, lower the attachments to the ground. Apply the park brake, put the transmission in neutral and stop the engine. Block both sides of all four wheels.

Disconnect the battery, to prevent the engine being started while you are beneath the machine.

GEN-4-1_1

Make sure that the hydraulic oil is at working temperature, i.e. 50°C (122°F).

1 *⇨ Fig 23. (L-165)*. Working under the RH side of the machine, connect a 0 - 400 bar (0 - 6000 lbf/in²) pressure gauge to the main system pressure test points **A** (P1 working pressure) at the loader valve, and **B** (P2 working pressure) at the outlet from the pump secondary section as shown.

2 Connect a 0 - 400 bar (0 - 6000 lbf/in²) pressure gauge to the load sense pressure test point **C** (in the LS hose as shown).

3 Uncouple the harness electrical connector at the inloader valve solenoid **D**. This will prevent the inloader valve being activated electrically.

4 With the engine running at 1500 rpm, check the operation of the inloader valve by operating the loader lift service as described below:

a Raise the loader arms slowly at first and observe the P1, P2 and load sense pressure gauges.

Note that when the rate of movement is slow, the flow available from the pump main section (P1) is more than sufficient to satisfy the flow demanded by the service. In this condition, P1 working pressure is always maintained at around 15 bar (215 lbf/in²) above the load sense pressure. The flow from the pump secondary section (P2) is not required and is dumped to tank, consequently the P2 working pressure is at minimum.

b Continue to raise the loader arms, progressively increasing the rate of movement and observe the P1, P2 and load sense pressure gauges.

Note that as the rate of movement increases, eventually the flow demanded by the service starts to exceed the flow available from the pump main section (P1) and the P1 working pressure starts to fall off.

The pressure difference between P1 working pressure and the load sense pressure reduces. When the pressure difference reduces to around 10 bar (145 lbf/in²) the inloader valve activates to connect the flow from the pump secondary section (P2) into the main hydraulic circuit. The additional flow from the pump secondary section (P2) now supplements the flow from the pump main section (P1) and the P2 working pressure will rise to equal the P1 working pressure.

5 After completing the tests, disconnect the pressure gauges from the hydraulic test points and couple the harness electrical connector to the inloader valve solenoid.

Important: *The extent of permissible servicing is the renewal of the solenoid coil. Further dismantling of the valve is not recommended. If the valve is suspected as being faulty it must be renewed as a complete assembly.*

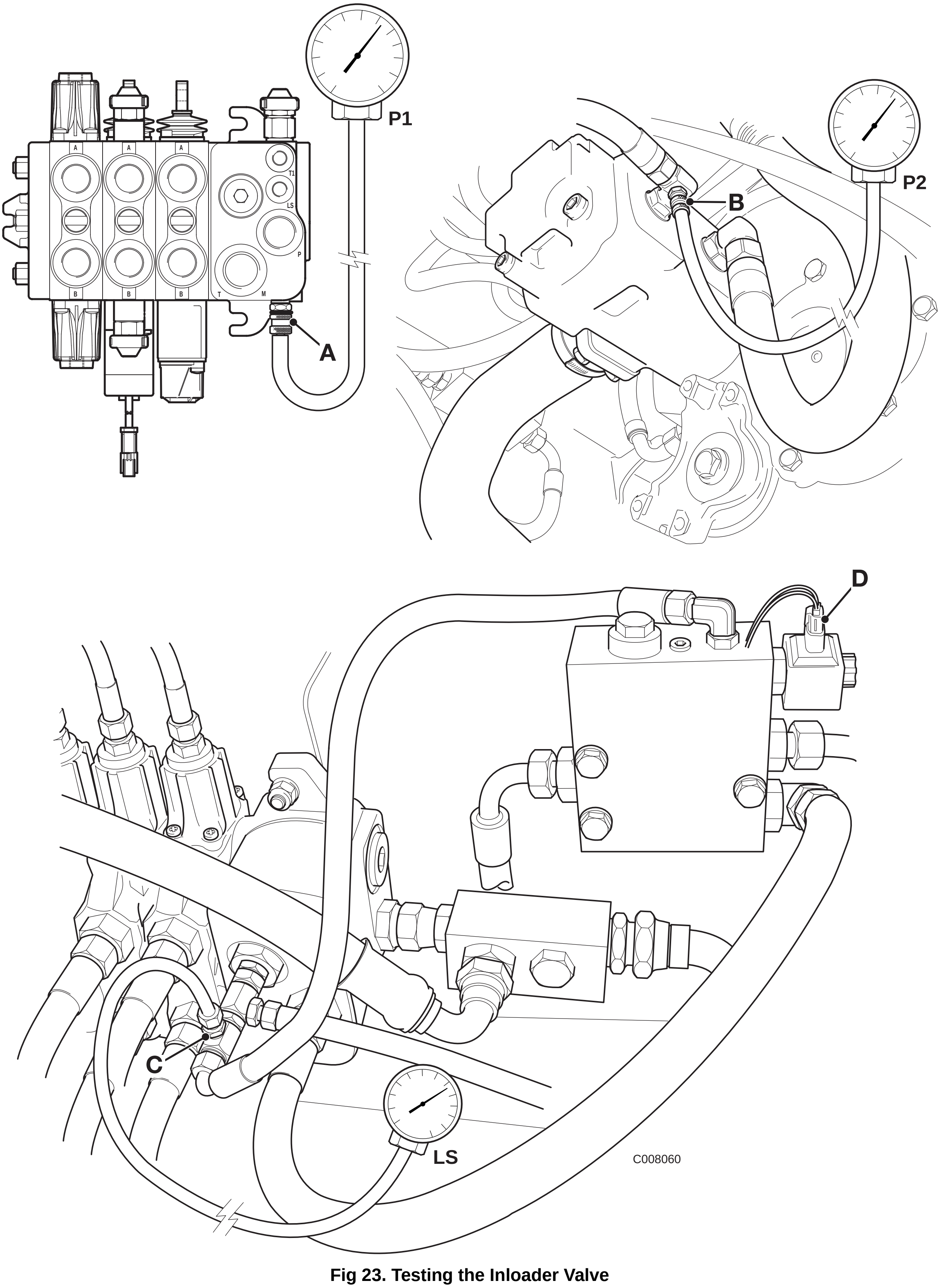


Fig 23. Testing the Inloader Valve

Pressure Compensator Network - Testing

The pressure compensator valve network can be easily checked as follows:

1 Start the engine and operate the hydraulic system until the oil is at working temperature.

2 With the engine at 1500 revs/min operate each service in turn starting with the service furthest from the pump inlet section.

If one control valve section function either fails to work or is slow to work in either one or both directions, the pressure compensator valve in that section may be at fault.

When a pressure compensator valve is suspected of malfunctioning, do the following check:

3 Stall any control valve that is nearer the pump inlet section than the suspected control valve section. This should stall the entire system. While at stall operate the malfunctioning valve section, if the section operates correctly the pressure compensator valve in question is at fault.

If the section still malfunctions the pressure compensator valve is NOT at fault.

Note: *The pressure compensator valves may be removed for inspection, refer to **Loader Valve (Sectional Type) or Excavator Valve (Sectional Type) - Dismantle and Assemble**. Clean and refit, or fit a new pressure compensator valve as required.*

Bleeding the Auxiliary Service Pilot Hose

⇨ *Fig 24. (L-167)*. Some machines are fitted with a bleed point at the pilot hose connection to the loader valve and excavator valve auxiliary spools.

If at any time the auxiliary service hoses are disconnected from the valve block to complete a repair, or if hoses are renewed, be sure to bleed the pilot hose as described below:

Note: *Two persons are required to carry out this procedure. Person 1 should be sitting in the operator seat in the cab, while person 2 requires access to the control valve assembly.*

⚠ WARNING

Communications

Bad communications can cause accidents. If two or more people are working on the machine, make sure each is aware of what the others are doing. Before starting the engine make sure the others are clear of the danger areas; examples of danger areas are: the rotating blades and belt on the engine, the attachments and linkages, and anywhere beneath or behind the machine. People can be killed or injured if these precautions are not taken.

INT-3-1-5

1 Park the machine on firm level ground, engage the parking brake and set the transmission to neutral. Lock the seat in the forward or rear facing position as applicable.

⚠ WARNING

Before proceeding with the bleeding procedure it is important to ensure that the park brake is engaged and that one pair of wheels is blocked on both sides.

BRAK-1-2

2 With the engine running at 1500 rev/min, operate the loader or excavator auxiliary service as applicable.

3 Hold the thumbwheel fully over in one direction (to fully open or close the applicable service ram), then get an assistant to carefully loosen the cap **A**. Unscrew the cap approximately 1 turn, sufficiently to vent the air from the hose. When bubble free oil seeps from the joint, tighten the cap.

4 Repeat step 3 holding the thumbwheel fully over in the opposite direction.

5 If necessary, repeat steps 3 and 4 as required.

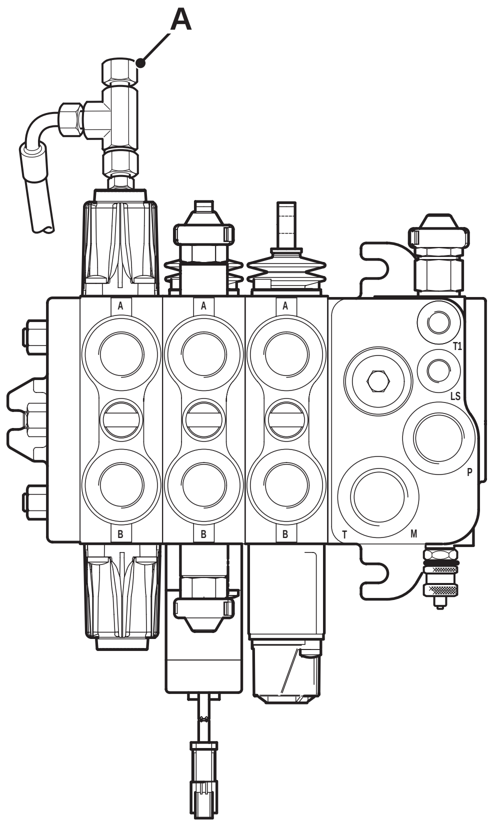


Fig 24. Bleed Point (Loader valve shown)

Note: *The bleed point **A** is not fitted on later machines which have the self-bleeding spools.*

Advanced EasyControl SYSTEM

Related Topics

The table lists other topics in the section that contain information related to this topic. Refer to the applicable topics to complete your procedures. Where applicable the text contains cross-references to help you find the correct information.

System Overview

Note: *This hydraulic system differs in many important aspects to the normal hydraulic system. Before attempting to service or fault find the system ensure that you read and understand all the descriptions in this section.* ***The following descriptions make some comparisons to the normal hydraulic system. `Normal system' refers to standard non-servo machines*** *detailed in Section E Hydraulics.*

The combined effect of the features described below ensure a precise and predictable response of the hydraulic services to operator input, and at the same time, maximises machine operating efficiency.

Loader and Excavator Servo Controls

⇨ *Fig 1. (L-172)*. The Advanced EasyControl system facilitates operation of the loader and backhoe (excavator) via joystick controllers **A** and **B** mounted in the arms of the seat, and operation of the stabilisers via levers **C** mounted in the side console.

The joysticks and stabiliser controls each directly operate proportional pilot control valve capsules **D**. These valves in turn operate the loader valve **E** and excavator valve **F** service spools via hydraulic pilot pressure. The pilot control valve capsules direct servo pilot oil at a pressure proportional to the amount the operator moves the applicable joystick. The interconnecting servo pilot hoses to and from the joystick controllers are routed through the central seat support pillar and then through the cab floor. **There are no mechanical linkages between the control levers and the service spools as used in the normal system**.

Servo Pilot Oil Supply: A servo pressure supply valve **G** provides a constant supply of oil at servo pressure to the joystick controllers and stabiliser controls. Note that if the operator's seat is not in the correct operating position, or the excavator/loader selector switch **Q** is set to OFF, the servo pressure supply valve isolates the servo pilot oil supply and the joystick controllers are disabled. ⇨ *Joystick Enable and Seat Interlock Switches (L-170)*.

Joystick Control Changeover: Three solenoid operated changeover valves **H** enable the RH joystick to control either the loader valve services or the excavator valve services, depending on which way the operator's seat is facing.

When the excavator/loader selector switch **Q** is in the excavator position, the solenoids are de-energised. The pilot pressure from the RH joystick is directed by the changeover valves to operate the excavator services.

When the selector switch is in the loader position, the solenoids are energised. The pilot pressure from the RH joystick is directed by the changeover valves to operate the loader services.

Variflow Pump

The hydraulic pump **J** is a variable displacement axial piston type. The pump output flow is controlled by varying the angle of the internal tilting swashplate mechanism. The angle of the swashplate is regulated automatically by the hydraulic load sense pressure, so that the pump only delivers the amount of oil that is needed to satisfy the hydraulic system demand.

Dual Horsepower Control (Machines upto serial no. 975288 only): Integral with the pump is the dual horsepower solenoid valve **K**. The valve is used to automatically pre-select the output flow characteristic of the pump for either loader operation or excavator operation as applicable.

When the excavator/loader selector switch **Q** is in the excavator position, the solenoid valve is de-energised, which sets the pump output for excavator operation. If required, the pump is able to deliver maximum flow, and therefore maximum hydraulic power of about 54kW is available for operation of the excavator services.

When the selector switch is in the loader position, the solenoid valve is energised. In this condition, the angular movement of the tilting swashplate is restricted, to reduce the maximum flow available from the pump by approximately 25%. This means that the available hydraulic power is limited to about 40kW for operation of the loader services. Reducing the pump output flow in this way reduces the load on the engine, and ensures that more of the engine power is available for traction when the machine is entering a stock pile during loading operations.

Load Sense and Pressure Compensator Function

Load Sensing: All the hydraulic services are connected to a hydraulic load sense circuit. When no services are operated, there is no demand for flow from the hydraulic system, the variflow pump does not draw oil from the tank and no oil is delivered. Note that the service spools are closed-centre. **There is no `neutral circuit' as defined in the normal system**.

When a service is operated, the variflow pump senses the demand and delivers oil to the hydraulic system, increasing the operating pressure to a value sufficient to operate the service. The load sense feature also incorporates the main pressure relief function, which is controlled by the load sense relief valve **L**. **This replaces the Main Relief Valve (MRV) used in the normal system**. ⇨ ***Hydraulic Operation and Schematics (L-173)***.

Pressure Compensation: Each service spool incorporates a pressure compensator valve **M**. When services are operated simultaneously, the system ensures consistent operating speed for all services, even when the limit of the hydraulic pump performance is approached.

Note: *Pressure compensator valves are not fitted at the excavator valve stabiliser spools.*

Auxiliary Service Thumbwheel Controls

The RH joystick incorporates a thumbwheel switch **N** to operate either the loader valve or the excavator valve auxiliary service as applicable.

The thumbwheel controls two electro-hydraulic proportional solenoid valves housed in the servo pressure supply valve block **G**.

Central to the control of the proportional solenoids is the PWM controller electronic control unit (ECU) **P** mounted in the floor plate above the loader valve. The ECU receives analogue electrical inputs from the thumbwheel switch **N**, and supplies a modulated output signal (PWM) to the relevant proportional solenoid valve.

The proportional solenoid valves work as separate pressure reducing valves, and direct servo pilot oil to move the auxiliary service spool at a pressure proportional to the amount the operator moves the thumbwheel switch. For a detailed description of proportional solenoid valve operation, see ***Servo Pressure Supply Valve - Descriptions***.

Joystick Enable and Seat Interlock Switches

To make the joystick controls active, the solenoid operated isolation valves (one for each joystick) housed in the servo pressure supply valve block **G** must be energised. The solenoids are energised via relays, by the excavator/ loader selector switch **Q** on the RH seat pod.

Note that the RH joystick is used to operate the loader services when the seat is locked in the forward facing position, and to operate the excavator services when the seat is locked in the rear facing position. The changeover from loader to excavator service is achieved by the solenoid operated changeover valves **H**.

Loader Joystick Control: When operating the loader, only the RH joystick is active (the LH joystick is disabled). To energise the isolation valve solenoid for the RH joystick, the seat must first be locked in the forward facing position, thereby activating the `seat forward' sensor switch **R** on the base of the seat. The operator must then press the selector switch **Q** to the loader position, and press and release the joysticks enable pushbutton. The green LED **S** on the RH joystick will then illuminate to indicate that it is active.

Note: *The LED **S** is also used by the auxiliary service PWM controller (ECU) to display a series of diagnostic ‘blink' codes,* ⇨ ***Thumbwheel Diagnostic ‘Blink' Codes (L-194)***.

Float Mode: The loader joystick controller **B** incorporates an electro-magnet to provide a detent, which holds the joystick over in the `float' position. Note that the electro-magnet is permanently energised while the selector switch **Q** is in the loader position, therefore the joystick has to be pulled back manually to return it to neutral.

Excavator Joystick Controls: When operating the excavator, both the RH and LH joysticks are active. To energise both isolation valve solenoids, the seat must first be locked in the rear facing position, thereby activating the `seat rear' sensor switch **T** on the base of the seat. The operator must then press the selector switch **Q** to the excavator position, and press and release the joystick enable pushbutton. The green LED's **S** on both joysticks will then illuminate to indicate that the joysticks are active.

To disable the joysticks the operator must either press the selector switch **Q** to the OFF position or unlock and move the seat. This will cause the isolation valve solenoids to de-energise, and the servo pilot oil supply to the joysticks will be isolated.

Note that the excavator joysticks can be enabled by the operator when the seat is locked in the forward facing position if required. This activates the `seat forward' sensor switch **R** on the base of the seat. The operator must then press and hold the pushbutton on the RH joystick. The warning buzzer will sound to alert the operator that the joysticks are active. When the operator releases the pushbutton, the joysticks become disabled and the warning buzzer will cease. For more details of the electrical circuit and connections, ⇨ ***Electrical Operation and Schematics (L-177)***.

The LH joystick houses a pushbutton to operate the rear horn. On some machine variants the joysticks may have additional mode pushbuttons, for example to operate a hydraulic quickhitch, or an auxiliary changeover valve, typically to select between jaw bucket and extending dipper operation.

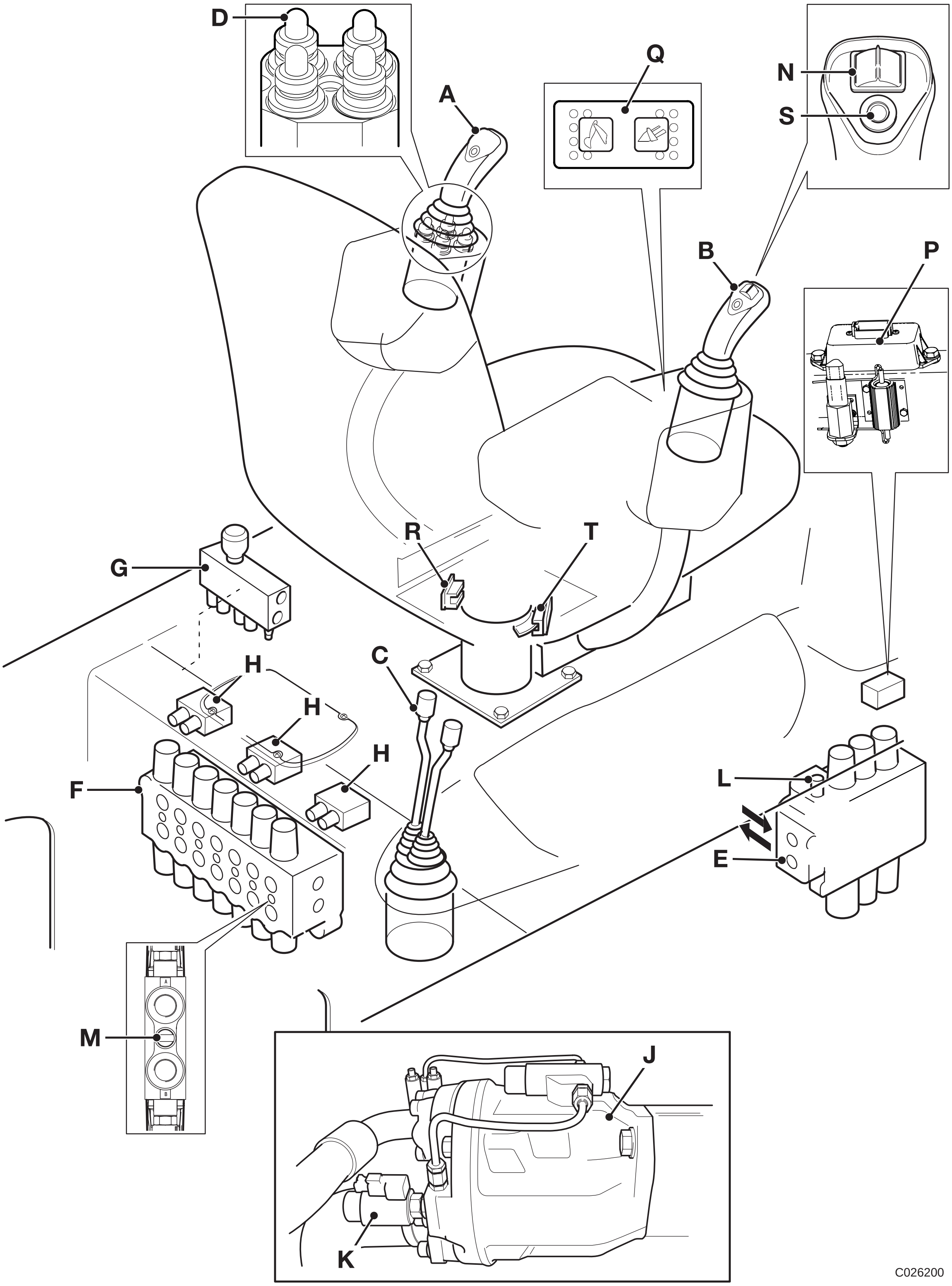


Fig 1. Component Location

Hydraulic Operation and Schematics

Note: *To make the description as clear as possible the diagrams show only part of the complete hydraulic system. For the complete hydraulic schematics, see* ***Schematic Circuits****.*

No Services Operated: ⇨ *Fig 2. (L-174)*.

Note that the service spools are closed-centre. With all the services in neutral, there is no demand for flow from the hydraulic pump **P**, and consequently the pump internal tilting swashplate is at its minimum angle. In this condition the pump delivers only the minimum flow that is needed to satisfy normal system internal leakage, and to generate a system standby pressure. A small amount of oil from the pump **P** flows to the inlet-outlet section of the loader valve **3** and to the inlet port of the excavator valve **6**. When the main system pressure reaches around 15 bar the spring **3a** in flushing valve **3b** is overcome and oil is returned back to tank. Note that the pump also supplies the steer circuit via the steer priority valve **1**.

Oil from the pump **P** also flows through the chassis mounted filter assembly **5** to the servo pressure supply valve **8**. The valve supplies servo pilot oil pressure regulated at 30 bar to the joystick controllers **4** and stabiliser controls.

Service Operation: ⇨ *Fig 3. (L-175)*.

When a service is operated, boom lift for example, movement of the applicable joystick controller **4** supplies pilot oil to actuate the service spool **6a**. The controller supplies pilot oil at a pressure proportional to the joystick movement, thus controlling how far the service spool is displaced. Oil passes across the service spool to the applicable pressure compensator valve **6c**. The valve opens and diverts oil to the load sense gallery and load hold check valve **6b**. Pressure in the load sense gallery increases and the flushing valve **3b** begins to close. At the same time, the pump **P** responds to the load sense pressure by increasing the angle of the tilting swashplate. As the swashplate angle increases, the output flow from the pump increases proportionally, and the main system pressure continues to rise until load hold check valve **6b** opens and the boom lift ram **7** operates.

The main system pressure will now be equal to the load sense pressure (load from the boom lift ram) + the force of flushing valve spring **3a** (around 15 bar).

Oil from the other side of the ram **7** flows across the service spool and returns back to tank in the normal way.

Multiple Service Operation: In the normal hydraulic system the services are connected in parallel, this means that when multiple services are operated simultaneously, the speed of one service can be affected by the operating pressure of another service. This is not the case with precision control.

The pressure compensator valves for each service react to the differing load pressures. For example, when a pressure compensator valve is subjected to a higher load sense pressure from another service, it reacts to reduce the flow to its service, ensuring that the associated ram operates at a constant speed, regardless of the increase in the main system pressure.

Main System Pressure Relief: ⇨ *Fig 4. (L-176)*.

The maximum main system pressure is controlled by limiting the maximum load sense pressure.

When a service ram reaches the end of its stroke, or the service meets resistance and generates pressure above 235 bar in the load sense line, the load sense relief valve **3c** opens and load sense oil is dumped to tank, preventing further pressure rise. Some of the system oil passes across the flushing valve **3b** as normal. At the same time, the pump **P** responds to the load sense pressure by decreasing the angle of the tilting swashplate towards its minimum angle. As the swashplate angle decreases, the output flow from the pump reduces accordingly so that the pump delivers only the minimum flow needed to maintain the system pressure at the maximum setting. Since the main system pressure required to open the flushing valve is around 15 bar above the load sense pressure it follows that the main system pressure will be limited to 235 bar + 15 bar, a total of 250 bar.

Note: *The pressure values given are examples for the purpose of explanation only. Actual values may be different depending on the machine variant. All pressure relief valves are factory set. No adjustment is normally required.* ⇨ ***Checking the Main System Pressures (L-196)****.*

Table 1. Colour Key to Oil Flow and Pressure

	Full Pressure
	Load Sense Line
	Servo
	Neutral
	Exhaust

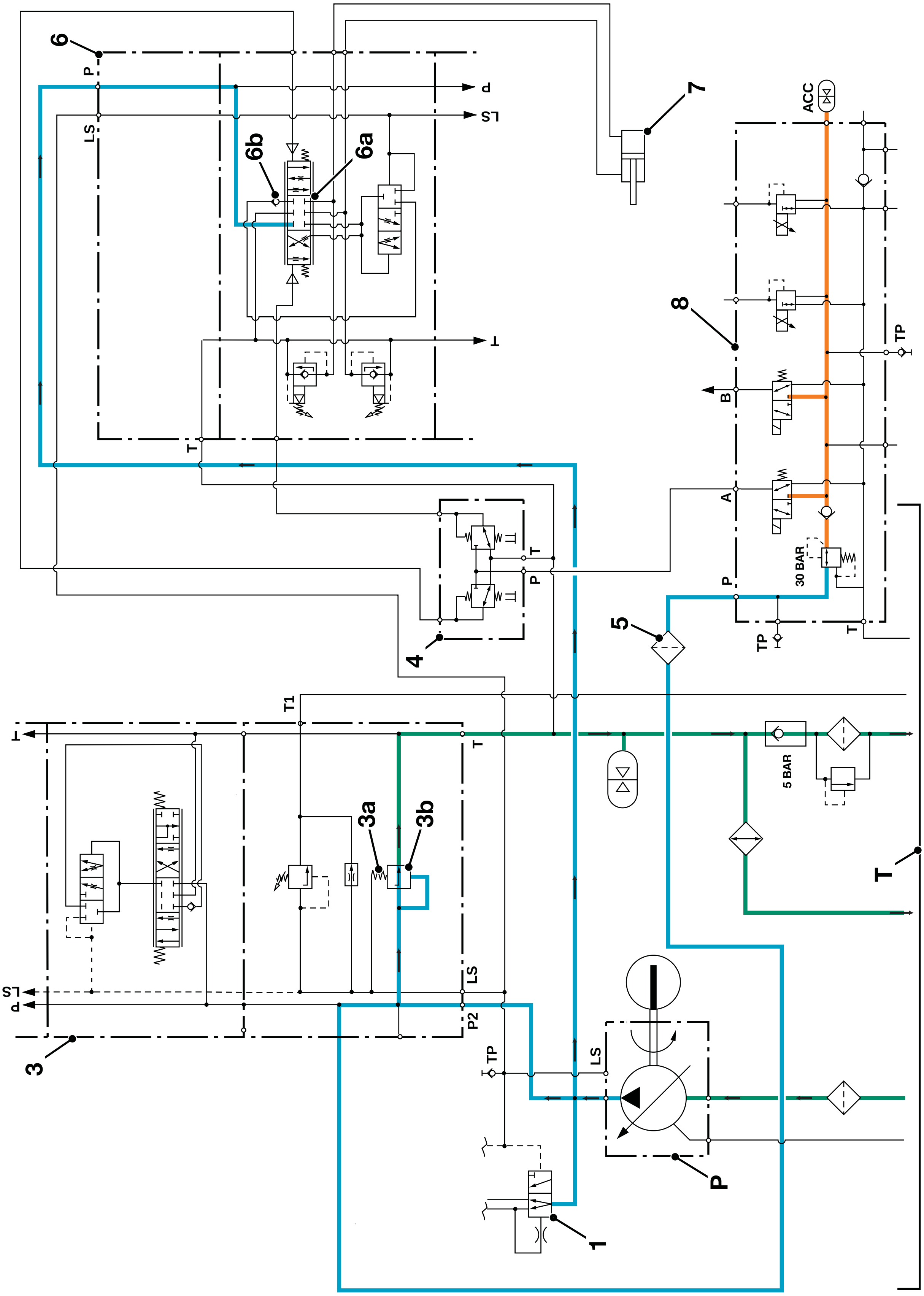


Fig 2. No Services Operated (Neutral)

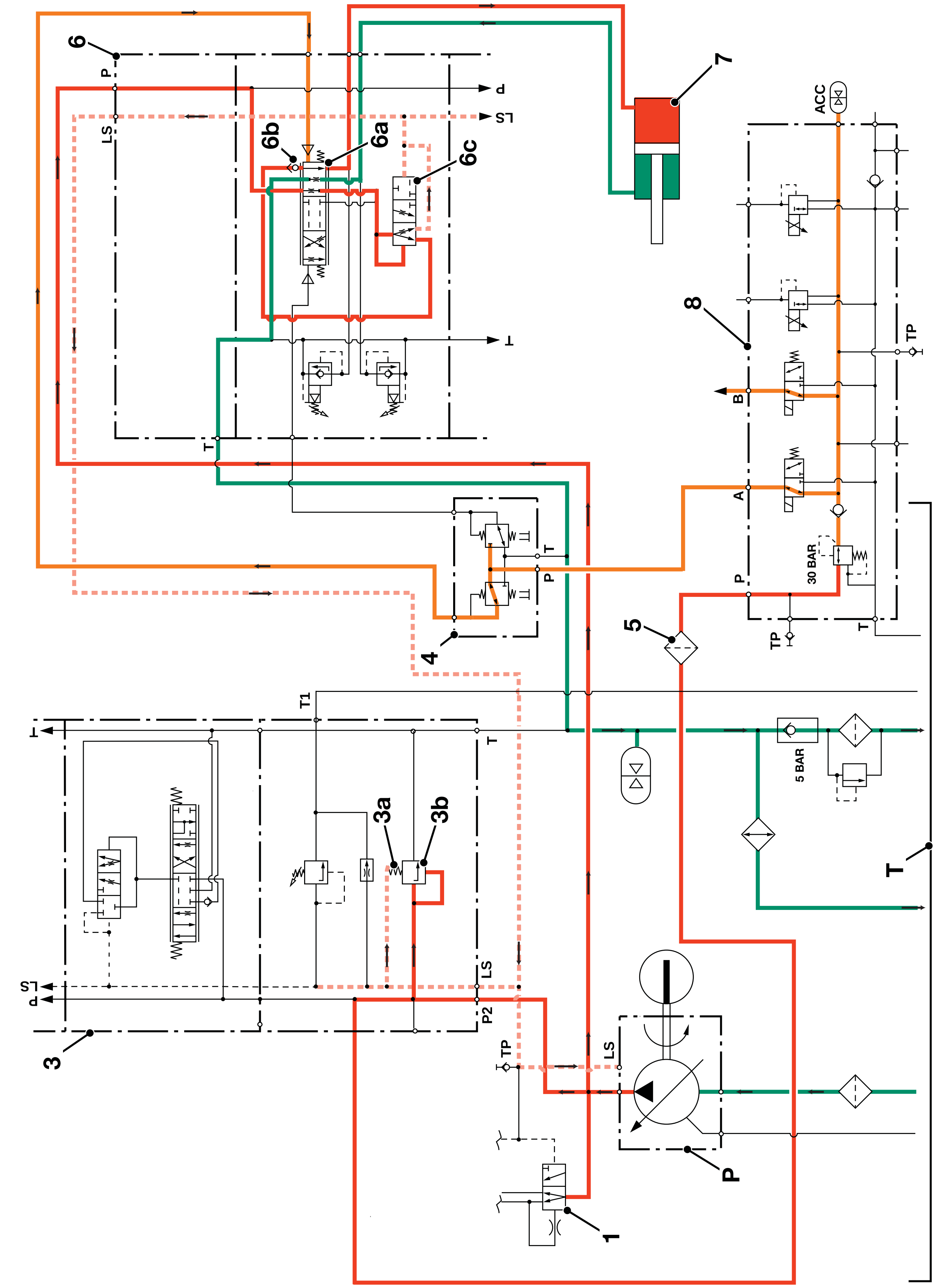


Fig 3. Service Operation

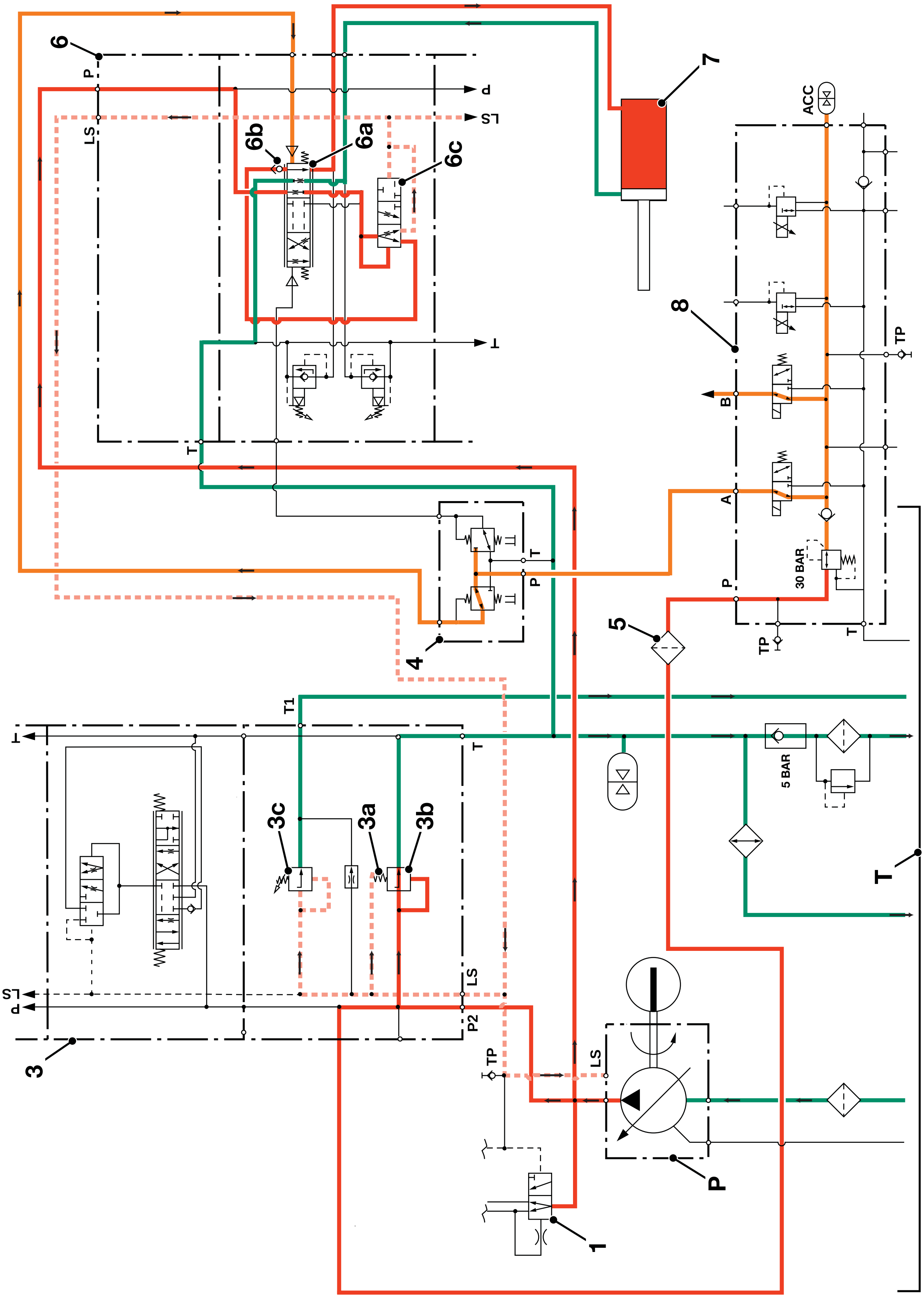


Fig 4. Main System Pressure Relief

Joysticks Enable Circuit

The diagrams in this section are intended to show how the electrical circuits work when different functions are operated.

The wire numbers and colours, where appropriate, are shown as an aid to identification while fault finding. The wires coloured red show the electrical live feeds. The wires coloured green show the electrical returns to earth.

Before fault finding make sure that you understand how the electrical circuits work. Most potential faults can be traced using a multimeter to carry out continuity checks on wires, switches and solenoids.

Seat Facing Rear and Excavator Selected: ⇒ Fig 5. (L-178).

When the seat is facing rear, the sensor switch **22** closes and energises relay **20**. With the excavator/ loader selector switch **8** set to the excavator position, pressing the joysticks enable pushbutton **9** energises the joysticks enable relay **12**. This completes the return circuit for the servo pilot valve relay **14**, which also energises. The servo pilot valve solenoids **16** and **17** then energise, which allows servo pilot pressure to be directed to the joystick controllers. Both the joystick controllers then become active.

The joystick enable relay **12** latches when the joysticks enable pushbutton **9** is released. The joystick controllers remain active until either the excavator/loader selector switch **8** is moved to the OFF position, or the seat is moved from the rear facing position, which causes the joysticks enable relay **12** to de-energise (and unlatch).

Seat Facing Forward and Loader Selected: ⇒ Fig 6. (L-179).

When the seat is facing forward, the sensor switch **21** closes and energises relay **19**. With the excavator/ loader selector switch **8** set to the loader position, pressing the joysticks enable pushbutton **9** energises the joysticks enable relay **12**. This completes the return circuit for the servo pilot valve relays **14** and **15**, which also energise. The servo pilot valve solenoid **17** then energises, which allows servo pilot pressure to be directed to the RH joystick controller. Only the RH joystick controller then becomes active.

Note: *Although both servo pilot valve relays **14** and **15** are energised, relay **14** has no effect on the circuit.*

The joystick enable relay **12** latches when the joysticks enable pushbutton **9** is released. The RH joystick controller remains active until either the excavator/loader selector switch **8** is moved to the OFF position, or the seat is moved from the forward facing position, which causes the joysticks enable relay **12** to de-energise (and unlatch).

Excavator/Loader Selector Switch OFF (Joysticks Cut-out): ⇒ Fig 7. (L-180).

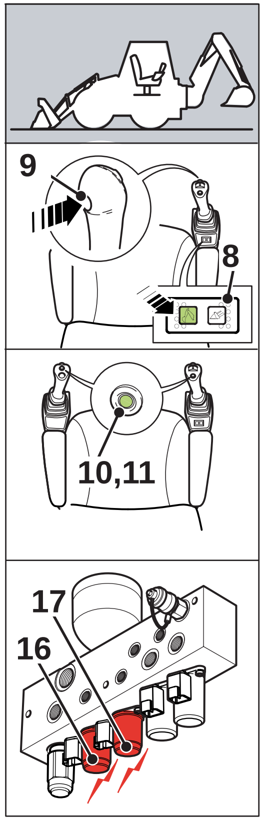
Moving the excavator/loader selector switch **8** to the OFF position de-energises the joysticks enable relay **12**. The relay unlatches and breaks the return circuit for the servo pilot valve relays **14** and **15**, which also de-energise. The servo pilot valve solenoids **16** and **17** then de-energise isolating the servo pilot pressure to the joystick controllers. Both the joystick controllers then become disabled.

Seat Facing Forward and Excavator Selected: ⇒ Fig 8. (L-181).

With the seat facing forward and the excavator/loader selector switch **8** set to the excavator position, the servo pilot valve solenoids **16** and **17** are energised only while the joysticks enable pushbutton **9** is `held' pressed. The joysticks enable relay **13** is energised and the joysticks `active' warning buzzer **18** will sound to alert the operator that the joysticks are active.

Component Key:

8	Excavator/Loader Selector Switch
9	Joysticks Enable Pushbutton (RH Joystick)
10	Joystick `Active' LED (LH Joystick)
11	Joystick `Active' LED (RH Joystick)
12	Joysticks Enable Latching Relay
13	Joysticks Enable Relay
14	Servo Pilot Valve Relay
15	Servo Pilot Valve Relay
16	Servo Pilot Valve Solenoid (LH Joystick)
17	Servo Pilot Valve Solenoid (RH Joystick)
18	Joysticks `Active' Warning Buzzer
19	Seat Forward Relay
20	Seat Rear Relay
21	Seat Forward Sensor Switch (Vane Type)
22	Seat Rear Sensor Switch (Vane Type)
B	To PWM Controller (ECU)
C	From ECU Power Relay
D	To ECU Power Relay



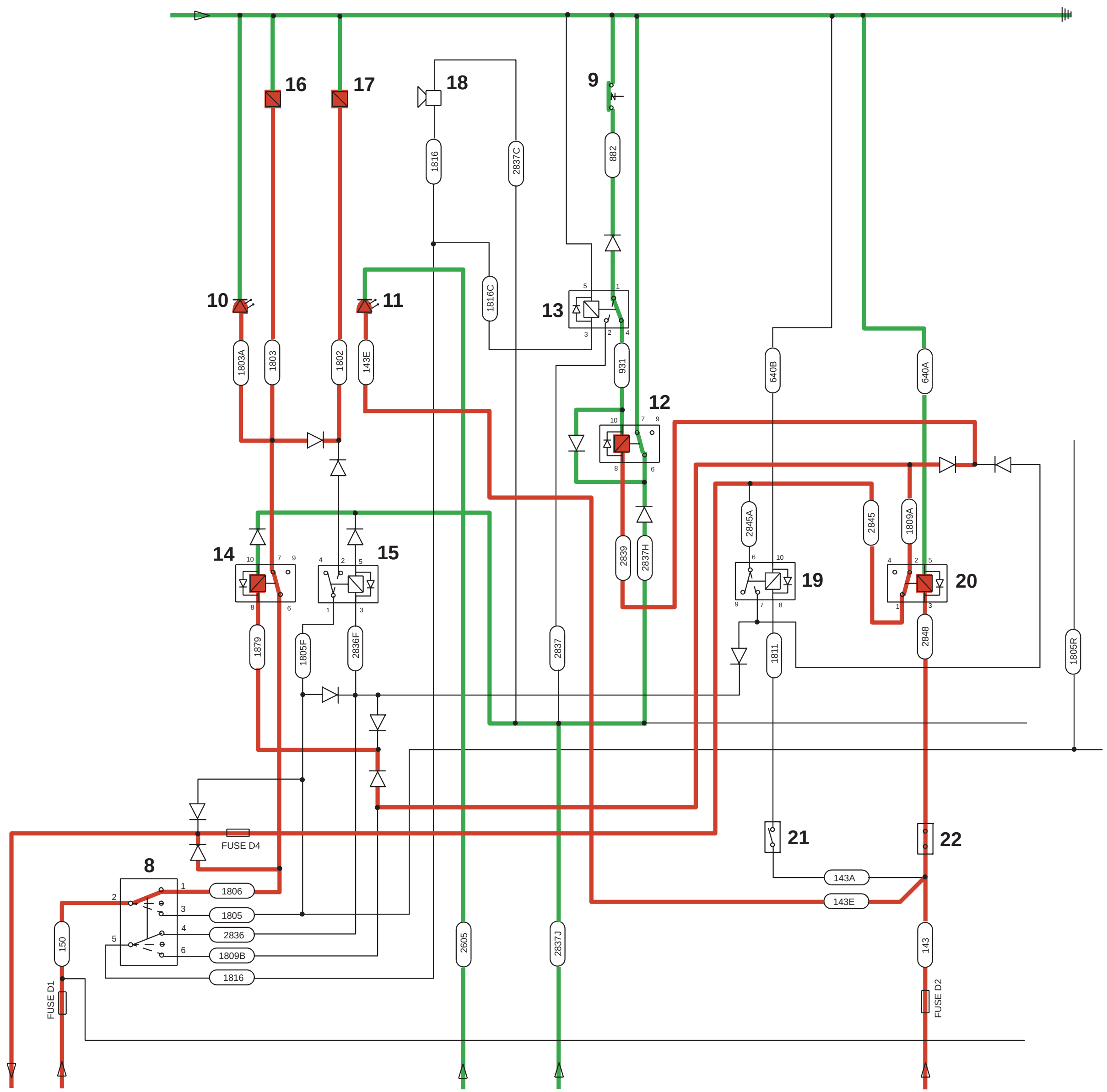
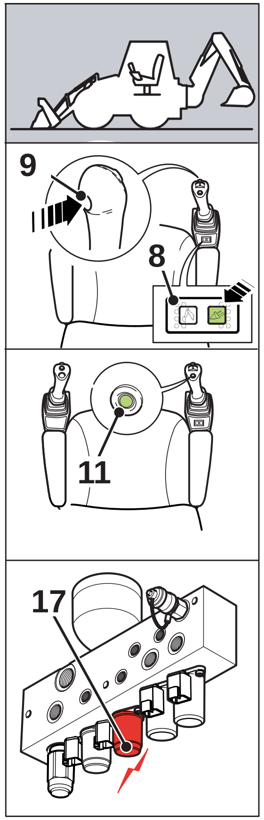


Fig 5. Joysticks Enable Circuit - Seat Facing Rear and Excavator Selected



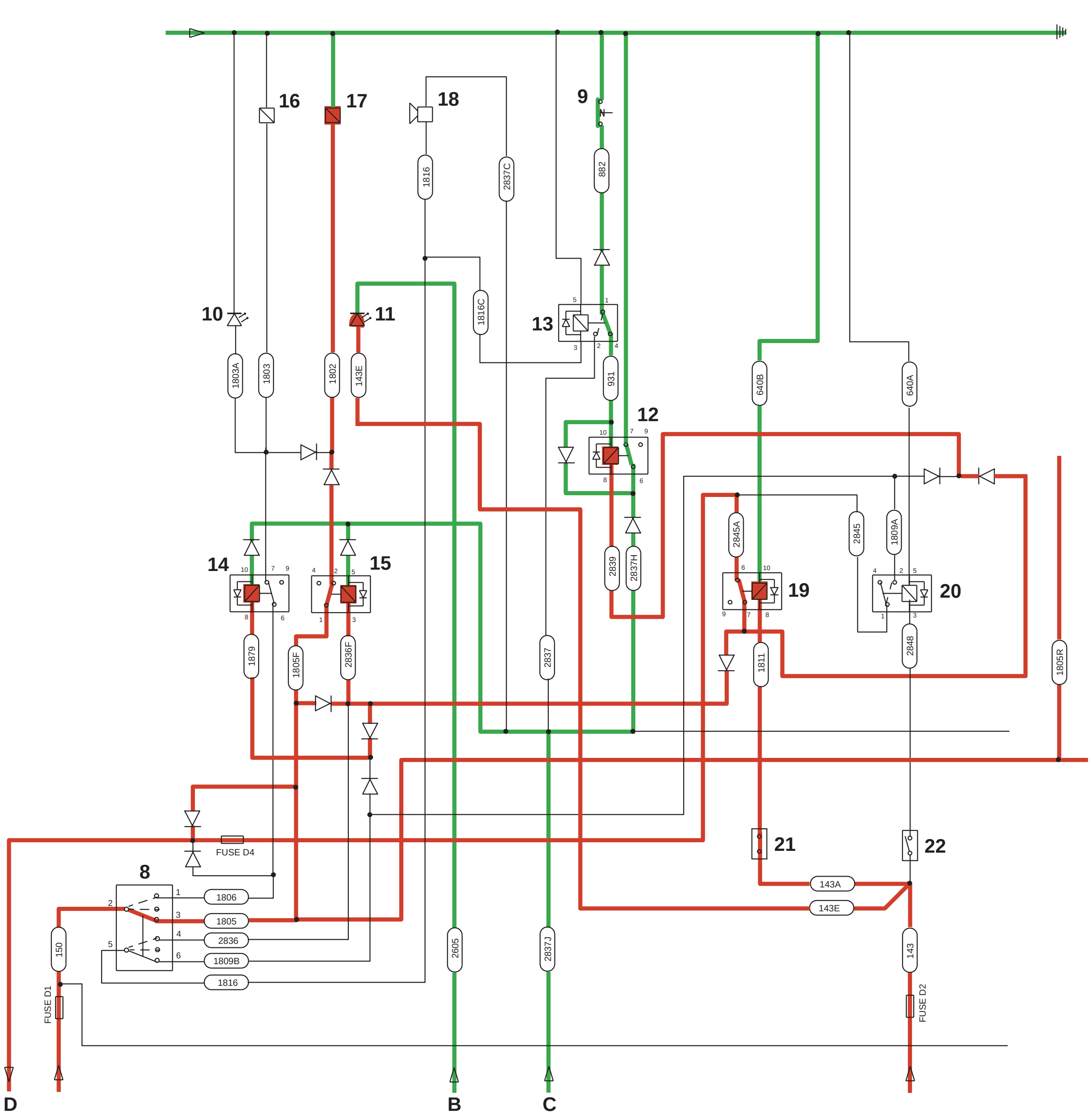
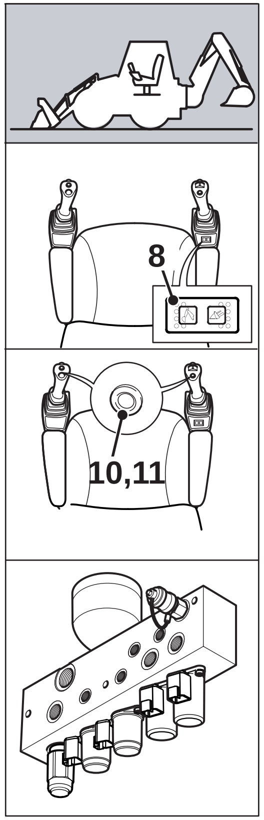


Fig 6. Joysticks Enable Circuit - Seat Facing Forward and Loader Selected



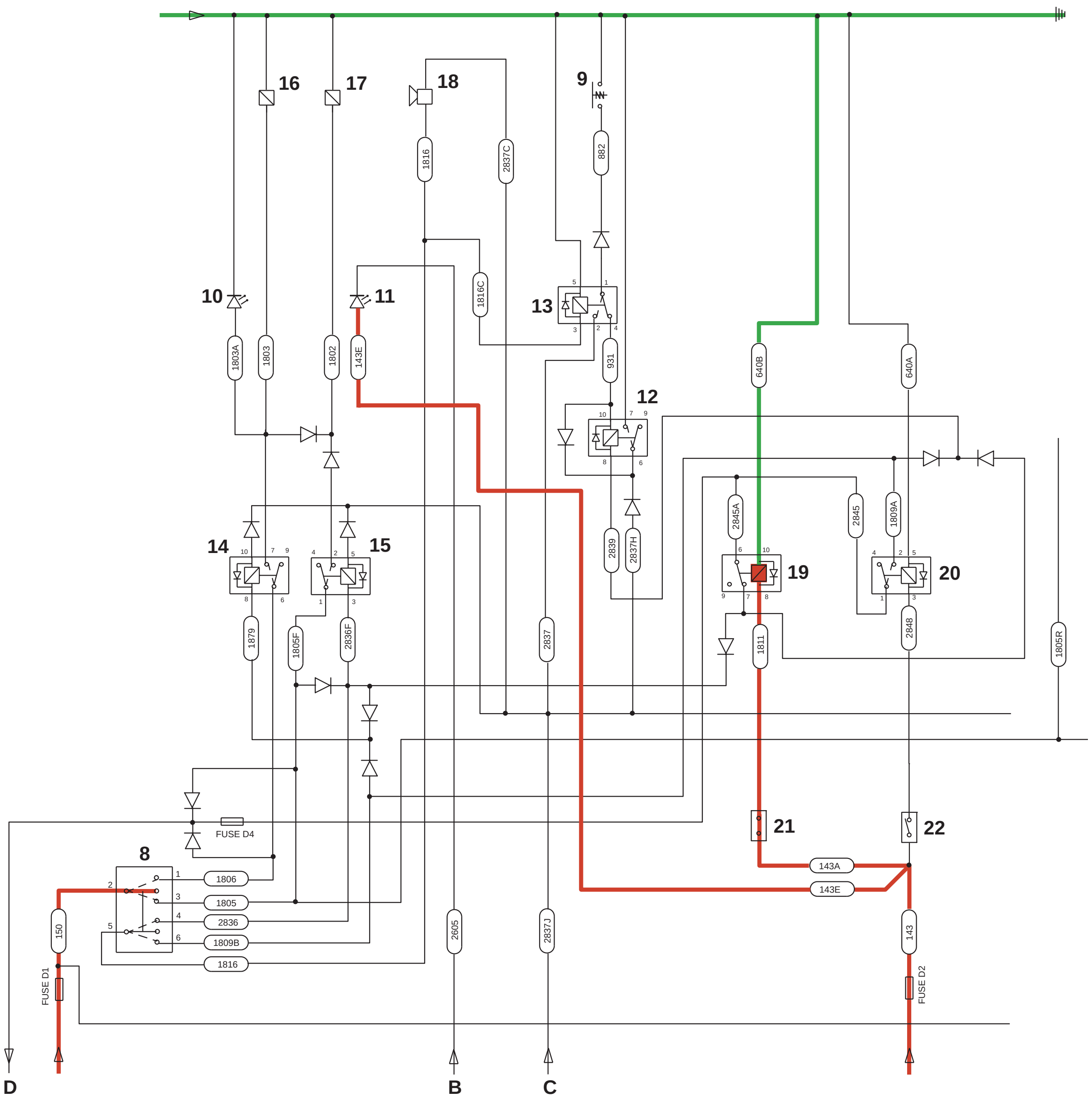
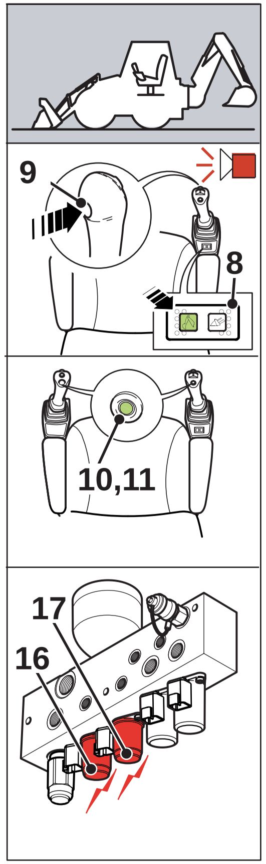


Fig 7. Joysticks Enable Circuit - Excavator/Loader Selector Switch OFF (Joysticks Cut-out)



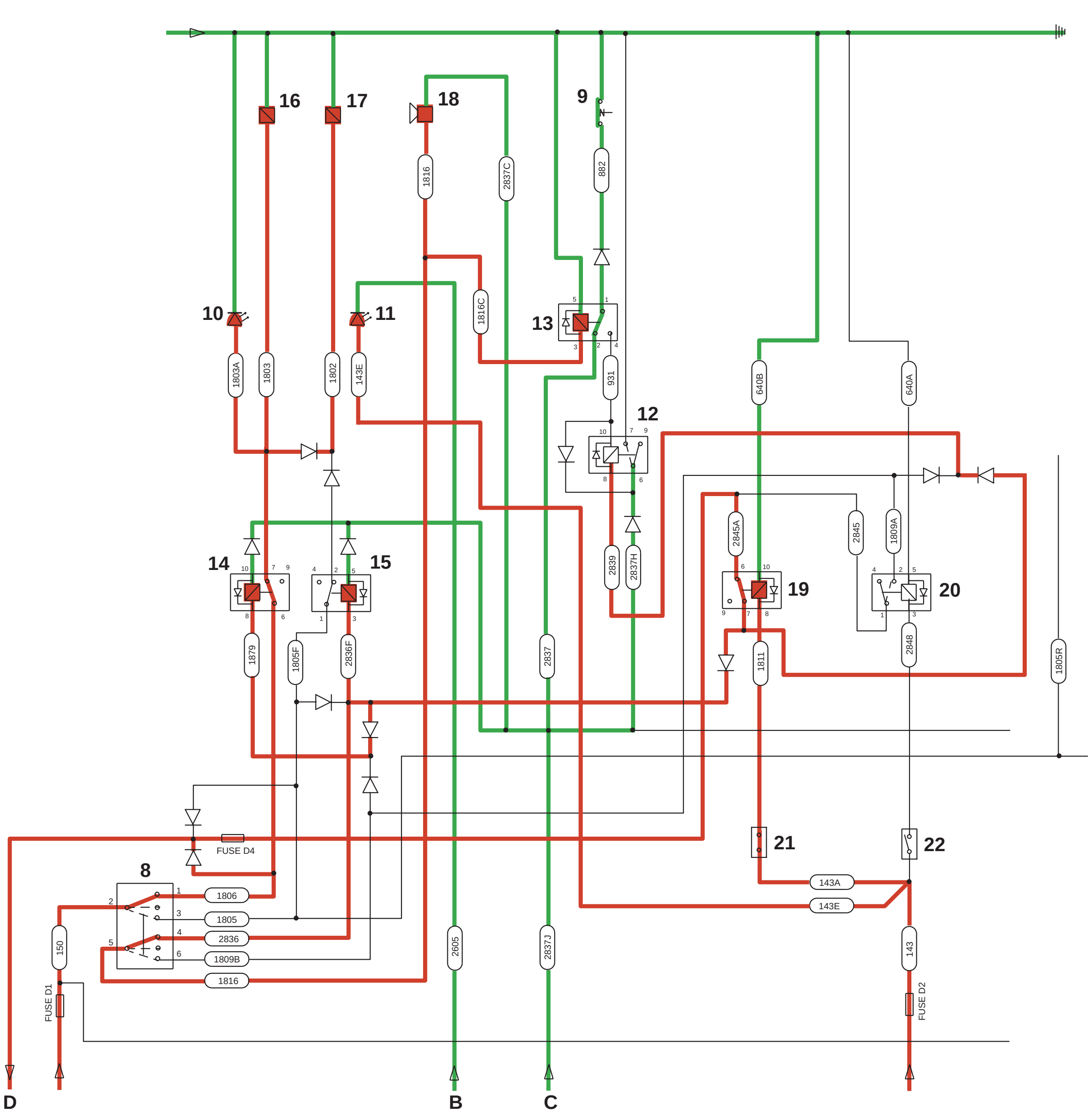


Fig 8. Joysticks Enable Circuit - Seat Facing Forward and Excavator Selected

Excavator/Loader Changeover Circuit

The diagrams in this section are intended to show how the electrical circuits work when different functions are operated.

The wire numbers and colours, where appropriate, are shown as an aid to identification while fault finding. The wires coloured red show the electrical live feeds. The wires coloured green show the electrical returns to earth.

Before fault finding make sure that you understand how the electrical circuits work. Most potential faults can be traced using a multimeter to carry out continuity checks on wires, switches and solenoids.

Loader Selected: ⇨ *Fig 9. (L-183)*.

With the excavator/loader selector switch **8** set to the loader position and the joystick activated, the joysticks enable relay **12** is energised and `latched'. This completes the return circuit for the changeover relays **23** and **24**, which also energise.

The changeover valve solenoids **25** then energise to direct the pilot pressure from the RH joystick to operate the loader valve block lift, lower, crowd and dump services. The changeover valve solenoids **27** are energised to direct the pilot pressure from the extend and retract proportional solenoid valves to operate the loader valve block auxiliary service.

Machines upto September 2006 Only: Pump dual horsepower valve solenoid **26** is also energised to set the pump output flow characteristic for loader operation.

Excavator Selected: ⇨ *Fig 10. (L-184)*.

With the excavator/loader selector switch **8** set to the excavator position and the joysticks activated, the changeover relays **23** and **24** are de-energised.

The changeover valve solenoids **25** are de-energised and direct the pilot pressure from the RH joystick to operate the excavator valve block lift, lower, crowd and dump services. The changeover valve solenoids **27** are de-energised and direct the pilot pressure from the extend and retract proportional solenoid valves to operate the excavator valve block auxiliary service.

Machines upto September 2006 Only: Pump dual horsepower valve solenoid **26** is also de-energised to set the pump output flow characteristic for excavator operation.

Component Key:

8	Excavator/Loader Selector Switch
9	Joysticks Enable Pushbutton (RH Joystick)
10	Joystick `Active' LED (LH Joystick)
11	Joystick `Active' LED (RH Joystick)
12	Joysticks Enable Latching Relay
13	Joysticks Enable Relay
14	Servo Pilot Valve Relay
15	Servo Pilot Valve Relay
16	Servo Pilot Valve Solenoid (LH Joystick)
17	Servo Pilot Valve Solenoid (RH Joystick)
18	Joysticks `Active' Warning Buzzer
19	Seat Forward Relay
20	Seat Rear Relay
21	Seat Forward Sensor Switch (Vane Type)
22	Seat Rear Sensor Switch (Vane Type)
23	Excavator/Loader Changeover Relay
24	Excavator/Loader Changeover Relay
25	Excavator/Loader C/O Valve Solenoids (Lift, Lower, Crowd and Dump Services)
26	Pump Dual Horsepower Valve Solenoid (1)
27	Excavator/Loader C/O Valve Solenoids (Auxiliary Extend and Retract Services)
B	To PWM Controller (ECU)
C	From ECU Power Relay
D	To ECU Power Relay

(1) No longer fitted on machines from serial no. 975289.

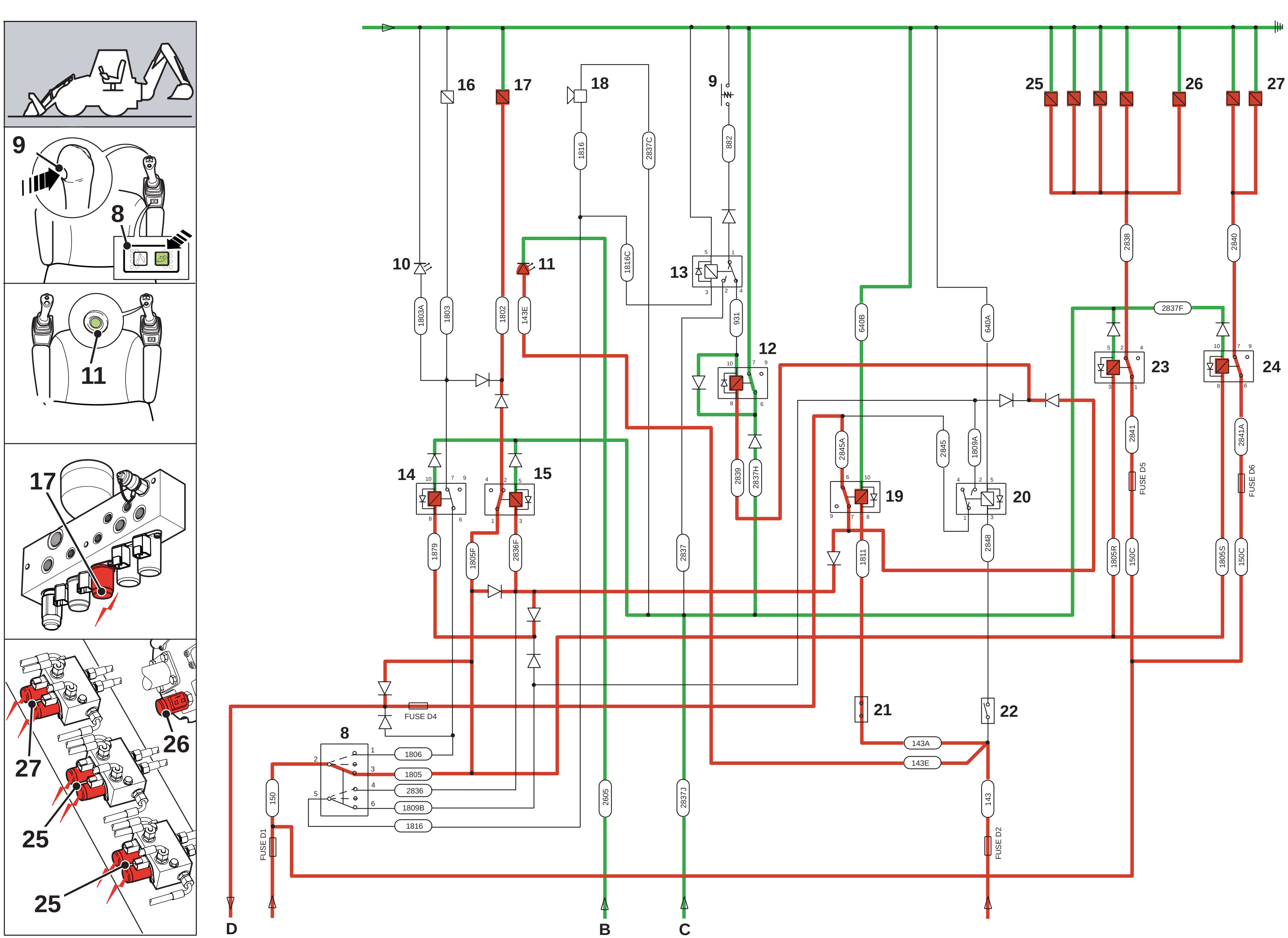


Fig 9. Excavator/Loader Changeover Circuit - Loader Selected

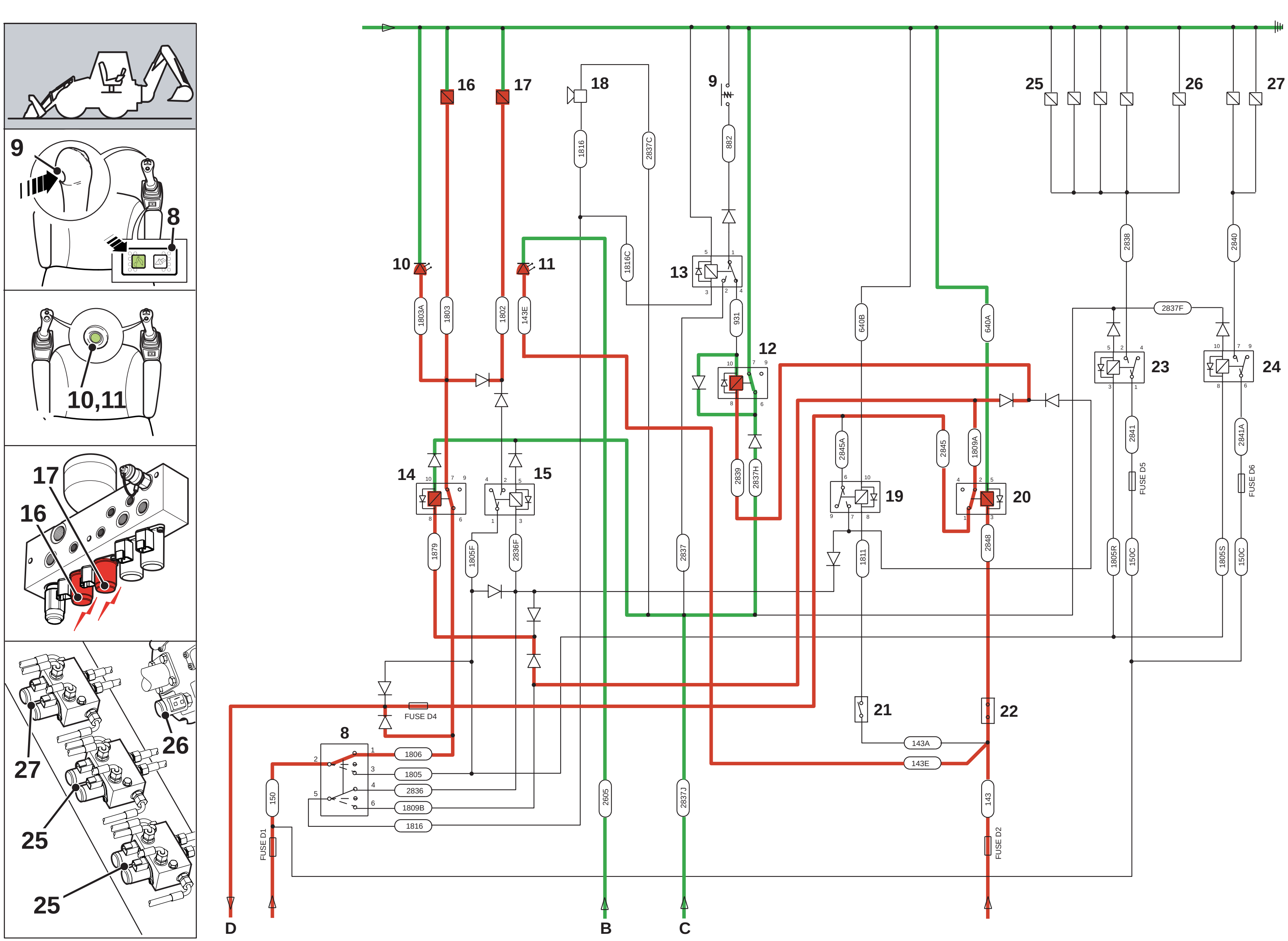


Fig 10. Excavator/Loader Changeover Circuit - Excavator Selected

Excavator/Loader Auxiliary Service Controls

The diagrams in this section are intended to show how the electrical circuits work when different functions are operated.

The wire numbers and colours, where appropriate, are shown as an aid to identification while fault finding. The wires coloured red show the electrical live feeds. The wires coloured green show the electrical returns to earth.

Before fault finding make sure that you understand how the electrical circuits work. Most potential faults can be traced using a multimeter to carry out continuity checks on wires, switches and solenoids.

Auxiliary Ram Extend: ⇒ *Fig 11. (L-186)*.

When the excavator/loader selector switch **8** is operated a live feed **D** energises the ECU cutout relay **45**. When energised, this relay completes the return circuit from the PWM controller (ECU) **29** as shown.

Pressing the joysticks enable pushbutton **9** energises the joysticks enable relay **12**. The relay `latches' and completes the return circuit for the ECU power relay **29A** which also energises. The power relay connects a live feed to the PWM controller (ECU) **29**, which is then able to function.

The auxiliary service thumbwheel switch **30** is fed from a separate 5 volt regulated supply **28**. When the thumbwheel is moved by the operator, the ECU converts the thumbwheel voltage (input) into a corresponding valve current signal (PWM output) to the extend proportional solenoid valve coil **31**.

The ECU controls the valve current signal by varying the duty cycle of the PWM output. Diodes connected at the solenoid coils condition the circuit so that the duty cycle/ valve current relationship functions correctly.

Connected in series with the solenoid coil return circuit is a 2.2 ohm, 150 Watt current sense resistor **33**. The resistor enables the ECU to measure the amount of current flowing through the solenoid coil.

Auxiliary Ram Retract:

The ram retract circuit works in the same way as the extend circuit, except:

When the thumbwheel **30** is moved in the opposite direction by the operator, the ECU converts the thumbwheel voltage (input) into a corresponding valve current signal (PWM output) to the retract proportional solenoid valve coil **32**.

Note that the auxiliary service controls are common for both the excavator and the loader auxiliary service rams. Which auxiliary ram operates, (either excavator or loader) is determined by the excavator/loader selector switch, and whether the changeover valve solenoids **27** are energised, ⇒ *Excavator/Loader Changeover Circuit (L-182)*.

Component Key:

8	Excavator/Loader Selector Switch
9	Joysticks Enable Pushbutton (RH Joystick)
12	Joysticks Enable Latching Relay
13	Joysticks Enable Relay
27	Excavator/Loader C/O Valve Solenoids (Auxiliary Extend and Retract Services)
28	5V Voltage Regulator
29	PWM Controller (ECU)
29A	ECU Power Relay
30	Auxiliary Service Thumbwheel (RH Joystick)
31	`Extend' Proportional Solenoid (Servo Pilot Valve)
32	`Retract' Proportional Solenoid (Servo Pilot Valve)
33	150W Resistor
45	ECU Cutout Relay
B	From Joystick `Active' LED (RH Joystick)
D	From Excavator/Loader Selector Switch

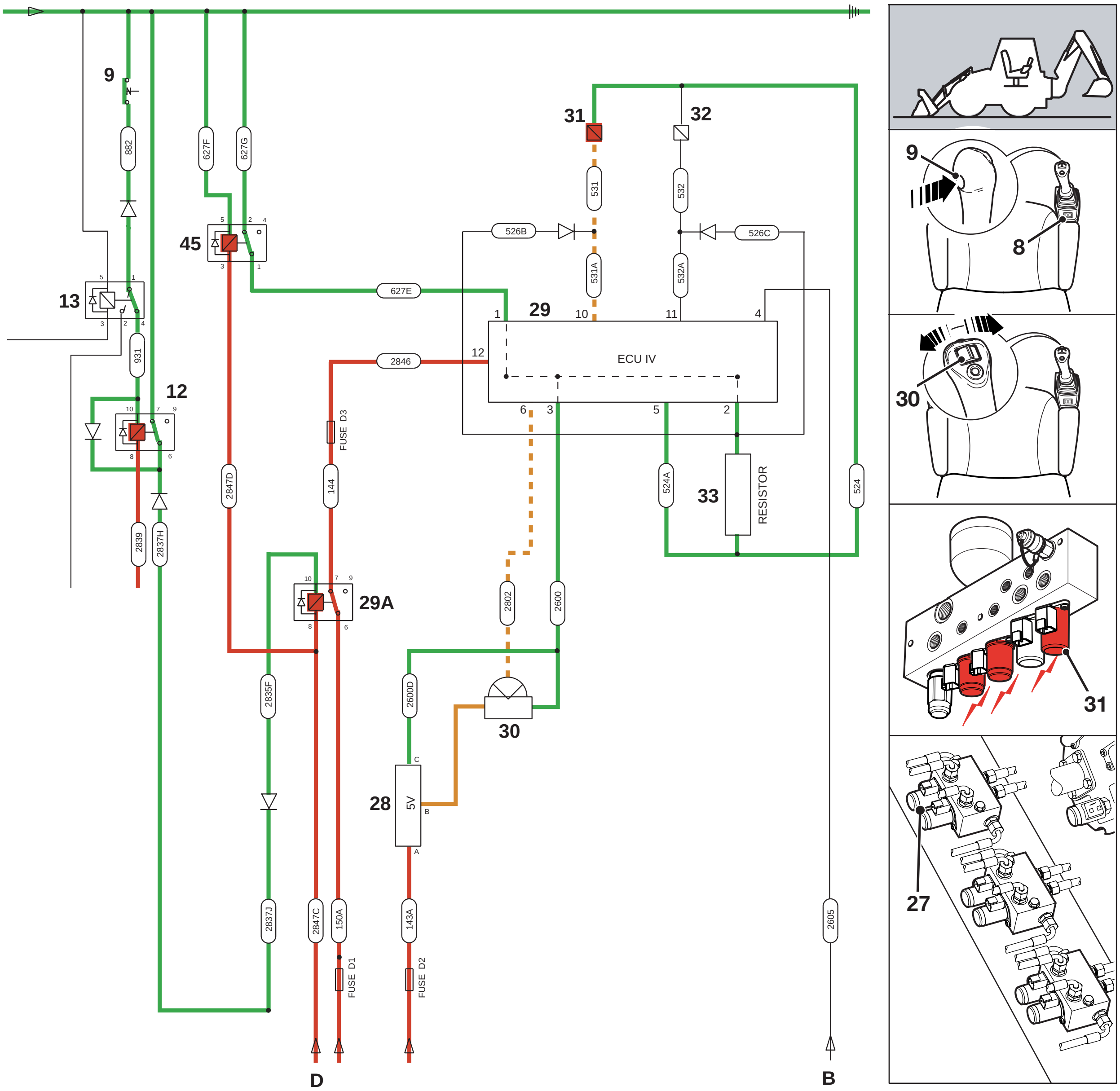


Fig 11. Excavator/Loader Auxiliary Service Controls - Auxiliary Ram Extend

Fault Finding

The purpose of this section is to help you trace a particular fault. The tables identify possible causes and give a suggested action with specific tests where applicable.

To help identify the hydraulic and electrical components mentioned in the fault finding tables, refer to the hydraulic and electrical schematic diagrams (near the beginning of this section).

1 Before you begin fault finding, read the safety information at the beginning of this manual.

2 Make any relevant electrical checks before moving on to the hydraulics.

3 Make simple checks before say, stripping a major hydraulic component.

4 Make sure that the hydraulic fluid is at the correct working temperature (50 °C, 122 °F).

5 If hydraulic contamination is found be sure to remove ALL debris, and if possible identify its origin. It may be part of a component from elsewhere in the hydraulic circuit.

6 What ever the fault, check the condition of the hydraulic fluid. Drain and replace if necessary.

7 Renew any seals such as `O' rings when re-assembling hydraulic components.

Fault Finding Tables

Fault Descriptions:		
1	No servo controls, the joysticks do not function.	⇨ Table 2. (L-188).
2	ALL services slow to operate.	⇨ Table 3. (L-189).
3	ALL services lack power, the machine is unable to lift.	⇨ Table 4. (L-190).
4	One service operates correctly, but slows down when a second service is selected.	⇨ Table 5. (L-191).
5	One service fails or is slow to operate.	⇨ Table 6. (L-192).
6	Clam shovel or extending dipper service does not operate.	⇨ Table 7. (L-193).

Electronic Fault Codes

The thumbwheel PWM controllers (ECU's) will generate a blink code for some fault conditions. ⇨ Thumbwheel Diagnostic `Blink' Codes (L-194).

Table 2.

Fault	Possible Cause	Action
No servo controls, the joysticks do not function.	**1** Fault in electrical interlock circuit wiring, or operation of electrical interlock switches.	Check the condition of the associated electrical wiring for damage and that the fuses are intact. For details of the electrical circuit and connections ⇨ ***Joysticks Enable Circuit (L-177)***.
	a Seat sensor switch defective.	Check the seat is locked in the correct position and that the seat sensor switch is operating.
	b Enable pushbutton defective.	Check the function of the joystick enable pushbutton.
	c Solenoid(s) at the servo pressure supply valve not energised.	Check the condition of the associated electrical wiring for damage and that the fuses are intact.
	d Solenoid coil faulty.	Check the solenoid for open or short circuits. Measure the solenoid coil resistance.
	2 Servo pilot pressure too low.	Measure the servo pilot pressure. ⇨ ***Checking the Servo Pressure (L-195)***.
	a Due to faulty servo regulating valve.	Renew the servo pressure supply valve. Refer to ***Servo Pressure Supply Valve - Removal and Replacement***.
	b Servo pilot filter blocked due to contamination.	Renew the filter element.

⇨ ***Fault Finding Tables (L-187)***.

Table 3.

Fault	Possible Cause	Action
ALL services slow to operate. (Indicates lack of flow in the hydraulic circuit)	**1** Insufficient hydraulic fluid.	Check for leaks and top up as required.
	2 Servo pilot pressure too low.	Measure the servo pilot pressure. ⇨ ***Checking the Servo Pressure (L-195)***.
	a Due to faulty servo regulating valve.	Renew the servo pressure supply valve. Refer to ***Servo Pressure Supply Valve - Removal and Replacement***.
	b Servo pilot filter blocked due to contamination.	Renew the filter element.
	3 Flushing valve piston within the loader valve inlet section sticking open due to contamination.	Dismantle and inspect the flushing valve piston. Refer to ***Loader Valve (Sectional Type) - Dismantle and Assemble***.
	4 Insufficient output flow from variflow pump because the pump is not receiving the correct load sense pressure.	
	a Due to load sense relief valve out of adjustment or defective.	Check and adjust as required. ⇨ ***Checking the Main System Pressures (L-196)***.
	b Due to internal leakage fault in the load sense circuit.	Measure the load sense pressure. ⇨ ***Checking for Internal Leakage Fault in Load Sense Line (L-201)***.
	5 Insufficient output flow from variflow pump.	
(Particularly noticeable when operating the excavator).	**a** Pump dual horsepower valve solenoid is energised (Output flow characteristic set for loader operation). (1)	Check the function of the changeover valve electrical circuit. For details of the electrical circuit and connections ⇨ ***Excavator/Loader Changeover Circuit (L-182)***.
	b Failure of the pump, or internal tilting swashplate mechanism due to contamination.	Renew the pump and flush the hydraulic system to remove all contamination.

(1) The dual horsepower solenoid valve is no longer fitted on machines from serial no. 975289.

⇨ ***Fault Finding Tables (L-187)***.

Table 4.

Fault	Possible Cause	Action
ALL services lack power, the machine is unable to lift. (Indicates lack of pressure in the hydraulic circuit)	**1** Insufficient hydraulic fluid.	Check for leaks and top up as required.
	2 Servo pilot pressure too low.	Measure the servo pilot pressure. ⇨ ***Checking the Servo Pressure (L-195)***.
	a Due to faulty servo regulating valve.	Renew the servo pressure supply valve. Refer to ***Servo Pressure Supply Valve - Removal and Replacement***.
	b Servo pilot filter blocked due to contamination.	Renew the filter element.
	3 Load sense relief valve out of adjustment or defective.	Check and adjust as required. ⇨ ***Checking the Main System Pressures (L-196)***.
	4 Internal leakage fault in the load sense circuit.	Measure the load sense pressure. ⇨ ***Checking for Internal Leakage Fault in Load Sense Line (L-201)***.

⇨ ***Fault Finding Tables (L-187)***.

Table 5.

Fault	Possible Cause	Action
One service operates correctly, but slows down when a second service is selected.	**1** Insufficient output flow from variflow pump because the pump is not receiving the correct load sense pressure.	
	a Due to internal leakage fault in the load sense circuit.	Measure the load sense pressure. ⇨ ***Checking for Internal Leakage Fault in Load Sense Line (L-201)***.
	2 Flushing valve piston within the loader valve inlet section sticking open due to contamination.	Dismantle and inspect the flushing valve piston. Refer to ***Loader Valve (Sectional Type) - Dismantle and Assemble***.

⇨ ***Fault Finding Tables (L-187)***.

Table 6.

Fault	Possible Cause	Action
One service fails or is slow to operate.	**1** Associated hoses damaged, trapped or kinked.	Check hoses and replace as required.
	2 Associated ram leaking.	Carry out ram leakage checks, renew seals as required.
	3 Auxiliary relief valve (ARV) out of adjustment or defective.	Renew the associated auxiliary relief valve.
	4 Pressure compensator piston sticking due to contamination.	Test pressure compensator operation. ⇨ ***Pressure Compensator Network - Testing (L-202)***. Dismantle and inspect the associated pressure compensator piston. Refer to ***Excavator Valve (Sectional Type)*** or ***Loader Valve (Sectional Type) - Dismantle and Assemble***.
	5 Service spool or associated load hold check valves damaged or sticking due to contamination.	Dismantle and inspect the service spool and load hold check valves. Refer to ***Excavator Valve (Sectional Type)*** or ***Loader Valve (Sectional Type) - Dismantle and Assemble***.

⇨ ***Fault Finding Tables (L-187)***.

Table 7.

Fault	Possible Cause	Action
Clam shovel or extending dipper service does not operate. ***Note:*** *For certain fault conditions, the PWM Controller (ECU) will generate a blink code,* ***⇒ Thumbwheel Diagnostic `Blink' Codes (L-194)***.	**1** Fault in electrical circuit wiring, or operation of PWM Controller (ECU).	Check the condition of the associated electrical wiring for damage and that the fuses are intact. For details of the electrical circuit and connections ***⇒ Excavator/Loader Auxiliary Service Controls (L-185)***.
	a Thumbwheel switch defective.	Check the function of the thumbwheel switch. See ***Servo Pressure Supply Valve - Descriptions***.
	b Solenoid at the servo pressure supply valve not energising.	Check the condition of the associated electrical wiring for damage and that the fuses are intact.
	c Solenoid coil faulty.	Check the applicable solenoid coil for open or short circuits. Measure the solenoid coil resistance. Renew the solenoid coil.
	d Faulty auxiliary changeover solenoid valve.	Check the function of the changeover valve electrical circuit. For details of the electrical circuit and connections ***⇒ Excavator/Loader Changeover Circuit (L-182)***.
	e Faulty PWM Controller (ECU).	Renew the PWM Controller (ECU). (1)
	2 Servo pilot pressure too low.	Measure the servo pilot pressure. ***⇒ Checking the Servo Pressure (L-195)***.
	a Due to faulty servo regulating valve.	Renew the servo pressure supply valve. Refer to ***Servo Pressure Supply Valve - Removal and Replacement***.
	b Servo pilot filter blocked due to contamination.	Renew the filter element.
	c Due to proportional solenoid valve cartridge damaged or sticking due to contamination.	Renew the servo pressure supply valve. Refer to ***Servo Pressure Supply Valve - Removal and Replacement***.

(1) The ECU is a non-serviceable part. The ECU is NOT programmable.

⇒ Fault Finding Tables (L-187).

Thumbwheel Diagnostic `Blink' Codes

If an electrical fault condition is detected while operating an auxiliary service, the green LED **A** on the RH joystick will illuminate to display a blink code. The blink code sequence consists of the LED being switched ON for 1.5 seconds followed by a number of flashes (the code) of 0.5 second ON, 0.5 second OFF, and is completed by the LED being switched OFF for 1.5 seconds. The sequence is repeated until the fault is cleared.

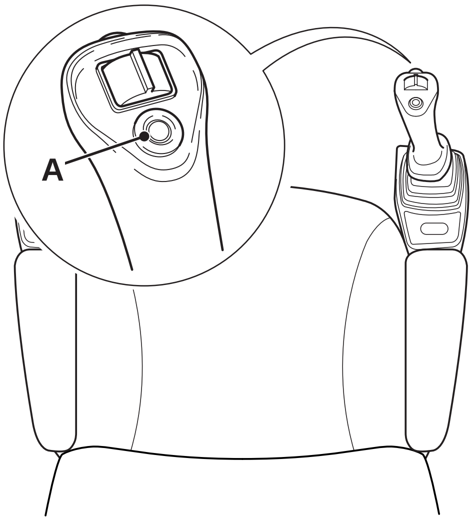


Fig 12.

Blink Code:	Fault:
1 Flash	Auxiliary ram `Extend' valve solenoid coil, or its associated wiring faulty (open or short circuit).
2 Flashes	Auxiliary ram `Retract' valve solenoid coil, or its associated wiring faulty (open or short circuit).
5 Flashes	Thumbwheel signal voltage too high (greater than 4.725 Volts).
6 Flashes	Thumbwheel signal voltage too low (less than 0.275 Volts).

For details of the electrical circuit and connections⇨ ***Excavator/Loader Auxiliary Service Controls (L-185)***.

Service Procedures

Checking the Servo Pressure

WARNING

Make the machine safe before working underneath it. Park the machine on level ground, lower the attachments to the ground. Apply the park brake, put the transmission in neutral and stop the engine. Block both sides of all four wheels.

Disconnect the battery, to prevent the engine being started while you are beneath the machine.

GEN-4-1_1

Make sure that the hydraulic oil is at working temperature, i.e. 50°C (122°F).

1 Working under the LH side of the machine, connect a 0 - 70 bar (0 - 1000 lbf/in^2) pressure gauge to the servo pressure test point **A** (at the servo pressure supply valve as shown).

2 With the engine running at 1500 rpm, check the reading on the pressure gauge. The servo pressure should be as stated below:

30 bar (30.6 kgf/cm^2, 435 lbf/in^2)

Note: *The servo pressure regulating valve* ***B*** *is factory set and sealed with a plastic tamper proof cap.*

Important: *The extent of permissible servicing is the renewal of the solenoid coils. Further dismantling of the valve is not recommended. If the valve is suspected as being faulty it must be renewed as a complete assembly. Note also that the pilot circuit accumulator is a non serviceable part and is sealed for life. It is not possible to recharge the accumulator with nitrogen.*

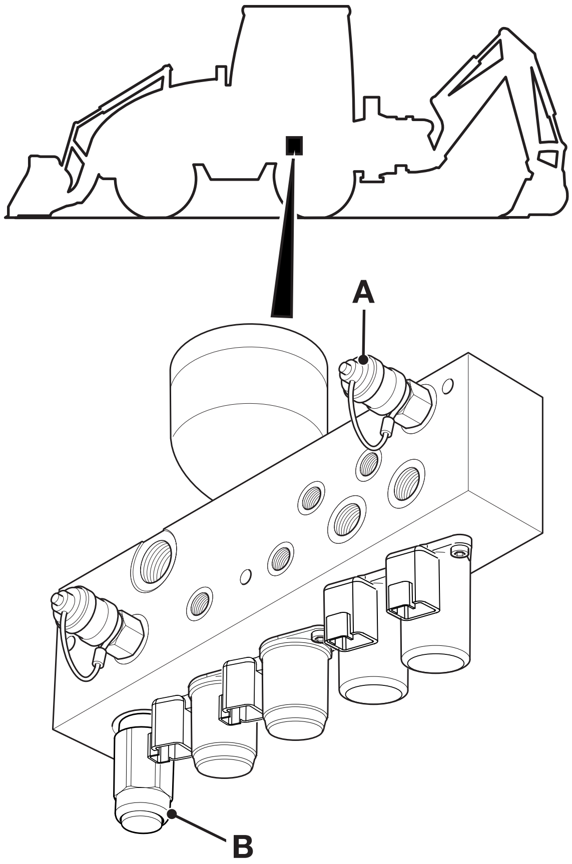


Fig 13.

Checking the Main System Pressures

Note: *This procedure describes the correct method to check the main system pressure, load sense pressure, pump standby pressure and delta-P pressure. A multi-channel digital pressure test set will be required to be able to measure the pressures accurately (see* ***Service Tools****).*

⚠ WARNING

Make the machine safe before working underneath it. Park the machine on level ground, lower the attachments to the ground. Apply the park brake, put the transmission in neutral and stop the engine. Block both sides of all four wheels.

Disconnect the battery, to prevent the engine being started while you are beneath the machine.

GEN-4-1_1

1 Lower the loader arms to the ground, then put the excavator into the travel position. Stop the engine.

2 Vent the hydraulic services and pilot circuit accumulator hydraulic pressure:

Switch the starter to ON without starting the engine. Activate the joystick controls, operate the joysticks several times to vent the hydraulic pressure from the servo system and service rams. Turn the starter switch to the OFF position and remove the key.

3 At the loader end, disconnect the loader auxiliary service hoses **A** and connect them together using an adaptor to form a loop circuit as shown.

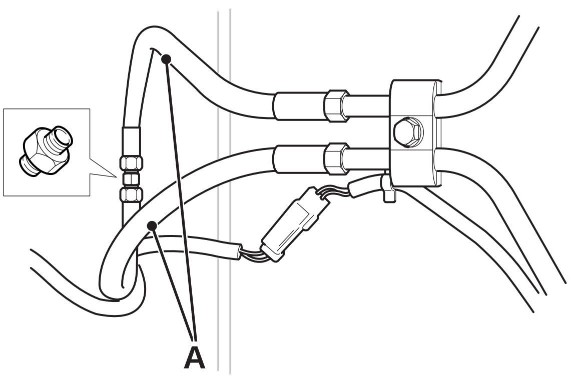


Fig 14.

4 Working under the RH side of the machine, connect a 0 - 600 bar (0 - 8500 lbf/in^2) pressure transducer to the main system pressure test point **B** (at the loader valve block) and connect to `Channel 1' on the test set.

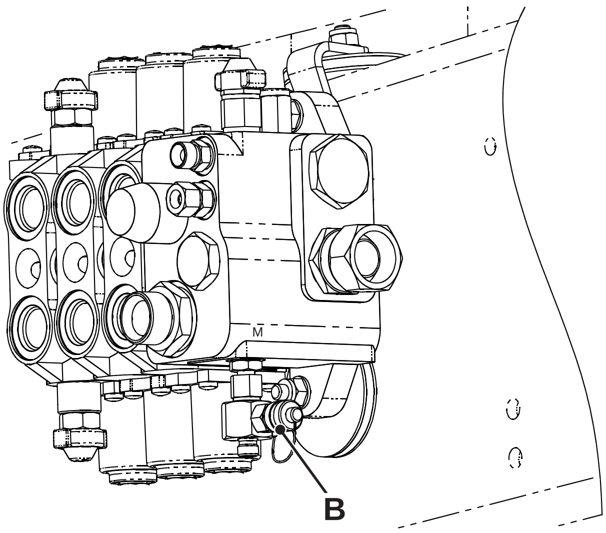


Fig 15.

5 Connect another 0 - 600 bar (0 - 8500 lbf/in^2) pressure transducer to the load sense pressure test point **C** (in the LS pipe as shown) and connect to `Channel 2' on the test set.

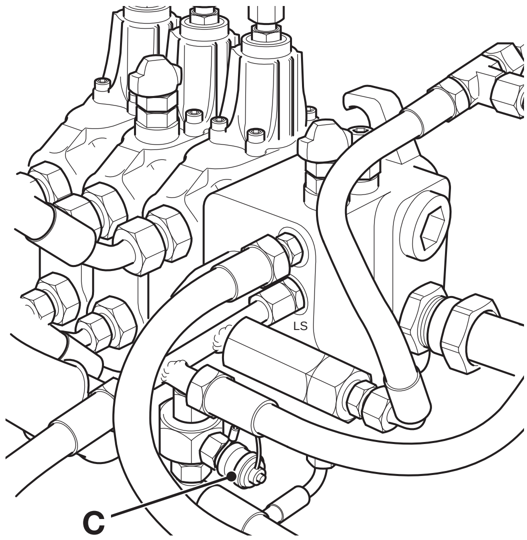


Fig 16.

6 Press button **D** to switch the test set ON, then press button **E** to set the screen to display delta-P between channels 1 and 2.

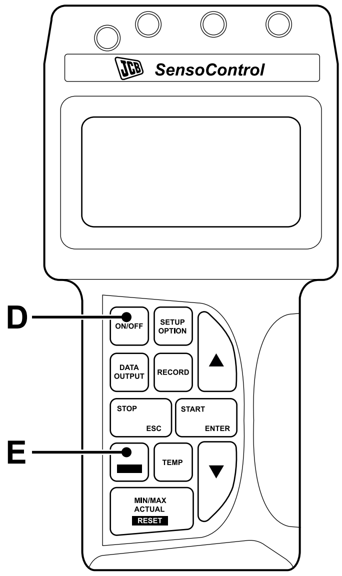


Fig 17.

7 Start the engine. Make sure that the hydraulic oil is at working temperature, i.e. 50°C (122°F).

8 Measure the **standby pressure**:

a With the seat locked in the rear facing position, activate the joystick controls.

b Set the engine speed to 1500 rpm.

c Note the pressure difference between the two pressure transducers on the test set. This is the standby pressure.

9 Measure the **main system pressure** and **load sense pressure**:

a Leave the seat in the rear facing position.

b Operate the joystick to fully crowd the excavator bucket, hold the joystick in this position to raise the main system pressure.

Note: *The pressure rise should be instantaneous. If the main system pressure rise is slow (laboured) to achieve maximum pressure, this indicates that there maybe an internal leakage fault in the load sense circuit.* *⇨ Checking for Internal Leakage Fault in Load Sense Line (L-201)*.

c Note the pressures on the test set. `Channel 1' is the main system pressure and `Channel 2' is the load sense pressure.

10 Measure the **delta-P** pressure:

a Turn the seat to the forward facing position.

b Make sure the joystick controls are active (enabled), and the engine speed is at 1500 rpm.

c Assuming that the looped out service is the loader auxiliary service (clam shovel), very gently and slowly operate the clam service.

d Note the pressure difference between the two pressure transducers on the test set. The pressure will move from standby pressure to delta-P pressure as the thumbwheel switch moves.

Ignore the pressure at the end of travel.

11 Record the pressures in a table as shown below:

Table 8.

	Standby	Main System	Load Sense	Delta-P
Required:	25 - 27 bar	257 bar	235 bar	20 bar
Recorded:				

If required the pressures can be adjusted, but this must be done in the correct sequence. *⇨ Pressure Adjustment (L-198)*.

Pressure Adjustment

If required the hydraulic system pressures can be adjusted, but this must be done in the correct sequence as described below:

1 Adjust the **standby pressure**:

To adjust the standby pressure, add shims to the flushing valve inside the loader valve block.

2 Adjust the **delta-P pressure**:

To adjust the delta-P pressure, loosen the locknut and turn the adjuster screw **X** (at the variflow pump as shown). Turn the adjuster screw clockwise to increase pressure and counter-clockwise to decrease the pressure.

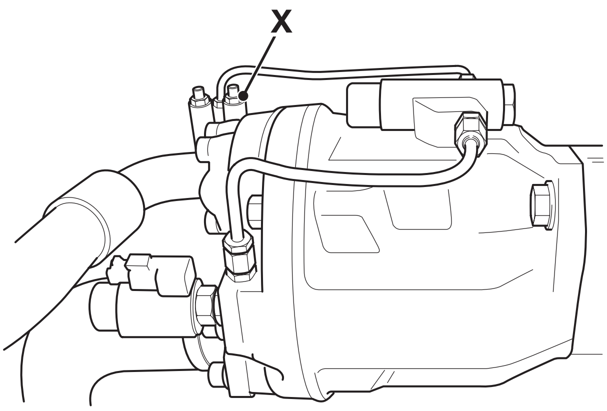


Fig 18.

Important: *The variflow pump fitted to Advanced EasyControl machines is different from other variflow pumps in the JCB range. UNDER NO CIRCUMSTANCES must the other adjuster screw (to the rear of the pump) be adjusted. This will change the characteristics of the horsepower control of the pump. This cannot be reset on the machine and will have to be returned to the manufacturer.*

After adjustment also check the load sense pressure and main system pressure which may have changed slightly after adjusting standby and delta-P.

3 Adjust the **load sense** and **main system pressure**:

Adjusting the load sense pressure alters the main system pressure.

To adjust the load sense pressure, remove the plastic cap from the load sense relief valve **Y** (at the loader valve block as shown). Loosen the locknut and turn the adjuster screw. Turn the adjuster screw clockwise to increase pressure and counter-clockwise to decrease the pressure.

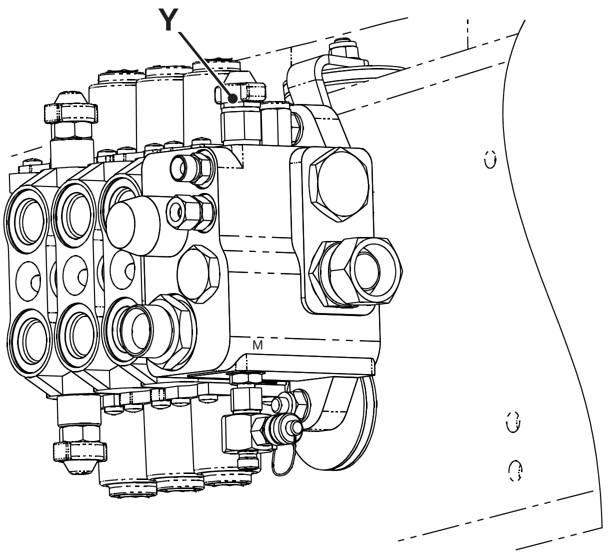


Fig 19.

Hydraulic Services Cycle Times

A practical method to determine the hydraulic pump performance is to measure the cycle times for the main hydraulic services. The table below gives the typical cycle times expected for each service. These values can be used as a guide to establish if the pump performance is satisfactory.

Table 9. Cycle Times (Oil Temperature 50 °C)

Service:	**Expected Time (Seconds):**
Loader	
Arms Up	3.84
Arms Down	3.77
Shovel Dump	1.82
Shovel Crowd	1.78
Clam Open	1.62
Clam Close	1.35
Excavator	
Slew Left	5.02
Slew Right	4.95
Boom Up	2.63 (1)
Boom Down	4.24
Dipper Dump	2.63
Dipper Crowd	4.24 (1)
Bucket Dump	1.95
Bucket Crowd	2.20
Extending Dipper Extend	2.86
Extending Dipper Retract	3.09

(1) Includes ram end-damping.

Hammer Auxiliary Service (Option)

The graph shows the typical pump flow expected for the hammer auxiliary service for given engine speeds.

Key:

A Theoretical Values

B Measured Values (actual)

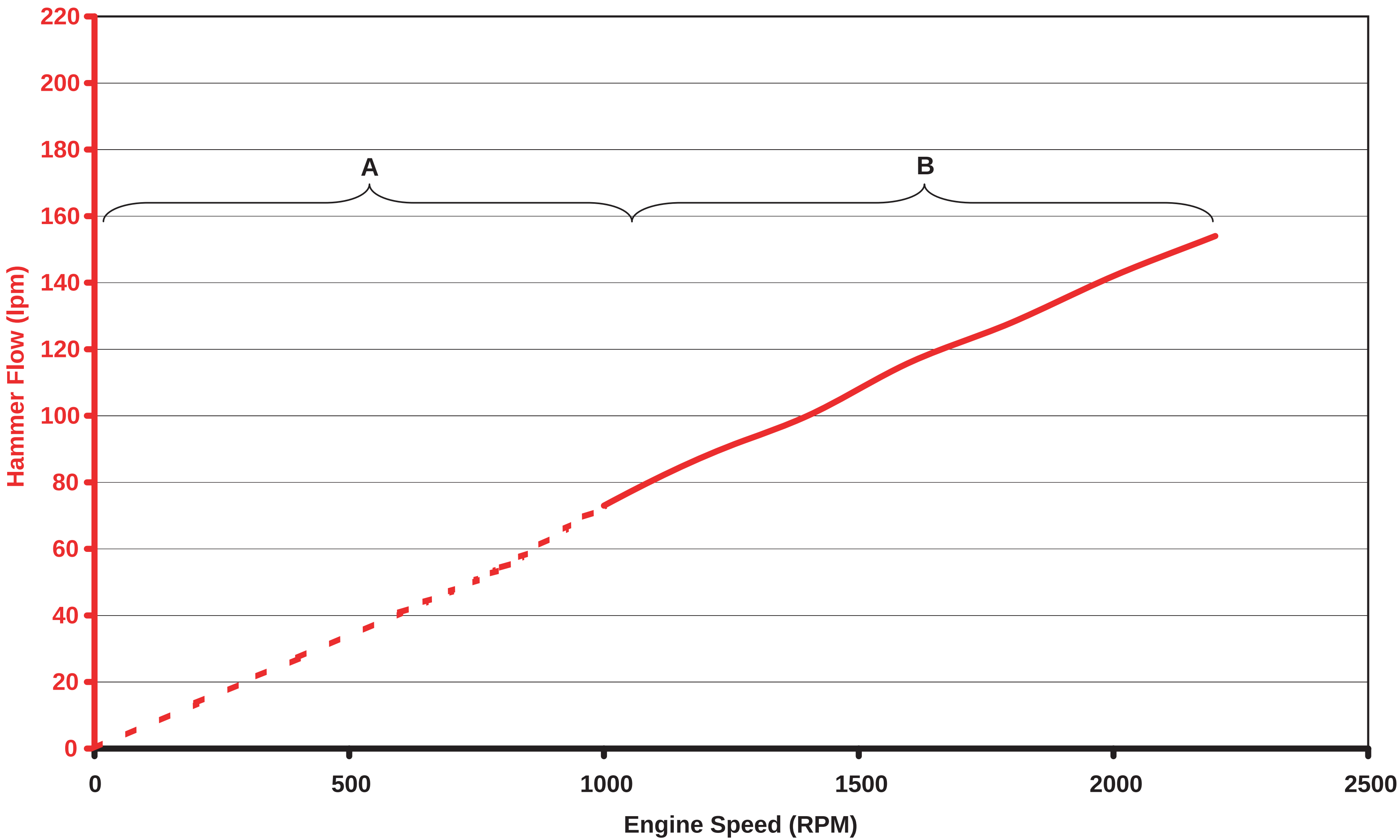


Fig 20. Graph of Pump Flow at 100 bar Operating Pressure (Oil Temperature 50 °C)

Checking for Internal Leakage Fault in Load Sense Line

1 Check the hydraulic system pressures. ⇨ *Checking the Main System Pressures (L-196)*.

Note: *If the main system pressure rise is slow (laboured) to achieve maximum pressure, this indicates that there may be an internal leakage fault in the load sense circuit.*

If an internal leakage fault is suspected in the load sense circuit, carry out the procedure described in the following steps to identify which valve assembly is at fault.

WARNING

Hydraulic Pressure

Hydraulic fluid at system pressure can injure you. Before connecting or removing any hydraulic hose, residual hydraulic pressure trapped in the service hose line must be vented. Make sure the hose service line has been vented before connecting or removing hoses. Make sure the engine cannot be started while the hoses are open.

INT-3-1-11_2

2 Before attempting to disconnect any hoses, vent the hydraulic services and pilot circuit accumulator hydraulic pressure:

Switch the starter to ON without starting the engine. Activate the joystick controls, operate the joysticks several times to vent the hydraulic pressure from the servo system and service rams. Turn the starter switch to the OFF position and remove the key.

3 Isolate the excavator valve from the load sense circuit:

a Disconnect the hose at the tee adaptor port **K**. Blank off the open port in the tee adaptor and the open end of the hose using suitable high pressure blanking plugs and caps.

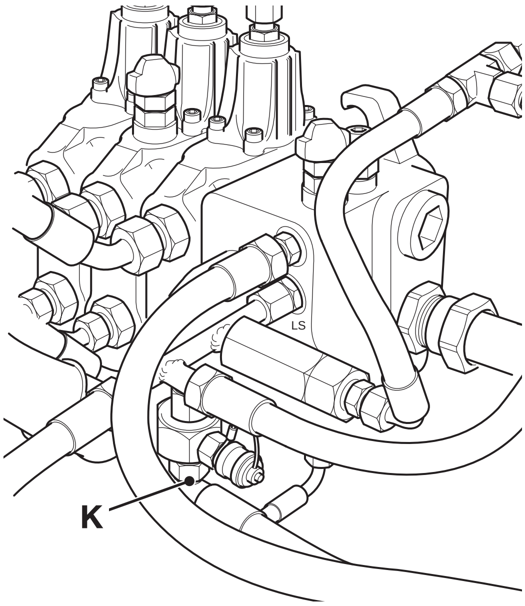


Fig 21.

b Repeat step 1 and note if there is any improvement in the main system pressure on the test set.

c If the pressure rise is instantaneous to achieve maximum pressure, the fault must be within the excavator valve assembly. Dismantle and inspect the excavator valve block, see ***Excavator Valve (Sectional Type) - Dismantle and Assemble***.

If the pressure rise is still slow (laboured) to achieve maximum pressure, the fault must be within the loader valve assembly. Dismantle and inspect the loader valve block, see ***Loader Valve (Sectional Type) - Dismantle and Assemble***.

Pressure Compensator Network - Testing

The pressure compensator valve network can be easily checked as follows:

1 Start the engine and operate the hydraulic system until the oil is at working temperature.

2 With the engine at 1500 revs/min operate each service in turn starting with the service furthest from the pump inlet section.

If one control valve section function either fails to work or is slow to work in either one or both directions, the pressure compensator valve in that section may be at fault.

When a pressure compensator valve is suspected of malfunctioning, do the following check:

3 Stall any control valve that is nearer the pump inlet section than the suspected control valve section. This should stall the entire system. While at stall operate the malfunctioning valve section, if the section operates correctly the pressure compensator valve in question is at fault.

If the section still malfunctions the pressure compensator valve is NOT at fault.

Note: *The pressure compensator valves may be removed for inspection, refer to* ***Loader Valve (Sectional Type) or Excavator Valve (Sectional Type) - Dismantle and Assemble****. Clean and refit, or fit a new pressure compensator valve as required.*

`Quick-Connect' Pilot Hoses

Some pilot hoses have quick-connect couplings. This type of coupling requires a special tool to release it.

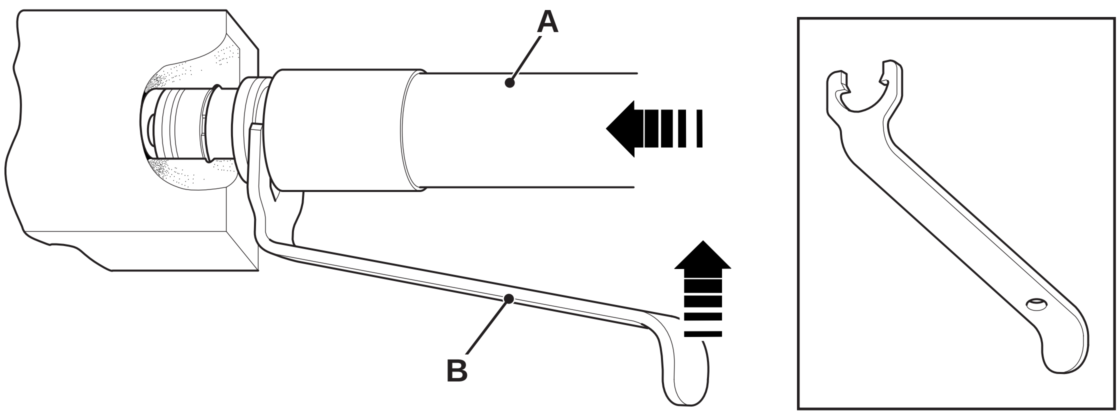


Fig 22.

Disconnecting

1 Push on the pilot hose **A** in the direction shown, and insert the correct tool **B**. See ***Service Tools***.

2 Push on the hose, and at the same time use the tool as a lever to release the coupling.

Connecting

1 Make sure that the hose coupling is clean and the O-rings are not damaged. Apply some clean hydraulic fluid to the O-rings.

2 Align the coupling directly to the hydraulic port. Push the coupling into the port as far as it will go. The coupling will click when it is fully engaged.

3 Pull on the hose to verify that the coupling is fully engaged. If the connection is not good the coupling will release very easily.

EasyControl SYSTEM

Related Topics

The table lists other topics in the section that contain information related to this topic. Refer to the applicable topics to complete your procedures. Where applicable the text contains cross-references to help you find the correct information.

System Overview

Note:** This hydraulic system differs in many important aspects to the normal hydraulic system. Before attempting to service or fault find the system ensure that you read and understand all the descriptions in this section.* ***The following descriptions make some comparisons to the normal hydraulic system. `Normal system' refers to standard non-servo machines *described in Section E, Hydraulics.*

The combined effect of the features described below ensure a precise and predictable response of the hydraulic services to operator input, and at the same time, maximises machine operating efficiency.

Excavator Servo Controls

⇨ *Fig 1. (L-207)*. The EasyControl system facilitates operation of the backhoe (excavator) via joystick controllers **A** and **B** mounted in the arms of the seat, and operation of the stabilisers via levers **C** mounted in the side console.

The joysticks and stabiliser controls each directly operate proportional pilot control valve capsules **D**. These valves in turn operate the excavator valve **E** service spools via hydraulic pilot pressure. The pilot control valve capsules direct servo pilot oil at a pressure proportional to the amount the operator moves the applicable joystick. The interconnecting servo pilot hoses to and from the excavator joystick controllers are routed through the central seat support pillar and then through the cab floor. **There are no mechanical linkages between the control levers and the excavator service spools as used in the normal system**.

Servo Pilot Oil Supply: A servo pressure supply valve **F** provides a constant supply of oil at servo pressure to the joystick controllers and stabiliser controls. Note that if the operator's seat is not in the correct operating position, or the excavator/loader selector switch **G** is set to OFF, the servo pressure supply valve isolates the servo pilot oil supply and the joystick controllers are disabled. ⇨ *Joystick Enable and Seat Interlock Switches (L-206)*.

Unloader and Hydraulic Speed Control (HSC) Function

Unloader Valve: The loader valve block **H** incorporates an unloader valve **J** which protects the engine from being overloaded if a service is being worked particularly hard E.g. when using the excavator to tear out.

The unloader valve automatically dumps the output flow from the secondary hydraulic pump **K** (pump P2) back to tank when the main system pressure rises to around 227 bar, allowing the engine power to be applied fully to the main pump section (pump P1). **This is the same as the normal system (Unloader operation)** described in Section E, Hydraulics.

Unloader Valve Solenoid: The solenoid allows the operator to activate the unloader valve electrically by pressing the Hydraulic Speed Control (HSC) switch **L** in the side console or the pushbutton in the loader lever. Dumping the pump P2 output flow back to tank in this way reduces the load on the engine, and ensures that more of the engine power is available to the machine transmission. In addition, the oil flow to the hydraulic services is also reduced, which makes the services operate slower for more precise work. **This is the same as the normal system (HSC operation)** described in Section E, Hydraulics.

Auxiliary Service Thumbwheel Controls

The RH joystick incorporates a thumbwheel switch **M** to operate the excavator auxiliary service (extending dipper). The loader lever knob also incorporates a thumbwheel switch **N** to operate the loader auxiliary service (clam shovel).

The thumbwheels control two electro-hydraulic proportional solenoid valves housed in the servo pressure supply valve block **F**.

Central to the control of the proportional solenoids is the auxiliary service PWM controller electronic control unit (ECU) **P** mounted in the floor plate above the loader valve. The ECU receives analogue electrical inputs from the thumbwheel switches **M** and **N**, and supplies a modulated output signal (PWM) to the relevant proportional solenoid valve.

The proportional solenoid valves work as separate pressure reducing valves, and direct servo pilot oil to move the auxiliary service spool at a pressure proportional to the amount the operator moves the thumbwheel switch. For a detailed description of proportional solenoid valve operation, see ***Servo Pressure Supply Valve - Descriptions***.

Auxiliary Service Control Changeover: A solenoid operated changeover valve **Q** allows control of either the loader auxiliary service **R** or the excavator auxiliary service **S**, depending on which way the operator's seat is facing.

When the excavator/loader selector switch **G** is in the excavator position, the solenoids are de-energised. The pilot pressure from the servo pressure supply valve block is directed by the changeover valve **Q** to operate the excavator auxiliary service **S**.

When the selector switch is in the loader position, the solenoids are energised. The pilot pressure from the servo pressure supply valve block is directed by the changeover valve **Q** to operate the loader auxiliary service **R**. For more details of the electrical circuit and connections ⇨ ***Electrical Operation and Schematics (L-213)***.

Joystick Enable and Seat Interlock Switches

To make the joystick controls active, the solenoid operated isolation valves (one for each joystick) housed in the servo pressure supply valve block **F** must be energised. The solenoids are energised via relays, by the excavator/ loader selector switch **G** on the RH seat pod.

Typically, to energise both isolation valve solenoids, the seat must first be locked in the rear facing position, thereby activating the `seat rear' sensor switch **T** on the base of the seat. The operator must then press the selector switch **G** to the excavator position, and press and release the joysticks enable pushbutton on the RH joystick. The green LED's **U** and **V** on both joysticks will then illuminate to indicate that the joysticks are active.

Note: *The RH LED* ***U*** *is also used by the auxiliary service PWM controller (ECU) to display a series of diagnostic 'blink' codes.* ⇨ ***Thumbwheel Diagnostic `Blink' Codes (L-228)***.

To disable the joysticks the operator must either press the selector switch **G** to the OFF position, or unlock and move the seat from the rear facing position. This will cause the isolation valve solenoids to de-energise, and the servo pilot oil supply to the joysticks will be isolated.

Note that the excavator joysticks can be enabled by the operator when the seat is locked in the forward facing position if required. This activates the `seat forward' sensor switch **W** on the base of the seat. The operator must then press and hold the pushbutton on the RH joystick. The warning buzzer will sound to alert the operator that the joysticks are active. When the operator releases the pushbutton, the joysticks become disabled and the warning buzzer will cease. For more details of the electrical circuit and connections ⇨ ***Electrical Operation and Schematics (L-213)***.

The LH joystick houses a pushbutton to operate the rear horn. On some machine variants the joysticks may have additional mode pushbuttons, for example to operate a hydraulic quickhitch, or an auxiliary changeover valve, typically to select between jaw bucket and extending dipper operation.

Excavator Bucket Thumb Ram - if fitted

On some machines, the LH joystick incorporates a thumbwheel switch **X** to operate a bucket thumb.

The thumbwheel controls two electro-hydraulic proportional solenoid valves housed in a separate thumb control valve **Y**.

Central to the control of the proportional solenoids is the thumb PWM controller electronic control unit (ECU) **Z** mounted in the floor plate above the loader valve. The ECU receives analogue electrical inputs from the thumbwheel switch **X**, and supplies a modulated output signal (PWM) to the relevant proportional solenoid valve.

The proportional solenoid valves work as separate pressure reducing valves, and direct servo pilot oil to move the bucket thumb ram at a pressure proportional to the amount the operator moves the thumbwheel switch.

Note: *The LH LED* ***V*** *is used by the thumb PWM controller (ECU) to display a series of diagnostic 'blink' codes.* ⇨ ***Thumbwheel Diagnostic `Blink' Codes (L-228)***.

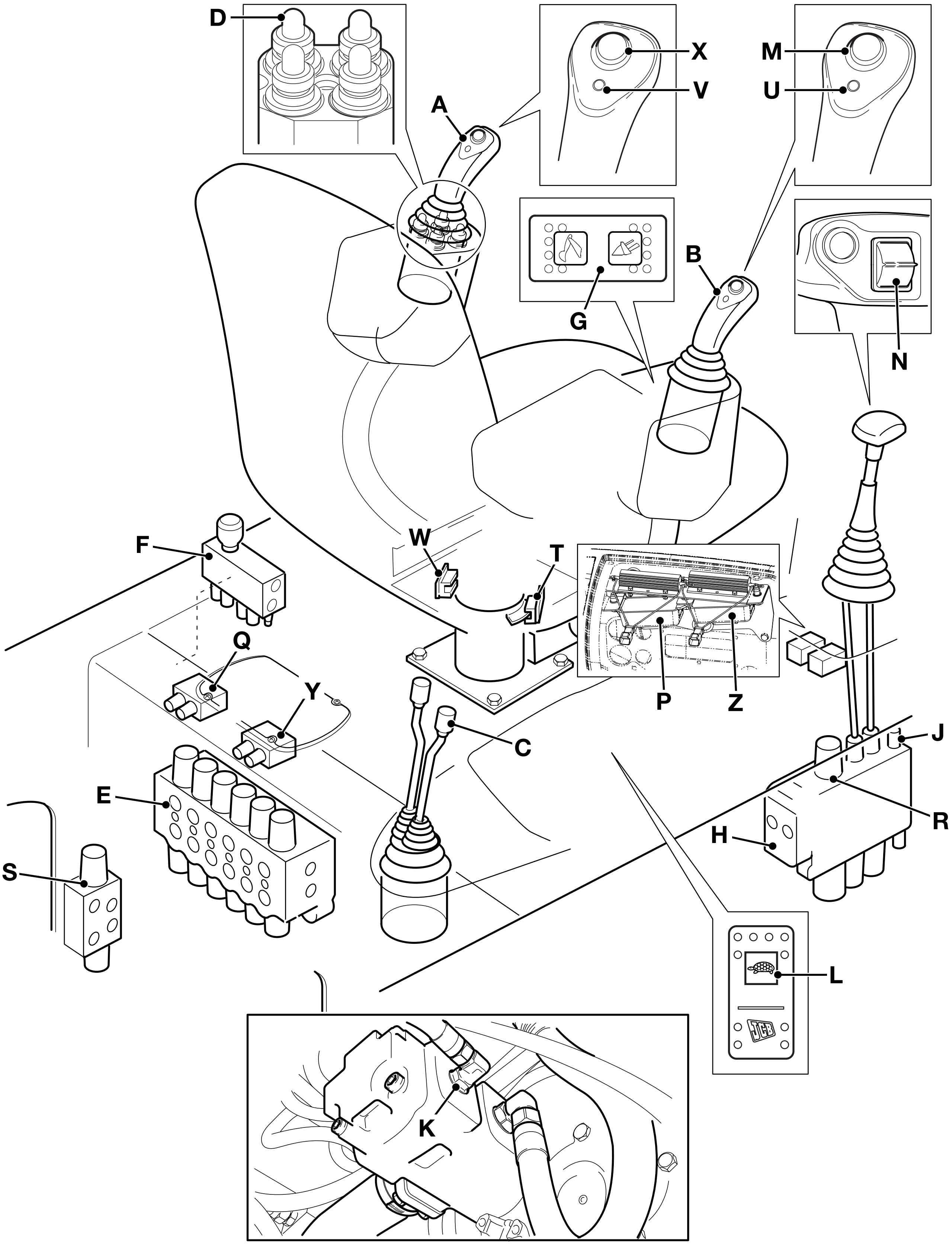


Fig 1. Component Location

Hydraulic Operation and Schematics

Note: *To make the description as clear as possible the diagram shows only part of the complete hydraulic system. For the complete hydraulic schematics, see* ***Schematic Circuits****.*

No Services Operated: ⇨ *Fig 2. (L-209)*.

Note that the service spools are open-centre. Oil from primary pump **P1** and secondary pump **P2** flows to the inlet section of the loader valve **3**. With all the hydraulic services in neutral, the combined oil flow from both pumps passes across the open-centre service spools **3a** and through the high pressure carry-over (HPCO) port to the inlet port of the excavator valve **6**. The combined oil flow passes across the open-centre service spools **6a** and through the HPCO port back to tank.

The main system pressure will be equal to the neutral circuit pressure.

Note that oil from secondary pump **P2** supplies the steer circuit via steer priority valve **2** in the normal way.

Oil from pump **P2** also flows through a constant pressure valve **3b** to the servo pressure supply valve **8** (via a filter **5**). The constant pressure valve **3b** ensures that when the engine is at idle (i.e. pump rpm is low), the oil supply to the servo pressure supply valve (derived from neutral circuit pressure) is at sufficient pressure. The servo pressure regulating valve **8a** regulates the incoming supply pressure to around 35 bar for operation of the joystick controllers **4** and stabiliser controls.

Service Operation: ⇨ *Fig 3. (L-210)*.

When a service is operated, boom lift for example, movement of the applicable joystick controller **4** supplies pilot oil to actuate the service spool **6a**. The controller supplies pilot oil at a pressure proportional to the joystick movement, thus controlling how far the service spool is displaced. Main system pressure continues to rise until load hold check valve **6b** opens and the boom lift ram **7** operates.

The main system pressure will now be equal to the working pressure (load from the boom lift ram).

Oil from the other side of the ram **7** flows across the service spool and back to tank in the normal way.

Unloader Operation: ⇨ *Fig 4. (L-211)*.

If high pressure is generated in the main hydraulic system, due to a high load acting on the service ram, the unloader spool **3c** operates automatically to dump the oil from pump **P2** back to tank. This allows all the engine power to be applied fully to the primary pump **P1**.

When the pressure reaches around 227 bar, the pilot valve **3d** opens. This allows oil to vent from behind the unloader spool **3c**, causing the spool to move off its seat. The action of the spool connects the flow from pump **P2** back to tank. Check valve **3e** closes to prevent oil from pump **P1** also being dumped.

Note: *The unloader valve solenoid* ***3f*** *allows the operator to activate the unloader valve electrically by pressing the Hydraulic Speed Control (HSC) switch in the cab.*

Main System Pressure Relief: ⇨ *Fig 5. (L-212)*.

The maximum main system pressure is set by the main relief valve (MRV).

When a service ram reaches the end of its stroke, or the service meets resistance and generates pressure around 250 bar in the main system, the main relief valve **3g** opens and oil is dumped back to tank, preventing further pressure rise.

Note: *The pressure values given are examples for the purpose of explanation only. Actual values may be different depending on the machine variant. All pressure relief valves are factory set. No adjustment is normally required.* *⇨ Checking the Main System Pressure (L-230)*.

Table 1. Colour Key to Oil Flow and Pressure

(orange-red)	Full Pressure
(orange)	Servo
(blue)	Neutral
(green)	Exhaust

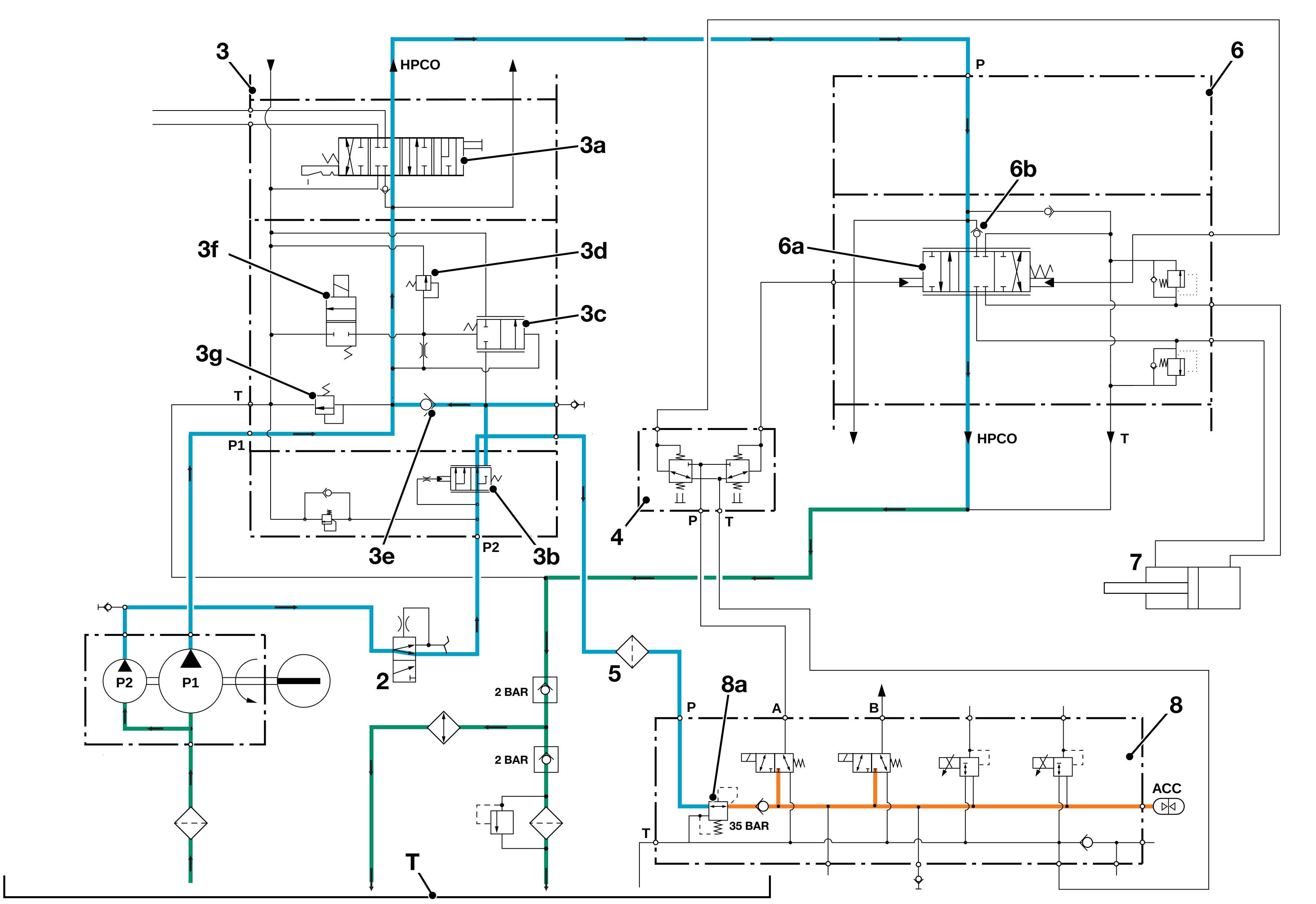


Fig 2. No Services Operated (Neutral)

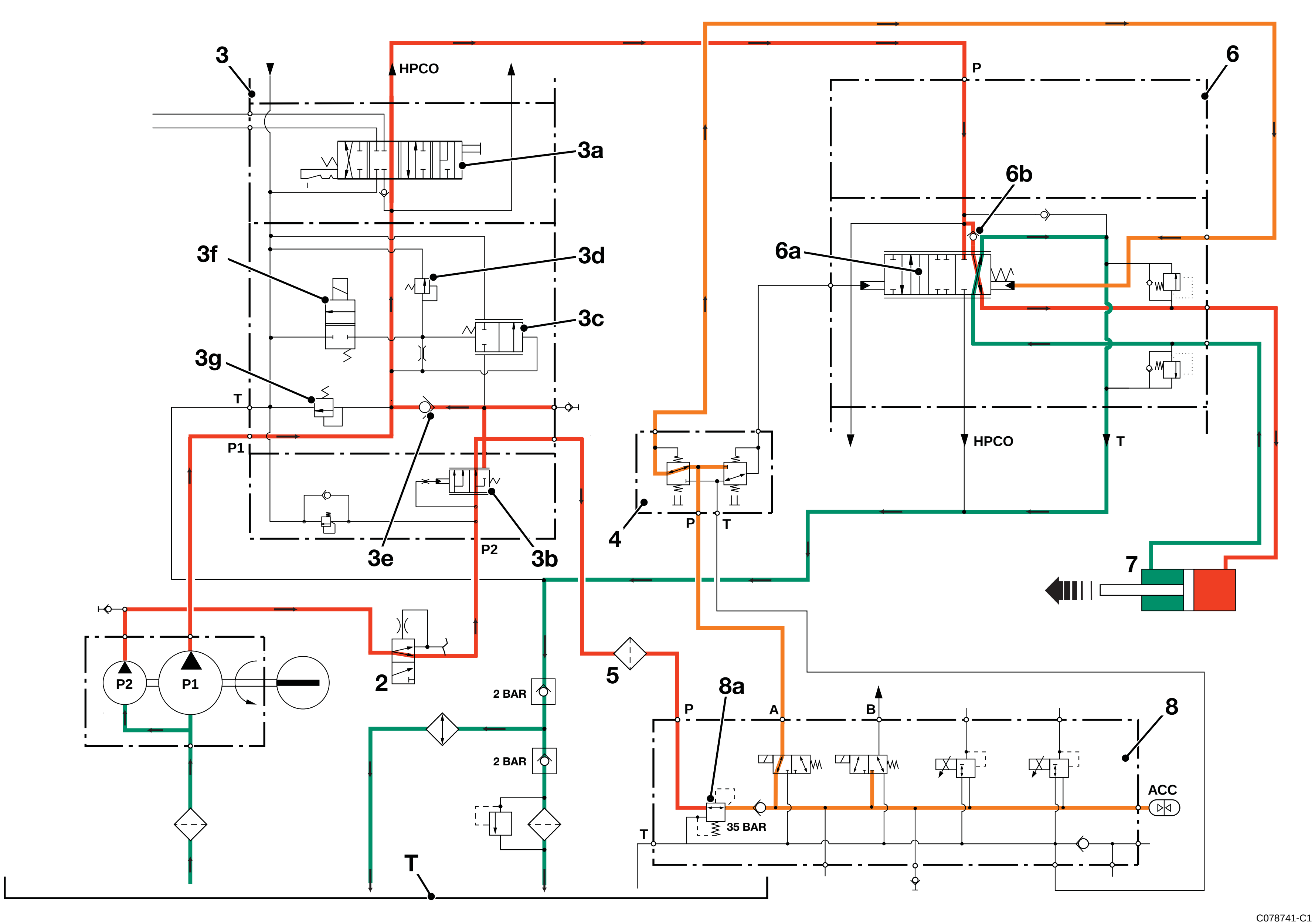


Fig 3. Service Operation

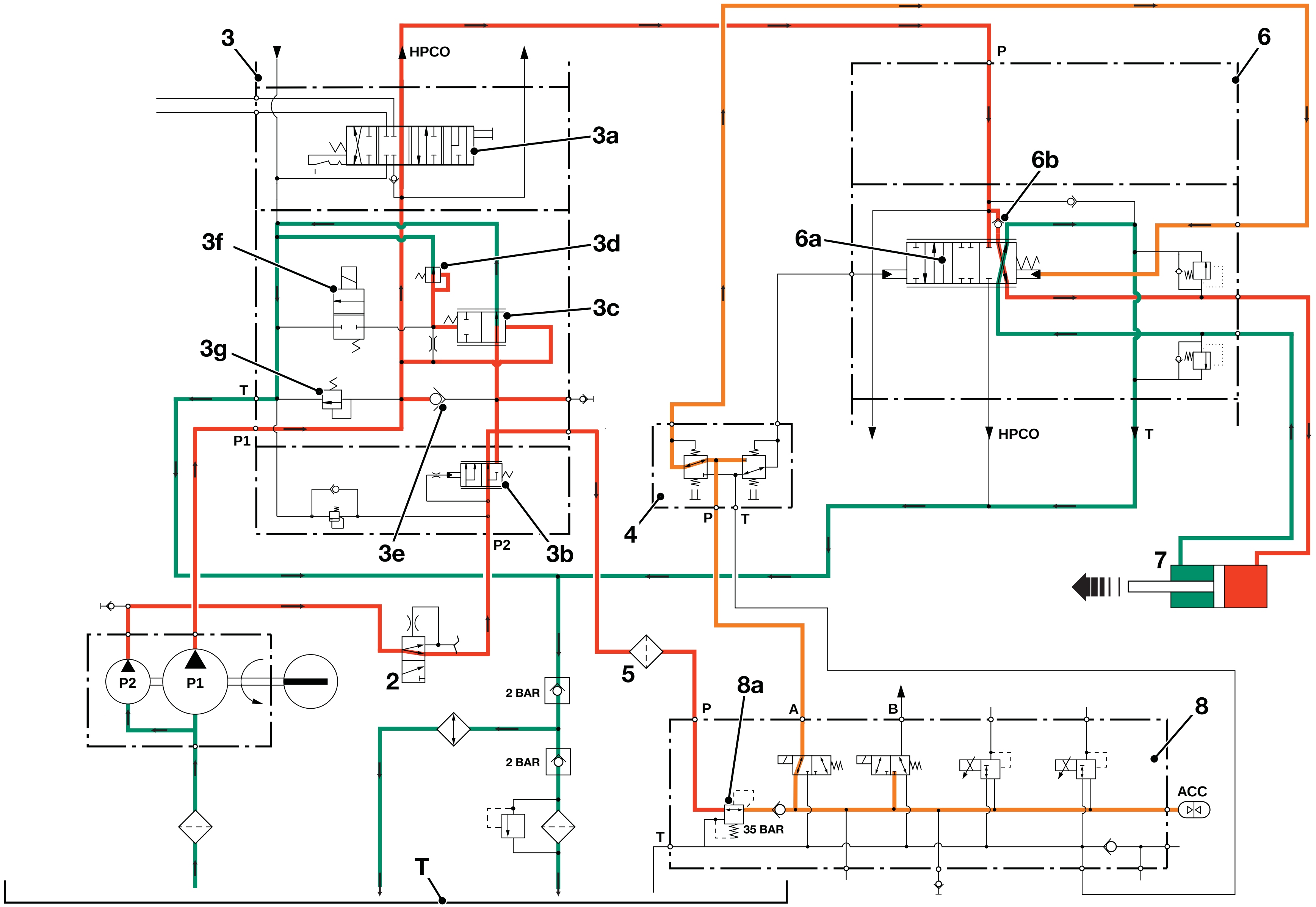


Fig 4. Unloader Operation

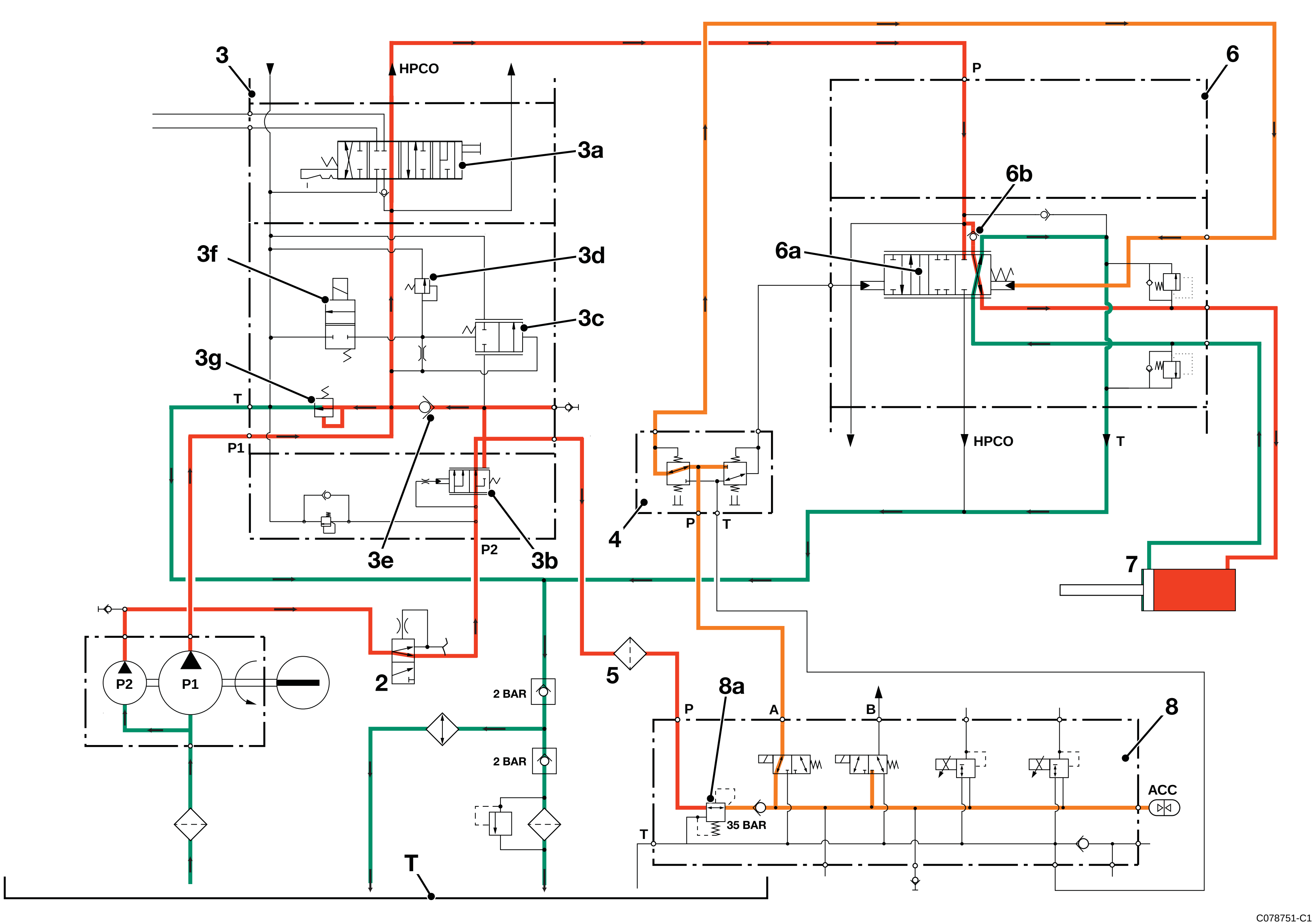


Fig 5. Main System Pressure Relief

Joysticks Enable Circuit

The diagrams in this section are intended to show how the electrical circuits work when different functions are operated.

The wire numbers and colours, where appropriate, are shown as an aid to identification while fault finding. The wires coloured red show the electrical live feeds. The wires coloured green show the electrical returns to earth.

Before fault finding make sure that you understand how the electrical circuits work. Most potential faults can be traced using a multimeter to carry out continuity checks on wires, switches and solenoids.

Seat Facing Rear and Excavator Selected: ⇒ Fig 6. (L-214).

When the seat is facing rear, the sensor switch **22** closes and energises auxiliary PWM changeover relay **15** and seat rear relay **20**. The auxiliary PWM relay contacts connect the output from the extending dipper thumbwheel switch on the RH joystick to the auxiliary PWM controller ECU (not shown).

With the excavator/loader selector switch **8** set to the excavator position, pressing the enable pushbutton **9** energises the enable relay **12**. This completes the return circuit for the servo pilot valve relay **14**, which also energises. The servo pilot valve solenoids **16** and **17** then energise, which allows servo pilot pressure to be directed to the joystick controllers. Both the joystick controllers then become active.

The enable relay **12** latches when the enable pushbutton **9** is released. The joystick controllers remain active until either the excavator/loader selector switch **8** is moved to the OFF position, or the seat is moved from the rear facing position, which causes the enable relay **12** to de-energise (and unlatch).

Excavator/Loader Selector Switch OFF (Joysticks Cut-out): ⇒ Fig 7. (L-215).

Moving the excavator/loader selector switch **8** to the OFF position de-energises the enable relay **12**. The relay unlatches and breaks the return circuit for the servo pilot valve relay **14**, which also de-energises. The servo pilot valve solenoids **16** and **17** then de-energise isolating the servo pilot pressure to the joystick controllers. Both the joystick controllers then become disabled.

Seat Facing Forward and Excavator Selected: ⇒ Fig 8. (L-216).

With the seat facing forward and the excavator/loader selector switch **8** set to the excavator position, the servo pilot valve solenoids **16** and **17** are energised only while the enable pushbutton **9** is \`held' pressed. The enable relay **13** is energised and the joysticks \`active' warning buzzer **18** will sound to alert the operator that the joysticks are active.

Component Key:

8	Excavator/Loader Selector Switch
9	Enable Pushbutton (RH Joystick)
10	Joystick \`Active' LED (LH Joystick)
11	Joystick \`Active' LED (RH Joystick)
12	Enable Latching Relay
13	Enable Relay
14	Servo Pilot Valve Relay
15	Auxiliary PWM Changeover Relay
16	Servo Pilot Valve Solenoid (LH Joystick)
17	Servo Pilot Valve Solenoid (RH Joystick)
18	Joysticks \`Active' Warning Buzzer
19	Seat Forward Relay
20	Seat Rear Relay
21	Seat Forward Sensor Switch (Vane Type)
22	Seat Rear Sensor Switch (Vane Type)
B	To Auxiliary PWM Controller (ECU)
C	From ECU Power Relay
D	To ECU Power Relay
E	From Extending Dipper Thumbwheel Switch (RH Joystick)
F	From Clam Shovel Thumbwheel Switch (Loader Lever)
G	To Auxiliary PWM Controller (ECU)

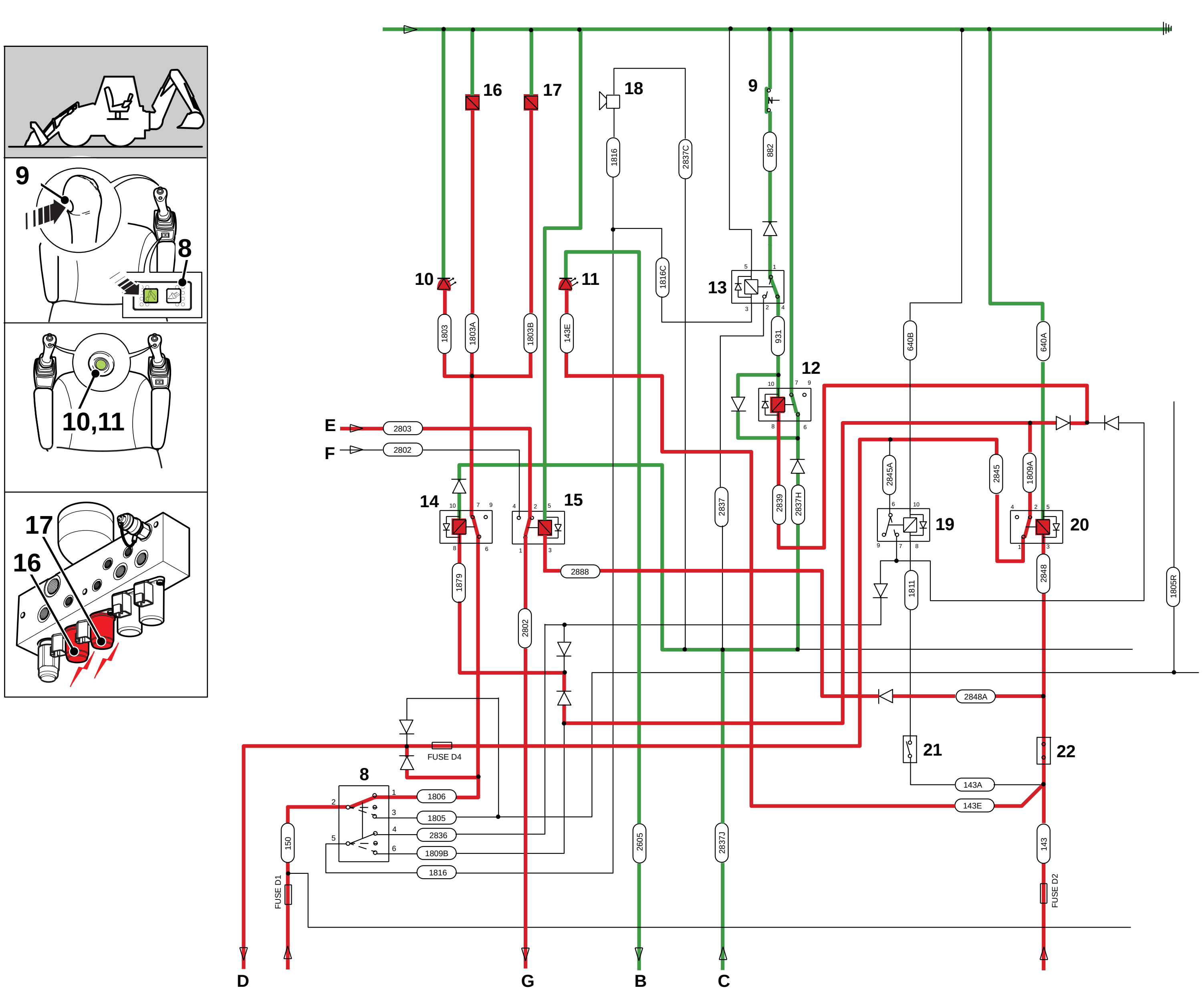
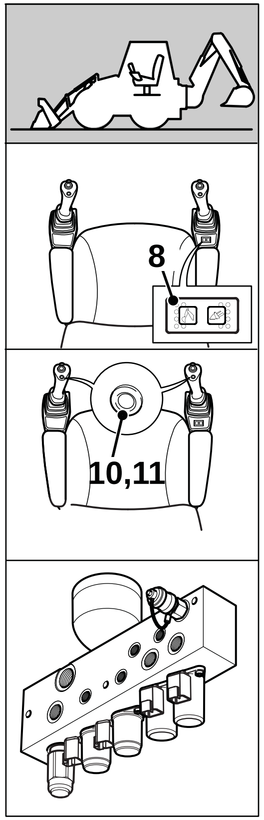


Fig 6. Joysticks Enable Circuit - Seat Facing Rear and Excavator Selected



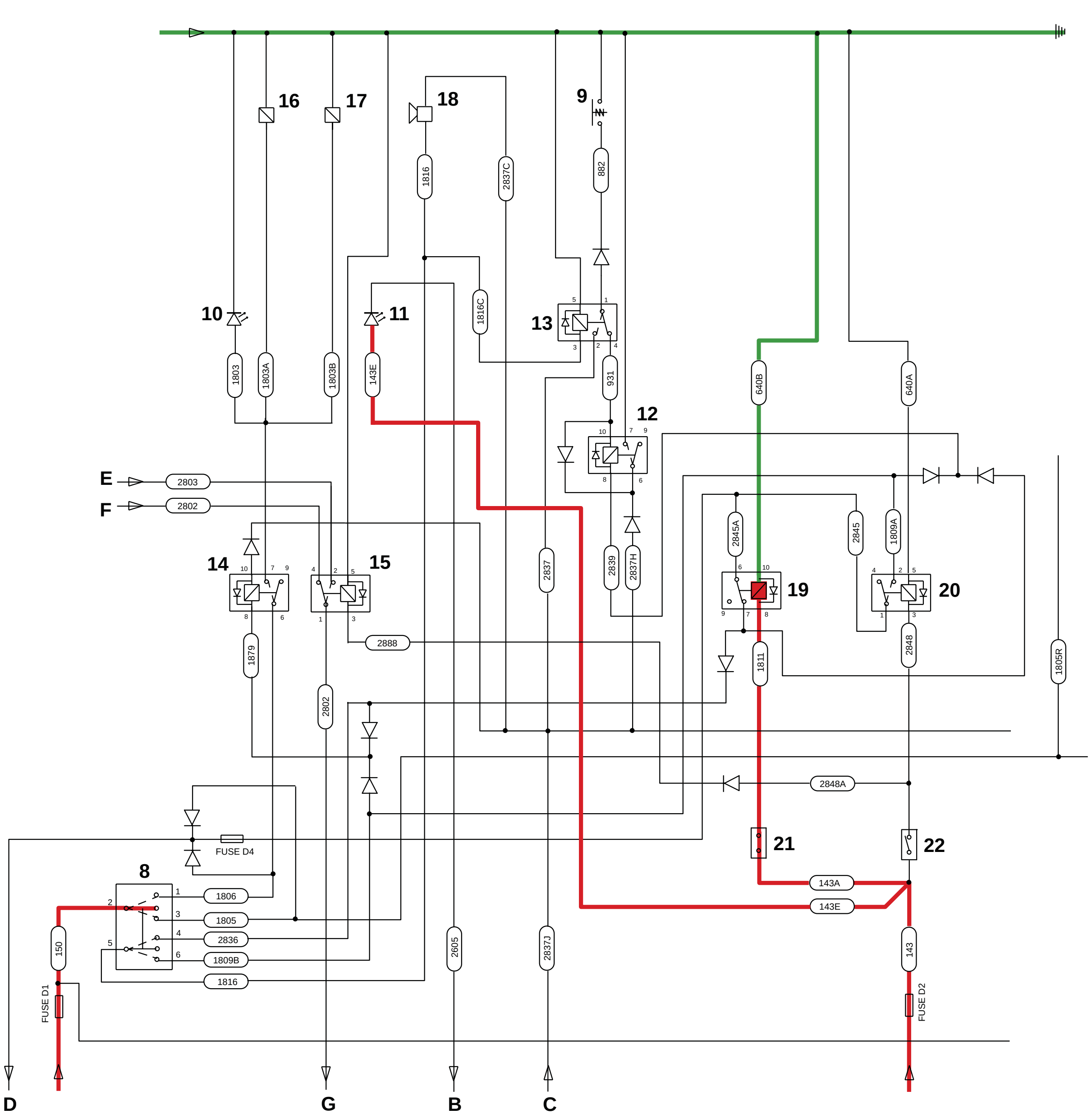


Fig 7. Joysticks Enable Circuit - Excavator/Loader Selector Switch OFF (Joysticks Cut-out)

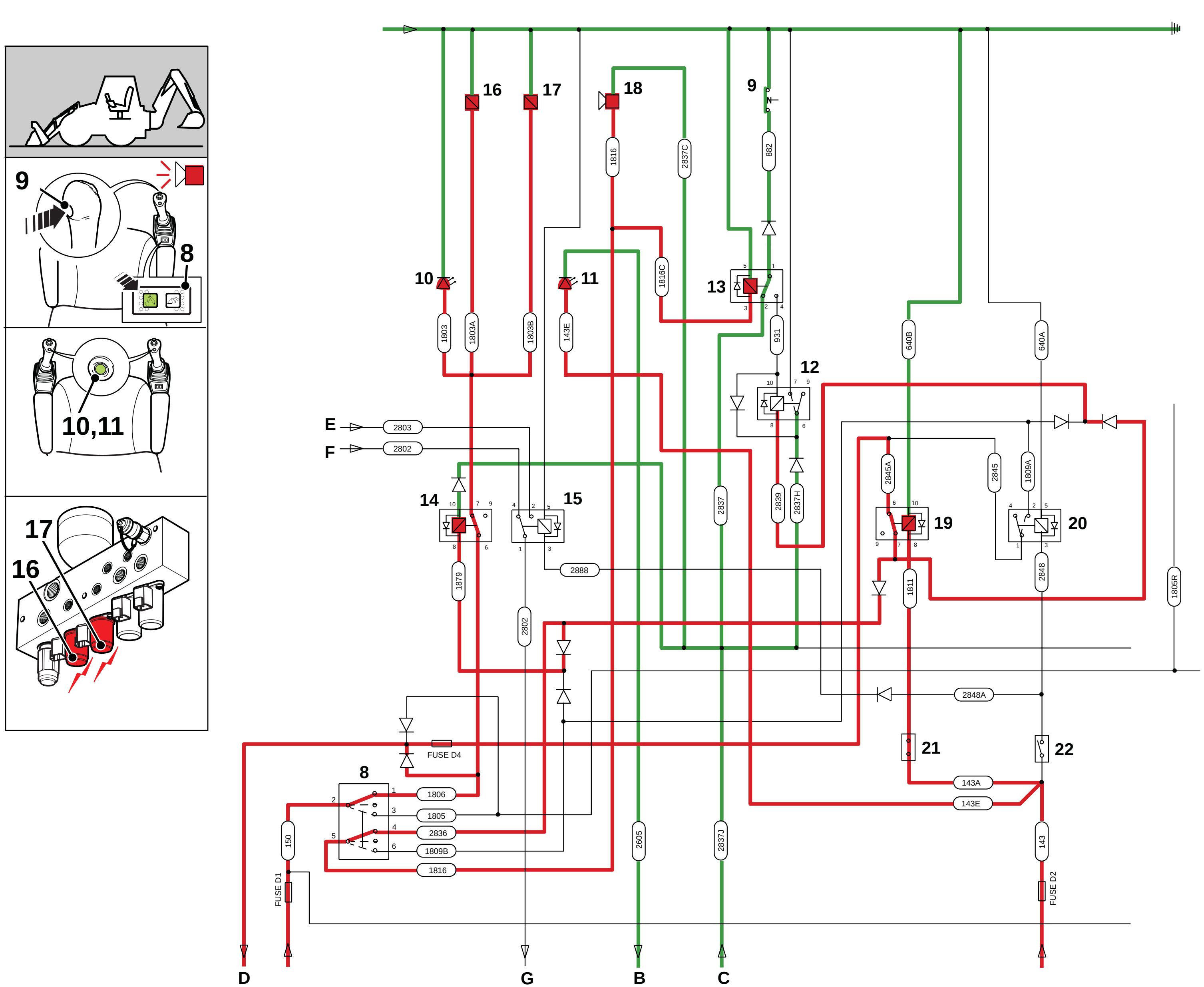


Fig 8. Joysticks Enable Circuit - Seat Facing Forward and Excavator Selected

Hydraulic Speed Control (HSC)

The hydraulic speed control (HSC) electrical circuit operates in the same way as standard non-servo machines described in Section E. See ***Section E, Hydraulics - Electrical Connections***.

Excavator/Loader Auxiliary Changeover Circuit

The diagrams in this section are intended to show how the electrical circuits work when different functions are operated.

The wire numbers and colours, where appropriate, are shown as an aid to identification while fault finding. The wires coloured red show the electrical live feeds. The wires coloured green show the electrical returns to earth.

Before fault finding make sure that you understand how the electrical circuits work. Most potential faults can be traced using a multimeter to carry out continuity checks on wires, switches and solenoids.

Loader Selected: ⇨ *Fig 9. (L-219)*.

When the excavator/loader selector switch **8** is set to the loader position and the enable relay **12** is energised and `latched', this completes the return circuit for the changeover relays **23** and **24**, which also energise.

The changeover valve solenoids **27** then energise to direct the pilot pressure from the extend and retract proportional solenoid valves to operate the loader valve block auxiliary service (clam shovel ram).

When the seat is facing forward, the auxiliary PWM changeover relay **15** is de-energised. The relay contacts connect the output **F** (from the clam shovel thumbwheel) to the auxiliary PWM controller (ECU).

Excavator Selected: ⇨ *Fig 10. (L-220)*.

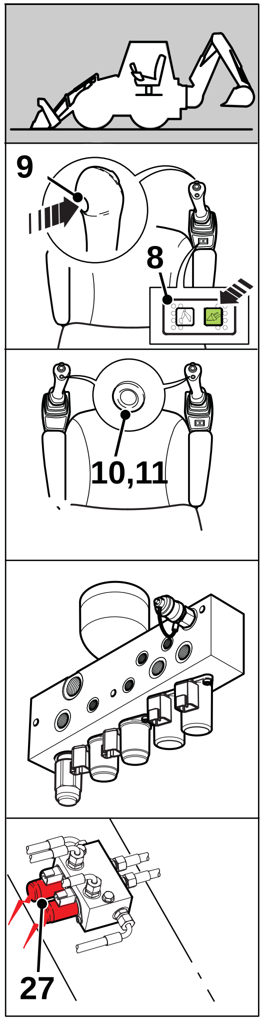
With the excavator/loader selector switch **8** set to the excavator position and the joysticks activated, the changeover relays **23** and **24** are de-energised.

The changeover valve solenoids **27** are de-energised and direct the pilot pressure from the extend and retract proportional solenoid valves to operate the excavator auxiliary service (extending dipper ram).

When the seat is facing rear, a live feed from the seat rear sensor switch **22** energises the auxiliary PWM changeover relay **15**. The relay contacts connect the output **E** (from the extending dipper thumbwheel) to the auxiliary PWM controller (ECU).

Component Key:

8	Excavator/Loader Selector Switch
9	Enable Pushbutton (RH Joystick)
10	Joystick `Active' LED (LH Joystick)
11	Joystick `Active' LED (RH Joystick)
12	Enable Latching Relay
13	Enable Relay
14	Servo Pilot Valve Relay
15	Auxiliary PWM Changeover Relay
16	Servo Pilot Valve Solenoid (LH Joystick)
17	Servo Pilot Valve Solenoid (RH Joystick)
18	Joysticks `Active' Warning Buzzer
19	Seat Forward Relay
20	Seat Rear Relay
21	Seat Forward Sensor Switch (Vane Type)
22	Seat Rear Sensor Switch (Vane Type)
23	Excavator/Loader Changeover Relay - not used
24	Excavator/Loader Changeover Relay
27	Excavator/Loader C/O Valve Solenoids (Auxiliary Service)
B	To Auxiliary PWM Controller (ECU)
C	From ECU Power Relay
D	To ECU Power Relay
E	From Extending Dipper Thumbwheel Switch (RH Joystick)
F	From Clam Shovel Thumbwheel Switch (Loader Lever)
G	To Auxiliary PWM Controller (ECU)



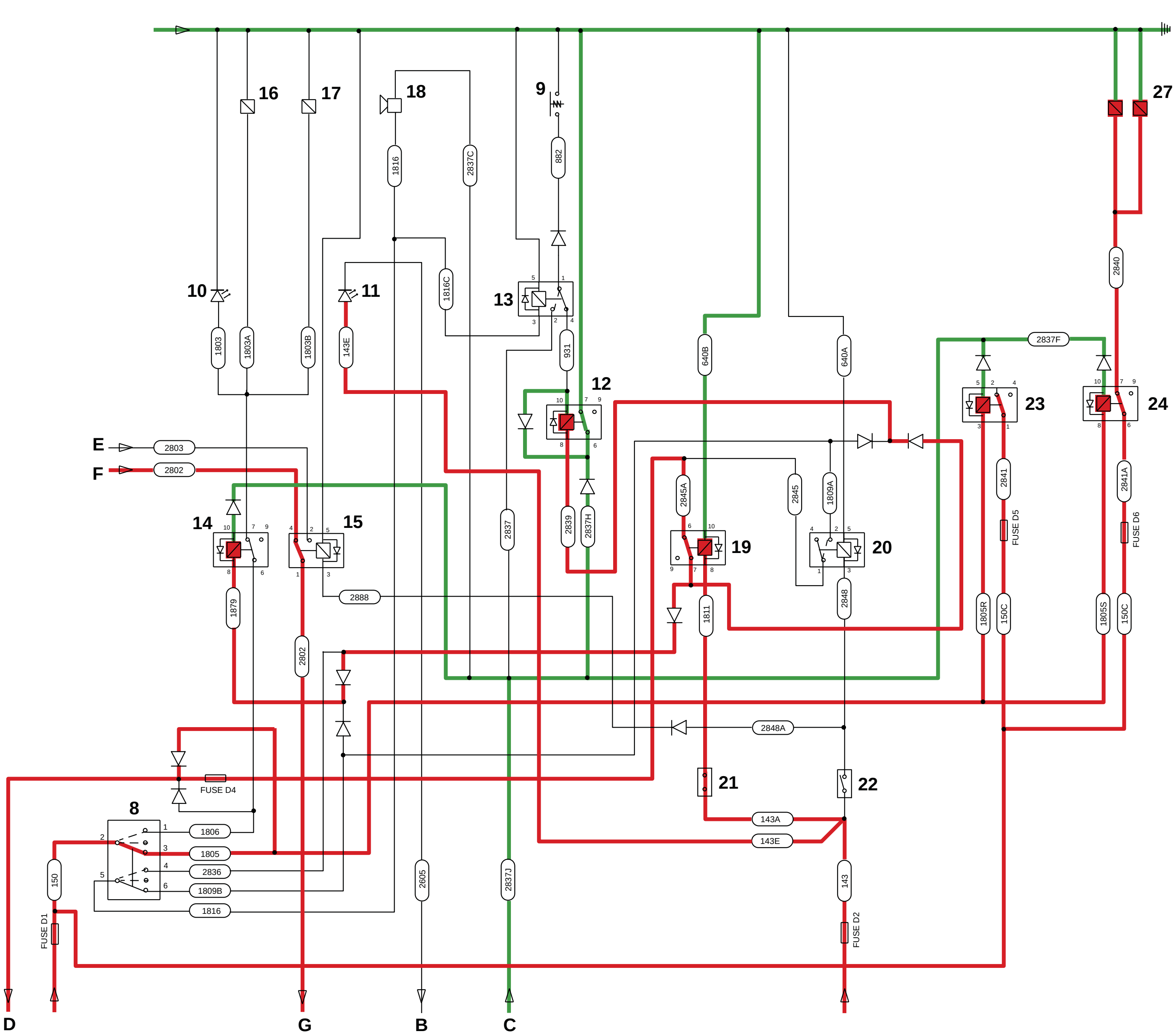


Fig 9. Excavator/Loader Auxiliary Changeover Circuit - Loader Selected

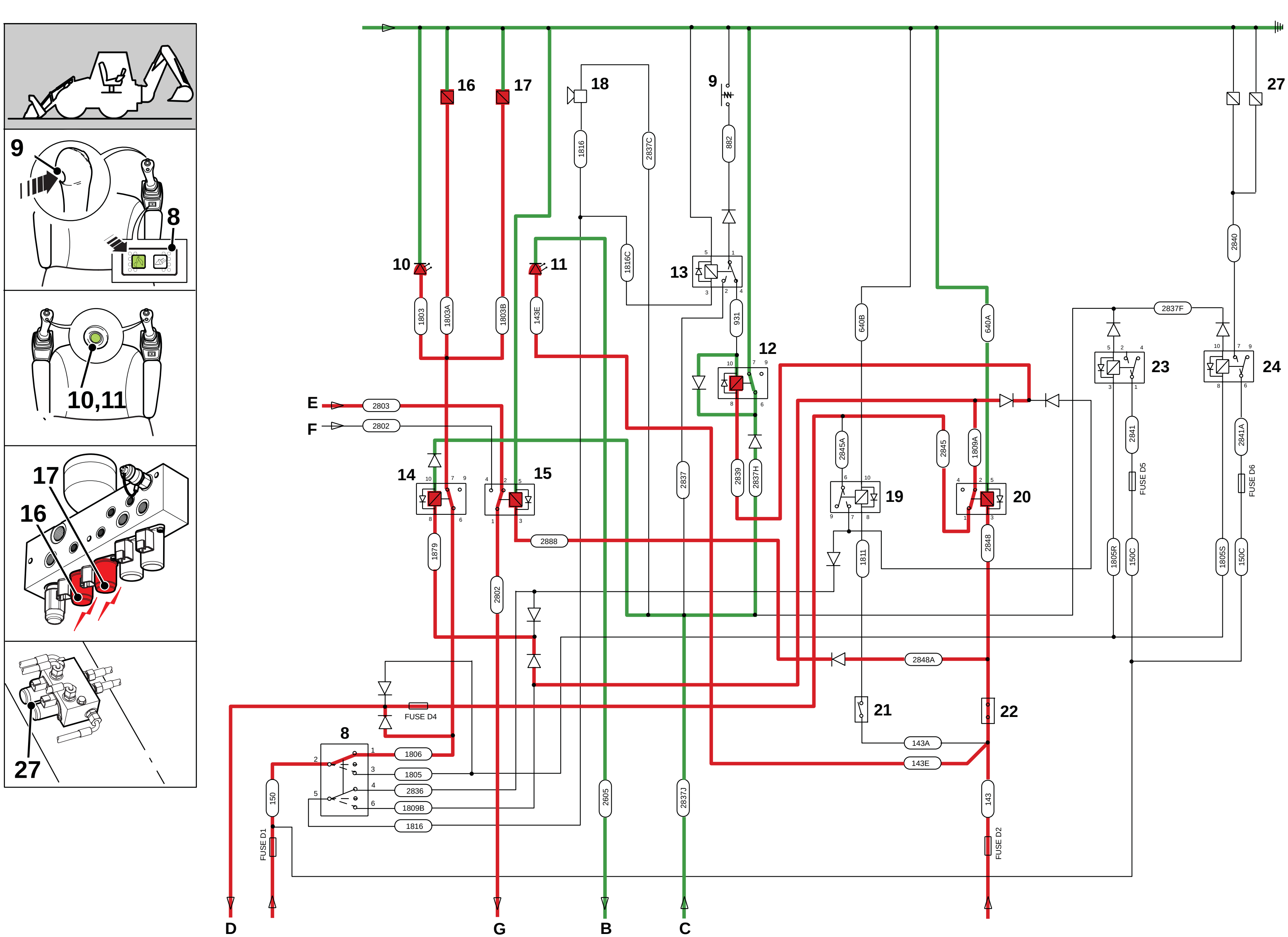


Fig 10. Excavator/Loader Auxiliary Changeover Circuit - Excavator Selected

Excavator/Loader Auxiliary Service Controls

The diagrams in this section are intended to show how the electrical circuits work when different functions are operated.

The wire numbers and colours, where appropriate, are shown as an aid to identification while fault finding. The wires coloured red show the electrical live feeds. The wires coloured green show the electrical returns to earth.

Before fault finding make sure that you understand how the electrical circuits work. Most potential faults can be traced using a multimeter to carry out continuity checks on wires, switches and solenoids.

Extending Dipper Ram - Extend: ⇨ *Fig 11. (L-222)*.

When the excavator/loader selector switch **8** is operated a live feed **D** energises the ECU cutout relay **45**. When energised, this relay completes the return circuit from the auxiliary PWM controller (ECU) **29** as shown.

Pressing the enable pushbutton **9** energises the enable relay **12**. The relay `latches' and completes the return circuit for the ECU power relay **29A** which also energises. The power relay connects a live feed to the auxiliary PWM controller (ECU) **29**, which is then able to function.

When the seat is facing rear, a live feed **H** (from the seat rear sensor switch) energises the auxiliary PWM changeover relay **15**. The relay contacts connect the output from the extending dipper thumbwheel **34** to the ECU.

The extending dipper thumbwheel switch **34** is fed from a separate 5 volt regulated supply **28**. When the thumbwheel is moved by the operator, the ECU converts the thumbwheel voltage (input) into a corresponding valve current signal (PWM output) to the extend proportional solenoid valve coil **31**.

The ECU controls the valve current signal by varying the duty cycle of the PWM output. Diodes connected at the solenoid coils condition the circuit so that the duty cycle/ valve current relationship functions correctly.

Connected in series with the solenoid coil return circuit is a 2.2 ohm, 150 Watt current sense resistor **33**. The resistor enables the ECU to measure the amount of current flowing through the solenoid coil.

Extending Dipper Ram - Retract:

The ram retract circuit works in the same way as the extend circuit, except:

When the thumbwheel **34** is moved in the opposite direction by the operator, the ECU converts the thumbwheel voltage (input) into a corresponding valve current signal (PWM output) to the retract proportional solenoid valve coil **32**.

Note that the same PWM controller ECU and proportional solenoid valves are used for both the excavator and the loader auxiliary service. Which auxiliary service operates, (either extending dipper or clam shovel) is dependant on whether the changeover valve solenoids **27** are energised, ⇨ *Excavator/Loader Auxiliary Changeover Circuit (L-218)*.

Component Key:

8	Excavator/Loader Selector Switch
9	Enable Pushbutton (RH Joystick)
12	Enable Latching Relay
13	Enable Relay
15	Auxiliary PWM Changeover Relay
27	Excavator/Loader C/O Valve Solenoids (Auxiliary Service)
28	5V Voltage Regulator
29	Auxiliary PWM Controller (ECU)
29A	ECU Power Relay
30	Clam Shovel Thumbwheel Switch (Loader Lever)
31	`Extend' Proportional Solenoid (Servo Pilot Valve)
32	`Retract' Proportional Solenoid (Servo Pilot Valve)
33	150W Resistor
34	Extending Dipper Thumbwheel Switch (RH Joystick)
45	ECU Cutout Relay
B	From Joystick `Active' LED (RH Joystick)
D	From Excavator/Loader Selector Switch
H	From Seat Rear Sensor Switch (Vane Type)

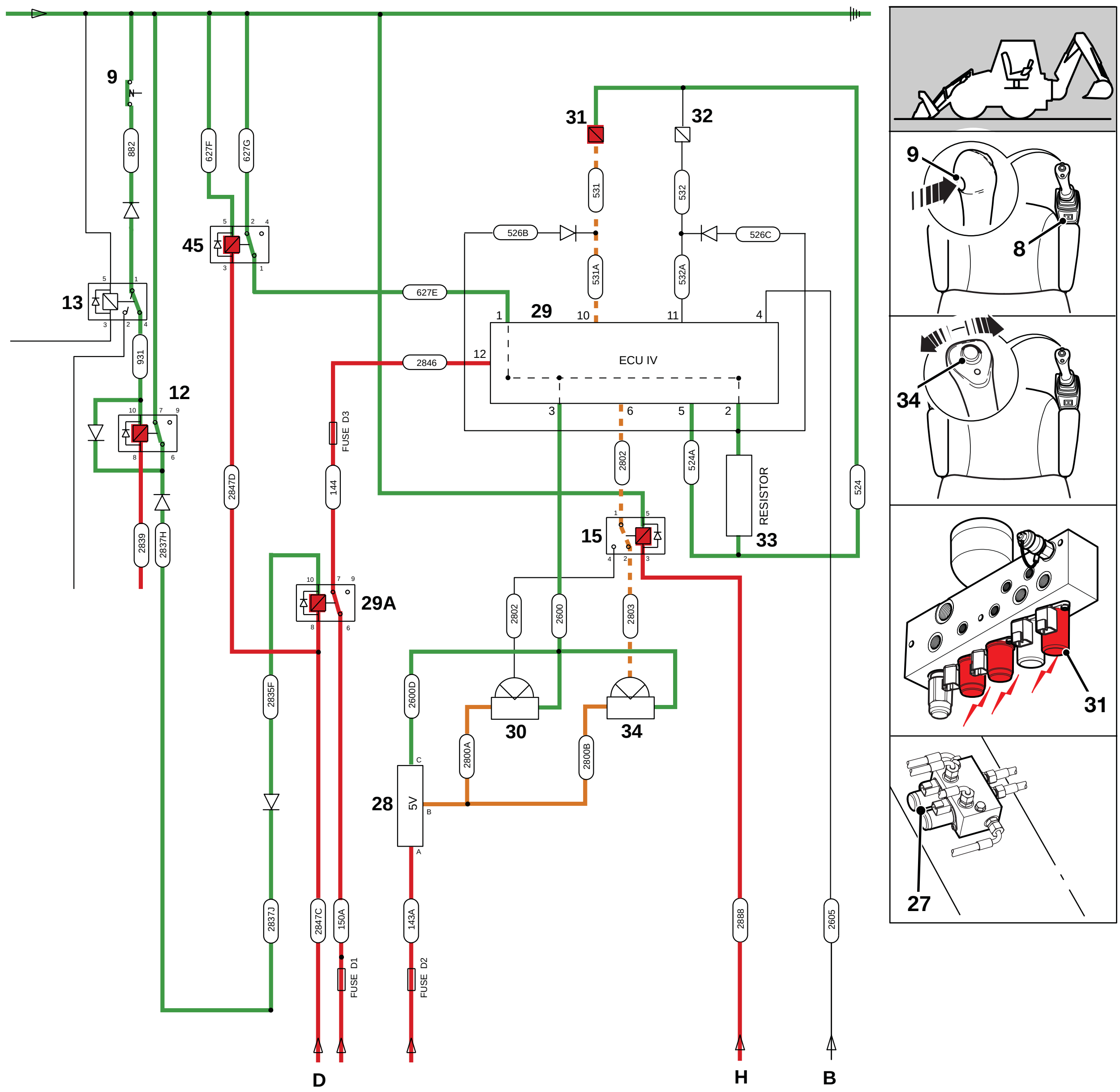


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Fig 11. Excavator/Loader Auxiliary Service Controls - Extending Dipper Ram - Extend

Fault Finding

The purpose of this section is to help you trace a particular fault. The tables identify possible causes and give a suggested action with specific tests where applicable.

To help identify the hydraulic and electrical components mentioned in the fault finding tables, refer to the hydraulic and electrical schematic diagrams (near the beginning of this section).

1 Before you begin fault finding, read the safety information at the beginning of this manual.

2 Make any relevant electrical checks before moving on to the hydraulics.

3 Make simple checks before say, stripping a major hydraulic component.

4 Make sure that the hydraulic fluid is at the correct working temperature (50 ºC, 122 ºF).

5 If hydraulic contamination is found be sure to remove ALL debris, and if possible identify its origin. It may be part of a component from elsewhere in the hydraulic circuit.

6 What ever the fault, check the condition of the hydraulic fluid. Drain and replace if necessary.

7 Renew any seals such as `O' rings when re-assembling hydraulic components.

Fault Finding Tables

Fault Descriptions:		
1	No servo controls, the joysticks do not function.	⇨ *Table 2. (L-224)*.
2	ALL services slow to operate (Particularly noticeable when operating the loader arms).	⇨ *Table 3. (L-225)*.
3	ALL services lack power, the machine is unable to lift.	⇨ *Table 4. (L-226)*.
4	One service operates correctly, but slows down when a second service is selected.	⇨ *Table 5. (L-226)*.
5	One service fails or is slow to operate.	⇨ *Table 6. (L-226)*.
6	Clam shovel or extending dipper service does not operate.	⇨ *Table 7. (L-227)*.

Electronic Fault Codes

The thumbwheel PWM controllers (ECU's) will generate a blink code for some fault conditions. ⇨ ***Thumbwheel Diagnostic `Blink' Codes (L-228)***.

Table 2.

Fault	Possible Cause	Action
No servo controls, the joysticks do not function.	**1** Fault in electrical interlock circuit wiring, or operation of electrical interlock switches.	Check the condition of the associated electrical wiring for damage and that the fuses are intact. For details of the electrical circuit and connections ⇨ ***Joysticks Enable Circuit (L-213)***.
	a Seat sensor switch defective.	Check the seat is locked in the rear facing position and that the seat sensor switch is operating.
	b Enable pushbutton defective.	Check the function of the joystick enable pushbutton.
	c Solenoid(s) at the servo pressure supply valve not energised.	Check the condition of the associated electrical wiring for damage and that the fuses are intact.
	d Solenoid coil faulty.	Check the solenoid for open or short circuits. Measure the solenoid coil resistance.
	2 Servo pilot pressure too low.	Measure the servo pilot pressure. ⇨ ***Checking the Servo Pressure (L-229)***.
	a Due to faulty servo regulating valve.	Renew the servo pressure supply valve. Refer to ***Servo Pressure Supply Valve - Removal and Replacement***.
	b Servo pilot filter blocked due to contamination.	Renew the filter element.

⇨ ***Fault Finding Tables (L-223)***.

Table 3.

Fault	Possible Cause	Action
ALL services slow to operate. (Indicates lack of flow in the hydraulic circuit)	**1** Insufficient hydraulic fluid.	Check for leaks and top up as required.
	2 Servo pilot pressure too low.	Measure the servo pilot pressure. ⇨ ***Checking the Servo Pressure (L-229)***.
	a Due to faulty servo regulating valve.	Renew the servo pressure supply valve. Refer to ***Servo Pressure Supply Valve - Removal and Replacement***.
	b Servo pilot filter blocked due to contamination.	Renew the filter element.
	3 Main relief valve (MRV) out of adjustment or defective.	Check and adjust as required. ⇨ ***Checking the Main System Pressure (L-230)***.
	4 Flow from P2 pump not in circuit because the unloader valve HSC solenoid is permanently energised.	
	a Due to Hydraulic Speed Control (HSC) switch selected.	Check the function of the HSC selector switch.

⇨ ***Fault Finding Tables (L-223)***.

Table 4.

Fault	Possible Cause	Action
ALL services lack power, the machine is unable to lift. (Indicates lack of pressure in the hydraulic circuit)	**1** Insufficient hydraulic fluid.	Check for leaks and top up as required.
	2 Servo pilot pressure too low.	Measure the servo pilot pressure. ⇨ ***Checking the Servo Pressure (L-229)***.
	a Due to faulty servo regulating valve.	Renew the servo pressure supply valve. Refer to ***Servo Pressure Supply Valve - Removal and Replacement***.
	b Servo pilot filter blocked due to contamination.	Renew the filter element.
	3 Main relief valve (MRV) out of adjustment or defective.	Check and adjust as required. ⇨ ***Checking the Main System Pressure (L-230)***.

Table 5.

Fault	Possible Cause	Action
One service operates correctly, but slows down when a second service is selected.	**1** Flow from P2 pump not in circuit because the unloader valve HSC solenoid is permanently energised.	
	a Due to Hydraulic Speed Control (HSC) switch selected.	Check the function of the HSC selector switch.

Table 6.

Fault	Possible Cause	Action
One service fails or is slow to operate.	**1** Associated hoses damaged, trapped or kinked.	Check hoses and replace as required.
	2 Associated ram leaking.	Carry out ram leakage checks, renew seals as required.
	3 Auxiliary relief valve (ARV) out of adjustment or defective.	Renew the associated auxiliary relief valve.
	4 Service spool or associated load hold check valves damaged or sticking due to contamination.	Dismantle and inspect the service spool and load hold check valves. Refer to ***Excavator Valve (Monoblock Type)*** or ***Loader Valve (Monoblock Type) - Dismantling and Assembly***.

⇨ ***Fault Finding Tables (L-223)***.

Table 7.

Fault	Possible Cause	Action
Clam shovel or extending dipper service does not operate. ***Note:*** *For certain fault conditions, the PWM Controller (ECU) will generate a blink code,* ***⇨ Thumbwheel Diagnostic `Blink' Codes (L-228)***.	**1** Fault in electrical circuit wiring, or operation of PWM Controller (ECU).	Check the condition of the associated electrical wiring for damage and that the fuses are intact. For details of the electrical circuit and connections ***⇨ Excavator/Loader Auxiliary Service Controls (L-221)***.
	a Thumbwheel switch defective.	Check the function of the applicable thumbwheel switch. See ***Servo Pressure Supply Valve - Descriptions***.
	b Solenoid at the servo pressure supply valve not energising.	Check the condition of the associated electrical wiring for damage and that the fuses are intact.
	c Faulty auxiliary changeover solenoid valve.	Check the function of the changeover valve electrical circuit. For details of the electrical circuit and connections ***⇨ Excavator/Loader Auxiliary Changeover Circuit (L-218)***.
	d Solenoid coil faulty.	Check the applicable solenoid coil for open or short circuits. Measure the solenoid coil resistance. Renew the solenoid coil.
	e Faulty PWM Controller (ECU).	Renew the PWM Controller (ECU). (1)
	2 Servo pilot pressure too low.	Measure the servo pilot pressure. ***⇨ Checking the Servo Pressure (L-229)***.
	a Due to faulty servo regulating valve.	Renew the servo pressure supply valve. Refer to ***Servo Pressure Supply Valve - Removal and Replacement***.
	b Servo pilot filter blocked due to contamination.	Renew the filter element.
	c Due to proportional solenoid valve cartridge damaged or sticking due to contamination.	Renew the servo pressure supply valve. Refer to ***Servo Pressure Supply Valve - Removal and Replacement***.

(1) The ECU is a non-serviceable part. The ECU is NOT programmable.

⇨ Fault Finding Tables (L-223).

Thumbwheel Diagnostic `Blink' Codes

The thumbwheel controls incorporate PWM Controllers (ECU's). The ECU's have the facility to detect faults with the proportional solenoid control valve electrical system and generate a blink code.

Auxiliary Service Control Faults: If a fault condition is detected while operating the extending dipper (RH Thumbwheel **A**), the green light **B** on the RH joystick will illuminate to display a blink code.

Note: *The blink code will not display when operating the loader auxiliary service (clam shovel).*

Bucket Thumb Ram Faults: If a fault condition is detected while operating the excavator bucket thumb (LH Thumbwheel **C**), the green light **D** on the LH joystick will illuminate to display a blink code.

The blink code sequence consists of the light being switched ON for approximately one second followed by a number of flashes (the code). The sequence is repeated until the fault is cleared.

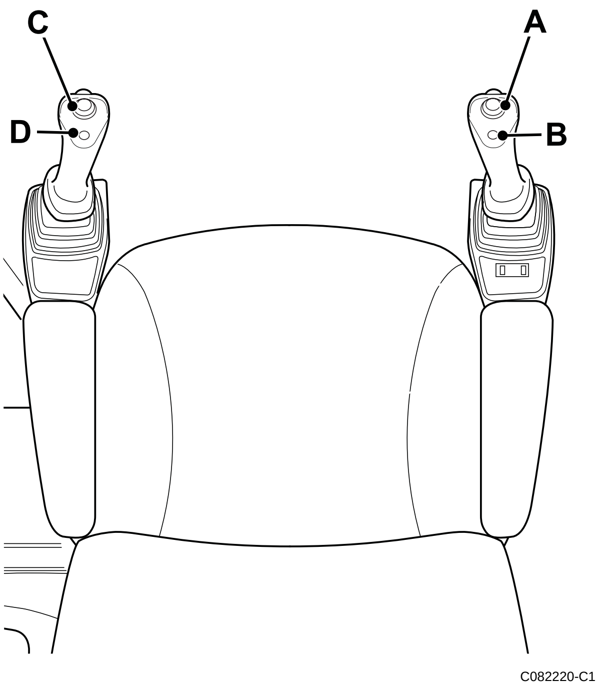

Fig 12.

Table 8. Thumbwheel 'Blink' Codes

Light **B**	**Fault:**
1 Flash	Extending dipper `Extend' valve solenoid coil, or associated wiring faulty (open or short circuit).
2 Flashes	Extending dipper `Retract' valve solenoid coil, or associated wiring faulty (open or short circuit).
5 Flashes	RH Thumbwheel voltage too high (greater than 4.725 Volts).
6 Flashes	RH Thumbwheel voltage too low (less than 0.275 Volts).
Light **D**	**Fault:**
1 Flash	Bucket thumb ram `Extend' valve solenoid coil, or associated wiring faulty (open or short circuit).
2 Flashes	Bucket thumb ram `Retract' valve solenoid coil, or associated wiring faulty (open or short circuit).
5 Flashes	LH Thumbwheel voltage too high (greater than 4.725 Volts).
6 Flashes	LH Thumbwheel voltage too low (less than 0.275 Volts).

For details of the electrical circuit and connections⇨ ***Excavator/Loader Auxiliary Service Controls (L-221)***.

Service Procedures

Checking the Servo Pressure

⚠ WARNING

Make the machine safe before working underneath it. Park the machine on level ground, lower the attachments to the ground. Apply the park brake, put the transmission in neutral and stop the engine. Block both sides of all four wheels.

Disconnect the battery, to prevent the engine being started while you are beneath the machine.

GEN-4-1_1

Make sure that the hydraulic oil is at working temperature, i.e. 50°C (122°F).

1 Working under the LH side of the machine, connect a 0 - 70 bar (0 - 1000 lbf/in^2) pressure gauge to the servo pressure test point **A** (at the servo pressure supply valve as shown).

2 With the engine running at 1500 rpm, check the reading on the pressure gauge. The servo pressure should be as stated below:

35 bar (35.7 kgf/cm^2, 500 lbf/in^2)

Note: *The servo pressure regulating valve **B** is factory set and sealed with a plastic tamper proof cap.*

Important: *The extent of permissible servicing is the renewal of the solenoid coils. Further dismantling of the valve is not recommended. If the valve is suspected as being faulty it must be renewed as a complete assembly. Note also that the pilot circuit accumulator is a non serviceable part and is sealed for life. It is not possible to recharge the accumulator with nitrogen.*

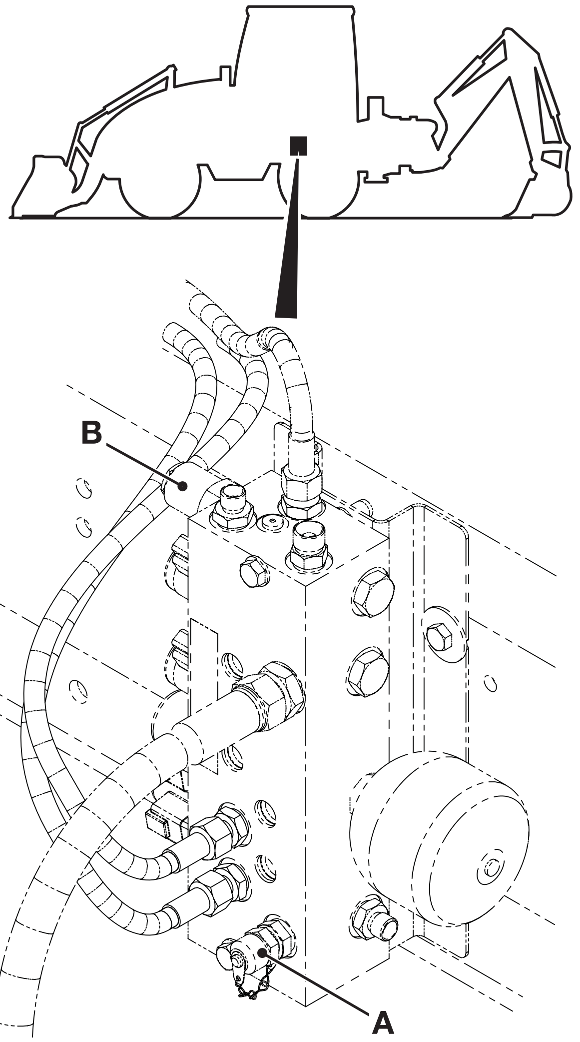

Fig 13.

Checking the Main System Pressure

⚠ WARNING

Make the machine safe before working underneath it. Park the machine on level ground, lower the attachments to the ground. Apply the park brake, put the transmission in neutral and stop the engine. Block both sides of all four wheels.

Disconnect the battery, to prevent the engine being started while you are beneath the machine.

GEN-4-1_1

Make sure that the hydraulic oil is at working temperature, i.e. 50°C (122°F).

1. Lower the loader arms to the ground, then put the excavator into the travel position. Stop the engine.

2. Vent the hydraulic services and pilot circuit accumulator hydraulic pressure:

   Switch the starter to ON without starting the engine. Activate the joystick controls, operate the joysticks several times to vent the hydraulic pressure from the servo system and service rams. Turn the starter switch to the OFF position and remove the key.

3. Working under the RH side of the machine, connect a 0 - 400 bar (0 - 6000 lbf/in²) pressure gauge to the main system pressure test point **B** (at the loader valve block as shown).

4. Start the engine, and set the engine speed to 1500 rpm.

5. With the seat locked in the rear facing position, activate the joystick controls.

6. Operate the joystick to fully crowd the excavator bucket, hold the joystick in this position to raise the main system pressure.

   Note the reading on the pressure gauge. The main system pressure should be as stated below:

   252 bar (257 kgf/cm², 3650 lbf/in²). This is the Main Relief Valve (MRV) setting.

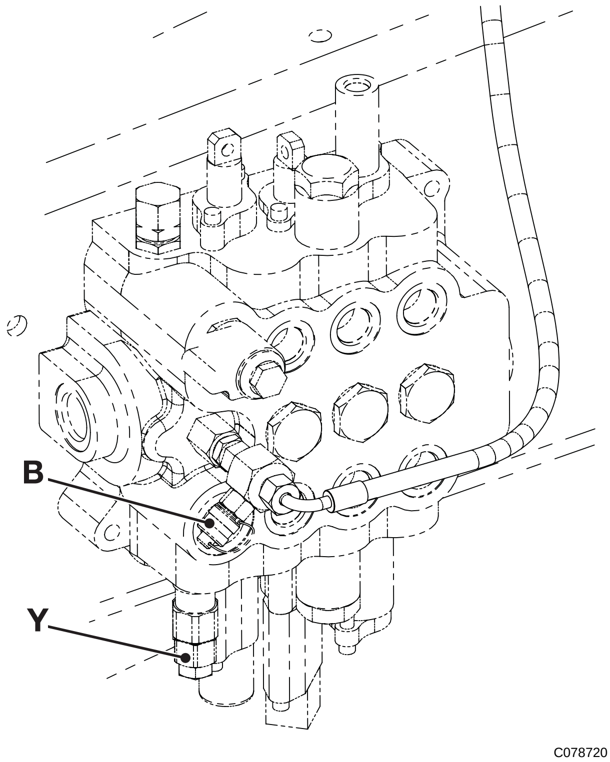

Fig 14.

Pressure Adjustment

To adjust the main system pressure, remove the cap from the main relief valve **Y** (at the loader valve block as shown). Loosen the locknut and turn the adjuster screw. Turn the adjuster screw clockwise to increase pressure and counter-clockwise to decrease the pressure.

`Quick-Connect' Pilot Hoses

Some pilot hoses have quick-connect couplings. This type of coupling requires a special tool to release it.

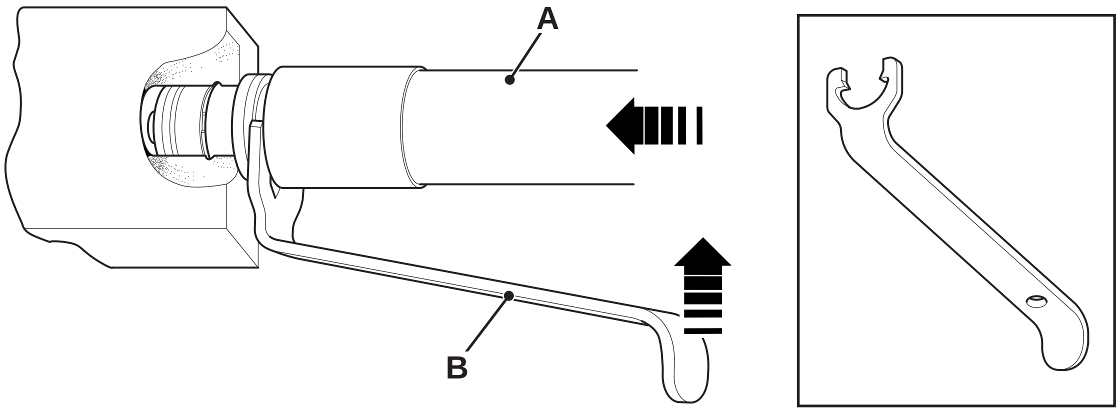

Fig 15.

Disconnecting

1. Push on the pilot hose **A** in the direction shown, and insert the correct tool **B**. See ***Service Tools***.

2. Push on the hose, and at the same time use the tool as a lever to release the coupling.

Connecting

1. Make sure that the hose coupling is clean and the O-rings are not damaged. Apply some clean hydraulic fluid to the O-rings.

2. Align the coupling directly to the hydraulic port. Push the coupling into the port as far as it will go. The coupling will click when it is fully engaged.

3. Pull on the hose to verify that the coupling is fully engaged. If the connection is not good the coupling will release very easily.

Joystick and Stabiliser Controls

Introduction

This topic contains information about a machine DEVICE. Make sure you are referring to the correct device.

This topic is intended to help you understand what the device does and how it works. Where applicable it also includes procedures such as removal and replacement and dismantle and assemble.

Descriptions

Joystick Controllers

The joystick controllers operate as direct acting pressure regulating valves, which consist of the control lever and four proportional pilot control valve capsules. Each pilot valve capsule consists of a spool **1** with a control spring, a plunger **2** and plunger return spring **3**.

In neutral, the control lever is kept central by the force of the plunger return springs **3**. In this position the joystick service ports are connected to the tank port `T' via the drillings **X** in the spools.

When the control lever is operated, the relevant plunger **2** pushes on the return spring **3** and the spool control spring. The spool control spring in turn moves the spool **1** down which connects the selected service port to the pressure port `P'.

The spool **1** regulates the incoming hydraulic servo pressure to balance the pressure in the service port with the force of the control spring. The interaction of the spool and control spring in this way means that the joystick will produce a pilot pressure in the selected service port which is proportional to the position of the control lever.

For more details of the hydraulic circuit and valve connections, see ***Schematic Circuits***.

Advanced EasyControl Machines: The loader joystick includes an electro-magnet on control spool 1 (arms lower) to provide a detent, which holds the joystick over in the `float' position.

Table 1. Colour Key to Oil Flow and Pressure

(orange)	Servo
(green)	Exhaust

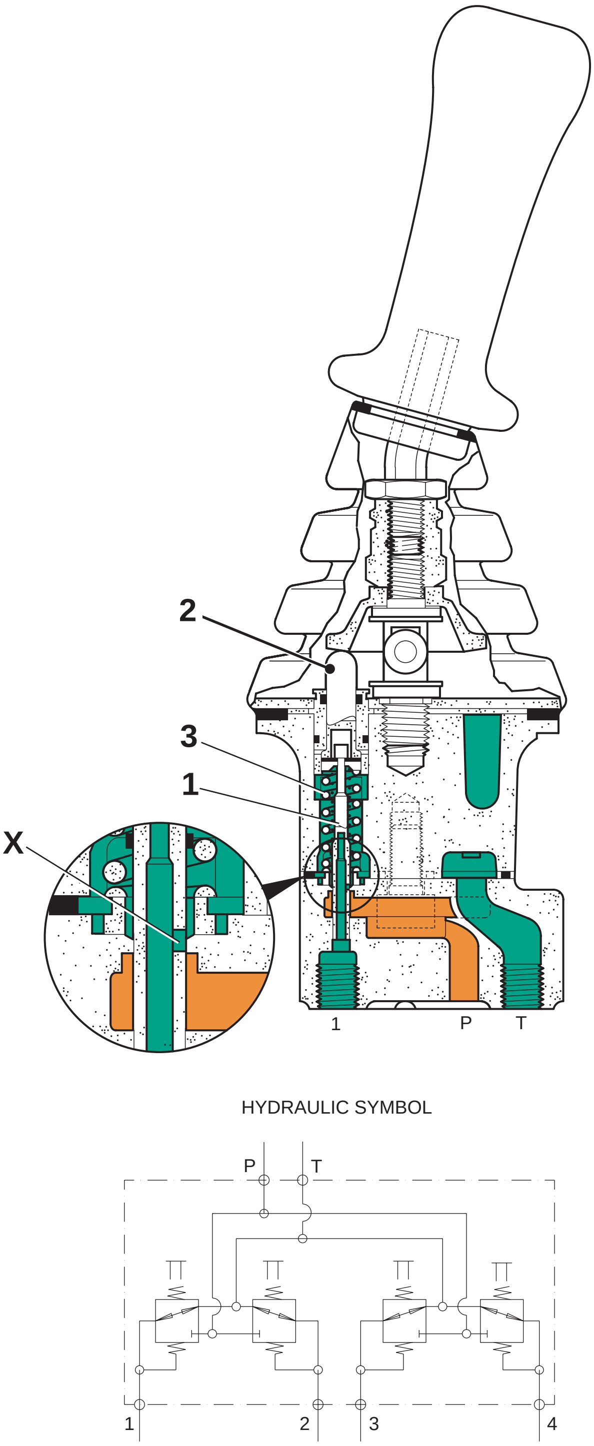

Fig 1.

Stabiliser Controls

⇒ *Fig 2. (L-234)*. The stabiliser controls utilise the same hydraulic valve as the excavator joystick controls. The hydraulic principle of operation is identical to that described for the joystick controls.

The illustration shows the controls with the protective rubber gaiter removed for clarity.

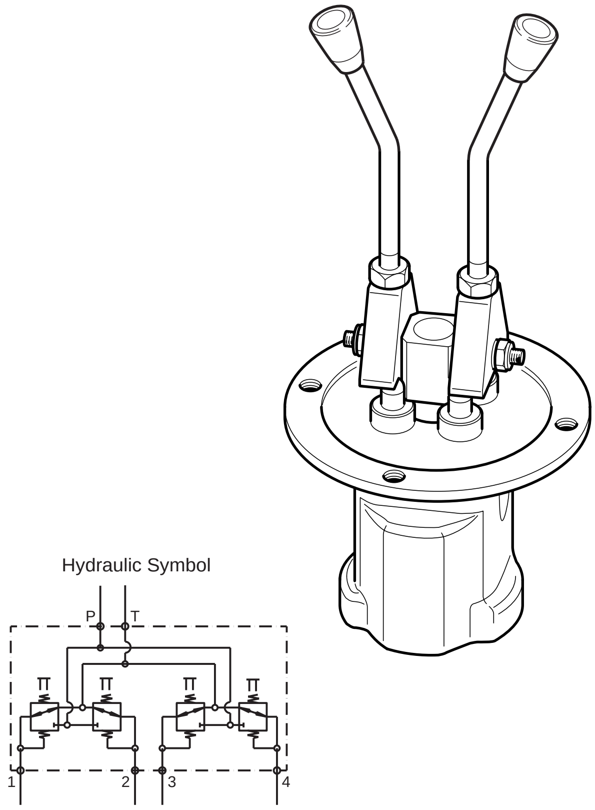

Fig 2.

ISO and SAE Control Pattern Changeover Valve - if fitted

⇒ *Fig 3. (L-234)*. On some machine variants a control pattern changeover valve is fitted. This enables the backhoe (excavator) control pattern to be pre-selected to either the ISO control pattern or the SAE control pattern as appropriate.

The control pattern changeover valve is a manually operated selector valve, the control knob is situated in the floor plate at the rear of the cab.

When operated some servo pilot hose connections are re-configured by the valve and become connected to different pilot ports on the excavator valve block, thereby changing the control pattern.

For more details of the hydraulic circuit and valve connections, see ***Schematic Circuits***.

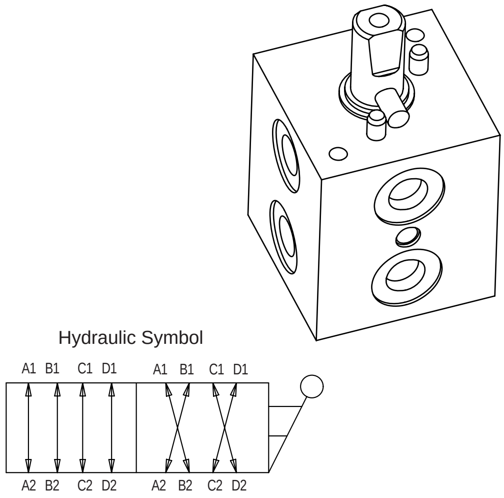

Fig 3.

Joystick/Auxiliary Control Changeover Valve - if fitted

Advanced EasyControl Machines: The changeover valves enable the RH joystick to be pre-selected to operate either the loader or the backhoe (excavator) as applicable.

EasyControl Machines: The changeover valve enables the auxiliary service pilot pressure to be directed to operate either the loader auxiliary service (clam shovel), or excavator auxiliary service (extending dipper) as applicable.

The valves function as solenoid operated selector valves. The solenoids are energised via relays, by the excavator/ loader selector switch on the RH seat pod.

When operated the servo pilot hose connections are reconfigured by the valves to connect to either the loader valve, or excavator valve services.

For more details of the hydraulic circuit and valve connections, see ***Schematic Circuits***.

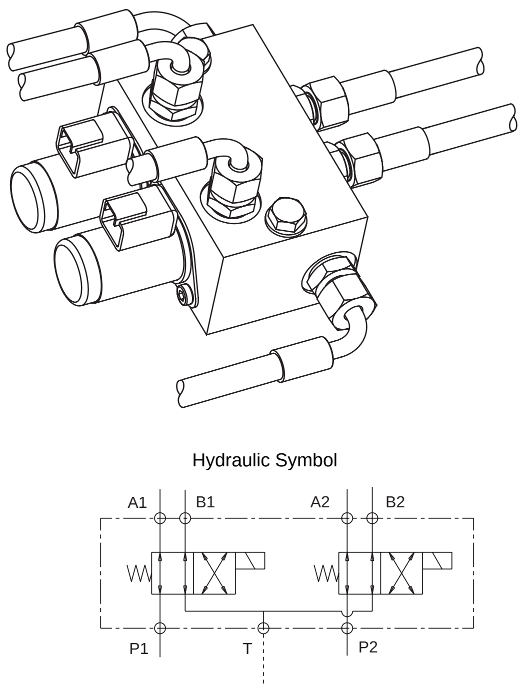

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Fig 4.

Removal and Replacement

⇒ *Fig 5. (L-236)*. Note that the illustration shows the left hand joystick controller. The removal and replacement procedure for the right hand joystick controller is identical.

⚠ WARNING

Hydraulic Pressure

Hydraulic fluid at system pressure can injure you. Before connecting or removing any hydraulic hose, residual hydraulic pressure trapped in the service hose line must be vented. Make sure the hose service line has been vented before connecting or removing hoses. Make sure the engine cannot be started while the hoses are open.

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Removal

1. Park the machine on firm level ground, engage the parking brake and set the transmission to neutral. Lower the attachments to the ground and stop the engine.

2. Vent the hydraulic services and pilot circuit accumulator hydraulic pressure:

   Switch the starter to ON without starting the engine. Activate the joystick controls, operate the joysticks several times to vent the hydraulic pressure from the servo system and service rams. Turn the starter switch to the OFF position and remove the key.

3. Remove the screws **A** (4 off) and lift off the cover **B** as shown.

4. Loosen the clip **C** and carefully pull back the flexible conduit **D** as shown. Uncouple the harness electrical connector **E** for the joystick handle switches.

5. Disconnect all hydraulic hoses from the valve block. Label each hose before disconnecting to ensure correct replacement. Plug hose ends to prevent ingress of dirt.

6. Remove the bulkhead nuts **F** from the adaptors (6 off) and lift the valve assembly from the seat.

Replacement

Replacement is the reverse of the removal sequence.

Note: *All hydraulic adaptors that are installed together with a bonded sealing washer must also have JCB Threadseal applied to the threads of the adaptor.*

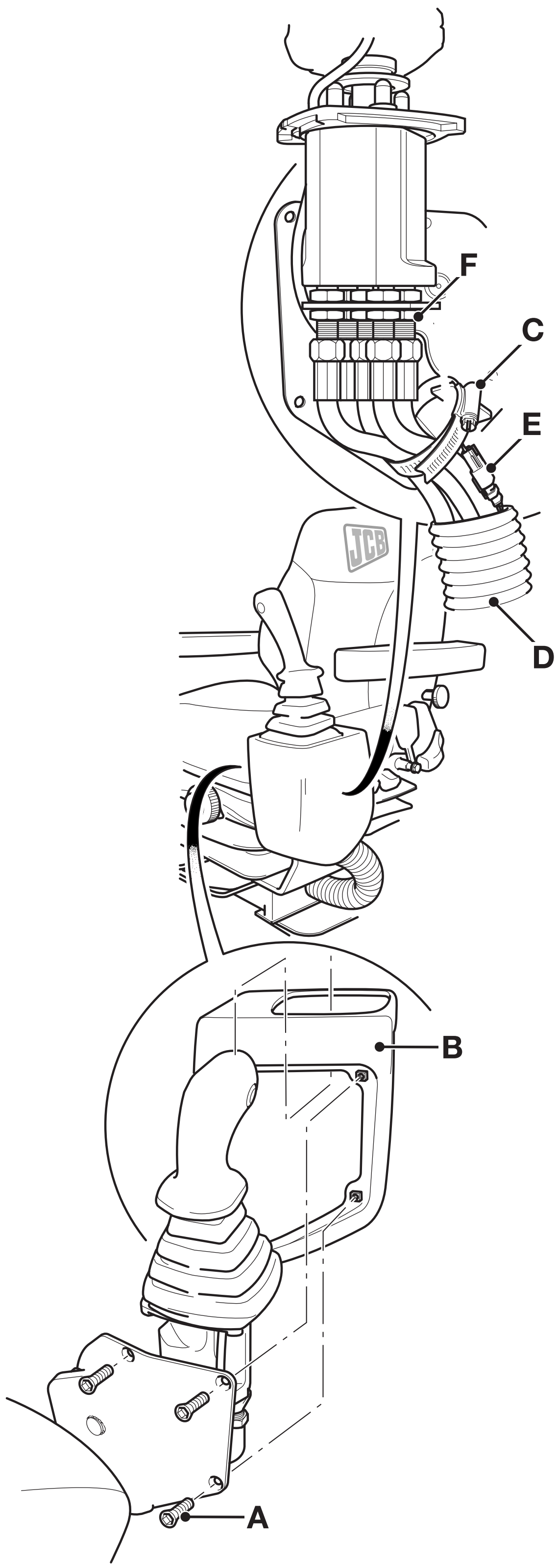


Fig 5. Joystick Controllers

Dismantle and Assemble

⇨ *Fig 6. (L-238)*. The illustration is intended as a guide to the dismantling and assembly.

Be sure to note the location of all components when dismantling. Although some components may appear to be identical they are not interchangeable. Make sure that components are assembled in their original positions.

Great care should be taken when dismantling and assembling a valve to avoid the following:

– **Contamination**
– **Damage to spools**
– **Damage to seal grooves**

Any of the above may result in possible problems with the operation of the valve.

Dismantle

1 Remove the joystick controller from the machine. ⇨ *Removal and Replacement (L-236)*

2 Carefully prise back the rubber gaiter **1**, loosen locknut **2** and unscrew the handle **3**.

3 Unscrew the universal joint assembly **4**. Take care to keep all the shims **5** together.

4 Remove the retaining plate **6**. Carefully withdraw the regulating valve assemblies **7** from the valve body **8**.

Regulating Valve Assemblies

Each of the regulating valve assemblies **7** can be removed as shown. Care must be taken to ensure that the spool is not damaged when removing it from the valve body. Note that all spools are similar in appearance but must not be interchanged as they are matched to their bores. All spools have the same centring and sealing components.

Assemble

Assembly is the reverse of the dismantling sequence.

1 Clean the valve components in an appropriate solvent.

2 Lubricate parts with JCB Hydraulic Fluid before assembling. Make sure that all the parts move freely.

3 Renew all `O' rings and back-up rings.

Table 2. Torque Settings

Item	Nm	kgf m	lbf ft
2	40	4.1	29.5
4	50	5.1	36.9

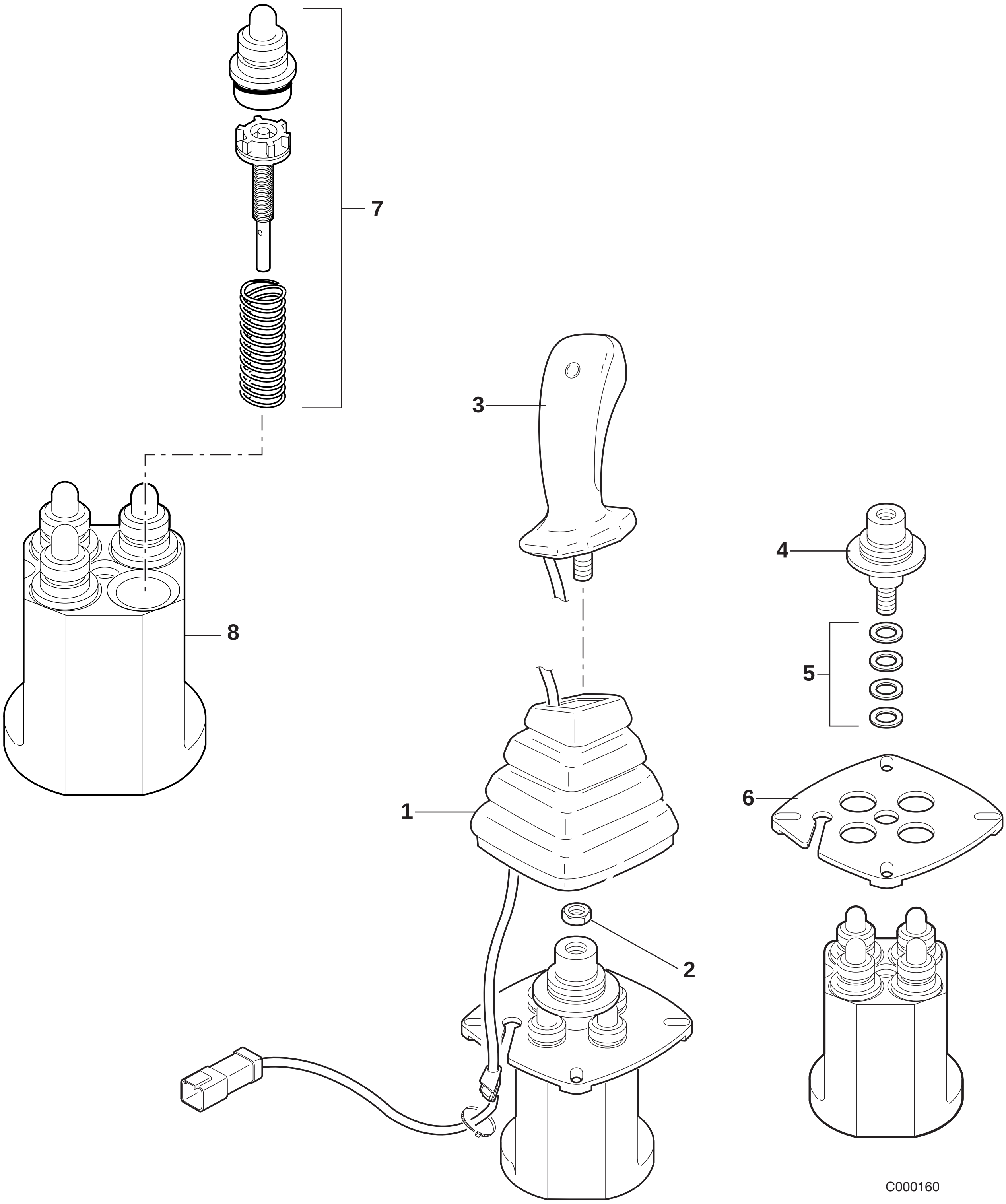


Fig 6. Joystick Controllers

Loader Lever Controls

Dismantle and Assemble

⇒ *Fig 7. (L-240)*. The illustration is intended as a guide to the dismantling and assembly.

Dismantle

1 Park the machine on firm level ground, apply the parking brake. Lower the loader arms and excavator to the ground, switch OFF the engine and remove the starter key. Disconnect the battery.

2 Working in the cab, remove the console panels surrounding the loader lever as shown at **A**.

3 Uncouple the transmission dump switch and thumbwheel switch electrical connectors, then remove the wires from the connectors. Use a screwdriver to release the wires and pins from the connectors, alternatively cut the wires and re-solder on assembly.

4 Lift off the loader lever knob and gaiter.

5 Disconnect the control rods from the loader valve spools. Remove the bolts securing the complete lever assembly to the chassis and withdraw the control lever and mounting bracket through the floor aperture.

Assemble

1 Bolt the mounting bracket **B** to the chassis. Fit the rubber cover **C** over the mounting bracket, make sure it is fitted the correct way round. Do not fix it to the floor at this stage.

2 Assemble the loader lever **D** to the mounting plate **E**, together with the universal joint as shown. Align side **X** of the universal joint with the edge **Y** on the mounting plate as shown.

3 Bolt the lever assembly onto the mounting bracket **B**. Fit the control rods **F** and **G** to the lever assembly. Ensure that the locking flats **Z** are at the top.

Note: *If necessary, loosen the locknuts and rotate the end fittings to give equal amounts of adjustment (thread) at each end of the control rod.*

4 Thread the control rods through the rubber cover **C** and connect them to the loader valve spools. Adjust the control rods as necessary, see ***Adjustment***. After the control rods are adjusted fit the gaiter over the loader lever.

5 Thread the transmission dump switch and thumbwheel switch cables through the loader lever **D** and fit the wires and pins into the electrical connectors. Couple the connectors to the chassis harness and fit the loader lever knob.

6 Reconnect the battery, check that the controls, transmission dump switch and thumbwheel switch operate correctly. Refit the rubber cover **C** and the console panels around the loader lever.

Adjustment

1 Adjust the control rods **F** and **G** so that the loader lever **D** is vertical, then tighten the control rod locknuts.

Loader controls that feature a control lever locking pin (option) as shown should be adjusted as described below:

a Fit the control lever locking pin **K**.

b Adjust the control rods **F** and **G** until the locking pin is a sliding fit, then tighten the control rods locknuts.

c Remove the lever locking pin **K**.

2 After adjustment operate the lever and check that there is sufficient travel to give full movement of the loader valve spools.

Note: *Make sure there is an equal amount of thread at each end of the control rod.*

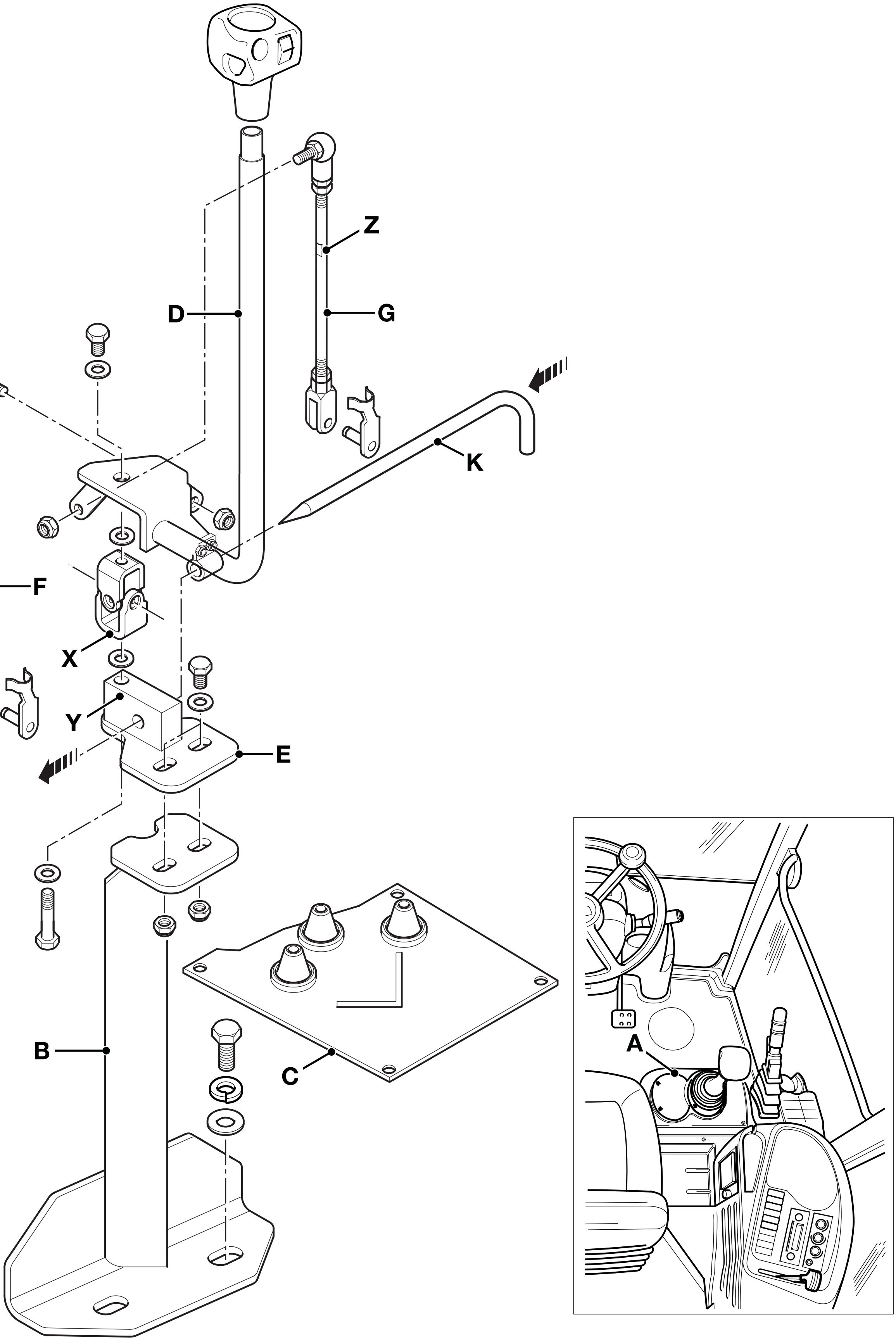


Fig 7.

Servo Pressure Supply Valve

Introduction

This topic contains information about a machine DEVICE. Make sure you are referring to the correct device.

This topic is intended to help you understand what the device does and how it works. Where applicable it also includes procedures such as removal and replacement and dismantle and assemble.

Descriptions

⇨ *Fig 8. (L-243)* and ⇨ *Fig 9. (L-243)*. The servo pressure supply valve incorporates a pressure regulating valve **1**, solenoid valve(s) **2** for servo pilot pressure isolation and proportional solenoid valves **3** for control of the excavator valve and loader valve auxiliary services.

The servo system is supplied from a single line tapped into the hydraulic pump feed at the loader valve block. The pressure regulating valve maintains servo pressure by regulating the incoming supply pressure. Servo pressure can be measured at the hydraulic test point **4**.

Down stream of the pressure regulating valve is located the servo accumulator **5** with its associated non-return valve. The accumulator traps and stores servo pressure to enable the service spools to be operated for a limited period with a stopped engine. This allows the attachments to be lowered safely to the ground should the engine stop.

The solenoid valve(s) **2** is energised via relays, by sensor switches on the operator's seat. When the solenoid is energised, servo pilot oil is directed through the ports to enable operation of the joystick controllers. When the solenoid is de-energised, the valve spool is spring returned to the closed position isolating the supply to the joystick controllers. Note that the servo pilot oil to the stabiliser controls is not isolated by the solenoid valve.

The proportional solenoid valves **3** are energised via the PWM controller electronic control unit (ECU) from the thumbwheel switch on the RH joystick (and loader lever on PC3 machines). When the thumbwheel switch is moved by the operator, the ECU sends a proportional PWM (Pulse Width Modulated) signal to the relevant solenoid. When the solenoid is signalled, servo pilot oil is directed through the applicable port to operate the excavator valve or loader valve auxiliary service spool. The proportional solenoid valve supplies pilot oil at a pressure relative to the amount of thumbwheel movement, thus controlling how far the applicable service spool is displaced. For more detailed descriptions of the proportional solenoid valves operation, see ⇨ *Proportional Solenoid Valves Operation (L-244)*.

Precision Control Machines: A system pressure switch **6** is included as part of the Hydraulic Speed Control System (HSC). The switch senses the main system pressure (P1) and activates the inloader valve under certain operating conditions.

Note: *The system pressure switch is no longer fitted on machines from serial no. 976693.*

Component Key: ⇨ *Fig 8. (L-243)*

1	Servo pressure regulating valve
2	Solenoid valve - Servo pilot pressure isolation (Joysticks)
3a	Proportional solenoid valve - Clam shovel \`close'
3b	Proportional solenoid valve - Clam shovel \`open'
3c	Proportional solenoid valve - Ext. dipper \`retract'
3d	Proportional solenoid valve - Ext. dipper \`extend'
4	Servo pressure test point
5	Accumulator
6	System pressure switch (1)

(1) No longer fitted on machines from serial no. 976693.

Component Key: ⇨ *Fig 9. (L-243)*

1	Servo pressure regulating valve
2a	Solenoid valve - Servo pilot pressure isolation (LH Joystick)
2b	Solenoid valve - Servo pilot pressure isolation (RH Joystick)
3a	Proportional solenoid valve - Auxiliary ram \`retract'
3b	Proportional solenoid valve - Auxiliary ram \`extend'
4	Servo pressure test point
5	Accumulator
6	System pressure test point - if fitted

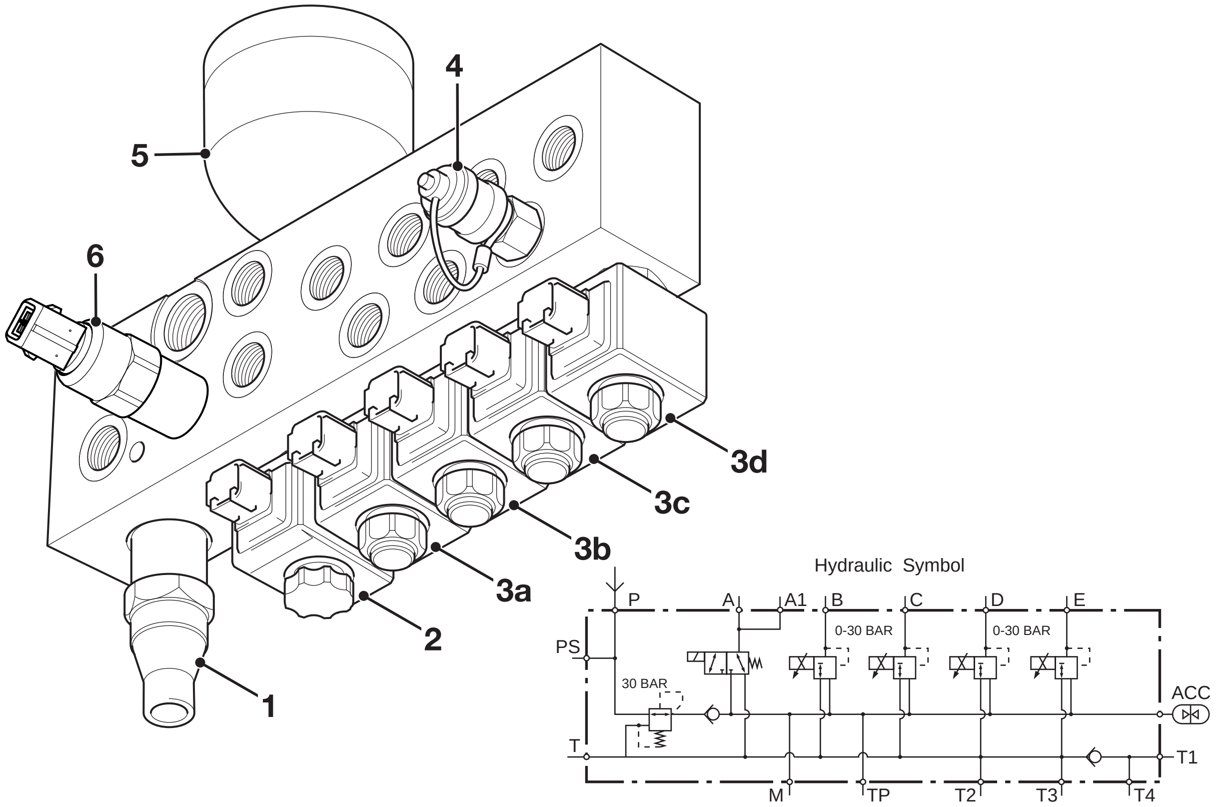


Fig 8. Precision Control Machines

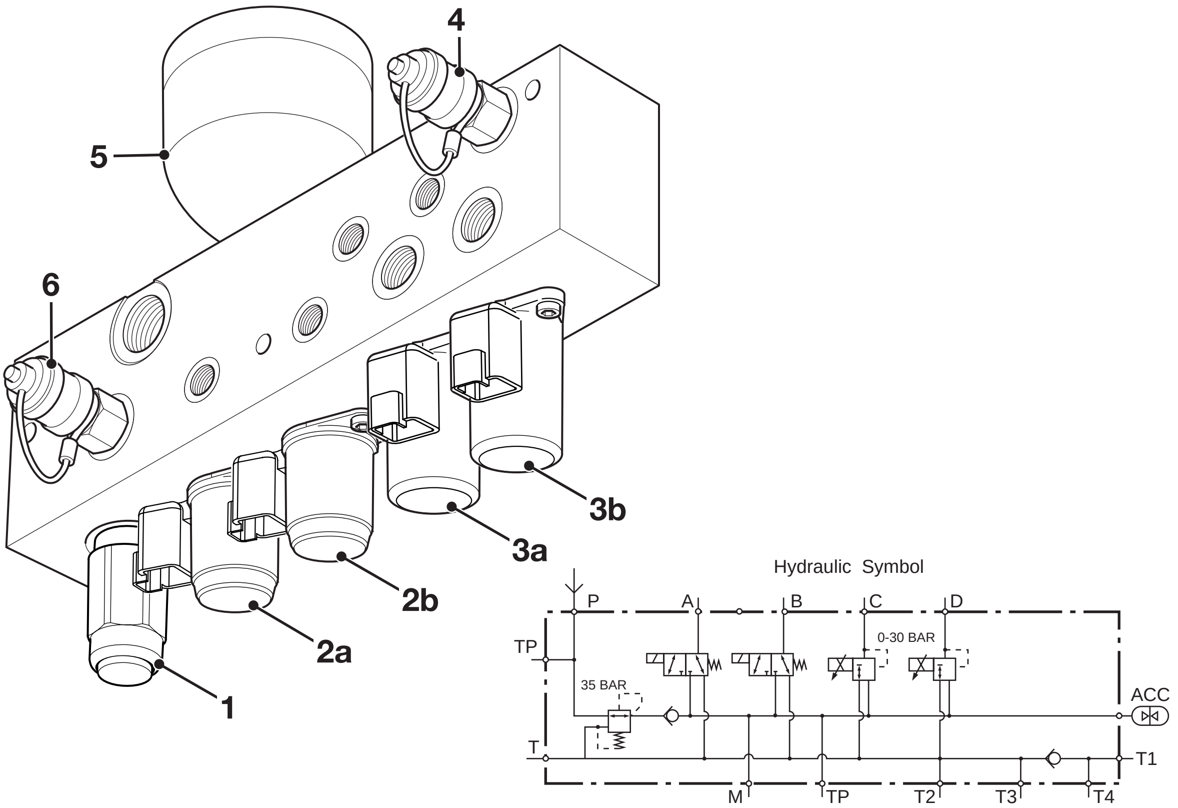


Fig 9. EasyControl and Advanced EasyControl Machines

Proportional Solenoid Valves Operation

Precision Control Machines

⇨ Fig 10. (L-246). Two proportional solenoid valves **C** are used to control the extending dipper `extend' and `retract' functions (excavator auxiliary spool), and another two proportional solenoid valves **D** control the clam shovel `open' and `close' functions (loader auxiliary spool). The solenoid valves are energised via the PWM controller electronic control unit (ECU) **B** from thumbwheel switches **A** on the RH excavator joystick and loader lever.

The thumbwheel switches are fed from a separate 5 volt regulated supply located on the loader lever tower. The ECU monitors the output voltage of either the extending dipper thumbwheel or the clam shovel thumbwheel, depending on the seat orientation. When a thumbwheel is moved by the operator, the ECU converts the thumbwheel voltage (input) into a corresponding valve current signal (output) to the relevant solenoid valve coil.

The ECU uses two pulse width modulated (PWM) outputs to control the four solenoid valves. One output operates the clam shovel `open' valve and ext. dipper `extend' valve. The other output operates the clam shovel `close' valve and ext. dipper `retract' valve. Because the ECU can only control one pair of valves simultaneously (one service at a time), there is a changeover relay connected in series with the solenoid coil return circuit, which enables the control to be switched between each pair of valves. The valves work as separate pressure reducing valves and direct servo pilot oil (at a pressure proportional to the valve current signal) to move the applicable service spool the required amount, thereby controlling the speed and direction of the applicable service ram.

The valve current signal from the ECU is controlled by varying the duty cycle of the PWM output. For a detailed explanation of the duty cycle and PWM outputs, see ⇨ Theory (L-255). The theoretical PWM duty cycle required to produce a given valve current signal (output) is already pre-programmed into the ECU memory (ROM). The ECU uses a closed loop control algorithm to constantly compare the actual valve current (via a current sense resistor) with the theoretical valve current (stored in memory), and automatically increases or decreases the PWM duty cycle if necessary, to compensate for variations in the resistance of the solenoid coil windings (due to changes in ambient temperature), or fluctuations in the machine's 12 volt supply.

ECU Boost Input: When the excavator joysticks are enabled, the operator can press a pushbutton on the LH joystick to signal a separate ECU input (boost). The ECU will send the maximum valve current signal (output) to the applicable solenoid valve, to activate the excavator auxiliary spool and retract the extending dipper at maximum speed. Note that this feature is also utilised to activate the excavator auxiliary spool when using certain hi-flow attachments E.g. Rockbreakers.

⇨ Precision Control Extending Dipper - Example (L-245).

Precision Control Extending Dipper - Example

⇨ *Fig 10. (L-246)*. With the seat facing rear, the PWM controller (ECU) **B** monitors the output voltage of the extending dipper thumbwheel **A**.

Note: *The graphs show the different voltage and current outputs for given thumbwheel positions. The values shown are examples for the purpose of explanation only, and should not be used as exact values for any given machine.*

– In the mid position (neutral), the thumbwheel output voltage is 2.5 volts. When the ECU input voltage is 2.5 volts, the ECU output current is 0 mA, therefore neither the extending dipper `extend' or `retract' solenoid valves will energise.
– When moved to the right, the thumbwheel output voltage increases to between 2.5 and 4.3 volts. When the ECU input voltage is greater than 2.5 volts, it sends a corresponding output current to energise the extending dipper `extend' solenoid valve.
– When moved to the left, the thumbwheel output voltage decreases to between 2.5 and 0.7 volts. When the ECU input voltage is less than 2.5 volts, it sends a corresponding output current to energise the extending dipper `retract' solenoid valve.

As the operator moves the thumbwheel **A** from the neutral position (plus a small dead band), the valve current signal from the ECU **B** will step from 0 to 250 mA. The relevant solenoid valve **C** will respond and direct servo pilot oil to one end of the auxiliary spool **E** (as applicable). The auxiliary spool is displaced a small amount, which allows flow from the main hydraulic system to the extending dipper ram **F**, causing the ram to move at a steady rate.

If the thumbwheel is moved further, the valve current signal will increase proportionally (linear), until the thumbwheel reaches its end stop and maximum valve current is reached. As the valve current signal increases, similarly the servo pilot pressure from the solenoid valve also increases proportionally, until maximum servo pilot pressure is reached.

When the servo pilot pressure is increased, the auxiliary spool is displaced further, which allows more flow from the main hydraulic system to the extending dipper ram, causing the ram to move at a faster rate.

Component Key:

A Thumbwheel Switch
A1 Thumbwheel Input (degrees)
A2 Thumbwheel Output (volts)
B PWM Controller (ECU)
B1 ECU Input (volts)
B2 ECU Output (mA)
C Proportional Solenoid Valves - Ext. Dipper
C1 Valve Output (bar)
C2 Valve Input (mA)
D Proportional Solenoid Valves - Clam Shovel
E Auxiliary Service Spool
F Extending Dipper Ram

For further details of the electrical circuit and connections, see ***Precision Control SYSTEM***.

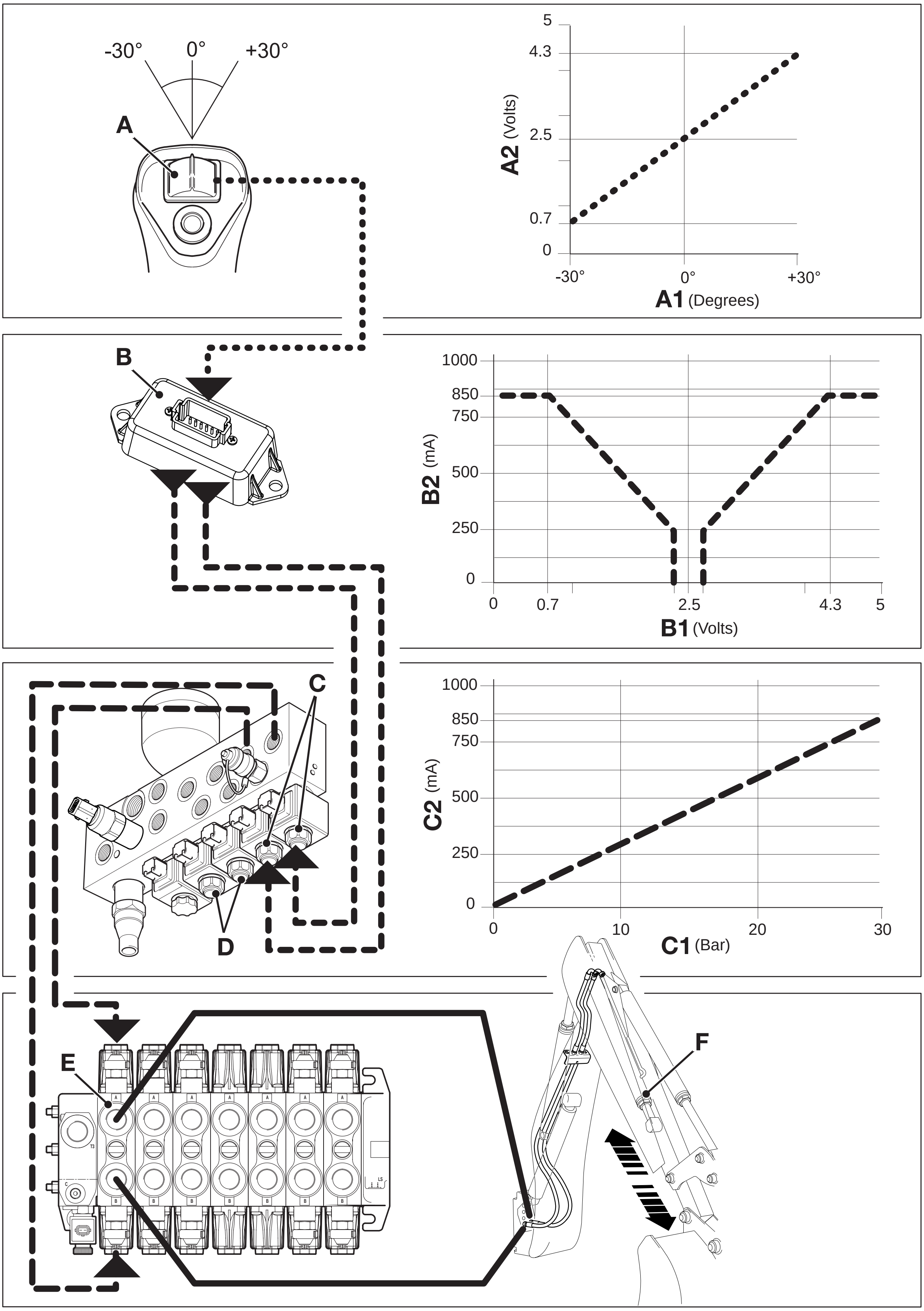


Fig 10. Precision Control - Extending Dipper (Example)

Advanced EasyControl Machines

⇨ *Fig 11. (L-249)*. Two proportional solenoid valves **C** are used to control auxiliary ram `extend' and `retract' functions. The valves operate for both the excavator and the loader auxiliary rams. Which ram operates (either excavator or loader) is determined by the excavator/loader selector switch, and whether the auxiliary changeover solenoid valve **D** is energised.

The proportional solenoid valves **C** are energised via the PWM controller electronic control unit (ECU) **B** from a thumbwheel switch **A** on the RH joystick. The thumbwheel switch is fed from a separate 5 volt regulated supply located near to the loader valve. When the thumbwheel is moved by the operator, the ECU converts the thumbwheel voltage (input) into a corresponding valve current signal (output) to the relevant solenoid valve coil.

The ECU uses two pulse width modulated (PWM) outputs to control the proportional solenoid valves. One output operates the `extend' valve. The other output operates the `retract' valve. The valves work as separate pressure reducing valves and direct servo pilot oil (at a pressure proportional to the valve current signal) to move the applicable service spool the required amount, thereby controlling the speed and direction of the applicable service ram.

The valve current signal from the ECU is controlled by varying the duty cycle of the PWM output. For a detailed explanation of the duty cycle and PWM outputs, see ⇨ *Theory (L-255)*. The theoretical PWM duty cycle required to produce a given valve current signal (output) is already pre-programmed into the ECU memory (ROM). The ECU uses a closed loop control algorithm to constantly compare the actual valve current (via a current sense resistor) with the theoretical valve current (stored in memory), and automatically increases or decreases the PWM duty cycle if necessary, to compensate for variations in the resistance of the solenoid coil windings (due to changes in ambient temperature), or fluctuations in the machine's 12 volt supply.

ECU Boost Input: When the joysticks are activated for excavator operation, the operator can press a pushbutton on the LH joystick to signal a separate ECU input (boost). The ECU will send the maximum valve current signal (output) to the applicable solenoid valve, to activate the excavator auxiliary spool and retract the extending dipper at maximum speed. Note that this feature is also utilised to activate the excavator auxiliary spool when using certain hi-flow attachments E.g. Rockbreakers.

⇨ *Advanced EasyControl Extending Dipper - Example (L-248)*.

Advanced EasyControl Extending Dipper - Example

⇨ Fig 11. (L-249). The PWM controller (ECU) **B** monitors the output voltage of the thumbwheel switch **A**.

Note: *The graphs show the different voltage and current outputs for given thumbwheel positions. The values shown are examples for the purpose of explanation only, and should not be used as exact values for any given machine.*

– In the mid position (neutral), the thumbwheel output voltage is 2.5 volts. When the ECU input voltage is 2.5 volts, the ECU output current is 0 mA, therefore neither the `extend' or `retract' solenoid valves will energise.
– When moved to the right, the thumbwheel output voltage increases to between 2.5 and 4.3 volts. When the ECU input voltage is greater than 2.5 volts, it sends a corresponding output current to energise the `extend' solenoid valve.
– When moved to the left, the thumbwheel output voltage decreases to between 2.5 and 0.7 volts. When the ECU input voltage is less than 2.5 volts, it sends a corresponding output current to energise the `retract' solenoid valve.

As the operator moves the thumbwheel **A** from the neutral position (plus a small dead band), the valve current signal from the ECU **B** will step from 0 to 250 mA. The relevant solenoid valve **C** will respond and direct servo pilot oil through the changeover solenoid valve **D** to one end of the auxiliary spool **E** (as applicable). The auxiliary spool is displaced a small amount, which allows flow from the main hydraulic system to the extending dipper ram **F**, causing the ram to move at a steady rate.

If the thumbwheel is moved further, the valve current signal will increase proportionally (linear), until the thumbwheel reaches its end stop and maximum valve current is reached. As the valve current signal increases, similarly the servo pilot pressure from the solenoid valve also increases proportionally, until maximum servo pilot pressure is reached.

When the servo pilot pressure is increased, the auxiliary spool is displaced further, which allows more flow from the main hydraulic system to the extending dipper ram, causing the ram to move at a faster rate.

Component Key:

A	Thumbwheel Switch
A1	Thumbwheel Input (degrees)
A2	Thumbwheel Output (volts)
B	PWM Controller (ECU)
B1	ECU Input (volts)
B2	ECU Output (mA)
C	Proportional Solenoid Valves
C1	Valve Output (bar)
C2	Valve Input (mA)
D	Auxiliary Changeover Solenoid Valve
E	Auxiliary Service Spool
F	Extending Dipper Ram

For further details of the electrical circuit and connections, see ***Advanced EasyControl SYSTEM***.

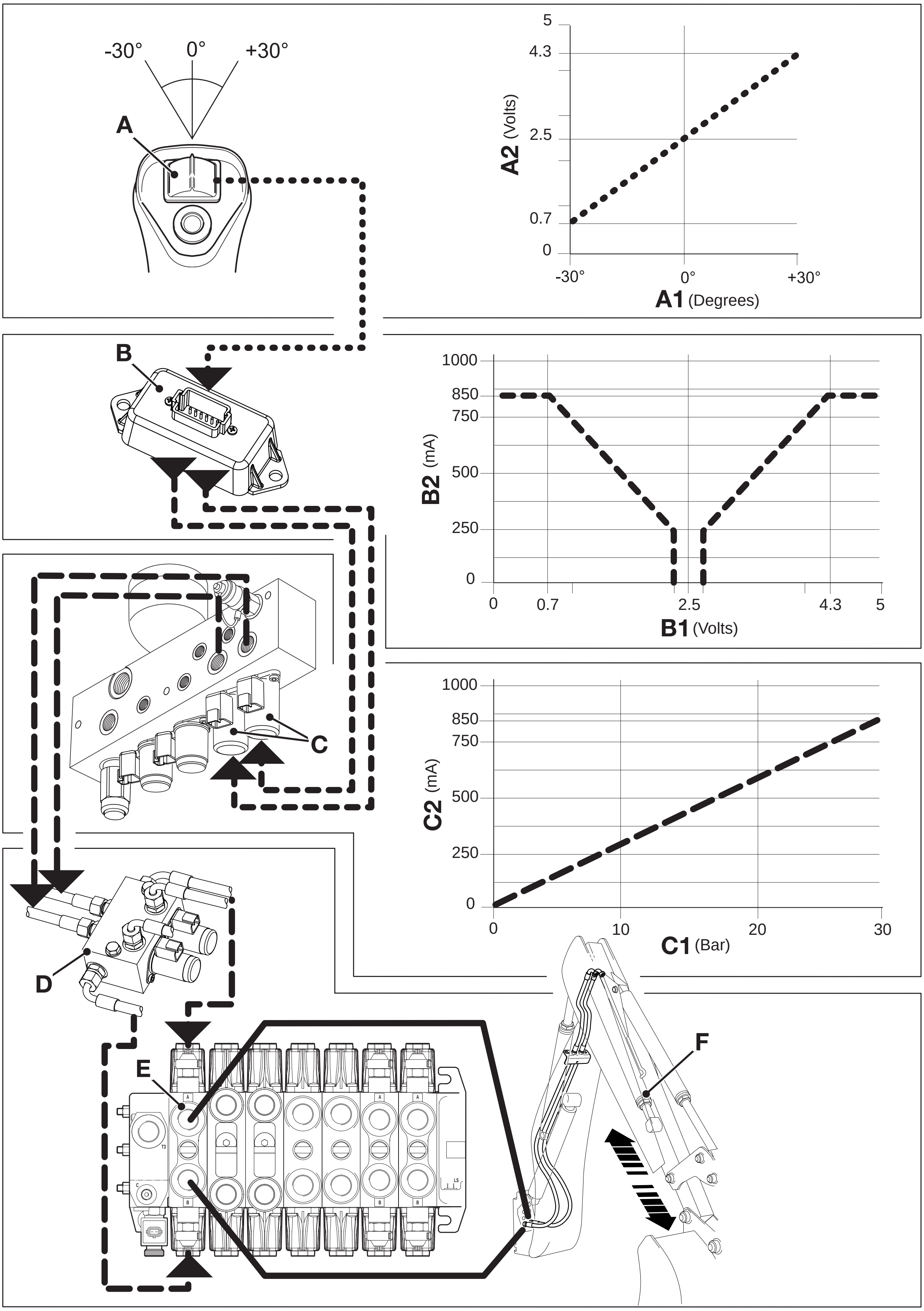


Fig 11. Advanced EasyControl - Extending Dipper (Example)

EasyControl Machines

⇨ *Fig 12. (L-252)*. Two proportional solenoid valves **C** are used to control auxiliary ram `extend' and `retract' functions. The valves operate for both the excavator and the loader auxiliary rams. Which ram operates (either excavator or loader) is determined by the excavator/loader selector switch, and whether the auxiliary changeover solenoid valve **D** is energised.

The proportional solenoid valves **C** are energised via the PWM controller electronic control unit (ECU) **B** from a thumbwheel switch **A** on the RH joystick. The thumbwheel switch is fed from a separate 5 volt regulated supply located near to the loader valve. When the thumbwheel is moved by the operator, the ECU converts the thumbwheel voltage (input) into a corresponding valve current signal (output) to the relevant solenoid valve coil.

The ECU uses two pulse width modulated (PWM) outputs to control the proportional solenoid valves. One output operates the `extend' valve. The other output operates the `retract' valve. The valves work as separate pressure reducing valves and direct servo pilot oil (at a pressure proportional to the valve current signal) to move the applicable service spool the required amount, thereby controlling the speed and direction of the applicable service ram.

The valve current signal from the ECU is controlled by varying the duty cycle of the PWM output. For a detailed explanation of the duty cycle and PWM outputs, see ⇨ *Theory (L-255)*. The theoretical PWM duty cycle required to produce a given valve current signal (output) is already pre-programmed into the ECU memory (ROM). The ECU uses a closed loop control algorithm to constantly compare the actual valve current (via a current sense resistor) with the theoretical valve current (stored in memory), and automatically increases or decreases the PWM duty cycle if necessary, to compensate for variations in the resistance of the solenoid coil windings (due to changes in ambient temperature), or fluctuations in the machine's 12 volt supply.

ECU Boost Input: When the joysticks are activated for excavator operation, the operator can press a pushbutton on the LH joystick to signal a separate ECU input (boost). The ECU will send the maximum valve current signal (output) to the applicable solenoid valve, to activate the excavator auxiliary spool and retract the extending dipper at maximum speed. Note that this feature is also utilised to activate the excavator auxiliary spool when using certain hi-flow attachments E.g. Rockbreakers.

⇨ *EasyControl Extending Dipper - Example (L-251)*.

EasyControl Extending Dipper - Example

⇨ *Fig 12. (L-252)*. The PWM controller (ECU) **B** monitors the output voltage of the thumbwheel switch **A**.

Note: *The graphs show the different voltage and current outputs for given thumbwheel positions. The values shown are examples for the purpose of explanation only, and should not be used as exact values for any given machine.*

- In the mid position (neutral), the thumbwheel output voltage is 2.5 volts. When the ECU input voltage is 2.5 volts, the ECU output current is 0 mA, therefore neither the `extend' or `retract' solenoid valves will energise.
- When moved to the right, the thumbwheel output voltage increases to between 2.5 and 4.3 volts. When the ECU input voltage is greater than 2.5 volts, it sends a corresponding output current to energise the `extend' solenoid valve.
- When moved to the left, the thumbwheel output voltage decreases to between 2.5 and 0.7 volts. When the ECU input voltage is less than 2.5 volts, it sends a corresponding output current to energise the `retract' solenoid valve.

As the operator moves the thumbwheel **A** from the neutral position (plus a small dead band), the valve current signal from the ECU **B** will step from 0 to 250 mA. The relevant solenoid valve **C** will respond and direct servo pilot oil through the changeover solenoid valve **D** to one end of the auxiliary spool **E** (as applicable). The auxiliary spool is displaced a small amount, which allows flow from the main hydraulic system to the extending dipper ram **F**, causing the ram to move at a steady rate.

If the thumbwheel is moved further, the valve current signal will increase proportionally (linear), until the thumbwheel reaches its end stop and maximum valve current is reached. As the valve current signal increases, similarly the servo pilot pressure from the solenoid valve also increases proportionally, until maximum servo pilot pressure is reached.

When the servo pilot pressure is increased, the auxiliary spool is displaced further, which allows more flow from the main hydraulic system to the extending dipper ram, causing the ram to move at a faster rate.

Component Key:

A	Thumbwheel Switch
A1	Thumbwheel Input (degrees)
A2	Thumbwheel Output (volts)
B	PWM Controller (ECU)
B1	ECU Input (volts)
B2	ECU Output (mA)
C	Proportional Solenoid Valves
C1	Valve Output (bar)
C2	Valve Input (mA)
D	Auxiliary Changeover Solenoid Valve
E	Auxiliary Service Spool
F	Extending Dipper Ram

For further details of the electrical circuit and connections, see ***EasyControl SYSTEM***.

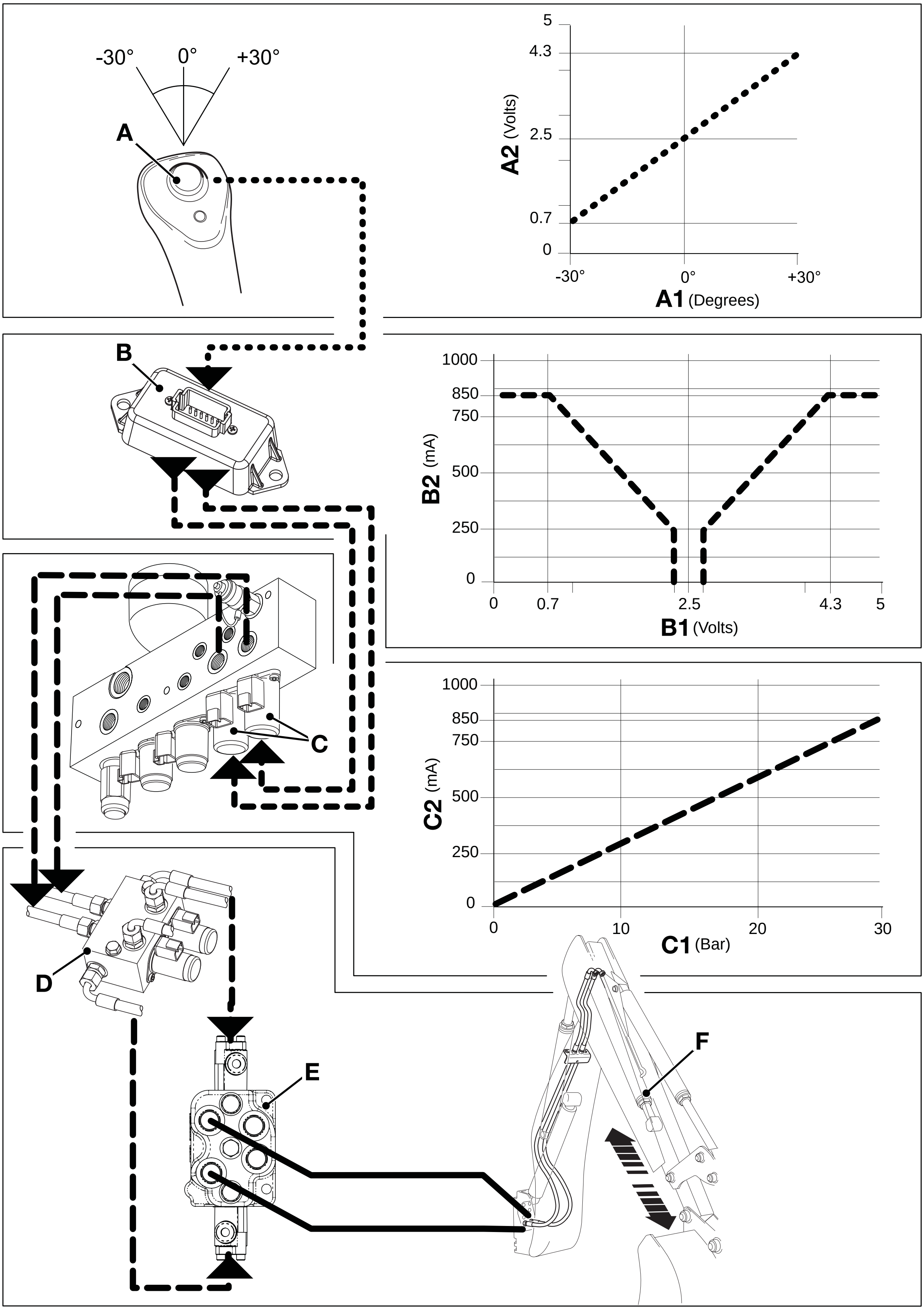
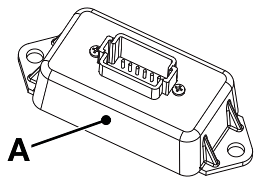


Fig 12. EasyControl - Extending Dipper (Example)

PWM Controller Electronic Control Unit (ECU)

Joystick control (servo) machines use an electronic control unit (ECU) **A** to provide a current signal output to operate proportional solenoid valves for the control of the loader and excavator auxiliary services. Note that the ECU is a non-serviceable part and is NOT programmable.



ECU's get electrical information from connected devices such as sensors and switches. Signals from these devices are the ECU 'Inputs'.

Information stored in the ECU internal memory is used to process information from the inputs. The result determines how the ECU controls electrical devices connected to its 'Outputs'. It is important to understand different types of inputs and outputs:

ECU Inputs

There are two main types of input, Digital and Analogue.

1 **Digital inputs (i.e. On-Off switch type inputs):** Digital type inputs are on-off type inputs (i.e. switches) and can be Low side inputs or High side inputs. Low side inputs are inputs that provide a ground to the ECU. High side inputs are inputs that provide a positive feed to the ECU.

Low side input: The low side input is the most frequently used input on an electrical system. The low side input can be in the form of rocker switches or pressure switches.

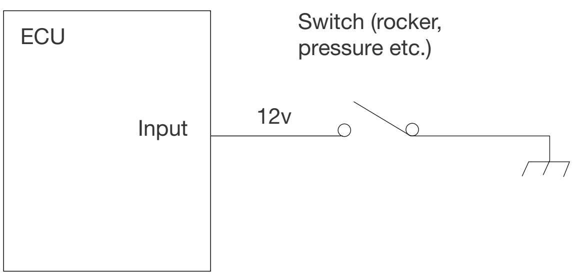


Fig 13.

High side input: The high side input is used on circuits that require a positive feed when the ignition is switched off, e.g. sidelights or hazard lights.

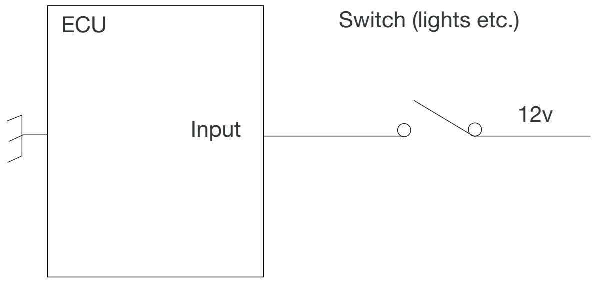


Fig 14.

2 **Analogue inputs (i.e. sensor type inputs):** Analogue inputs are sensor type inputs that provide a varying type input to the ECU, this input could be a voltage, resistance or frequency type input.

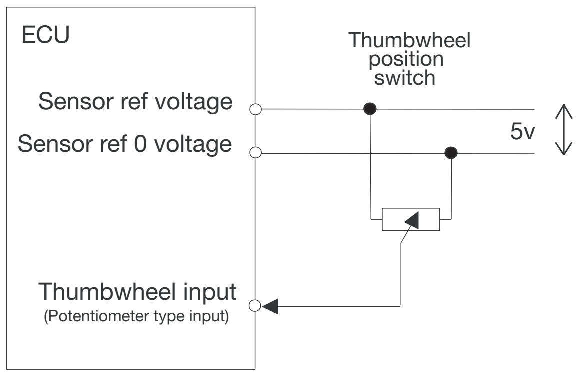


Fig 15.

ECU Outputs

There are three main types of outputs. Low side output, High side output and Modulated output.

1 **Low side output:** In the Low side output circuit the solenoid or relay which is being driven already has a positive feed available, the ECU then provides the ground side of the circuit.

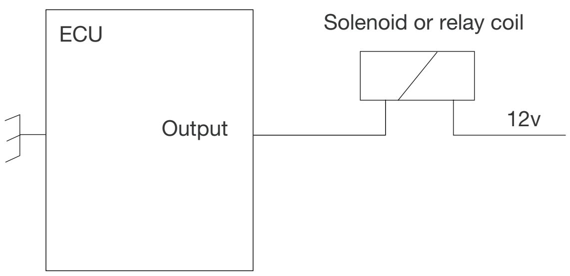


Fig 16.

2 **High side output:** In the High side output circuit the solenoid or relay which is being driven already has a ground available, the ECU provides the positive side of the circuit.

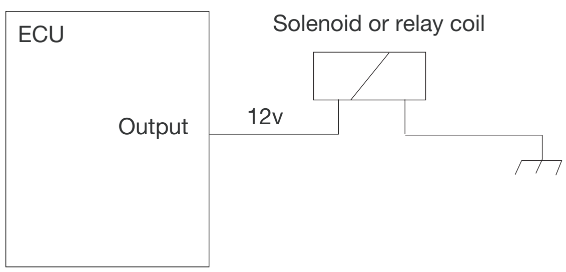


Fig 17.

3 **Modulated outputs:** In the Modulated Output circuit the ECU provides a PWM (Pulse Width Modulation) signal to a proportional valve. As the ECU varies the duty cycle of the signal the proportional valve will select more or less depending on the change in duty cycle. ⇨ ***Theory (L-255)***.

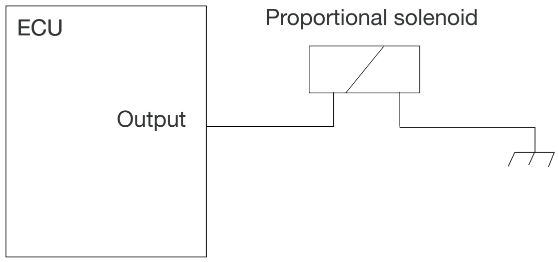


Fig 18.

Pulse Width Modulation (PWM)

Theory

Ohms law states that, the amount of current flow in a circuit is determined by the voltage, and the resistance. A 12v circuit with a resistance of 6 ohms, would draw a current of 2 amps. This would be the case for a standard solenoid, which is either on or off.

Once the voltage is applied to the circuit, it is present 100% of the time. This would be known as a 100% duty cycle. Therefore the circuit will draw 2 amps constantly.

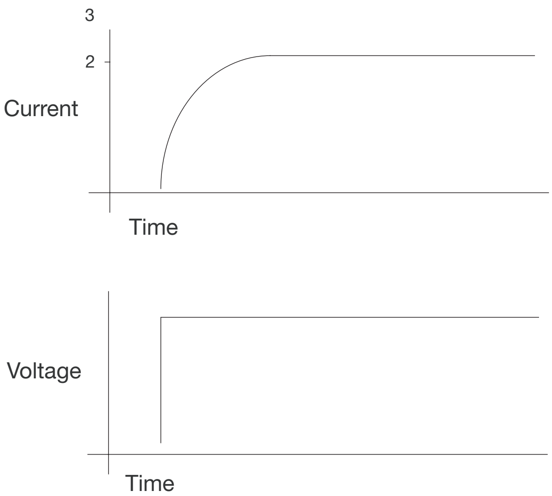


Fig 19.

A proportional solenoid requires differing amounts of current, depending on its condition. As the coil has a fixed resistance, changing the current rating can be done in either of two ways,

1 Having lots of different resistors switched in and out of the circuit at different times to change the current flowing.

2 To change the duty cycle of the solenoid.

It is easier, more economical, and more reliable to change the duty cycle of the circuit, especially using today's computer - controller technology.

The duty cycle is the amount of time a component is switched on compared to the time it is switched off. If a solenoid is on for three seconds, then off for one second, on for three, off for one etc. this would be a 75% duty cycle.

The graph **A** although unstable would give a current rating of 1.5 amps. To stabilise the current in the circuit, the frequency would need to be increased. If the time scale on the graph **A** was one second, the frequency would be 4Hz (Hertz (cycles per second)). The graph **B** shows the same duty cycle, but at a higher frequency of 32 Hz. Note that the proportional solenoids can operate at a frequency of 250 Hz.

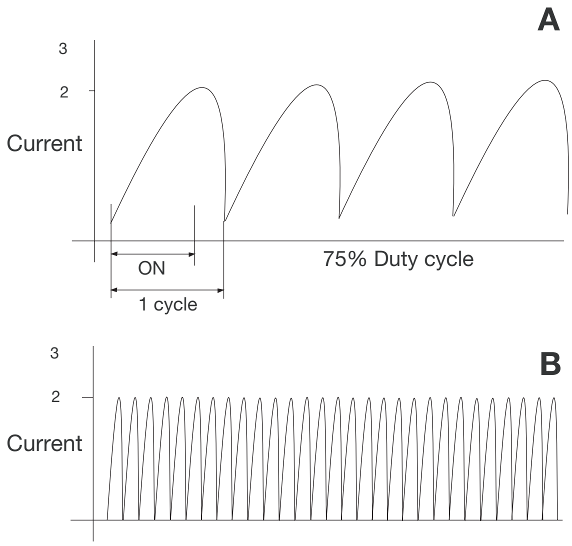


Fig 20.

Removal and Replacement

⚠ WARNING

Make the machine safe before working underneath it. Park the machine on level ground, lower the attachments to the ground. Apply the park brake, put the transmission in neutral and stop the engine. Block both sides of all four wheels.

Disconnect the battery, to prevent the engine being started while you are beneath the machine.

GEN-4-1_1

⚠ WARNING

Hydraulic Pressure

Hydraulic fluid at system pressure can injure you. Before connecting or removing any hydraulic hose, residual hydraulic pressure trapped in the service hose line must be vented. Make sure the hose service line has been vented before connecting or removing hoses. Make sure the engine cannot be started while the hoses are open.

INT-3-1-11_2

Removal

1 Vent the hydraulic services and pilot circuit accumulator hydraulic pressure:

Switch the starter to ON without starting the engine. Activate the joystick controls, operate the joysticks several times to vent the hydraulic pressure from the servo system and service rams. Turn the starter switch to the OFF position and remove the key.

2 ⇨ *Fig 21. (L-257)*. Working under the LH side of the machine, uncouple the harness electrical connectors at the solenoids **A**, and at the pressure switch **B** (if fitted). Label each connector before disconnecting to ensure correct replacement.

3 Disconnect all hydraulic hoses from the valve block. Label each hose before disconnecting to ensure correct replacement. Plug the open ports and cap the hose ends to prevent loss of fluid and ingress of dirt.

Note: *Some pilot hoses have quick-connect couplings. This type of coupling requires a special tool to release it. Refer to the applicable machine* ***SYSTEM - Service Procedures****.*

4 Take hold of the valve assembly, loosen and remove the fixing bolts **C** (3 off) securing the valve to the chassis. Lift the valve assembly from the machine. Take care to retrieve the spacers **D** (3 off).

Replacement

Replacement is the reverse of the removal sequence.

After replacement check the servo pilot pressure. Refer to the applicable machine ***SYSTEM - Service Procedures***.

Important: *The extent of permissible servicing is the renewal of the solenoid coils. Further dismantling of the valve is not recommended. If the valve is suspected as being faulty it must be renewed as a complete assembly. Note also that the pilot circuit accumulator is a non serviceable part and is sealed for life. It is not possible to recharge the accumulator with nitrogen.*

Removal and Replacement

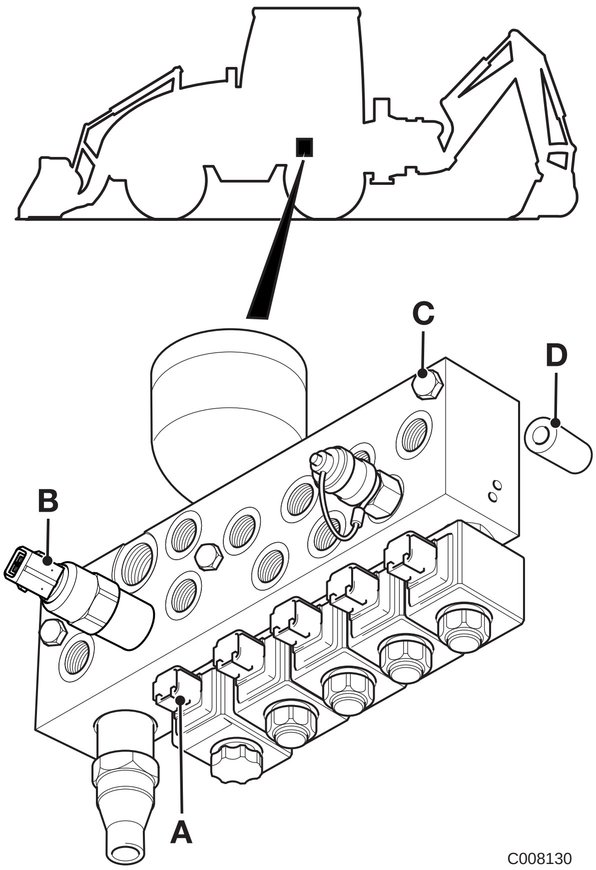


Fig 21. Servo Pressure Supply Valve (Typical valve shown)

Inloader Valve

Introduction

This topic contains information about a machine DEVICE. Make sure you are referring to the correct device.

This topic is intended to help you understand what the device does and how it works. Where applicable it also includes procedures such as removal and replacement and dismantle and assemble.

Specifications

Model Reference:	0704BP
Inloader Valve Setting (sets Delta-P) (1)	
Machines to serial no. 1336068	10 bar (10.2 kgf/cm², 145 lbf/in²)
Machines from serial no. 1336069	12 bar (12.2 kgf/cm², 175 lbf/in²)
Weight:	TBA kg (TBA lbs)

(1) Factory set with shims.

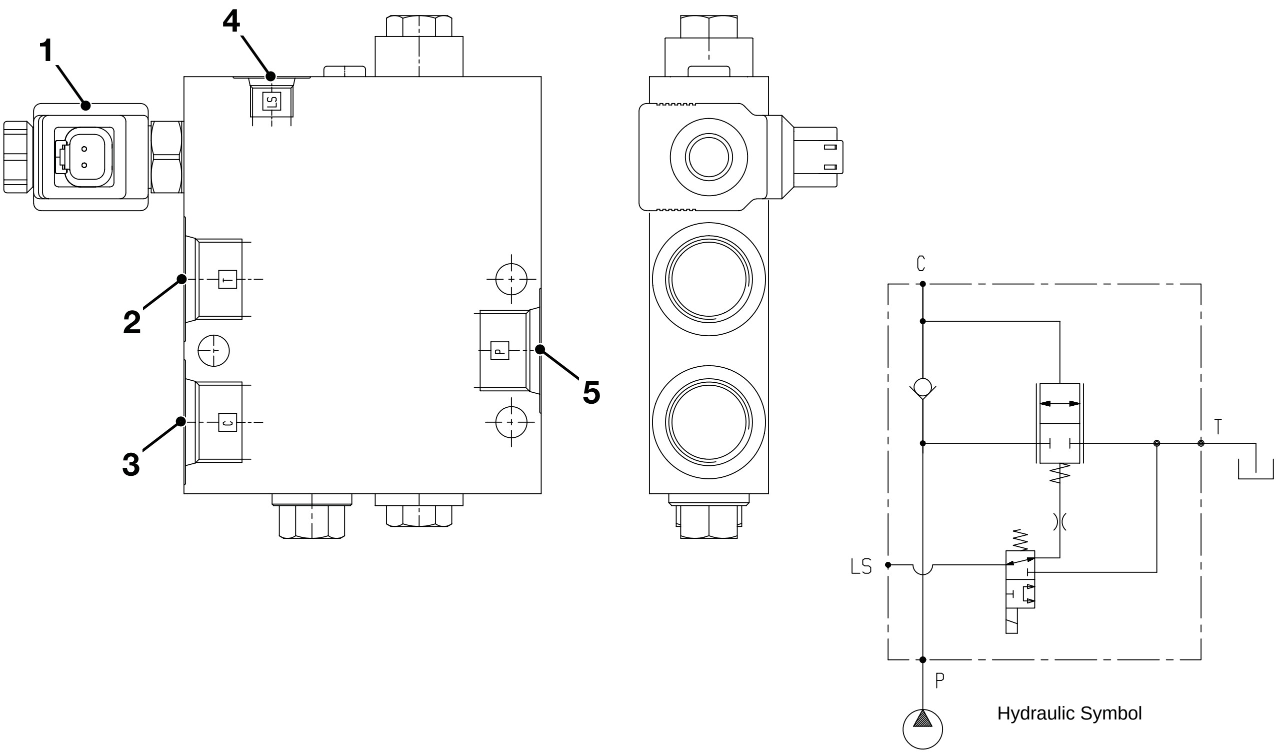


Fig 22.

Component Key:

1 Inloader solenoid
2 Tank port
3 Outlet port
4 Load sense port
5 Inlet port

Descriptions

The inloader valve is an integral part of the Hydraulic Speed Control System (HSC).

The valve senses the pressure in the load sense circuit via port **LS** and the P1 working pressure via port **C**. The valve automatically connects the flow from the pump secondary section (P2) through port **P** into the main hydraulic circuit to supplement the flow from the pump main section (P1) when there are large demands on the hydraulic system. Such as, when operating multiple hydraulic services simultaneously, or when a high flow is required by a single service.

The valve incorporates a solenoid **1**, which enables the hydraulic operation of the valve to be electrically overridden. The solenoid is energised by the operator pressing the hydraulic speed control (HSC) selector switch in the side console, or the pushbutton in the loader lever.

When the solenoid is energised, the additional flow available from the pump secondary section (P2) cannot be connected into the main hydraulic system, and is always dumped to tank through port **T**, thereby reducing the load on the engine.

The inloader valve operates in 1 of 3 possible modes:

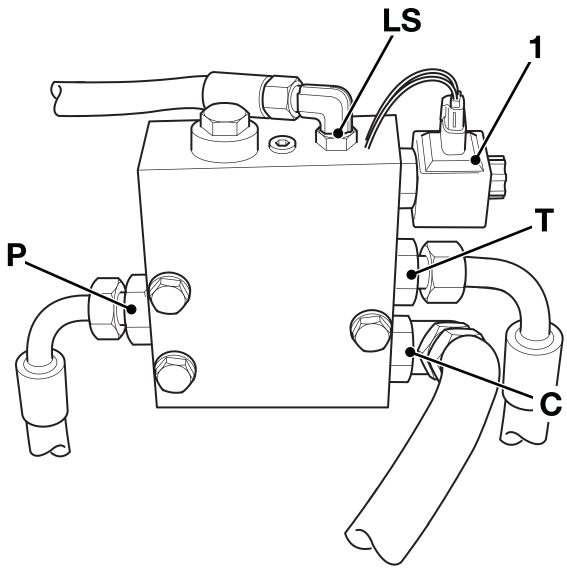


Fig 23.

⇒ ***Pump P2 Directed to Tank (L-261)***.

⇒ ***Pump P2 in Circuit (Inloader Operation) (L-261)***.

⇒ ***Inloader Operation Override (L-262)***.

Pump P2 Directed to Tank

⇒ *Fig 24. (L-261)*. For most of the time during the machines work cycle, it is the flow from the main pump section **P1** which is available within the main circuit. The flow from the secondary pump section **P2** is dumped to the hydraulic tank by the inloader valve, reducing the load on the engine.

Normally, the flow available from the main pump section **P1** is more than sufficient to satisfy the flow demanded, and the main pump circuit **P1** pressure is always around 15 bar above the load sense circuit **LS** pressure. Pressure from the main circuit holds the inloader valve spool **1a** open and flow from pump **P2** is directed back to tank.

Pump P2 in Circuit (Inloader Operation)

⇒ *Fig 25. (L-261)*. If the flow demanded by a service or multiple services, begins to exceed the flow available, the main circuit pressure will start to fall off. The pressure difference between the main pump circuit **P1** and the load sense circuit **LS** will therefore reduce. When the pressure difference reduces to around 10 bar, inloader valve spring **1b** causes the spool **1a** to close, connecting the additional flow from the secondary pump section **P2** into the main hydraulic circuit. This ensures a surplus of flow in the main hydraulic circuit.

⇒ *Graph of System Pressures (L-263)*. The graph shows typical hydraulic pressures for inloader valve operation when the loader lift service is operated fully.

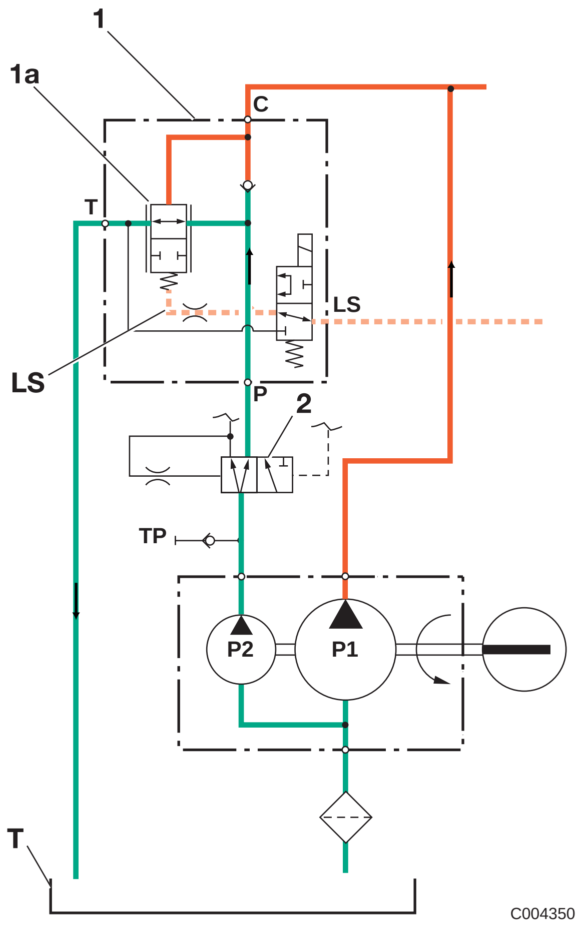


Fig 24.

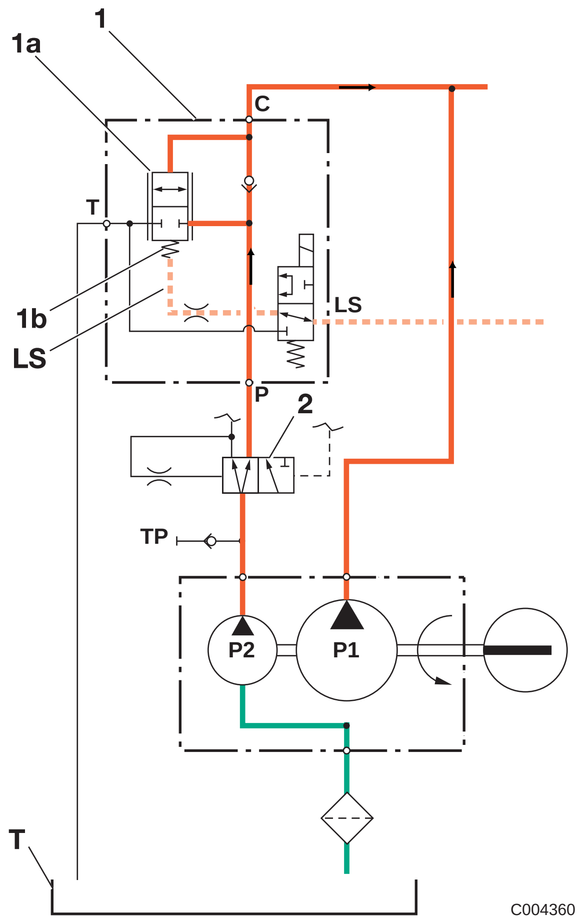


Fig 25.

Table 3. Colour Key to Oil Flow and Pressure

■	System Pressure
■	Load Sense Pressure
■	Exhaust

Inloader Operation Override

⇨ *Fig 26. (L-262)*. The hydraulic operation of the inloader can be overridden electrically via solenoid **1c**. The solenoid **1c** is energised either by the hydraulic speed control (HSC) selector switch in the cab (or under certain operating conditions, by the system pressure switch housed in the servo pressure supply valve block). The solenoid valve spool isolates the inloader valve spool **1a** from the load sense pressure and directs trapped pressure back to tank. The inloader valve spool **1a** is now always held in the open position by pressure from the main circuit. In this way the output from pump **P2** is always directed to tank.

***Note:** The system pressure switch is no longer fitted on machines from serial no. 976693.*

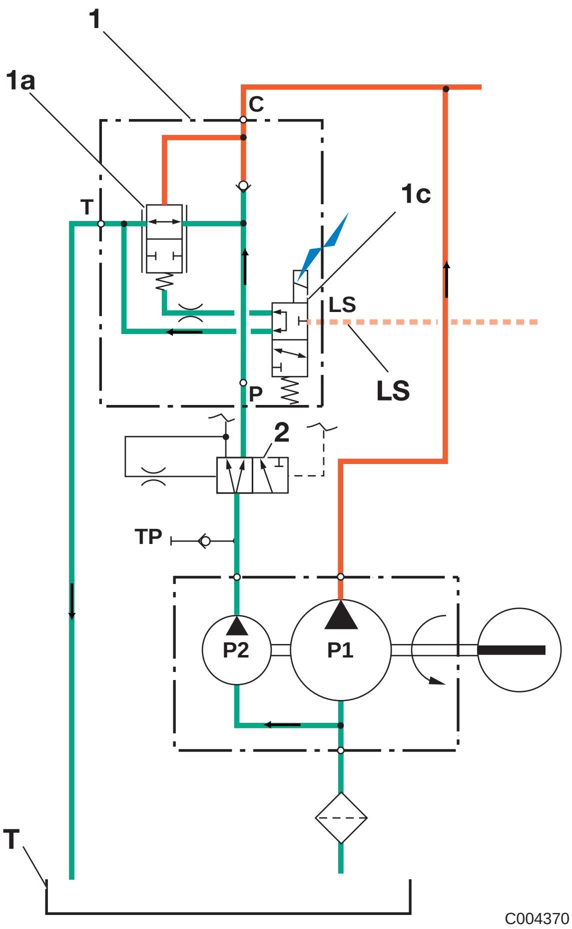


Fig 26.

⇨ *Table 3. Colour Key to Oil Flow and Pressure (L-261)*.

Graph of System Pressures

⇨ Fig 27. (L-264). The graph shows the typical P1, P2 and load sense pressures when the loader lift service is operated fully.

At point **X**, the differential between the P1 working pressure and the load sense pressure has reduced to around 10 bar. The inloader valve activates to connect the flow from the pump secondary section (P2) into the main hydraulic circuit, supplementing the flow from the pump main section (P1).

At point **Y**, the lift rams reach the end of their stroke. The differential between the P1 working pressure and the load sense pressure returns to normal (around 15 bar). The additional flow from the pump secondary section (P2) is not required and is dumped to tank, consequently the P2 working pressure falls to minimum.

Table 4. Colour Key to Oil Flow and Pressure

(red-orange)	P1 working pressure
(blue)	P2 working pressure
(light orange)	Load sense pressure

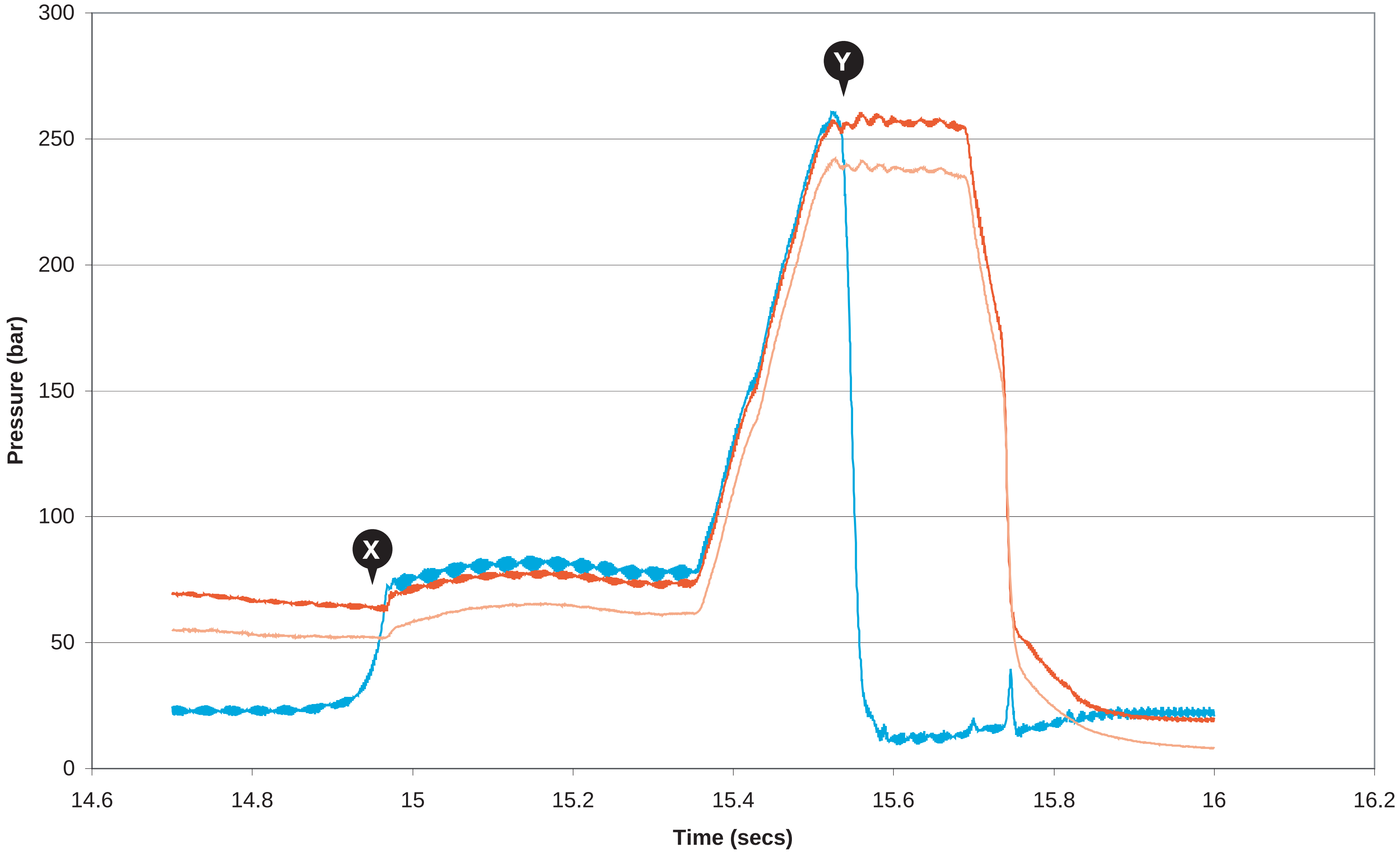


Fig 27. Graph of System Pressures

⇨ Table 4. Colour Key to Oil Flow and Pressure (L-263).

Removal and Replacement

⚠ WARNING

Make the machine safe before working underneath it. Park the machine on level ground, lower the attachments to the ground. Apply the park brake, put the transmission in neutral and stop the engine. Block both sides of all four wheels.

Disconnect the battery, to prevent the engine being started while you are beneath the machine.

GEN-4-1_1

⚠ WARNING

Hydraulic Pressure

Hydraulic fluid at system pressure can injure you. Before connecting or removing any hydraulic hose, residual hydraulic pressure trapped in the service hose line must be vented. Make sure the hose service line has been vented before connecting or removing hoses. Make sure the engine cannot be started while the hoses are open.

INT-3-1-11_2

Removal

1 Vent the hydraulic services and pilot circuit accumulator hydraulic pressure:

Switch the starter to ON without starting the engine. Activate the joystick controls, operate the joysticks several times to vent the hydraulic pressure from the servo system and service rams. Turn the starter switch to the OFF position and remove the key.

2 Working under the RH side of the machine, uncouple the harness electrical connector at the solenoid **A**. Label the connector before disconnecting to ensure correct replacement.

3 Disconnect all hydraulic hoses from the valve block and plug the ports to prevent ingress of dirt. Label each hose before disconnecting to ensure correct replacement. Plug hose ends to prevent ingress of dirt.

4 Take hold of the valve assembly, loosen and remove the fixing bolts **B** (3 off) securing the valve to the chassis. Lift the valve assembly from the machine.

Replacement

Replacement is the reverse of the removal sequence.

After replacement check the valve operation. Refer to the applicable machine ***SYSTEM - Service Procedures***.

Important: *The extent of permissible servicing is the renewal of the solenoid coil. Further dismantling of the valve is not recommended. If the valve is suspected as being faulty it must be renewed as a complete assembly.*

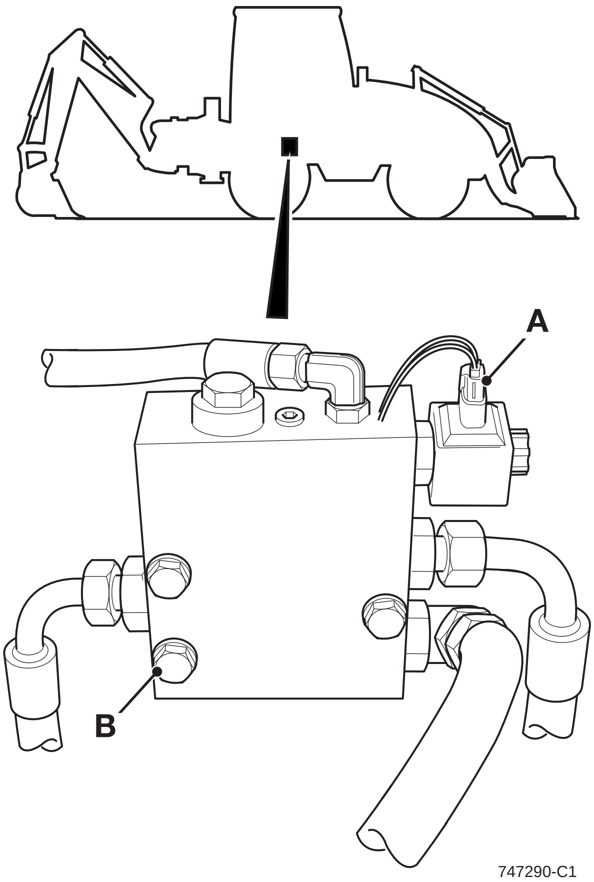


Fig 28.

Hydraulic Pump (Gearpumps)

Introduction

This topic contains information about a machine DEVICE. Make sure you are referring to the correct device.

This topic is intended to help you understand what the device does and how it works. Where applicable it also includes procedures such as removal and replacement and dismantle and assemble.

⇒ *Specifications (L-267)*
⇒ *Descriptions (L-268)*
⇒ *Removal and Replacement (L-269)*
⇒ *Dismantle and Assemble (L-270)*

Specifications

The gearpump is similar to those used for standard non-servo machines described in section E. See ***Section E, Hydraulics - Technical Data***.

Descriptions

The gearpump is similar to those used for standard non-servo machines described in section E. See ***Section E, Hydraulics - Circuit Descriptions***.

Removal and Replacement

The procedures are similar to those used for standard non-servo machines described in section E. See ***Section E, Hydraulics - Main Pump***.

Dismantle and Assemble

The procedures are similar to those used for standard non-servo machines described in section E. See ***Section E, Hydraulics - Main Pump***.

Hydraulic Pump (Variflow)

Introduction

This topic contains information about a machine DEVICE. Make sure you are referring to the correct device.

This topic is intended to help you understand what the device does and how it works. Where applicable it also includes procedures such as removal and replacement and dismantle and assemble.

Specifications

Model Reference:	A10V0
Type:	Axial piston pump - variable displacement (fully load sensed, flow on demand)
Mounting:	Gearbox
Direction of Rotation:	Clockwise
Maximum Displacement:	74 cc/rev; 4.5 in^3/rev
Flow at System Pressure:	It is not possible to measure maximum flow at system pressure because the pump swashplate will return to minimum angle (minimum flow) when the system reaches full pressure. A practical method to determine the pump performance is to measure the cycle times for the main hydraulic services. See ***Advanced EasyControl SYSTEM - Service Procedures***.
Relief Valve Setting:	
Flow Compensator Valve (sets Delta-P)	20 bar (20.4 kgf/cm^2, 290 lbf/in^2)
Weight:	35 kg (77 lbs)

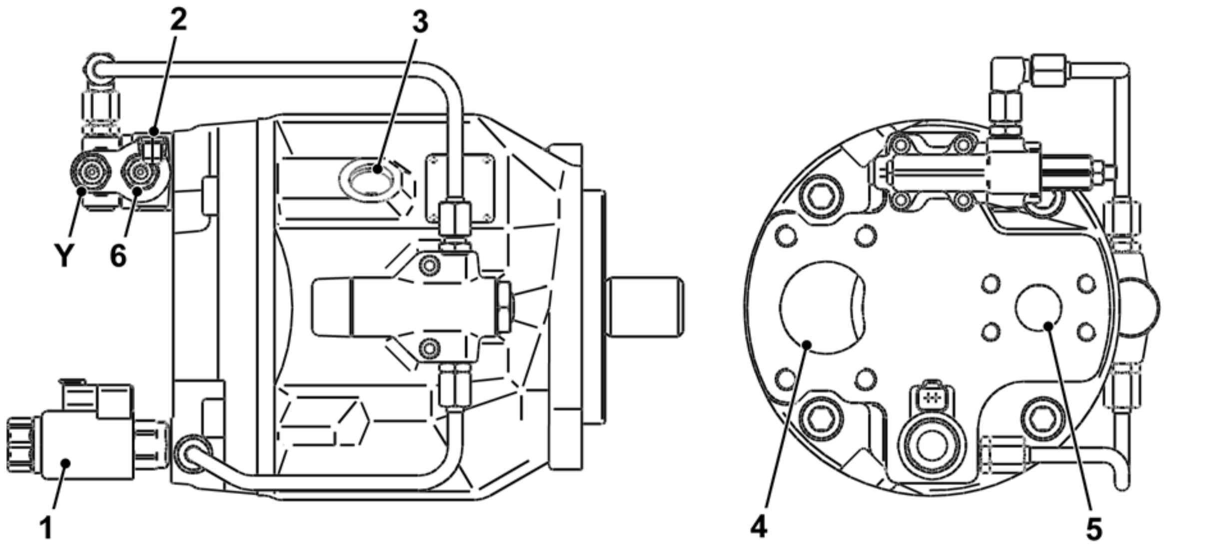


Fig 1.

Component Key:

1 Dual horsepower solenoid valve - if fitted [(1)]
2 Load sense port
3 Case drain port
4 Suction (Inlet)
5 Discharge (Outlet)
6 Flow compensator valve

(1) The dual horsepower solenoid valve is no longer fitted on machines from serial no. 975289.

Important: *The variflow pump fitted to Advanced EasyControl machines is different from other variflow pumps in the JCB range. UNDER NO CIRCUMSTANCES must the valve* ***Y*** *(to the rear of the pump) be adjusted. This valve changes the characteristics of the horsepower control of the pump. This cannot be reset on the machine and will have to be returned to the manufacturer.*

Descriptions

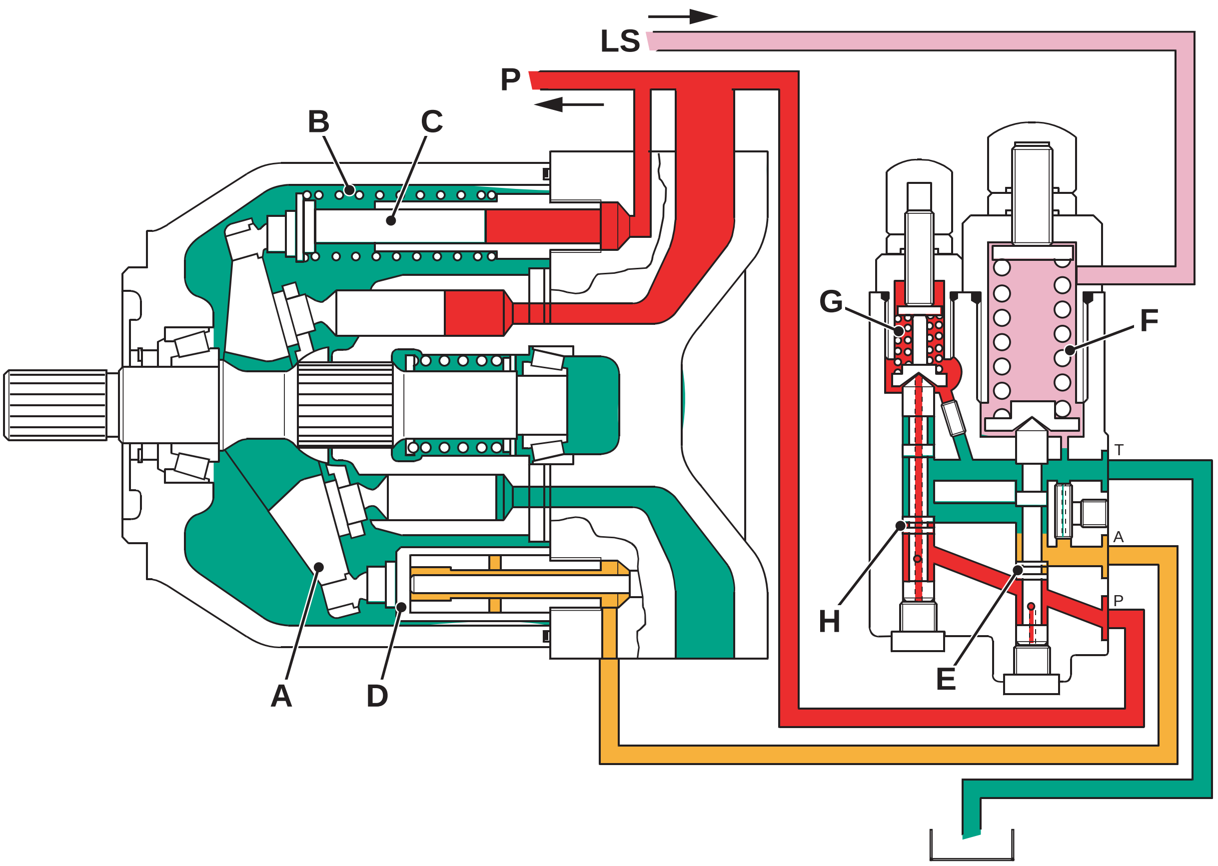


Fig 2. Sectioned View

The pump output flow and operating pressure are controlled by varying the angle of the tilting swashplate **A**. The swashplate is moved in one direction by the pump operating pressure (red) and the force of the spring **B** acting on the stroking piston **C**; and in the opposite direction by control pressure (orange) acting on the swash control piston **D**. The control pressure is derived from the pump operating pressure by the action of the flow compensator spool **E**. The flow compensator spool regulates the angle of the swashplate automatically in response to changes in the hydraulic load sense pressure (pink) from the hydraulic service.

Flow Compensator Valve: When a hydraulic service is operated, loader lift for example, a pressure signal (demand) is generated in the load sense line **LS** from the loader valve block. The increase in the load sense pressure, combined with the force of the spring **F** pushes the flow compensator spool **E** down, this in turn, allows some control pressure acting on the swash control piston **D** to vent back to tank via the case drain (green). The force of the spring **B** increases the angle of the swashplate **A** and the pump output flow increases proportionally.

When the output flow is enough to satisfy the flow demanded by the service, the pump operating pressure **P** (i.e. main system pressure) increases sufficiently to start to move the service ram. The increase in the pump operating pressure pushes the flow compensator spool **E** up, against the force of the spring **F** and hydraulic load sense pressure; this in turn increases the control pressure acting on the swash control piston **D**, which decreases the angle of the swashplate **A** against the force of spring **B**. As the swashplate angle decreases, the output flow from the pump decreases. In this way, the pump delivers only the minimum flow needed to maintain the system pressure required to operate the service.

Note: *The flow compensator spool **E** is moving constantly, thereby regulating the pump swashplate to balance the pressures acting on each end of the spool. The additional force of spring **F** is factory set to be equivalent to 20 bar (290 lbf/in^2), therefore the pump operating pressure (i.e. main system pressure) will always be maintained at 20 bar above the load sense pressure. **This is sometimes referred to as the 'Delta-P' pressure setting**.*

Pressure Cut-Off Valve: The pressure cut-off valve is a secondary safety device to limit the maximum operating pressure, and thereby protect the pump from over pressurisation. If the pump operating pressure **P** (i.e. main system pressure) ever reaches the setting of the valve springs **G**, the pressure cut-off spool **H** will be pushed up, this in turn, increases the control pressure acting on the swash control piston **D**, which decreases the angle of the swashplate, and reduces the pump output flow to minimum. While the pressure cut-off valve is operating, the pump will remain hydraulically stalled i.e. maintaining maximum operating pressure at minimum flow.

Removal and Replacement

The procedures are similar to those used for standard non-servo machines described in section E. See ***Section E, Hydraulics - Main Pump***.

Dismantle and Assemble

The hydraulic pump is a non-serviceable part. Specialist tools and test equipment are needed for setting-up the pump during assembly, and for subsequent testing. For this reason, the pump should not be dismantled. If the pump is suspected as being faulty it must be renewed as a complete assembly.

Loader Valve (Sectional Type)

Introduction

This topic contains information about a machine DEVICE. Make sure you are referring to the correct device.

This topic is intended to help you understand what the device does and how it works. Where applicable it also includes procedures such as removal and replacement and dismantle and assemble.

Specifications

Model Reference:	SX14		
Relief Valve Settings:	**bar**	**kgf/cm²**	**lbf/in²**
Shovel Ram Head Side (ARV) (1)	170 - 178	173 - 176	2450 - 2600
Shovel Ram Rod Side (ARV)	310 - 318	316 - 324	4500 - 4600
Load Sense Relief Valve (LSRV) (2)	245 - 253 (3)	250 - 258	3550 - 3650
	230 - 238 (4)	235 - 243	3350 - 3450
Flushing Valve (sets standby pressure) (5)			
Precision Control Machines - to serial no. 1336068	15 - 17	15.3 - 17.3	215 - 245
Precision Control Machines - from serial no. 1336069	19	19.4	275
Advanced EasyControl Machines	27	27.5	390
Weight:	TBA kg (TBA lbs)		

(1) All the auxiliary relief valves (ARV's) are factory set and sealed with a plastic tamper proof cap. If a relief valve is suspected as being faulty it must be renewed as a complete assembly.
(2) The load sense relief valve sets the maximum pressure that can be achieved within the main hydraulic system. For pressure testing and adjustment of the load sense relief valve, see Service Procedures.
(3) When measured in the main hydraulic circuit at test point X1, see Schematic Circuits.
(4) When measured in the load sense line at test point X4, see Schematic Circuits.
(5) Factory set with shims.

Component Key: ⇨ *Fig 3.* (L-279) and ⇨ *Fig 4.* (L-279)

1	Auxiliary service	**8**	Load sense port
2	Shovel service	**9**	Load sense relief valve
3	Arms lift service	**10**	L.S. relief valve drain port
4	Auxiliary relief valve	**11**	Flow regulator valve
5	Service ports	**12**	Flushing valve housing
6	Inlet port	**13**	Inlet port
7	Tank port		

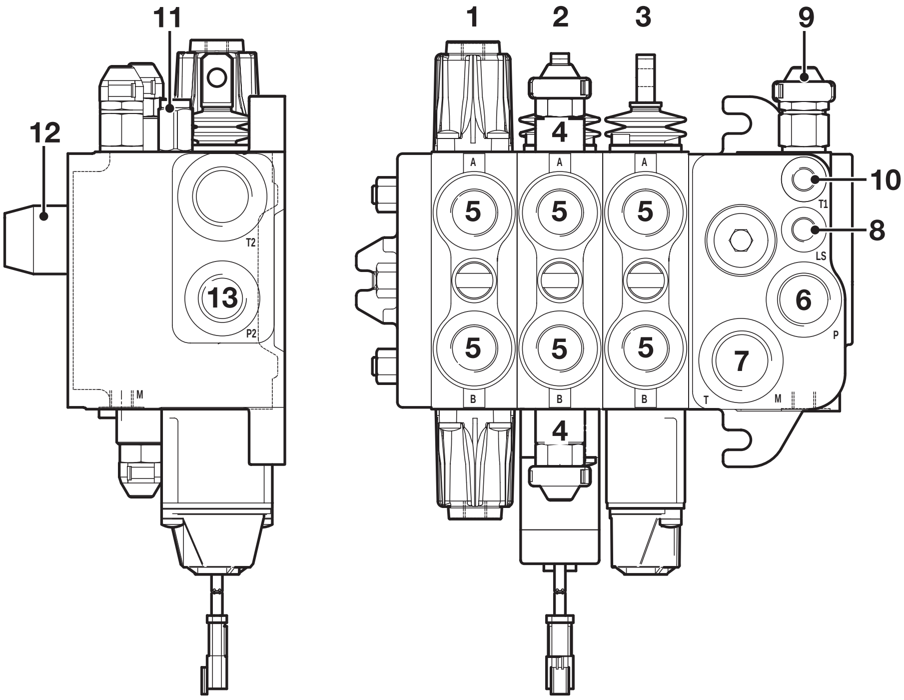


Fig 3. Precision Control Machines

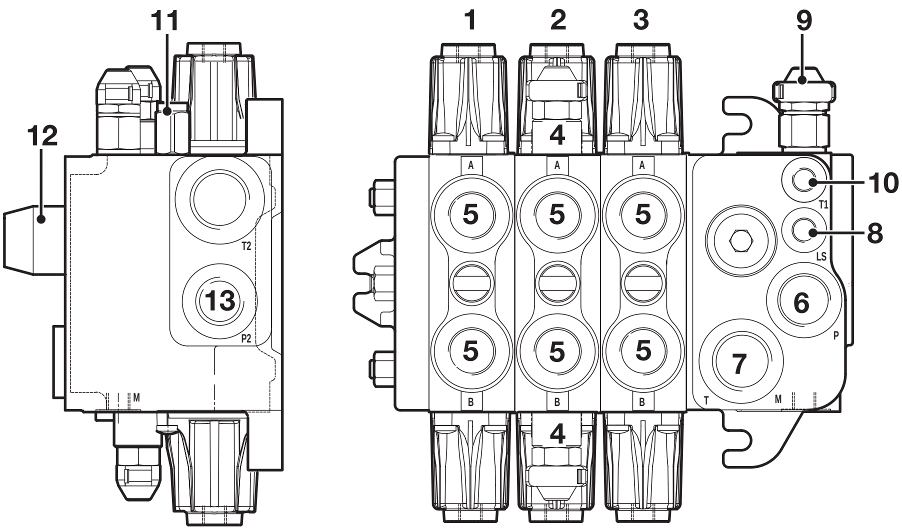


Fig 4. Advanced EasyControl Machines

Descriptions

Loader Valve Services

The loader valve may have both manually operated and servo pilot operated spools **1** depending on the machine variant. The valve spools are of a closed-centre design, and incorporate pressure compensator valves **PC** for each service.

With the spools **1** in the neutral position, the oil from the hydraulic pump(s) enters the valve block inlet gallery **P** and is dead-ended by the central land of the spool.

When a service is selected, the spool **1** moves against the force of the centering spring **2**, allowing oil to flow out of one of the service ports (either **A** or **B**) to move the applicable service ram. When the service is de-selected, the centering spring **2** returns the spool to the neutral position.

When multiple services are selected simultaneously, the pressure compensator valves **PC** sense which service is generating the highest load pressure. This allows the pump operating pressure to adjust to a value sufficient to operate the ram with the highest load. The load hold check valves **3** prevent the load falling back if the load pressure is greater than the pump pressure.

The closed-centre design means that the hydraulic services are not connected in parallel, which ensures consistent service operation regardless of load.

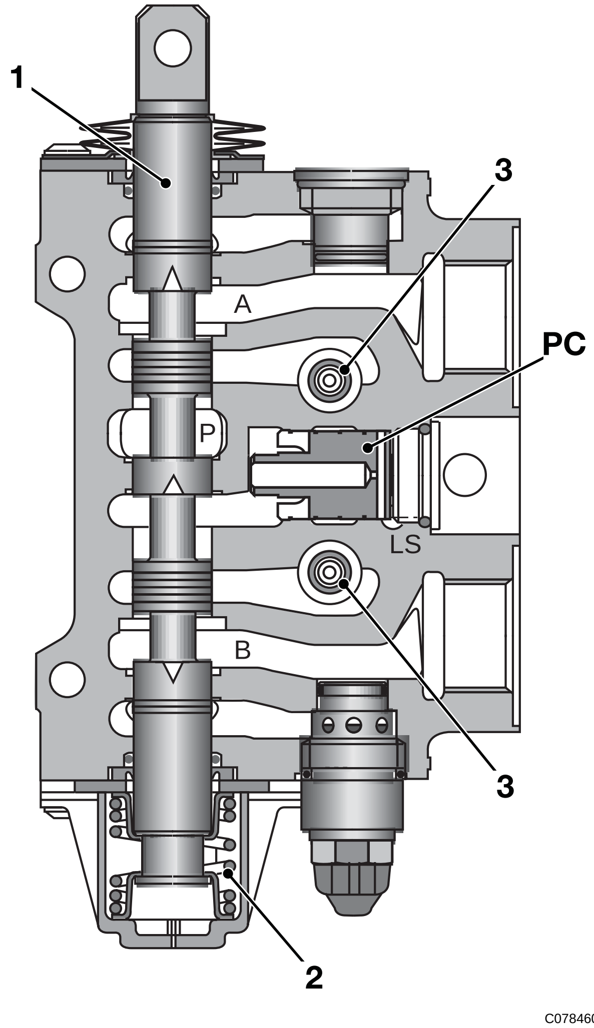


Fig 5. Manually operated spool shown

Pressure Compensator Valves Operation

Operating an Individual Service

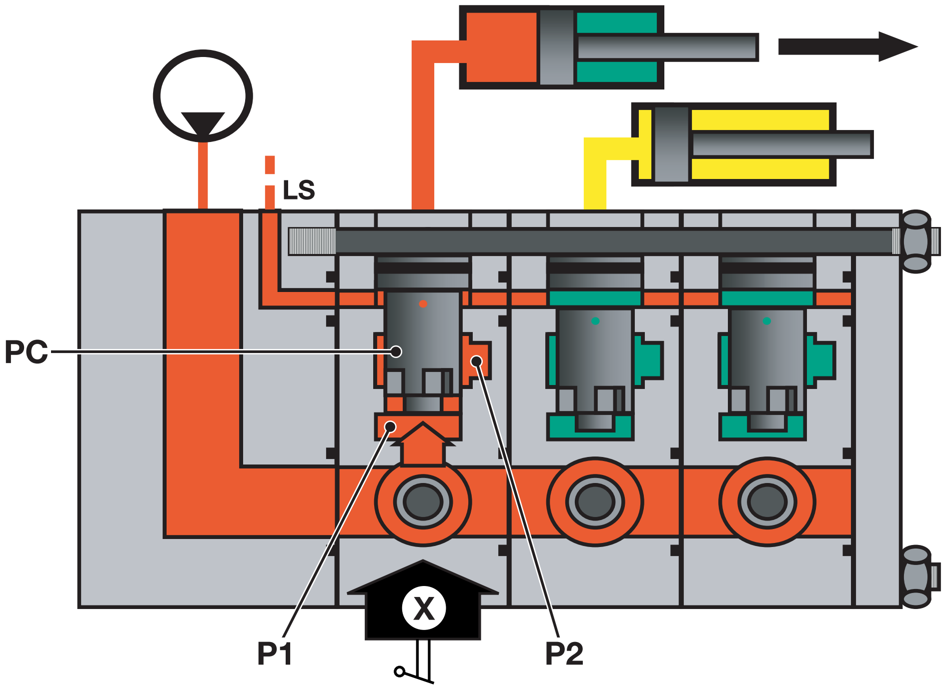


Fig 6.

It must be noted that the load sense gallery **LS** is connected to all the pressure compensator valves **PC** (one for each service) as shown in *Fig 6. (L-281)*. The pressure in the load sense gallery **LS** will always be equal to the highest load from any of the services.

The pressure compensator valves are fitted between each service spool and service ram, and sense the pressure acting on either side of the particular service spool. The pressure compensator valve will move in response to the pressure drop (pressure differential) created across the spool.

When one service only is operated **X**, the pressure compensator valve **PC** is FULLY opened as shown, connecting the gallery **P1** to gallery **P2** and to the ram service port without any pressure drop.

Table 1. Colour Key to Oil Flow and Pressure

(orange-red)	Full Pressure
(light orange)	Pressure
(blue)	Neutral
(green)	Exhaust
(yellow)	Lock Up

Operating Multiple Services

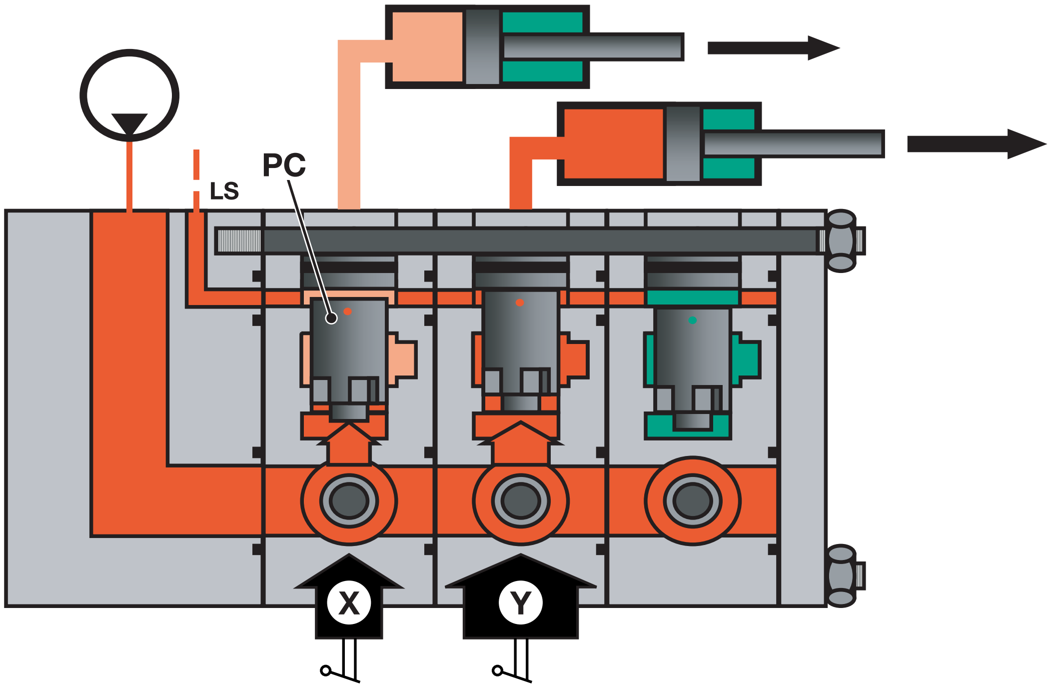


Fig 7.

Normal Condition

When another service with a higher load is operated simultaneously, a typical example is the lifting of the boom **Y** and simultaneous operation of the bucket **X** as shown in ⇒ *Fig 7. (L-282)*.

The higher load pressure in the boom service causes the pressure compensator valve **PC** in the bucket service to partially close, reducing the size of the opening through which the oil must flow, and in this way maintains a pressure drop across the pressure compensator equal to the pressure drop across the bucket service spool.

In this example, because of the action of the pressure compensator valve the bucket service is always kept independent of the other services, the bucket ram speed remains constant (as controlled by the bucket service spool) and is not affected by the greater operating pressure in the boom service.

With Insufficient Flow from Pump

Should the oil flow demanded by the sum of the combined services operating ever exceed that of the pump, all the pressure compensator valves will partially close accordingly, effectively dividing the available flow between all the services proportionally.

In this condition the service ram with the highest load will NOT stop, because the speed of the other service rams operating will have been reduced proportionally by the action of the pressure compensator valves to compensate.

When one of the service spools is returned to neutral, the speed of the other service rams still operating will all increase proportionally.

⇒ *Table 1. Colour Key to Oil Flow and Pressure (L-281)*.

Removal and Replacement

⚠ WARNING

Make the machine safe before working underneath it. Park the machine on level ground, lower the attachments to the ground. Apply the park brake, put the transmission in neutral and stop the engine. Block both sides of all four wheels.

Disconnect the battery, to prevent the engine being started while you are beneath the machine.

GEN-4-1_1

Before commencing work, ensure that the exterior of the loader valve block and the working area are thoroughly cleaned and free of possible sources of contamination.

Removal

1 Vent the hydraulic services and pilot circuit accumulator hydraulic pressure:

Switch the starter to ON without starting the engine. Activate the joystick controls, operate the joysticks several times to vent the hydraulic pressure from the servo system and service rams. Turn the starter switch to the OFF position and remove the key.

Machines with Manual Spools: Operate the loader control levers back and forth several times to vent any residual hydraulic pressure.

2 Working beneath the machine, disconnect all the hydraulic hoses from the loader valve block. Label each hose before disconnecting to ensure correct replacement.

Plug the open ports and cap the hose ends to prevent loss of fluid and ingress of dirt. Put a suitable receptacle beneath the valve block to collect any hydraulic fluid spillage.

Machines with Manual Spools: Disconnect the control rod linkages from the ends of the spools.

⚠ WARNING

This component is heavy. It must only be removed or handled using a suitable lifting method and device.

BF-4-1_1

3 Remove the three securing nuts **A**, then carefully lift the valve block away from the resilient mounts **B**.

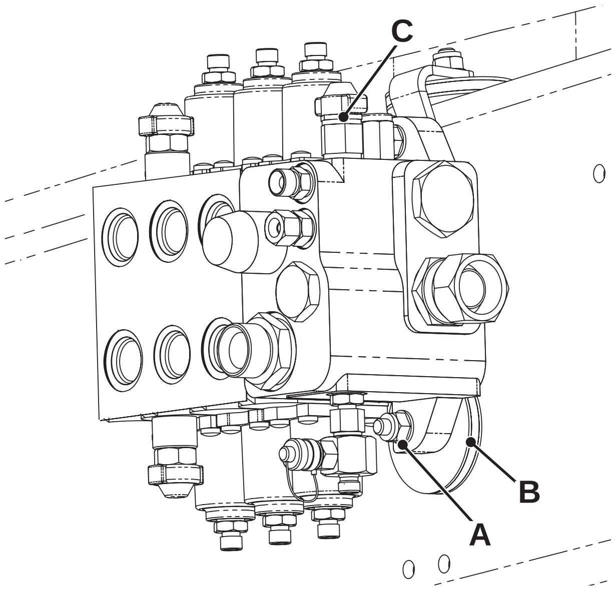


Fig 8. Typical Valve Shown

Replacement

Replacement is the reverse of the removal sequence, but note the following:

Inspect the resilient mounts **B** for damage, cracking etc. If the mounts are not in good condition, replace them with new ones.

Apply JCB Threadlocker and Sealer to the threads of nuts **A** before fitting.

Ensure the hoses are correctly installed, and phased in the same position as removal to prevent chafing.

On completion, run the engine and check for leaks.

If a new valve block has been fitted, check the pressure setting of the load sense relief valve (LSRV) **C**. Refer to the applicable machine ***SYSTEM - Service Procedures***.

Dismantle and Assemble

Valve Block Sections

⇨ *Fig 9. (L-285)* and ⇨ *Fig 10. (L-286)*. The valve block is a `sectional' type, which is made up of a number of separate sections. The illustration is intended as a guide to identifying the components.

Be sure to note the location of all components when dismantling. Although some components may appear to be identical they are not interchangeable. Make sure that components are assembled in their original positions.

Great care should be taken when dismantling and assembling a valve to avoid the following:

- **Contamination**
- **Damage to spools**
- **Damage to seal grooves**

Any of the above may result in possible problems with the operation of the valve.

Dismantle

1 Remove the valve block from the machine.

2 Remove the three tie rod nuts **1**.

3 Carefully separate and remove the end plate **2** followed by the remaining service sections **3**. If the inlet section **4** is to be replaced, remove and retain the tie rods **5**.

Assemble

Assembly is the reverse of the dismantling sequence but note the following:

Clean the valve components in an appropriate solvent. Ensure that the mating faces of the valve sections are thoroughly clean before assembly.

Renew the `O' rings located between the valve sections. Make sure the `O' ring seals are not trapped or damaged.

Check the Load Hold Check Valve `O' rings and replace if necessary. ⇨ ***Load Hold Check Valves (L-304)***.

Lubricate parts with JCB Hydraulic Fluid before assembling. Make sure that all the parts move freely.

If the tie rods **5** were unscrewed from the inlet section **4**, apply JCB Threadlocker and Sealer to the threads before refitting. Apply JCB Threadlocker and Sealer to the threads of nuts **1**.

Table 2. Torque Settings

Item	Nm	kgf m	lbf ft
1	35	3.6	25.8

Component Key:

1	Tie Rod Nuts
2	End Plate
3	Service Sections
4	Inlet - Outlet Section
5	Tie Rods
6	Load Hold Check Valves
7	Pressure Compensator Valves
8	Service Spool - Servo Operated
9	Service Spool - Manually Operated Electric Detent (PC3 Machines)
10	Service Spool - Manually Operated Mechanical Detent (PC3 Machines)
11	Flushing Valve
12	Load Sense Relief Valve
13	Flow Regulator Valve
14	Auxiliary Relief Valve (ARV)
15	Blanking Plug

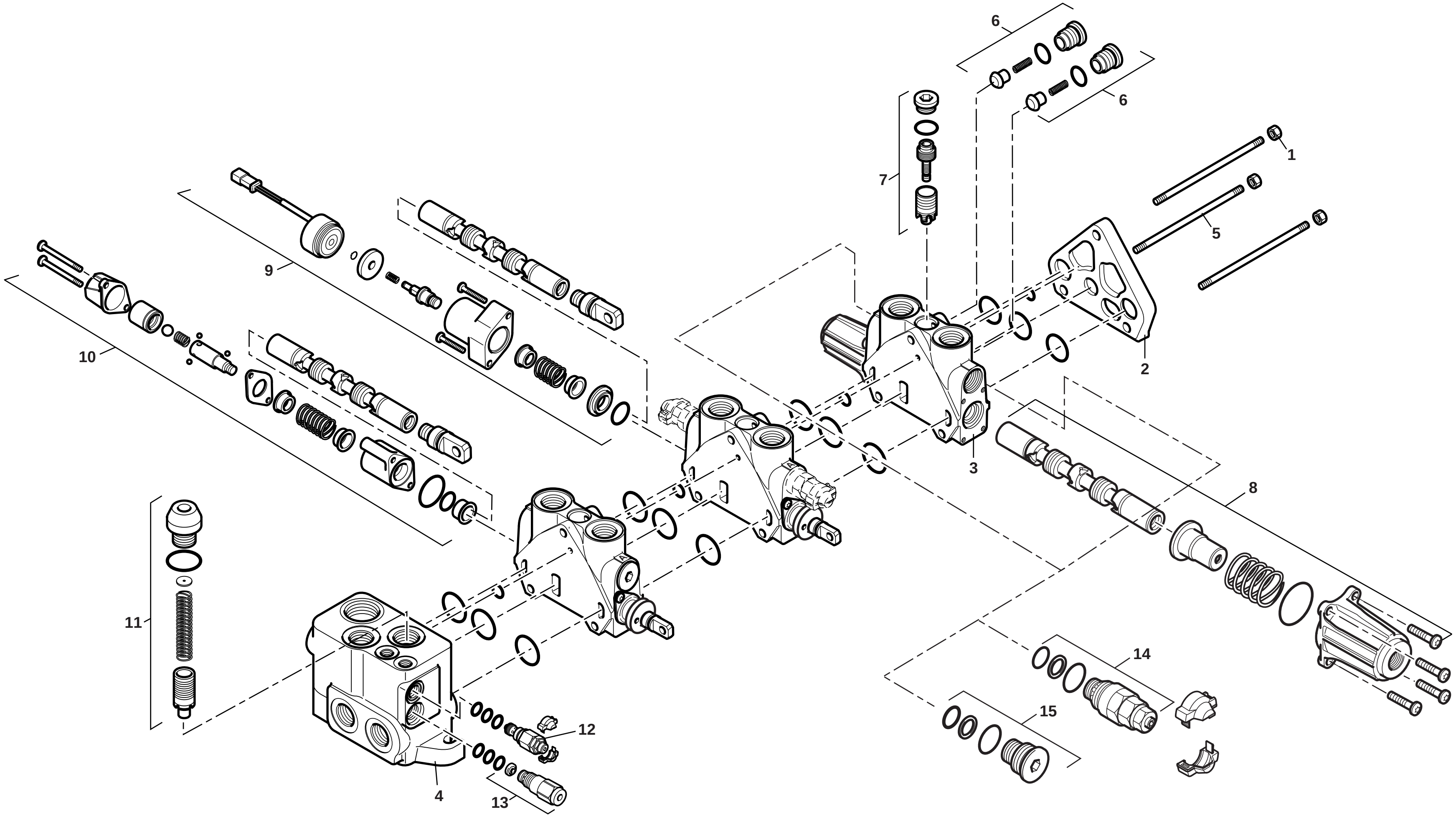


Fig 9. Valve Components (Precision Control Machines)

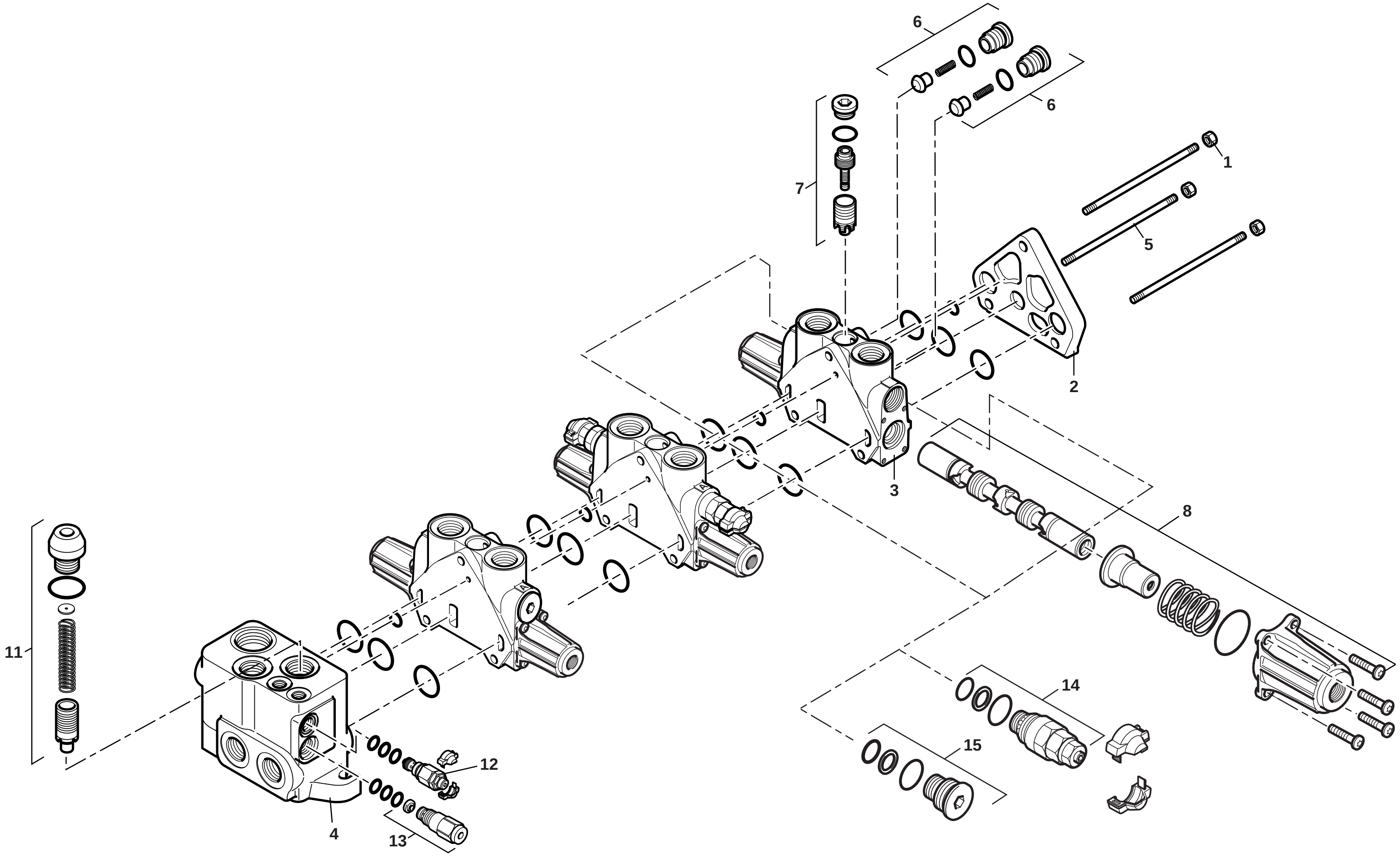


Fig 10. Valve Components (Advanced EasyControl Machines)

Servo Operated Spool

Removal

⇨ *Fig 11. (L-288)*. It is possible to remove a spool without removing the loader valve block from the machine. Working beneath the machine, it may be easier to remove the spool from the bottom as shown.

⚠ WARNING

Make the machine safe before working underneath it. Park the machine on level ground, lower the attachments to the ground. Apply the park brake, put the transmission in neutral and stop the engine. Block both sides of all four wheels.

Disconnect the battery, to prevent the engine being started while you are beneath the machine.

GEN-4-1_1

Before commencing work, ensure that the exterior of the valve block and the working area are thoroughly cleaned and free of possible sources of contamination.

1 Vent the hydraulic services and pilot circuit accumulator hydraulic pressure:

Switch the starter to ON without starting the engine. Activate the joystick controls, operate the joysticks several times to vent the hydraulic pressure from the servo system and service rams. Turn the starter switch to the OFF position and remove the key.

2 Gain access to the loader valve and disconnect and blank any hoses or pipes which may interfere with the removal of the spool.

3 Disconnect and blank the servo pilot hoses connected to the end caps **2** at each end of the spool.

4 Remove the screws **1** and carefully lift off the end cap **2**. Retrieve the spring **4** and spring retainer **5**, then withdraw the spool **6** from the valve body.

Note: *When removing 'O' Rings and seals, use an appropriately rounded tool that WILL NOT cause any damage to the seal grooves. Discard ALL 'O' Rings and back-up rings. DO NOT use worn or damaged items.*

Inspection

Inspect the valve components for scratches, pitting, corrosion or any other type of damage. Replace as necessary.

Assemble

Assembly is the reverse of the removal sequence but note the following:

Clean the valve components in an appropriate solvent.

Lubricate parts with JCB Hydraulic Fluid before assembling. Make sure that all the parts move freely.

Renew 'O' ring **3**.

Spool Orientation: The spool may have a ring **A** machined into it, which must be positioned downwards. ⇨ *Servo Spool Orientation (L-289)*.

Table 3. Torque Settings

Item	Nm	kgf m	lbf ft
1	10	1	7.4

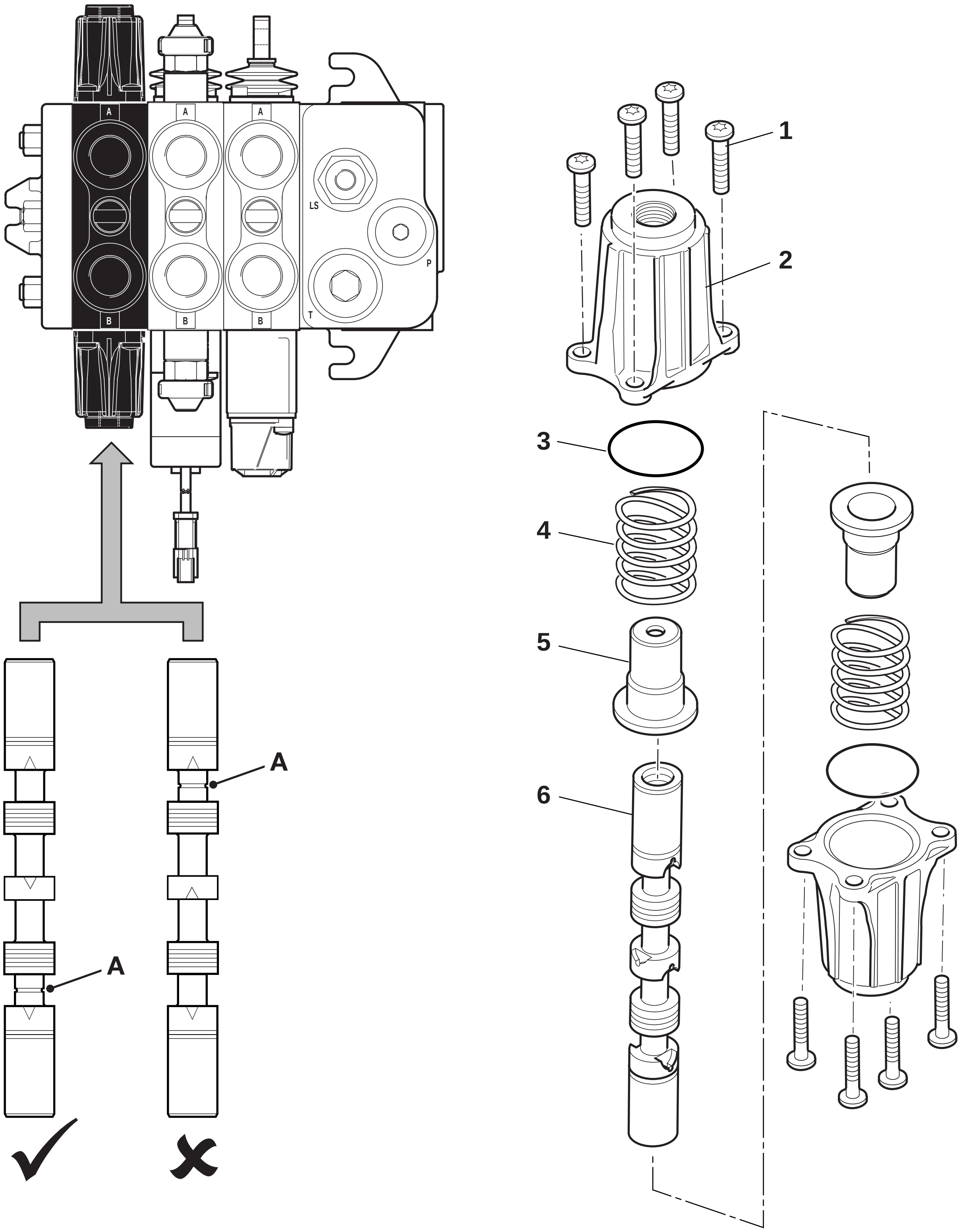


Fig 11. Servo Operated Spool

Servo Spool Orientation

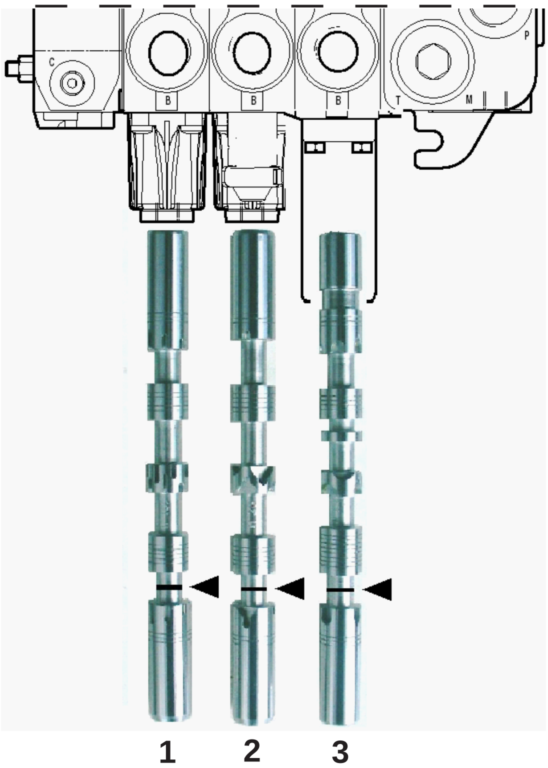


Fig 12.

The auxiliary, shovel and loader spools have rings machined in them which must be positioned downwards.

Important: *The spools are very different and must be replaced in their original sections. Failure to do so will result in problems with the operation of the valve.*

Component Key:

1 Auxiliary spool

2 Shovel spool

3 Loader spool

Manually Operated - Electric Detent Spool

Removal

⇨ Fig 13. (L-291). It is possible to remove a spool without removing the loader valve block from the machine. The centring spring **15** is at the bottom, so the spool must be removed from the bottom.

⚠ WARNING

Make the machine safe before working underneath it. Park the machine on level ground, lower the attachments to the ground. Apply the park brake, put the transmission in neutral and stop the engine. Block both sides of all four wheels.

Disconnect the battery, to prevent the engine being started while you are beneath the machine.

GEN-4-1_1

1 Vent the hydraulic services and pilot circuit accumulator hydraulic pressure:

Switch the starter to ON without starting the engine. Activate the joystick controls, operate the joysticks and loader lever controls several times to vent the hydraulic pressure from the servo system and service rams. Turn the starter switch to the OFF position and remove the key.

2 Gain access to the loader valve and disconnect and blank any hoses or pipes which may interfere with the removal of the spool.

3 Disconnect the control rod linkage from the spool tongue.

4 Remove the screws **1**, boot **2** and plate **3**.

5 Unscrew the solenoid **6** from the housing **8**. Remove the screws **7**, housing **8** and carefully withdraw the spool assembly from the valve body.

Dismantle

1 Hold the spool assembly in a vice using a spool clamp (refer to ***Service Tools***) as shown at **A**.

2 Remove the circlip **10**, disc **11** and spring **12**.

3 Unscrew the spool end **13** and remove the centring spring **15** with spring retainers **14** and **16**. It may be necessary to pre-heat the spool to 200° C in an oven or with a heat gun to remove the spool end.

Note: *When removing 'O' Rings and seals, use an appropriately rounded tool that WILL NOT cause any damage to the seal grooves. Discard ALL 'O' Rings and back-up rings. DO NOT use worn or damaged items.*

Inspection

Inspect the valve components for scratches, pitting, corrosion or any other type of damage. Replace as necessary.

Assemble

Assembly is the reverse of the removal sequence but note the following:

Clean the valve components in an appropriate solvent.

Lubricate parts with JCB Hydraulic Fluid before assembling. Make sure that all the parts move freely.

Renew lip seal **4** and 'O' rings **5** and **18**. ⇨ Renewing the Valve Spool Seals (L-292).

Table 4. Torque Settings

Item	Nm	kgf m	lbf ft
1	10	1	7.4
7	10	1	7.4
13	10	1	7.4
19	10	1	7.4

Tongue Replacement (if necessary)

1 Hold the spool assembly in a vice using a spool clamp (refer to ***Service Tools***).

2 Loosen the tongue **19** with an open ended wrench as shown at **B**. It may be necessary to pre-heat the spool to 200° C in an oven or with a heat gun to dismantle the spool.

Important: *DO NOT use a welding torch to heat the tongue as deformation of the spool may result.*

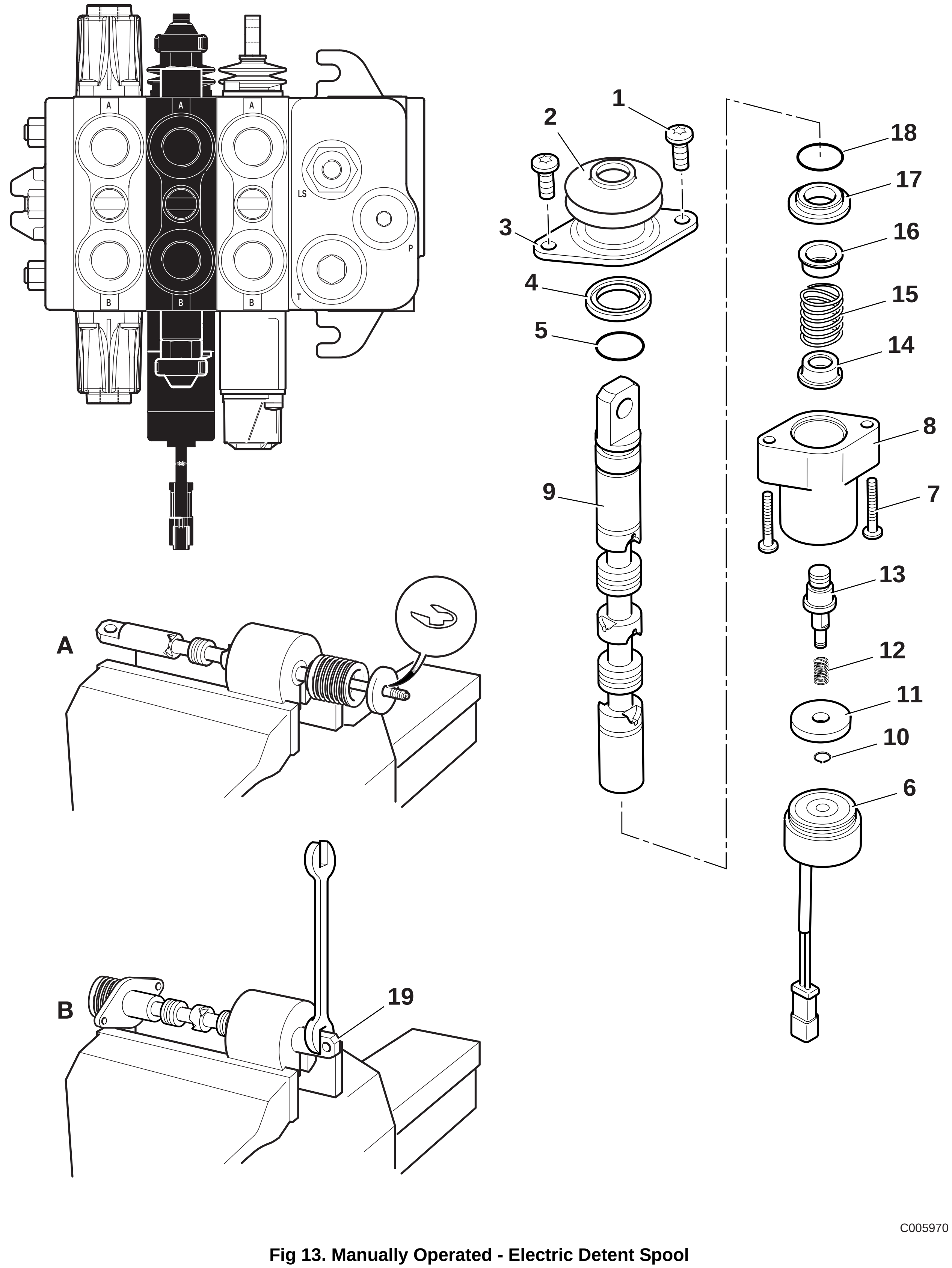


Fig 13. Manually Operated - Electric Detent Spool

Renewing the Valve Spool Seals

Note that the procedure described below is applicable for manually operated spools only.

1 ⇨ *Fig 14. (L-292)*. Lubricate the spool **1**, bore and seal groove with JCB Hydraulic Fluid. Move the spool to position A and then install the seal **2** in its groove.

Note: *The seal MUST be fitted carefully onto the end of the spool to ensure that it is not damaged by the spool lands and that its tightness property does not deteriate. The metal part of the seal should be on the outside.*

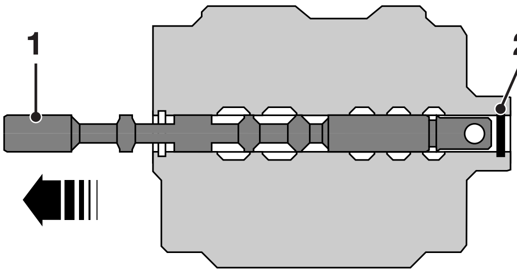


Fig 14. Position A

2 ⇨ *Fig 15. (L-292)*. Move the spool to position B and then install the seal **3**. It is important to note that the spool must not be moved beyond position B, otherwise the edge of the spool (face **D**) may damage the seal fitted first (item **2**).

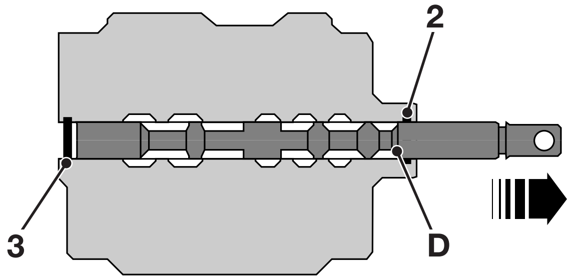


Fig 15. Position B

3 ⇨ *Fig 16. (L-292)*. Position the spool in its central position C. Reassemble the spool centering spring mechanism.

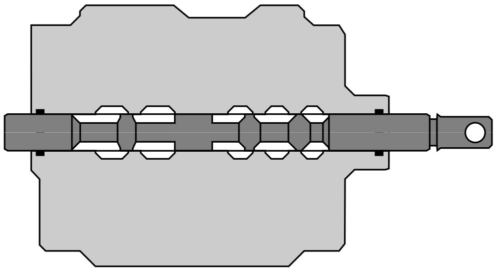


Fig 16. Position C

Manually Operated - Mechanical Detent Spool

Removal

Fig 17. (L-295). It is possible to remove a spool without removing the loader valve block from the machine. The centring spring **16** is at the bottom, so the spool must be removed from the bottom.

WARNING

Make the machine safe before working underneath it. Park the machine on level ground, lower the attachments to the ground. Apply the park brake, put the transmission in neutral and stop the engine. Block both sides of all four wheels.

Disconnect the battery, to prevent the engine being started while you are beneath the machine.

GEN-4-1_1

1 Vent the hydraulic services and pilot circuit accumulator hydraulic pressure:

Switch the starter to ON without starting the engine. Activate the joystick controls, operate the joysticks and loader lever controls several times to vent the hydraulic pressure from the servo system and service rams. Turn the starter switch to the OFF position and remove the key.

2 Gain access to the loader valve and disconnect and blank any hoses or pipes which may interfere with the removal of the spool.

3 Disconnect the control rod linkage from the spool tongue.

4 Remove the screws **1**, boot **2** and plate **3**.

5 Remove the screws **6**, cover **7** and carefully withdraw the spool assembly from the valve body.

Dismantle

1 Hold the spool assembly in a vice using a spool clamp (refer to ***Service Tools***) as shown at **A**.

2 Use a metal rod (min. length 80 mm x 6 mm diameter) to push on the central ball **10** while extracting the detent bush **9** as shown. Mark the orientation of the bush to ensure that it is fitted the correct way round on re-assembly.

3 Carefully remove the balls **10** and **12**, and the spring **11**.

4 Unscrew the spool end **13** and remove the centring spring **16** with spring retainers **15** and **17**. It may be necessary to pre-heat the spool to 200° C in an oven or with a heat gun to remove the spool end.

Note: *When removing 'O' Rings and seals, use an appropriately rounded tool that WILL NOT cause any damage to the seal grooves. Discard ALL 'O' Rings and back-up rings. DO NOT use worn or damaged items.*

Inspection

Inspect the valve components for scratches, pitting, corrosion or any other type of damage. Replace as necessary.

Assemble

Assembly is the reverse of the removal sequence but note the following:

Clean the valve components in an appropriate solvent.

Lubricate parts with JCB Hydraulic Fluid before assembling. Make sure that all the parts move freely.

Renew lip seal **4** and 'O' rings **5**, **19** and **20**. *Renewing the Valve Spool Seals (L-292)*.

Table 5. Torque Settings

Item	Nm	kgf m	lbf ft
1	10	1	7.4
6	10	1	7.4
13	10	1	7.4
22	10	1	7.4

Tongue Replacement (if necessary)

1 Hold the spool assembly in a vice using a spool clamp (refer to ***Service Tools***).

2 Loosen the tongue **22** with an open ended wrench as shown at **B**. It may be necessary to pre-heat the spool to 200° C in an oven or with a heat gun to dismantle the spool.

***Important:** DO NOT use a welding torch to heat the tongue as deformation of the spool may result.*

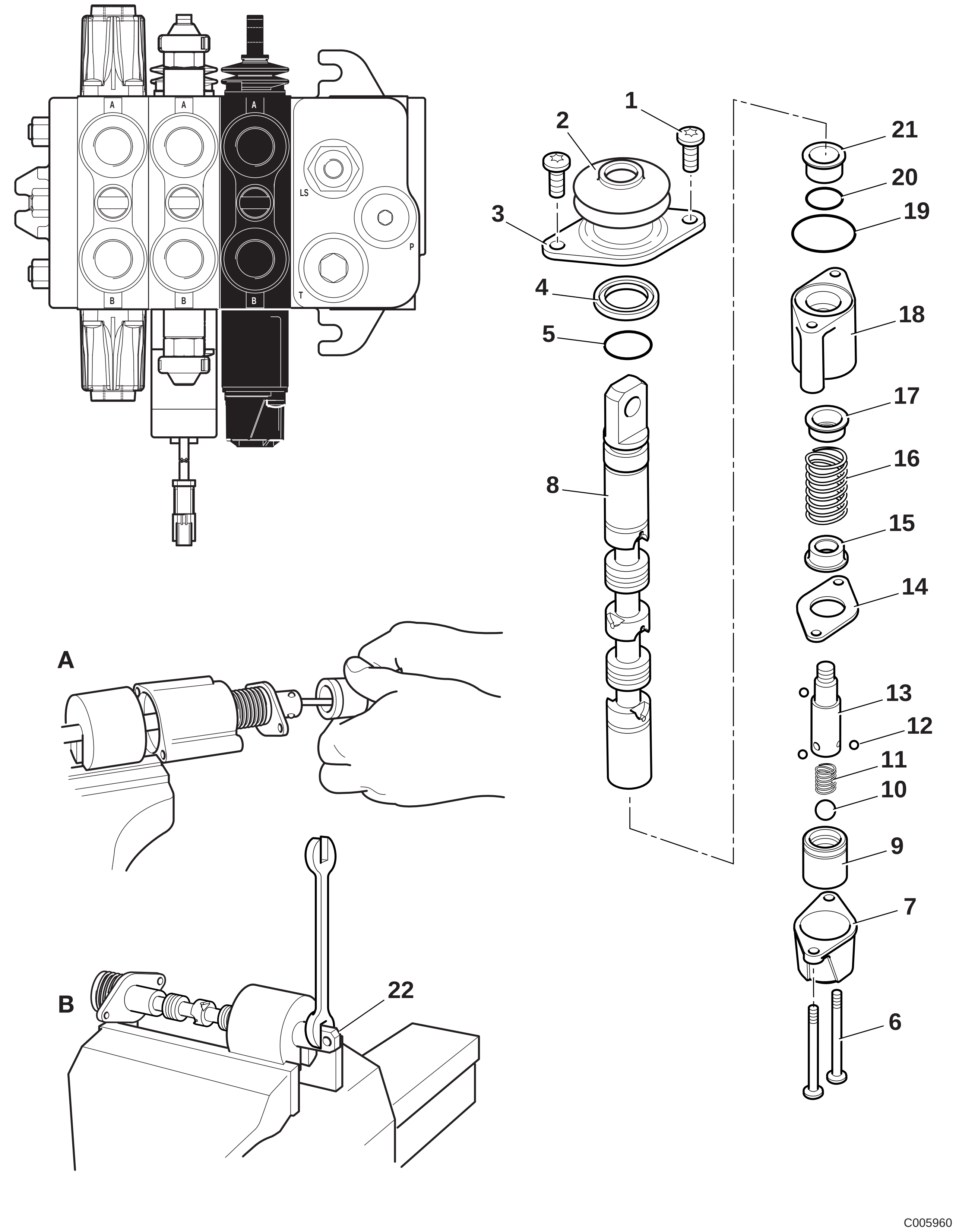


Fig 17. Manually Operated - Mechanical Detent Spool

Load Sense Relief Valve

⇨ *Fig 18. (L-297)*.

Removal

It is possible to remove a valve without removing the valve block from the machine.

⚠ WARNING

Make the machine safe before working underneath it. Park the machine on level ground, lower the attachments to the ground. Apply the park brake, put the transmission in neutral and stop the engine. Block both sides of all four wheels.

Disconnect the battery, to prevent the engine being started while you are beneath the machine.

GEN-4-1_1

1 Vent the hydraulic services and pilot circuit accumulator hydraulic pressure:

Switch the starter to ON without starting the engine. Activate the joystick controls, operate the joysticks several times to vent the hydraulic pressure from the servo system and service rams. Turn the starter switch to the OFF position and remove the key.

2 Gain access to the valve and disconnect and blank any hoses or pipes which may interfere with the removal of the load sense relief valve.

3 Unscrew the load sense relief valve from the valve block. Cover the ports to prevent the ingress of dirt and remove to a clean working area.

Dismantle

1 Loosen locknut **1**, unscrew and remove adjuster nut **2** and adjuster screw **3**.

2 Carefully remove spring **4** and poppet **5** from valve body.

Note: *When removing 'O' Rings and seals, use an appropriately rounded tool that WILL NOT cause any damage to the seal grooves. Discard ALL 'O' Rings and back-up rings. DO NOT use worn or damaged items.*

Inspection

Inspect the valve components for scratches, pitting, corrosion or any other type of damage.

Note: *If any part other than `O' rings are damaged the entire valve must be renewed.*

Assemble

Assembly is the reverse of the dismantling sequence but note the following:

Clean the valve components in an appropriate solvent.

Lubricate parts with JCB Hydraulic Fluid before assembling. Make sure that all the parts move freely.

Renew all 'O' rings and back-up rings.

Adjust the pressure setting as required. Refer to the applicable machine ***SYSTEM - Service Procedures***.

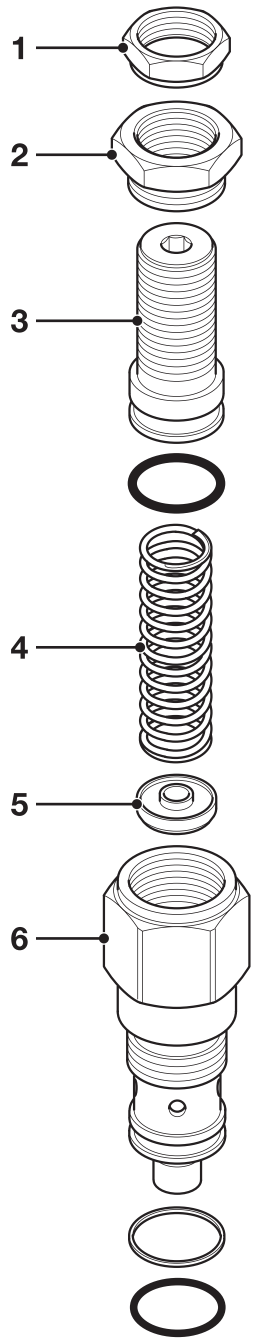


Fig 18. Load Sense Relief Valve

Table 6. Torque Settings

Item	Nm	kgf m	lbf ft
6	45	4.6	33.2

External Auxiliary Relief Valves (ARV's)

Removal

⇨ *Fig 19. (L-299)*. It is possible to remove an external auxiliary relief valve without removing the valve block from the machine.

⚠ WARNING

Make the machine safe before working underneath it. Park the machine on level ground, lower the attachments to the ground. Apply the park brake, put the transmission in neutral and stop the engine. Block both sides of all four wheels.

Disconnect the battery, to prevent the engine being started while you are beneath the machine.

GEN-4-1_1

1 Vent the hydraulic services and pilot circuit accumulator hydraulic pressure:

Switch the starter to ON without starting the engine. Activate the joystick controls, operate the joysticks several times to vent the hydraulic pressure from the servo system and service rams. Turn the starter switch to the OFF position and remove the key.

2 Gain access to the valve and disconnect and blank any hoses or pipes which may interfere with the removal of the auxiliary relief valve(s).

3 Unscrew the auxiliary relief valve(s) from the valve block. Cover the ports to prevent the ingress of dirt and remove to a clean working area.

Dismantle

1 Prise off plastic locking cap.

2 Loosen locknut **1** and remove adjuster screw **2**.

3 Carefully remove spring **3** and poppet **4**.

4 Unscrew upper valve body **5** and remove springs **6** and piston **7**.

Note: *When removing 'O' Rings and seals, use an appropriately rounded tool that WILL NOT cause any damage to the seal grooves. Discard ALL 'O' Rings and back-up rings. DO NOT use worn or damaged items.*

Inspection

Inspect the valve components for scratches, pitting, corrosion or any other type of damage.

Note: *If any part other than `O' rings are damaged the entire valve must be renewed.*

Assemble

Assembly is the reverse of the dismantling sequence but note the following:

Important: *The ARV's appear identical but have various pressure settings.* ⇨ ***Specifications (L-278)****. Ensure that they are correctly adjusted and fitted in their specified positions.*

Clean the valve components in an appropriate solvent.

Lubricate parts with JCB Hydraulic Fluid before assembling. Make sure that all the parts move freely.

Renew all 'O' rings and back-up rings.

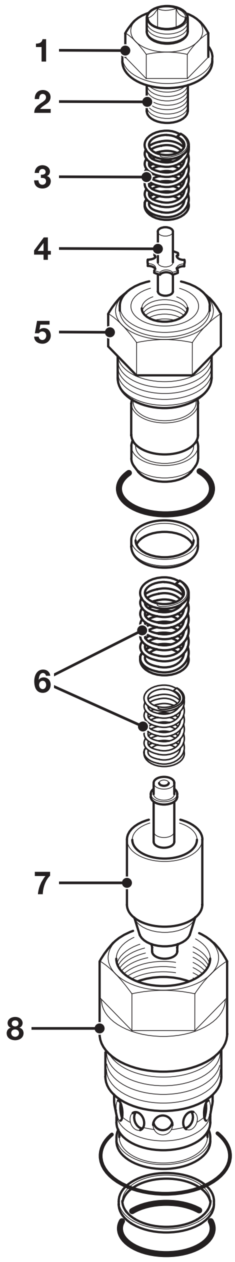


Fig 19. Auxiliary Relief Valve - External Type

Table 7. Torque Settings

Item	Nm	kgf m	lbf ft
8	70	7.1	51.6

Internal Auxiliary Relief Valves (ARV's) - if fitted

The internal auxiliary relief valves are accessible through the loader valve service ports. It may be possible to remove an auxiliary relief valve without removing the valve block from the machine.

WARNING

Make the machine safe before working underneath it. Park the machine on level ground, lower the attachments to the ground. Apply the park brake, put the transmission in neutral and stop the engine. Block both sides of all four wheels.

Disconnect the battery, to prevent the engine being started while you are beneath the machine.

GEN-4-1_1

Before commencing work, ensure that the exterior of the valve block and the working area are thoroughly cleaned and free of possible sources of contamination.

Removal

1 Vent the hydraulic services and pilot circuit accumulator hydraulic pressure:

Switch the starter to ON without starting the engine. Activate the joystick controls, operate the joysticks several times to vent the hydraulic pressure from the servo system and service rams. Turn the starter switch to the OFF position and remove the key.

2 Gain access to the valve block, and disconnect and blank any hoses or pipes which may interfere with the removal of the auxiliary relief valve(s).

3 Unscrew and remove the adaptor **1** from the applicable service port.

4 Unscrew the auxiliary relief valve **2** from the valve block section. Cover the ports to prevent the ingress of dirt and remove to a clean working area.

Inspection

Inspect the valve components for scratches, pitting, corrosion or any other type of damage.

Note: *If any part other than `O' rings are damaged the entire valve must be renewed.*

Replacement

Replacement is the reverse of the removal sequence, but note the following:

Important: *The internal ARV's appear identical but have various pressure settings.* ***⇒ Specifications (L-278)***.

The internal ARV's are factory set and cannot be adjusted. Ensure that they are refitted in their specified positions.

Clean the valve components in an appropriate solvent.

Lubricate parts with JCB Hydraulic Fluid before assembling. Make sure that all the parts move freely.

Renew all `O' rings and back-up rings.

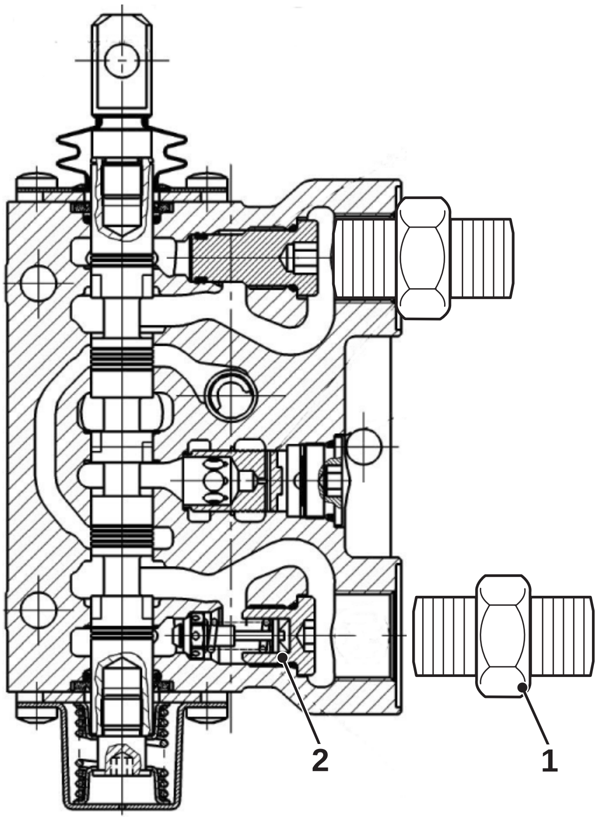


Fig 20. Typical Valve Block - Sectioned View

Table 8. Torque Settings

Item	Nm	kgf m	lbf ft
2	30 - 35	3 - 3.5	22 - 26

Flow Regulator Valve

⇨ *Fig 21. (L-302)*.

Removal

It is possible to remove a valve without removing the valve block from the machine.

WARNING

Make the machine safe before working underneath it. Park the machine on level ground, lower the attachments to the ground. Apply the park brake, put the transmission in neutral and stop the engine. Block both sides of all four wheels.

Disconnect the battery, to prevent the engine being started while you are beneath the machine.

GEN-4-1_1

1 Vent the hydraulic services and pilot circuit accumulator hydraulic pressure:

Switch the starter to ON without starting the engine. Activate the joystick controls, operate the joysticks several times to vent the hydraulic pressure from the servo system and service rams. Turn the starter switch to the OFF position and remove the key.

2 Gain access to the valve and disconnect and blank any hoses or pipes which may interfere with the removal of the flow regulator valve.

3 Unscrew the flow regulator valve from the valve block. Cover the ports to prevent the ingress of dirt and remove to a clean working area.

Dismantle

1 Unscrew and remove top plug **1**.

2 Carefully remove shims **2**, spring **3** and piston **4**.

Note: *When removing 'O' Rings and seals, use an appropriately rounded tool that WILL NOT cause any damage to the seal grooves. Discard ALL 'O' Rings and back-up rings. DO NOT use worn or damaged items.*

Inspection

1 Inspect the valve components for scratches, pitting, corrosion or any other type of damage.

2 Clean the filter gauze **5** fitted in the end of the valve body.

Note: *If any part other than `O' rings are damaged the entire valve must be renewed.*

Assemble

Assembly is the reverse of the dismantling sequence but note the following:

Clean the valve components in an appropriate solvent.

Lubricate parts with JCB Hydraulic Fluid before assembling. Make sure that all the parts move freely.

Renew all 'O' rings and back-up rings.

Be sure to fit filter gauze **5** the correct way round.

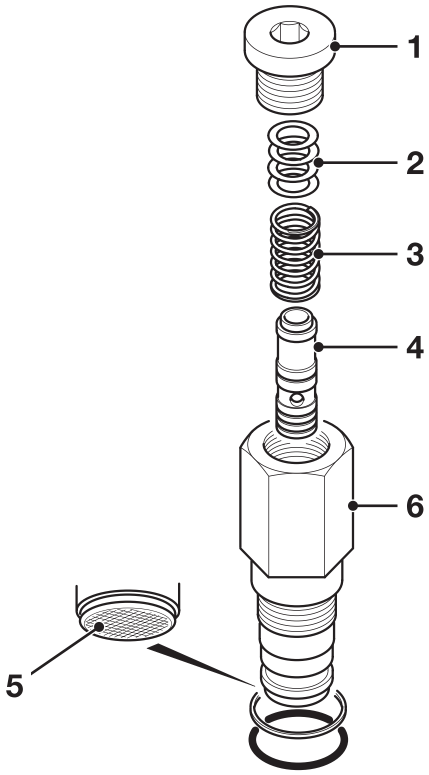


Fig 21. Flow Regulator Valve

Table 9. Torque Settings

Item	Nm	kgf m	lbf ft
6	20	2	14.8

Pressure Compensator Valves

Removal

WARNING

Make the machine safe before working underneath it. Park the machine on level ground, lower the attachments to the ground. Apply the park brake, put the transmission in neutral and stop the engine. Block both sides of all four wheels.

Disconnect the battery, to prevent the engine being started while you are beneath the machine.

GEN-4-1_1

1 To gain access to the pressure compensator valves, remove the middle tie rod from the hole **A** (leaving the valve block sections held together with the remaining two tie rods).

In order to remove the middle tie rod, it may be necessary to undo the valve block securing nuts, and pull the valve block away from the chassis.

2 Use an 8mm Allen key to remove the compensator plug **1**.

3 Use a magnet to extract the compensator valve **2** from its bore.

4 Inspect the valve components for scratches, pitting, corrosion or any other type of damage. Replace as necessary.

Replacement

Replacement is the reverse of the removal sequence but note the following:

Clean the valve components in an appropriate solvent.

Lubricate parts with JCB Hydraulic Fluid before assembling. Make sure that all the parts move freely.

Renew all 'O' rings and back-up rings.

Apply JCB Threadlocker and Sealer to the threads of the tie rod, and tie rod nut before fitting.

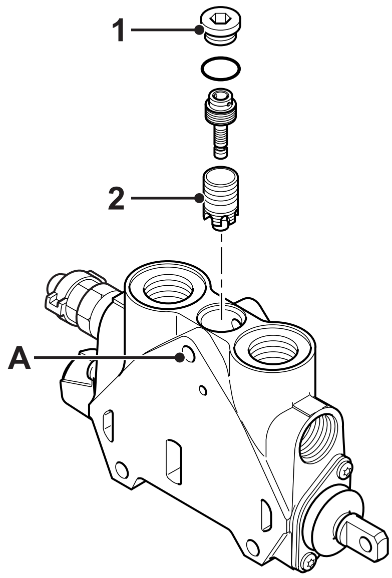


Fig 22.

Table 10. Torque Settings

Item	Nm	kgf m	lbf ft
1	60	6.1	44.3

Load Hold Check Valves

Removal

WARNING

Make the machine safe before working underneath it. Park the machine on level ground, lower the attachments to the ground. Apply the park brake, put the transmission in neutral and stop the engine. Block both sides of all four wheels.

Disconnect the battery, to prevent the engine being started while you are beneath the machine.

GEN-4-1_1

1 Remove the valve block from the machine.

2 To gain access to the load hold check valves, separate the valve block sections. ⇒ ***Valve Block Sections (L-284)***.

3 Use an Allen key to remove the load hold check valve plug **1**.

4 Remove spring **2** and poppet **3**.

5 Inspect the valve components for scratches, pitting, corrosion or any other type of damage. Ensure good condition of seating faces on poppets **3**, and on the mating faces in the valve block. Replace as necessary.

Replacement

Replacement is the reverse of the removal sequence but note the following:

Clean the valve components in an appropriate solvent.

Lubricate parts with JCB Hydraulic Fluid before assembling. Make sure that all the parts move freely.

Renew all 'O' rings and back-up rings.

Carefully assemble the valve block sections. ⇒ ***Valve Block Sections (L-284)***.

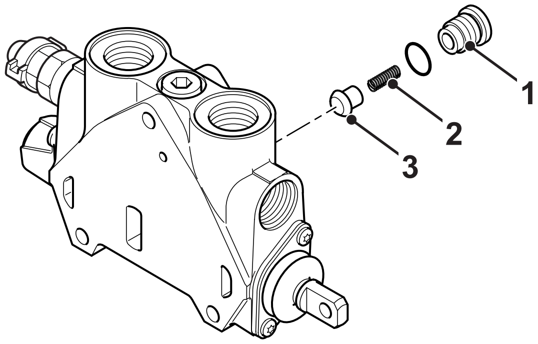


Fig 23.

Table 11. Torque Settings

Item	Nm	kgf m	lbf ft
1	30	3	22.1

Loader Valve (Monoblock Type)

Introduction

This topic contains information about a machine DEVICE. Make sure you are referring to the correct device.

This topic is intended to help you understand what the device does and how it works. Where applicable it also includes procedures such as removal and replacement and dismantle and assemble.

Specifications

Model Reference:	6650C		
Relief Valve Settings:	**bar**	**kgf/cm²**	**lbf/in²**
Shovel Ram Head Side (ARV) (1)	172	175	2500
Shovel Ram Rod Side (ARV)	310	316	4500
Main Relief Valve (MRV)	252	257	3650
Unloader Valve	227	231	3300
Weight:	43 kg (95 lbs)		

(1) *All the auxiliary relief valves (ARV's) are factory set. If a relief valve is suspected as being faulty it must be renewed as a complete assembly.*

Component Key: ⇒ *Fig 1. (L-307)*

1	Auxiliary service	**8**	Load hold check valve
2	Shovel service	**9**	Main relief valve (MRV)
3	Arms lift service	**10**	Unloader valve
4	Auxiliary relief valve	**11**	Tank port
5	Service ports	**12**	High pressure carryover port (HPCO)
6	Inlet port (P1 pump)	**13**	Unloader solenoid
7	Inlet port (P2 pump)		

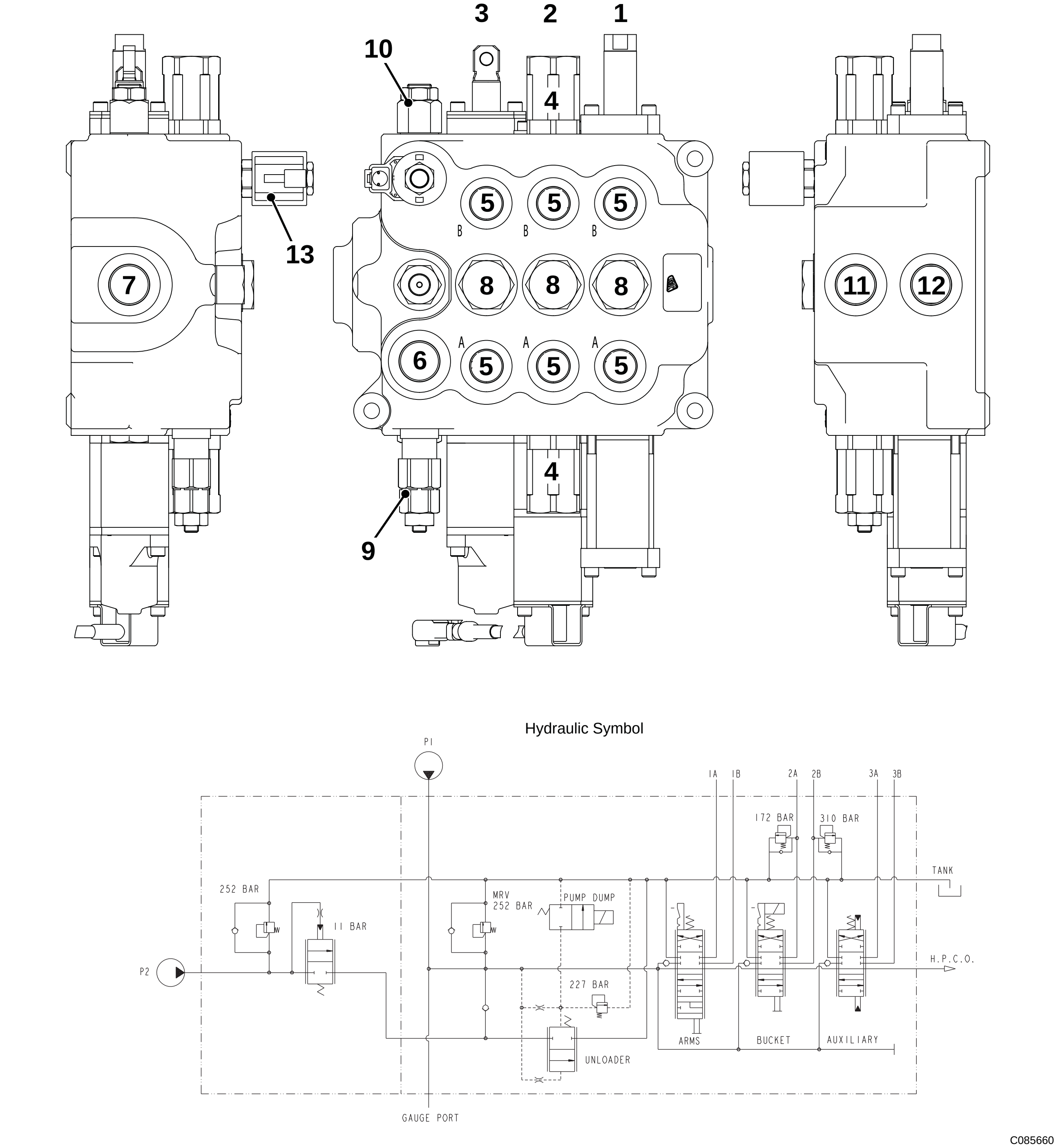

3
2
1
10
4
5
B
13
7
8
11
12
6
A
9
Hydraulic Symbol
P1
1A
1B
2A
2B
3A
3B
172 BAR
310 BAR
TANK
252 BAR
MRV
252 BAR
PUMP DUMP
11 BAR
P2
H.P.C.O.
227 BAR
ARMS
BUCKET
AUXILIARY
UNLOADER
GAUGE PORT
C085660

Fig 1.

Descriptions

Loader Valve Services

The loader valve may have both manually operated and servo pilot operated spools **1** depending on the machine variant. The valve spools are of a open-centre design.

With the spools **1** in the neutral position, the oil from the hydraulic pump(s) flows through the valve block neutral gallery **N** (around the central waist of the spool) and eventually back to tank.

When a service is selected, the spool **1** moves against the force of the centering spring **2**, allowing oil to flow out of one of the service ports (either **A** or **B**) to move the applicable service ram. When the service is de-selected, the centering spring **2** returns the spool to the neutral position.

The load hold check valve **3** prevents the load falling back if the load pressure is greater than the pump pressure.

The open-centre design means that the hydraulic services are connected in parallel.

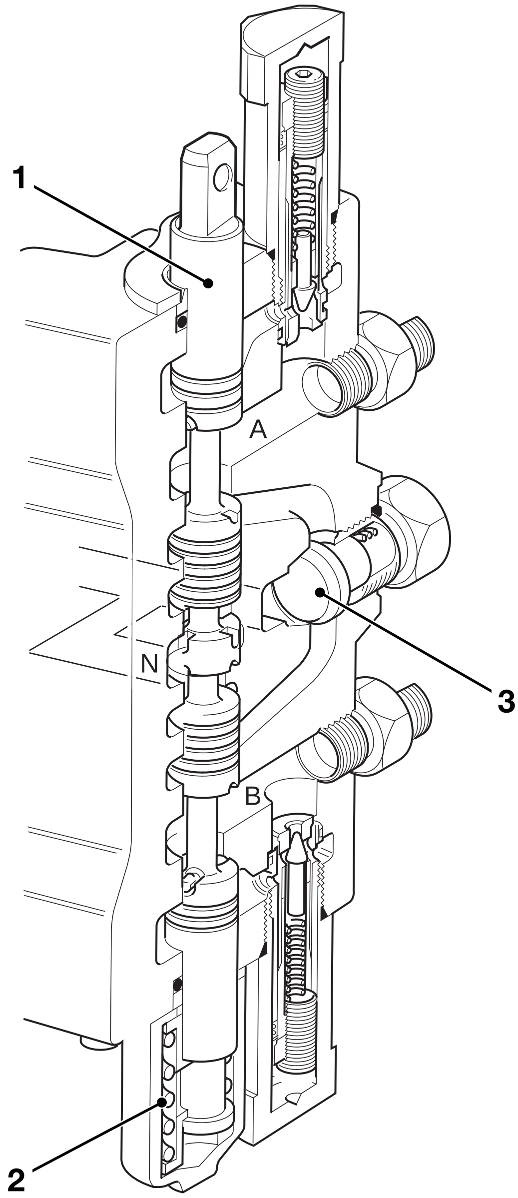


Fig 2. Manually operated spool shown

Unloader Operation

The unloader operates in the same way as standard non-servo machines described in Section E. See ***Section E, Hydraulics - Circuit Descriptions***.

Removal and Replacement

The procedures are similar to those used for standard non-servo machines described in section E. See ***Section E, Hydraulics - Loader Valve***.

Dismantle and Assemble

The procedures are similar to those used for standard non-servo machines described in section E. See ***Section E, Hydraulics - Loader Valve***.

Excavator Valve (Sectional Type)

Introduction

This topic contains information about a machine DEVICE. Make sure you are referring to the correct device.

This topic is intended to help you understand what the device does and how it works. Where applicable it also includes procedures such as removal and replacement and dismantle and assemble.

Specifications

Model Reference:	SX14		
Relief Valve Settings:	**bar**	**kgf/cm²**	**lbf/in²**
Boom Ram Head Side (ARV) (1)	262 - 269	267 - 274	3800 - 3900
Boom Ram Rod Side (ARV)	345 - 352	351 - 358	5000 - 5100
Bucket Ram Head Side (ARV) (2)	262 - 269	267 - 274	3800 - 3900
Bucket Ram Rod Side (Rockbreaker option only) (2)	270 - 273 (3)	275 - 278	3900 - 3950
Dipper Ram Head Side (ARV) (2)	262 - 269	267 - 274	3800 - 3900
Dipper Ram Rod Side (ARV) (2)	262 - 269	267 - 274	3800 - 3900
Slew Left and Right (ARV)	262 - 269	267 - 274	3800 - 3900
Extending Dipper Ram Head Side (ARV)	140 - 148	143 - 150	2050 - 2150
Extending Dipper Ram Rod Side (ARV)	210 - 218	214 - 222	3050 - 3150
Weight:	TBA kg (TBA lbs)		

(1) *All the auxiliary relief valves (ARV's) are factory set. The external type ARV's (item 8 and 8a) are sealed with a plastic tamper proof cap. The internal type ARV's (inside the service ports) cannot be adjusted. If a relief valve is suspected as being faulty it must be renewed as a complete assembly.*
(2) *Internal type ARV from machine serial no. 975547.*
(3) *Was 255 - 258 bar (external type ARV) on machines upto serial no. 975546.*

Component Key: ⇒ *Fig 3. (L-314)* and ⇒ *Fig 4. (L-314)*

1	Auxiliary service	**8a**	Auxiliary relief valve (Rockbreaker option - if fitted)
2	Bucket service	**9**	Service ports
3	Dipper service	**10**	Load sense port
4	Stabiliser service	**11**	Hydraclamp port (Sideshift)
5	Stabiliser service	**12**	Hydraclamp solenoid (Sideshift)
6	Boom service	**13**	Inlet port
7	Slew service	**14**	Tank port
8	Auxiliary relief valve - External type		

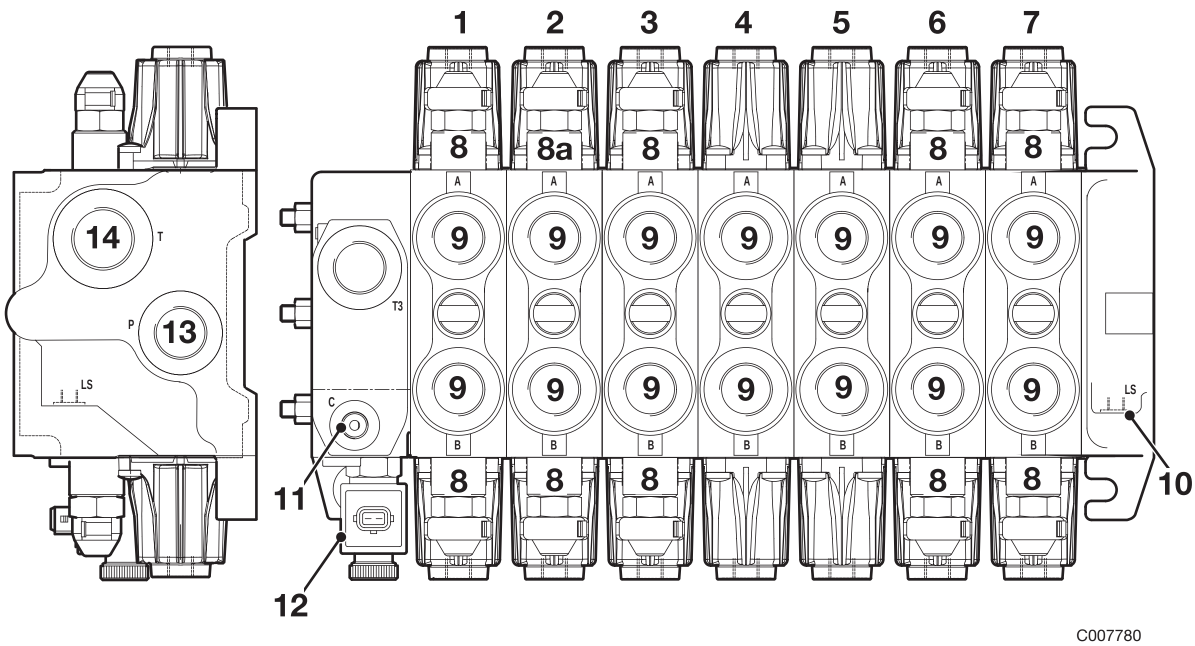


Fig 3. Machines upto serial no. 975546

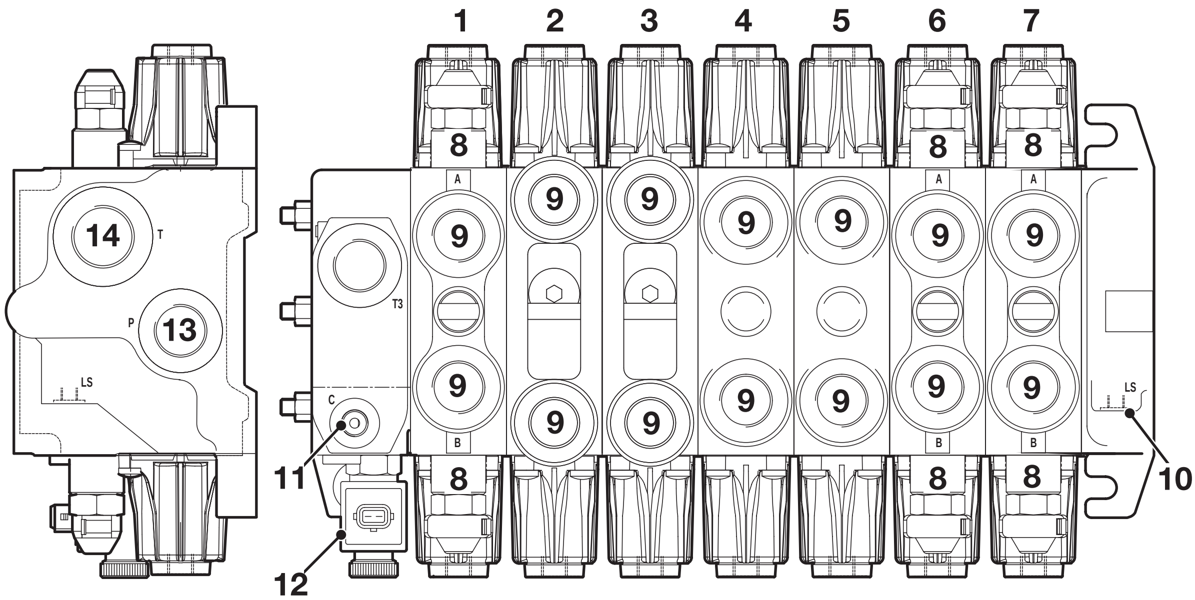


Fig 4. Machines from serial no. 975547

Descriptions

Excavator Valve Services

The excavator valve has servo pilot operated spools **1**. The valve spools are of a closed-centre design, and incorporate pressure compensator valves **PC** for each service.

Note: *Pressure compensator valves are not fitted at the excavator valve stabiliser spools on Advanced EasyControl machines, or on Precision Control machines from October 2005.*

With the spools **1** in the neutral position, the oil from the hydraulic pump(s) enters the valve block inlet gallery **P** and is dead-ended by the central land of the spool.

When a service is selected, the spool **1** moves against the force of the centering spring **2**, allowing oil to flow out of one of the service ports (either **A** or **B**) to move the applicable service ram. When the service is de-selected, the centering spring **2** returns the spool to the neutral position.

When multiple services are selected simultaneously, the pressure compensator valves **PC** sense which service is generating the highest load pressure. This allows the pump operating pressure to adjust to a value sufficient to operate the ram with the highest load. The load hold check valves **3** prevent the load falling back if the load pressure is greater than the pump pressure.

The closed-centre design means that the hydraulic services are not connected in parallel, which ensures consistent service operation regardless of load.

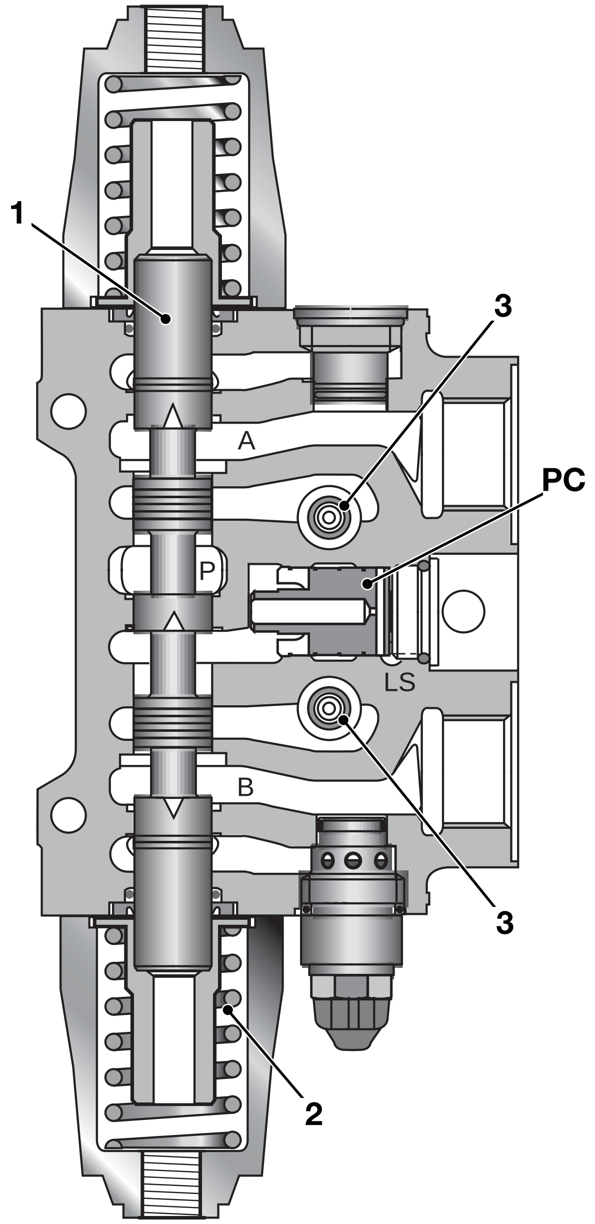


Fig 5.

Pressure Compensator Valves Operation

Operating an Individual Service

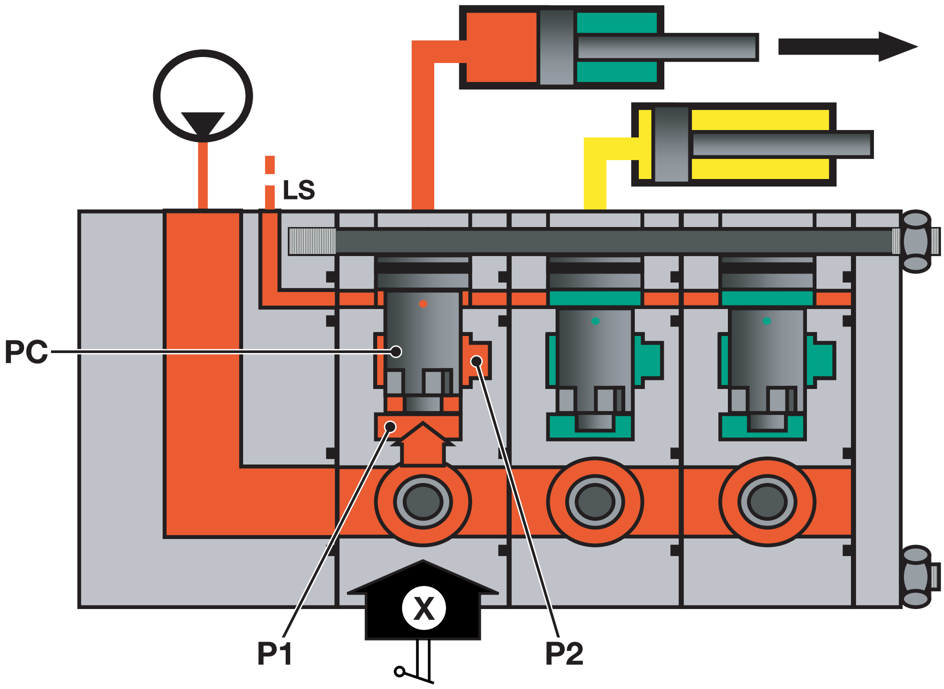


Fig 6.

It must be noted that the load sense gallery **LS** is connected to all the pressure compensator valves **PC** (one for each service) as shown in ⇒ *Fig 6. (L-316)*. The pressure in the load sense gallery **LS** will always be equal to the highest load from any of the services.

The pressure compensator valves are fitted between each service spool and service ram, and sense the pressure acting on either side of the particular service spool. The pressure compensator valve will move in response to the pressure drop (pressure differential) created across the spool.

When one service only is operated **X**, the pressure compensator valve **PC** is FULLY opened as shown, connecting the gallery **P1** to gallery **P2** and to the ram service port without any pressure drop.

Table 1. Colour Key to Oil Flow and Pressure

(red)	Full Pressure
(light orange)	Pressure
(blue)	Neutral
(green)	Exhaust
(yellow)	Lock Up

Operating Multiple Services

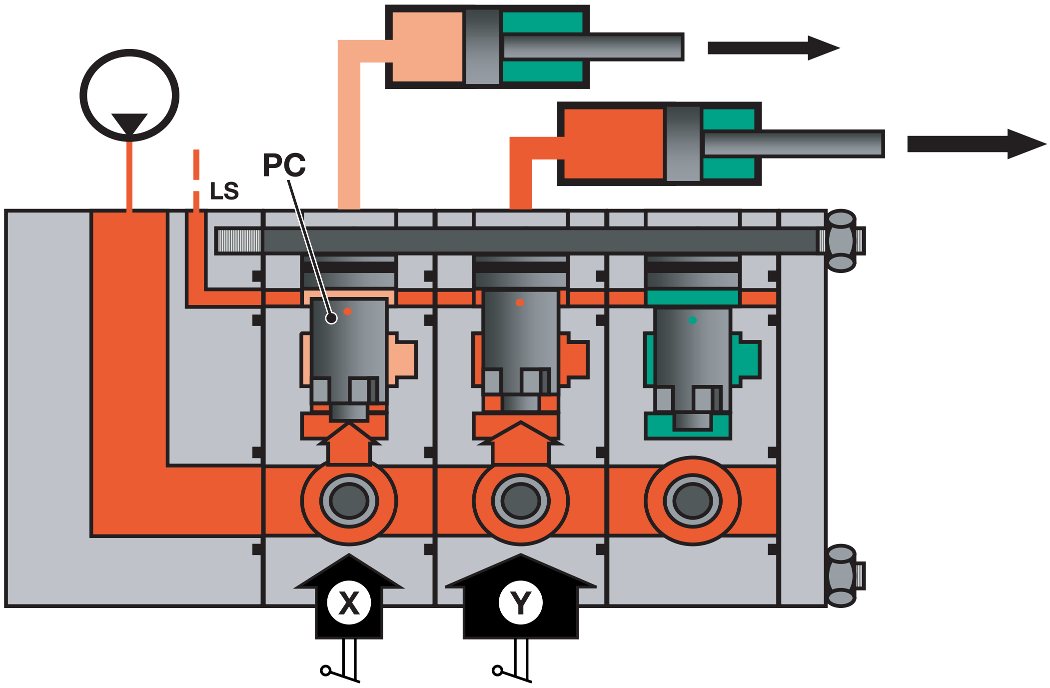


Fig 7.

Normal Condition

When another service with a higher load is operated simultaneously, a typical example is the lifting of the boom **Y** and simultaneous operation of the bucket **X** as shown in ⇨ *Fig 7. (L-317)*.

The higher load pressure in the boom service causes the pressure compensator valve **PC** in the bucket service to partially close, reducing the size of the opening through which the oil must flow, and in this way maintains a pressure drop across the pressure compensator equal to the pressure drop across the bucket service spool.

In this example, because of the action of the pressure compensator valve the bucket service is always kept independent of the other services, the bucket ram speed remains constant (as controlled by the bucket service spool) and is not affected by the greater operating pressure in the boom service.

With Insufficient Flow from Pump

Should the oil flow demanded by the sum of the combined services operating ever exceed that of the pump, all the pressure compensator valves will partially close accordingly, effectively dividing the available flow between all the services proportionally.

In this condition the service ram with the highest load will NOT stop, because the speed of the other service rams operating will have been reduced proportionally by the action of the pressure compensator valves to compensate.

When one of the service spools is returned to neutral, the speed of the other service rams still operating will all increase proportionally.

⇨ *Table 1. Colour Key to Oil Flow and Pressure (L-316)*.

Removal and Replacement

WARNING

Make the machine safe before working underneath it. Park the machine on level ground, lower the attachments to the ground. Apply the park brake, put the transmission in neutral and stop the engine. Block both sides of all four wheels.

Disconnect the battery, to prevent the engine being started while you are beneath the machine.

GEN-4-1_1

Sideshift Machines: To improve access to the valve block, sideshift the excavator fully to the left, then lower to the ground.

Before commencing work, ensure that the exterior of the excavator valve block and the working area are thoroughly cleaned and free of possible sources of contamination.

Removal

1 Vent the hydraulic services and pilot circuit accumulator hydraulic pressure:

Switch the starter to ON without starting the engine. Activate the joystick controls, operate the joysticks several times to vent the hydraulic pressure from the servo system and service rams. Turn the starter switch to the OFF position and remove the key.

2 Working beneath the machine, disconnect all the hydraulic hoses from the excavator valve block. Label each hose before disconnecting to ensure correct replacement.

Plug the open ports and cap the hose ends to prevent loss of fluid and ingress of dirt. Put a suitable receptacle beneath the valve block to collect any hydraulic fluid spillage.

3 **Sideshift Machines:** Disconnect the harness electrical connector at the hydraclamps solenoid **C**.

WARNING

This component is heavy. It must only be removed or handled using a suitable lifting method and device.

BF-4-1_1

4 Support the weight of the valve block with suitable lifting equipment, then remove the three securing nuts **A**. Carefully lift the valve block away from the resilient mounts **B**.

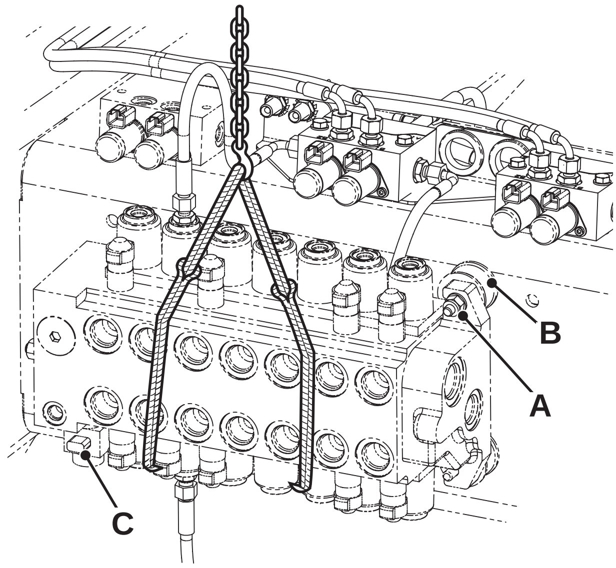


Fig 8.

Replacement

Replacement is the reverse of the removal sequence, but note the following:

Inspect the resilient mounts **B** for damage, cracking etc. If the mounts are not in good condition, replace them with new ones.

Apply JCB Threadlocker and Sealer to the threads of nuts **A** before fitting.

Ensure the hoses are correctly installed, and phased in the same position as removal to prevent chafing.

On completion, run the engine and check for leaks.

Dismantle and Assemble

Valve Block Sections

⇨ Fig 9. (L-320). The valve block is a `sectional' type, which is made up of a number of separate sections. The illustration is intended as a guide to identifying the components.

Be sure to note the location of all components when dismantling. Although some components may appear to be identical they are not interchangeable. Make sure that components are assembled in their original positions.

Great care should be taken when dismantling and assembling a valve to avoid the following:

- **Contamination**
- **Damage to spools**
- **Damage to seal grooves**

Any of the above may result in possible problems with the operation of the valve.

Dismantle

1 Remove the valve block from the machine.

2 Remove the three tie rod nuts **1**.

3 Carefully separate and remove the end plate **2** followed by the remaining service sections **3**. If the inlet section **4** is to be replaced, remove and retain the tie rods **5**.

Assemble

Assembly is the reverse of the dismantling sequence but note the following:

Clean the valve components in an appropriate solvent. Ensure that the mating faces of the valve sections are thoroughly clean before assembly.

Renew the `O' rings located between the valve sections. Make sure the `O' ring seals are not trapped or damaged.

Check the Load Hold Check Valve `O' rings and replace if necessary. ⇨ Load Hold Check Valves (L-328).

Lubricate parts with JCB Hydraulic Fluid before assembling. Make sure that all the parts move freely.

If the tie rods **5** were unscrewed from the inlet section **4**, apply JCB Threadlocker and Sealer to the threads before refitting. Apply JCB Threadlocker and Sealer to the threads of nuts **1**.

Table 2. Torque Settings

Item	Nm	kgf m	lbf ft
1	35	3.6	25.8

Component Key:

1	Tie Rod Nuts
2	End Plate
3	Service Sections
4	Inlet - Outlet Section
5	Tie Rods
6	Load Hold Check Valves
7	Pressure Compensator Valves
8	Service Spool (Servo Operated)
9	Hydraclamp Valve
10	Hydraclamp Solenoid
11	Auxiliary Relief Valve (ARV)
12	Blanking Plug

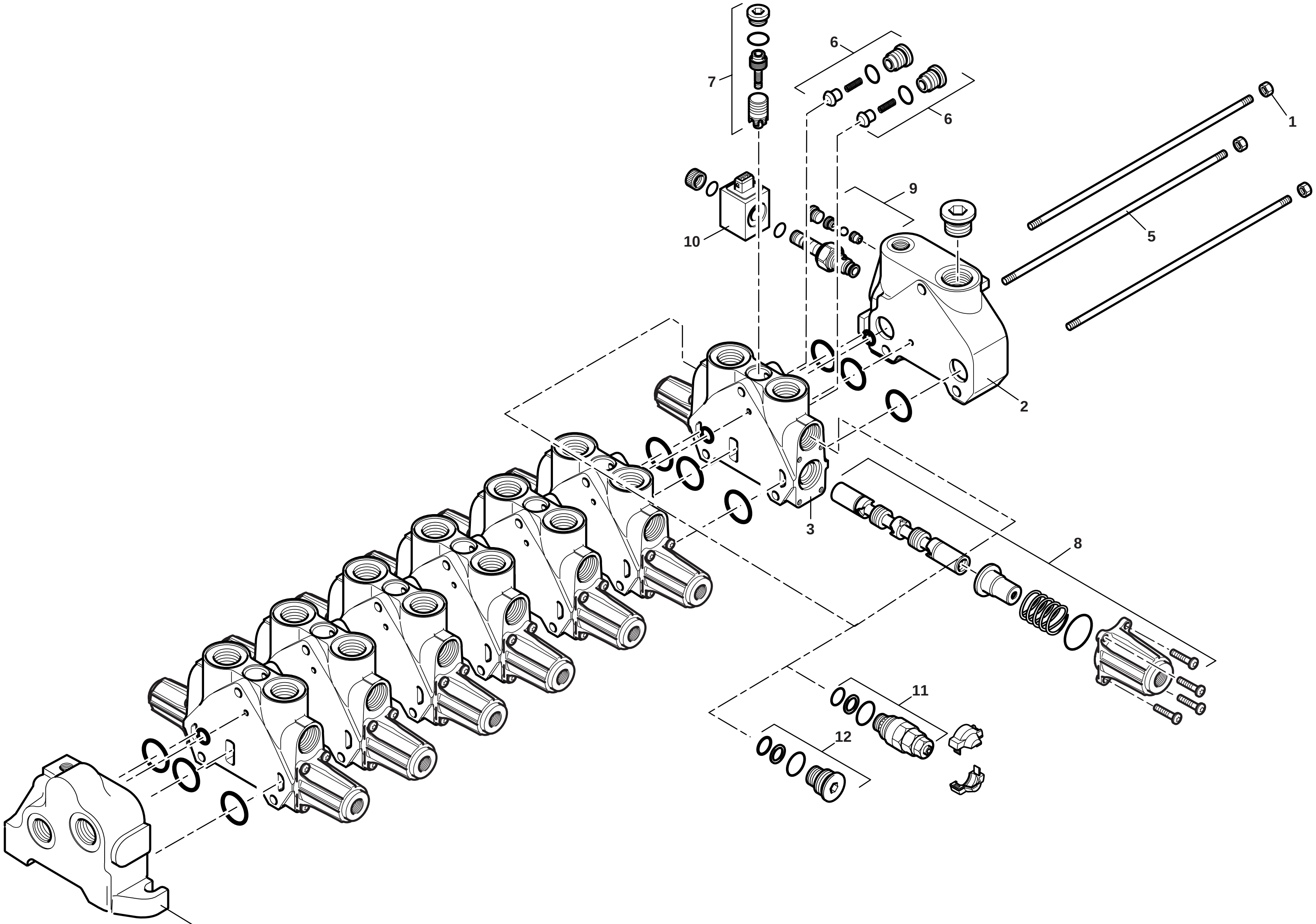


Fig 9. Valve Components (Precision Control and Advanced EasyControl Machines)

Servo Operated Spool

Removal

⇨ *Fig 10. (L-322)*. It is possible to remove a spool without removing the excavator valve block from the machine. Working beneath the machine, it may be easier to remove the spool from the bottom as shown.

⚠ WARNING

Make the machine safe before working underneath it. Park the machine on level ground, lower the attachments to the ground. Apply the park brake, put the transmission in neutral and stop the engine. Block both sides of all four wheels.

Disconnect the battery, to prevent the engine being started while you are beneath the machine.

GEN-4-1_1

Before commencing work, ensure that the exterior of the valve block and the working area are thoroughly cleaned and free of possible sources of contamination.

1 Vent the hydraulic services and pilot circuit accumulator hydraulic pressure:

  Switch the starter to ON without starting the engine. Activate the joystick controls, operate the joysticks several times to vent the hydraulic pressure from the servo system and service rams. Turn the starter switch to the OFF position and remove the key.

2 Gain access to the excavator valve and disconnect and blank any hoses or pipes which may interfere with the removal of the spool.

3 Disconnect and blank the servo pilot hoses connected to the end caps **2** at each end of the spool.

4 Remove the screws **1** and carefully lift off the end cap **2**. Retrieve the spring **4** and spring retainer **5**, then withdraw the spool **6** from the valve body.

Note: *When removing 'O' Rings and seals, use an appropriately rounded tool that WILL NOT cause any damage to the seal grooves. Discard ALL 'O' Rings and back-up rings. DO NOT use worn or damaged items.*

Inspection

Inspect the valve components for scratches, pitting, corrosion or any other type of damage. Replace as necessary.

Assemble

Assembly is the reverse of the removal sequence but note the following:

Clean the valve components in an appropriate solvent.

Lubricate parts with JCB Hydraulic Fluid before assembling. Make sure that all the parts move freely.

Renew 'O' ring **3**.

Spool Orientation: The spool may have a ring **A** machined into it, which must be positioned downwards. ⇨ *Servo Spool Orientation (L-323)*.

Table 3. Torque Settings

Item	Nm	kgf m	lbf ft
1	10	1	7.4

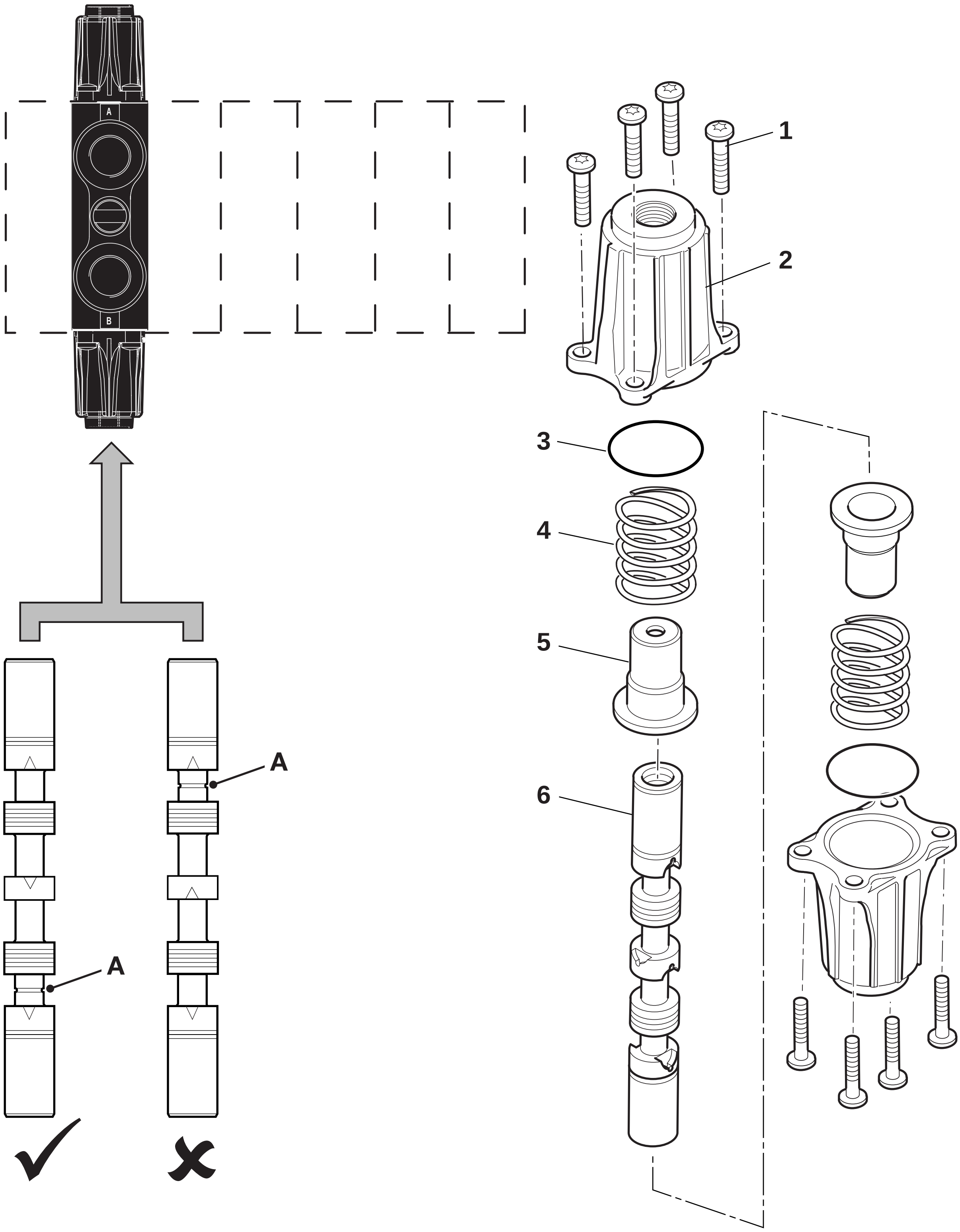


Fig 10. Servo Operated Spool

Servo Spool Orientation

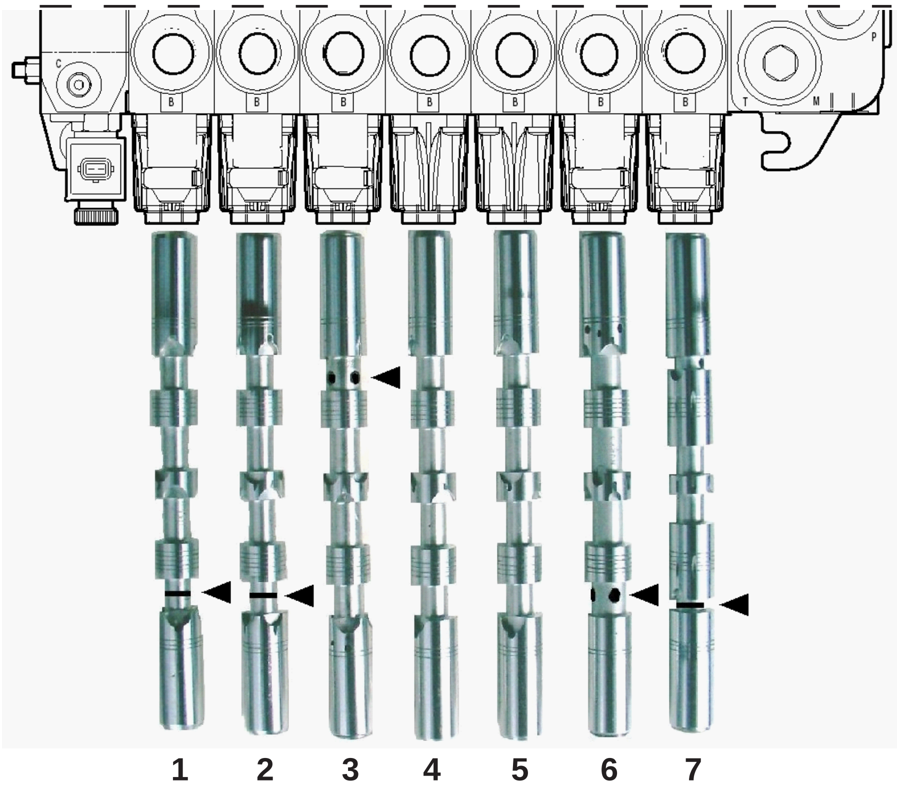


Fig 11.

The auxiliary, bucket and slew spools have rings machined in them which must be positioned downwards.

The dipper and boom spools have regeneration holes which must be positioned as shown.

The stabiliser spools have no particular orientation, however it is good practice to refit the spools in the same orientation that they were removed.

Important: *The spools are very different and must be replaced in their original sections. Failure to do so will result in problems with the operation of the valve.*

Component Key:

1 Auxiliary spool
2 Bucket spool
3 Dipper spool
4 Stabiliser spool
5 Stabiliser spool
6 Boom spool
7 Slew spool

External Auxiliary Relief Valves (ARV's)

Removal

⇨ *Fig 12. (L-325)*. It is possible to remove an external auxiliary relief valve without removing the valve block from the machine.

⚠ WARNING

Make the machine safe before working underneath it. Park the machine on level ground, lower the attachments to the ground. Apply the park brake, put the transmission in neutral and stop the engine. Block both sides of all four wheels.

Disconnect the battery, to prevent the engine being started while you are beneath the machine.

GEN-4-1_1

1 Vent the hydraulic services and pilot circuit accumulator hydraulic pressure:

Switch the starter to ON without starting the engine. Activate the joystick controls, operate the joysticks several times to vent the hydraulic pressure from the servo system and service rams. Turn the starter switch to the OFF position and remove the key.

2 Gain access to the valve and disconnect and blank any hoses or pipes which may interfere with the removal of the auxiliary relief valve(s).

3 Unscrew the auxiliary relief valve(s) from the valve block. Cover the ports to prevent the ingress of dirt and remove to a clean working area.

Dismantle

1 Prise off plastic locking cap.

2 Loosen locknut **1** and remove adjuster screw **2**.

3 Carefully remove spring **3** and poppet **4**.

4 Unscrew upper valve body **5** and remove springs **6** and piston **7**.

Note: *When removing 'O' Rings and seals, use an appropriately rounded tool that WILL NOT cause any damage to the seal grooves. Discard ALL 'O' Rings and back-up rings. DO NOT use worn or damaged items.*

Inspection

Inspect the valve components for scratches, pitting, corrosion or any other type of damage.

Note: *If any part other than `O' rings are damaged the entire valve must be renewed.*

Assemble

Assembly is the reverse of the dismantling sequence but note the following:

Important: *The ARV's appear identical but have various pressure settings.* ⇨ ***Specifications (L-313)***. *Ensure that they are correctly adjusted and fitted in their specified positions.*

Clean the valve components in an appropriate solvent.

Lubricate parts with JCB Hydraulic Fluid before assembling. Make sure that all the parts move freely.

Renew all 'O' rings and back-up rings.

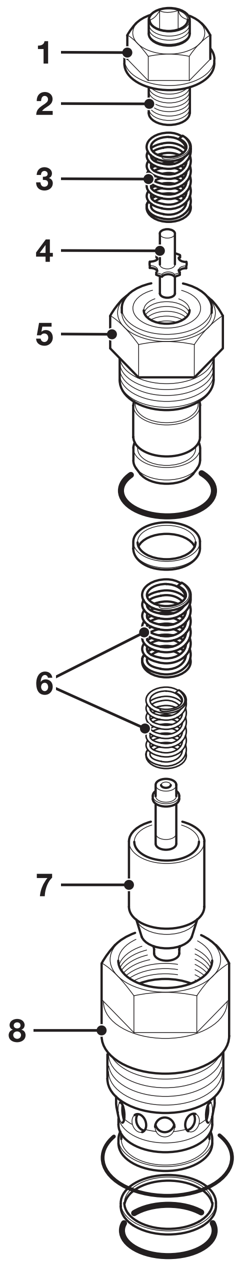


Fig 12. Auxiliary Relief Valve - External Type

Table 4. Torque Settings

Item	Nm	kgf m	lbf ft
8	70	7.1	51.6

Internal Auxiliary Relief Valves (ARV's) - if fitted

The internal auxiliary relief valves are accessible through the excavator valve service ports. It may be possible to remove an auxiliary relief valve without removing the valve block from the machine.

WARNING

Make the machine safe before working underneath it. Park the machine on level ground, lower the attachments to the ground. Apply the park brake, put the transmission in neutral and stop the engine. Block both sides of all four wheels.

Disconnect the battery, to prevent the engine being started while you are beneath the machine.

GEN-4-1_1

Before commencing work, ensure that the exterior of the valve block and the working area are thoroughly cleaned and free of possible sources of contamination.

Removal

1 Vent the hydraulic services and pilot circuit accumulator hydraulic pressure:

Switch the starter to ON without starting the engine. Activate the joystick controls, operate the joysticks several times to vent the hydraulic pressure from the servo system and service rams. Turn the starter switch to the OFF position and remove the key.

2 Gain access to the valve block, and disconnect and blank any hoses or pipes which may interfere with the removal of the auxiliary relief valve(s).

3 Unscrew and remove the hose adaptor from the applicable service port.

4 Use an allen key to remove the auxiliary relief valve **1** from the valve block section. Cover the ports to prevent the ingress of dirt and remove to a clean working area.

5 Inspect the valve components for scratches, pitting, corrosion or any other type of damage.

Note: *If any part other than `O' rings are damaged the entire valve must be renewed.*

Replacement

Replacement is the reverse of the removal sequence, but note the following:

Important: *The internal ARV's appear identical but have various pressure settings.* *⇨ Specifications (L-313)*.

The internal ARV's are factory set and cannot be adjusted. Ensure that they are refitted in their specified positions.

Clean the valve components in an appropriate solvent.

Lubricate parts with JCB Hydraulic Fluid before assembling. Make sure that all the parts move freely.

Renew all `O' rings and back-up rings.

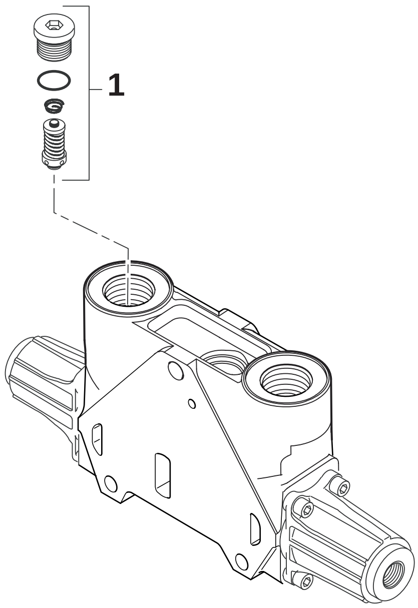


Fig 13.

Table 5. Torque Settings

Item	Nm	kgf m	lbf ft
1	30 - 35	3 - 3.5	22 - 26

Pressure Compensator Valves

Note: *Pressure compensator valves are not fitted at the stabiliser spools on Advanced EasyControl machines, or on Precision Control machines from October 2005.*

Removal

WARNING

Make the machine safe before working underneath it. Park the machine on level ground, lower the attachments to the ground. Apply the park brake, put the transmission in neutral and stop the engine. Block both sides of all four wheels.

Disconnect the battery, to prevent the engine being started while you are beneath the machine.

GEN-4-1_1

1 To gain access to the pressure compensator valves, remove the middle tie rod from the hole **A** (leaving the valve block sections held together with the remaining two tie rods).

In order to remove the middle tie rod, it may be necessary to undo the valve block securing nuts, and pull the valve block away from the chassis.

2 Use an 8mm Allen key to remove the compensator plug **1**.

3 Use a magnet to extract the compensator valve **2** from its bore.

4 Inspect the valve components for scratches, pitting, corrosion or any other type of damage. Replace as necessary.

Replacement

Replacement is the reverse of the removal sequence but note the following:

Clean the valve components in an appropriate solvent.

Lubricate parts with JCB Hydraulic Fluid before assembling. Make sure that all the parts move freely.

Renew all 'O' rings and back-up rings.

Apply JCB Threadlocker and Sealer to the threads of the tie rod, and tie rod nut before fitting.

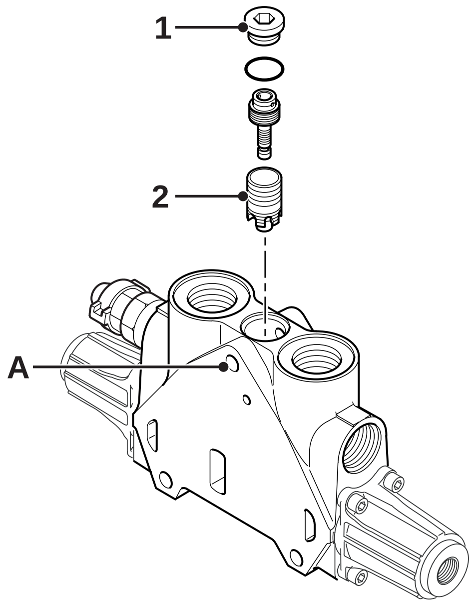


Fig 14. Full flow share (2-piece) compensator shown

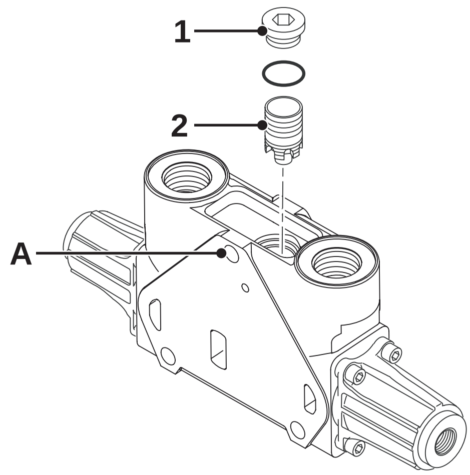


Fig 15. Partial flow share (1-piece) compensator shown

Table 6. Torque Settings

Item	Nm	kgf m	lbf ft
1	60	6.1	44.3

Load Hold Check Valves

Removal

WARNING

Make the machine safe before working underneath it. Park the machine on level ground, lower the attachments to the ground. Apply the park brake, put the transmission in neutral and stop the engine. Block both sides of all four wheels.

Disconnect the battery, to prevent the engine being started while you are beneath the machine.

GEN-4-1_1

1 Remove the valve block from the machine.

2 To gain access to the load hold check valves, separate the valve block sections. ⇒ *Valve Block Sections (L-319)*.

3 Use an Allen key to remove the load hold check valve plug **1**.

4 Remove spring **2** and poppet **3**.

5 Inspect the valve components for scratches, pitting, corrosion or any other type of damage. Ensure good condition of seating faces on poppets **3**, and on the mating faces in the valve block. Replace as necessary.

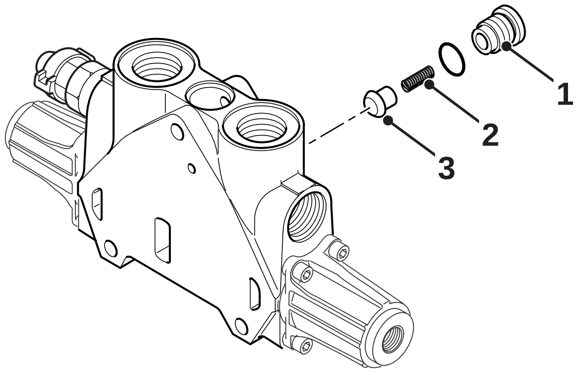


Fig 16.

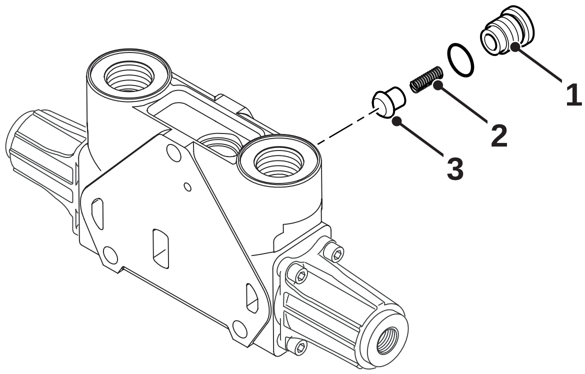


Fig 17.

Replacement

Replacement is the reverse of the removal sequence but note the following:

Clean the valve components in an appropriate solvent.

Lubricate parts with JCB Hydraulic Fluid before assembling. Make sure that all the parts move freely.

Renew all 'O' rings and back-up rings.

Carefully assemble the valve block sections. ⇒ *Valve Block Sections (L-319)*.

Table 7. Torque Settings

Item	Nm	kgf m	lbf ft
1	30	3	22.1

Excavator Valve (Monoblock Type)

Introduction

This topic contains information about a machine DEVICE. Make sure you are referring to the correct device.

This topic is intended to help you understand what the device does and how it works. Where applicable it also includes procedures such as removal and replacement and dismantle and assemble.

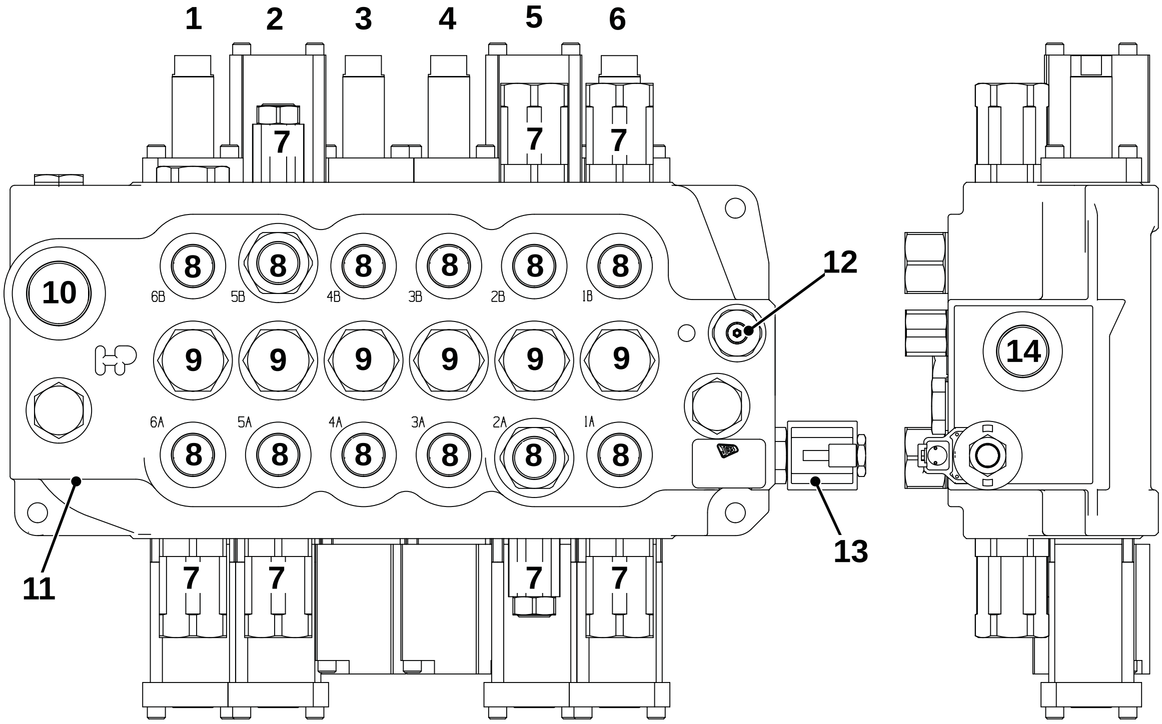
Specifications

Model Reference:	6600F		
Relief Valve Settings:	**bar**	**kgf/cm²**	**lbf/in²**
Boom Ram Head Side (ARV) (1)	262	267	3800
Boom Ram Rod Side (ARV)	345	351	5000
Bucket Ram Head Side (ARV)	262	267	3800
Bucket Ram Rod Side (Rockbreaker option only)	270	275	3900
Dipper Ram Head Side (ARV)	262	267	3800
Dipper Ram Rod Side (ARV)	262	267	3800
Slew Left and Right (ARV)	262	267	3800
Weight:	67 kg (147 lbs)		

(1) All the auxiliary relief valves (ARV's) are factory set. If a relief valve is suspected as being faulty it must be renewed as a complete assembly.

Component Key: ⇒ *Fig 1. (L-331)*

1	Bucket service	**8**	Service ports
2	Dipper service	**9**	Load hold check valve
3	Stabiliser service	**10**	Tank port
4	Stabiliser service	**11**	High pressure carryover port (HPCO)
5	Boom service	**12**	Hydraclamp port (Sideshift)
6	Slew service	**13**	Hydraclamp solenoid (Sideshift)
7	Auxiliary relief valve	**14**	Inlet port



Hydraulic Symbol

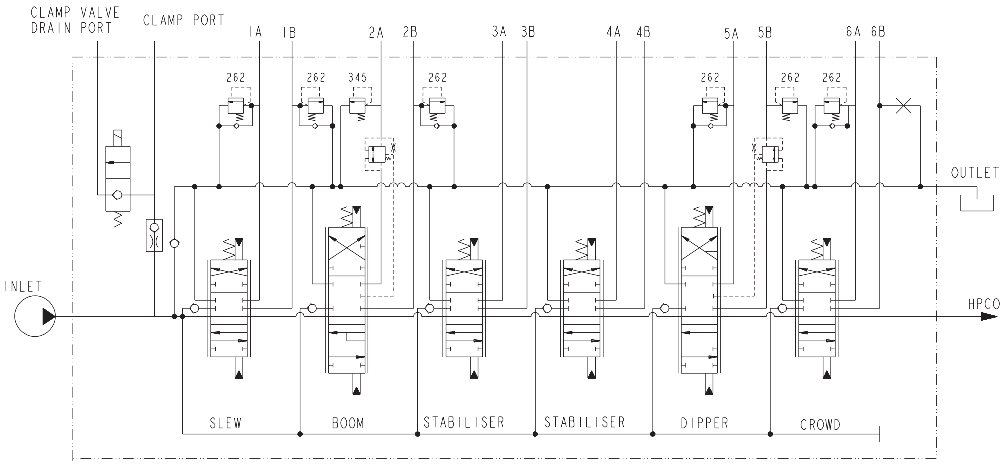


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Fig 1.

Descriptions

Excavator Valve Services

The excavator valve may have both manually operated and servo pilot operated spools **1** depending on the machine variant. The valve spools are of a open-centre design.

With the spools **1** in the neutral position, the oil from the hydraulic pump(s) flows through the valve block neutral gallery **N** (around the central waist of the spool) and eventually back to tank.

When a service is selected, the spool **1** moves against the force of the centering spring **2**, allowing oil to flow out of one of the service ports (either **A** or **B**) to move the applicable service ram. When the service is de-selected, the centering spring **2** returns the spool to the neutral position.

The load hold check valve **3** prevents the load falling back if the load pressure is greater than the pump pressure.

The open-centre design means that the hydraulic services are connected in parallel.

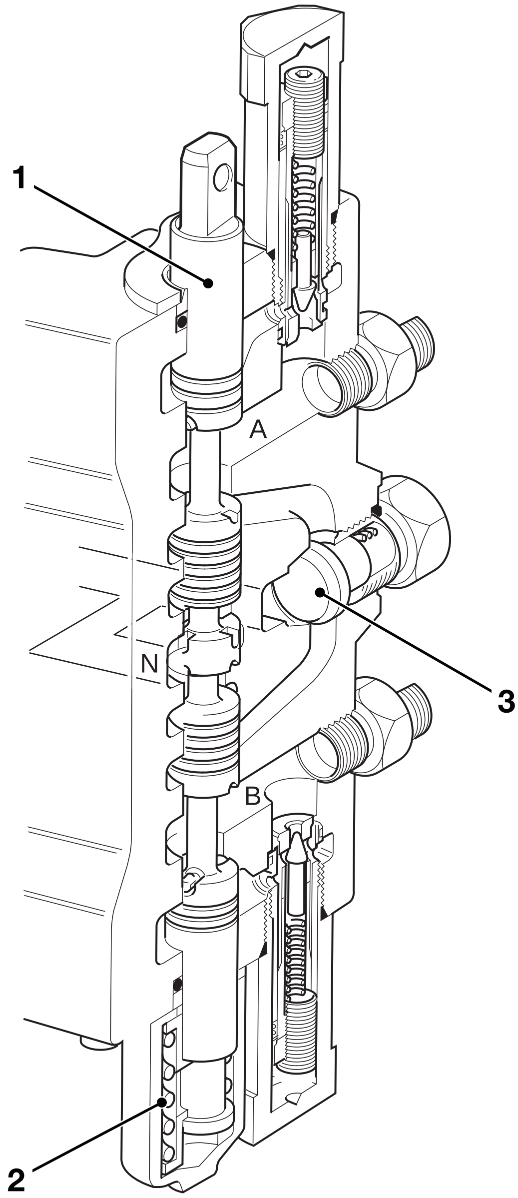


Fig 2. Manually operated spool shown

Hydraclamps Operation

The hydraclamps operate in the same way as standard non-servo machines described in Section E. See ***Section E, Hydraulics - Circuit Descriptions***.

Removal and Replacement

The procedures are similar to those used for standard non-servo machines described in section E. See ***Section E, Hydraulics - Excavator Valve***.

Dismantle and Assemble

The procedures are similar to those used for standard non-servo machines described in section E. See ***Section E, Hydraulics - Excavator Valve***.

Auxiliary Valve Block (Sectional Type)

Introduction

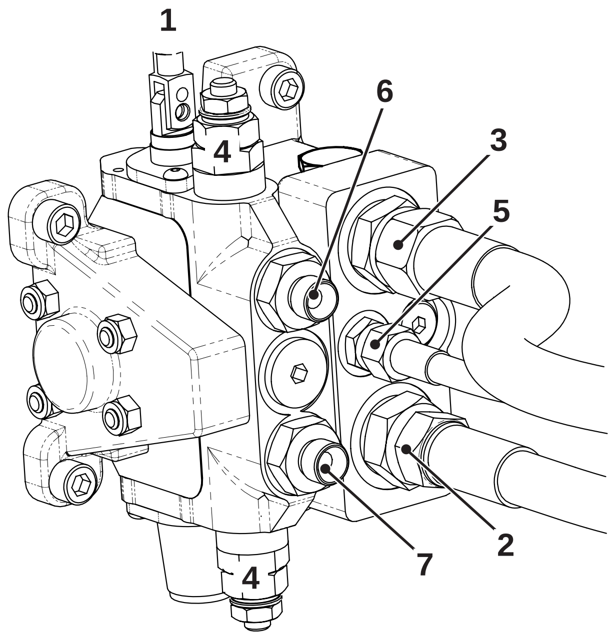
This topic contains information about a machine DEVICE. Make sure you are referring to the correct device.

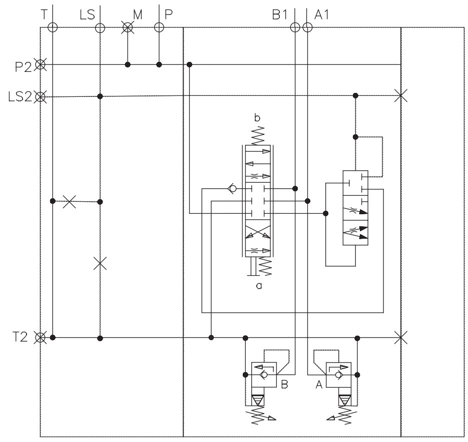
This topic is intended to help you understand what the device does and how it works. Where applicable it also includes procedures such as removal and replacement and dismantle and assemble.

⇨ *Specifications (L-337)*
⇨ *Descriptions (L-338)*

Specifications

Model Reference:	SX12		
Relief Valve Settings:	**bar**	**kgf/cm^2**	**lbf/in^2**
Auxiliary Relief Valve (ARV) - port A	TBA		
Auxiliary Relief Valve (ARV) - port B	TBA		
Weight:	11 kg (25 lbs)		





Hydraulic Symbol

Fig 1.

Component Key:

1 Auxiliary spool (Manually operated)
2 Inlet port `P'
3 Outlet port `T'
4 Auxiliary relief valve (ARV)
5 Load sense port `LS'
6 Service port `A'
7 Service port `B'

Descriptions

Precision Control and Advanced EasyControl machines with excavator 2nd auxiliary circuit only.

Some machines may be fitted with an excavator second auxiliary circuit to operate bi-directional hydraulic attachments connected to the dipper.

This circuit has a separate auxiliary valve block **A**, mounted on the rear of the chassis. The valve block houses a load sensed, pressure compensated service spool, which is manually actuated from a footpedal **B** inside the cab. The load sense line is connected into the load sense port (LS) at the excavator valve block.

For more details of the hydraulic circuit and valve connections, see ***Schematic Circuits***.

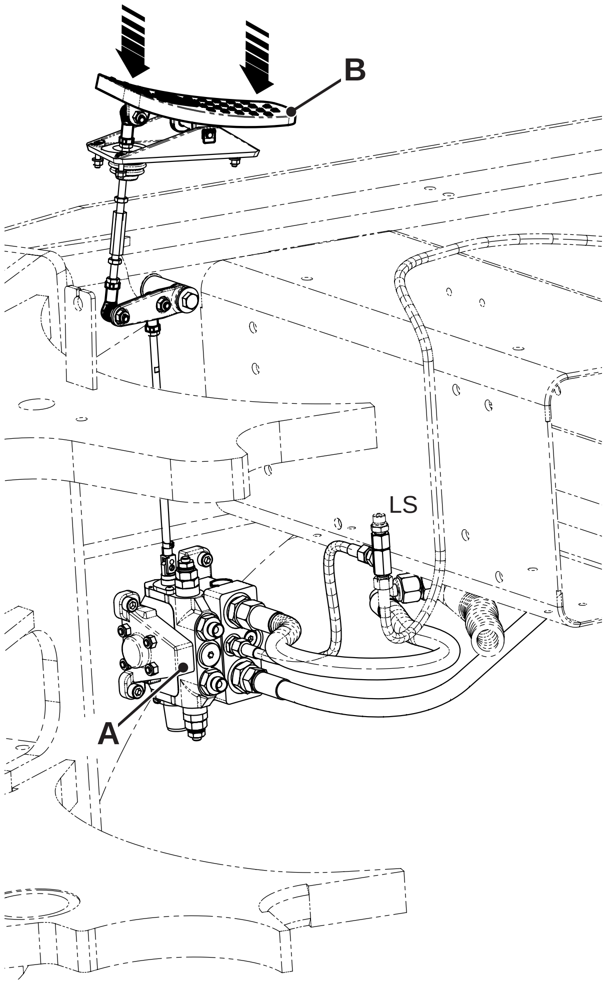


Fig 2.

Auxiliary Valve Block (Monoblock Type)

Introduction

This topic contains information about a machine DEVICE. Make sure you are referring to the correct device.

This topic is intended to help you understand what the device does and how it works. Where applicable it also includes procedures such as removal and replacement and dismantle and assemble.

⇨ *Specifications (L-340)*
⇨ *Descriptions (L-341)*

Specifications

Model Reference:	2050A2		
Relief Valve Settings:	**bar**	**kgf/cm²**	**lbf/in²**
Extending Dipper Ram Head Side (ARV)	138	141	2000
Extending Dipper Ram Rod Side (ARV)	207	211	3000
Weight:	5.6 kg (12 lbs)		

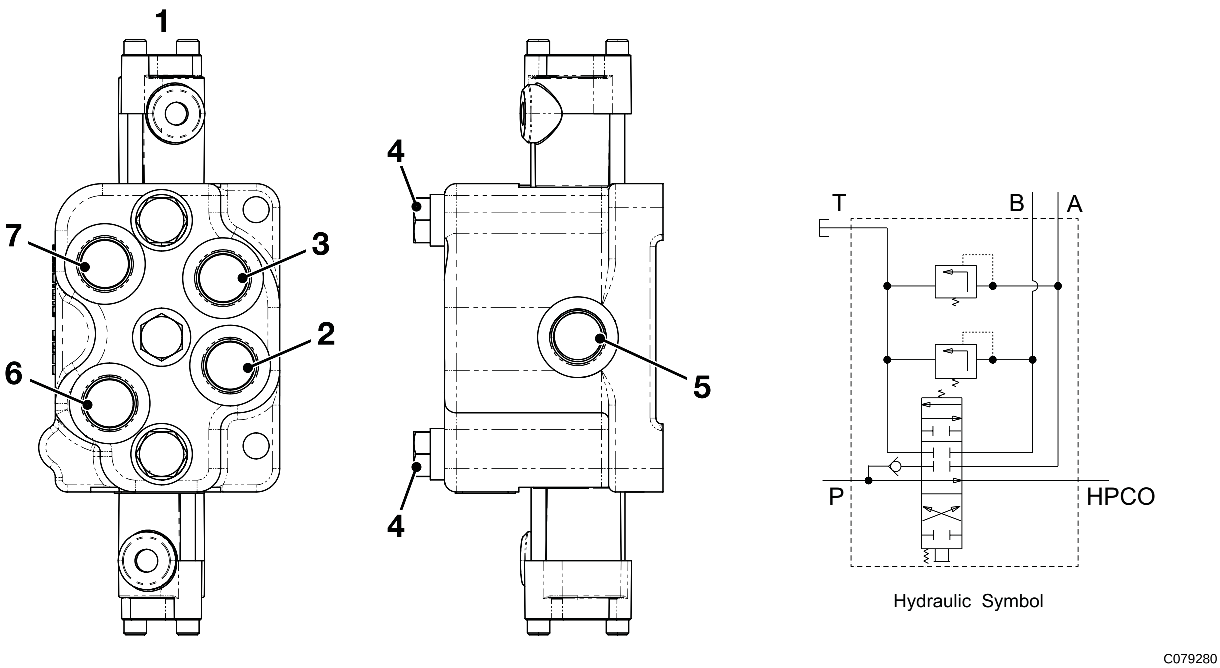


Fig 1.

Component Key:

1 Auxiliary spool (Servo operated)
2 Inlet port `P'
3 Outlet port `T'
4 Auxiliary relief valve (ARV)
5 High pressure carry-over (HPCO) port
6 Service port `A'
7 Service port `B'

Descriptions

EasyControl machines only.

The excavator auxiliary circuit operates the extending dipper, or powered sideshift - if fitted.

This circuit has a separate auxiliary valve block **A**, mounted on the rear of the chassis next to the excavator valve. The valve block houses an open-centre service spool, which is actuated by servo pilot pressure (via a changeover solenoid valve **B**) by pressing the thumbwheel switch in the RH joystick (not shown).

For more details of the hydraulic circuit and valve connections, see ***Schematic Circuits***.

For more details of the thumbwheel switch control, see the applicable machine ***SYSTEM - Electrical Operation and Schematics***.

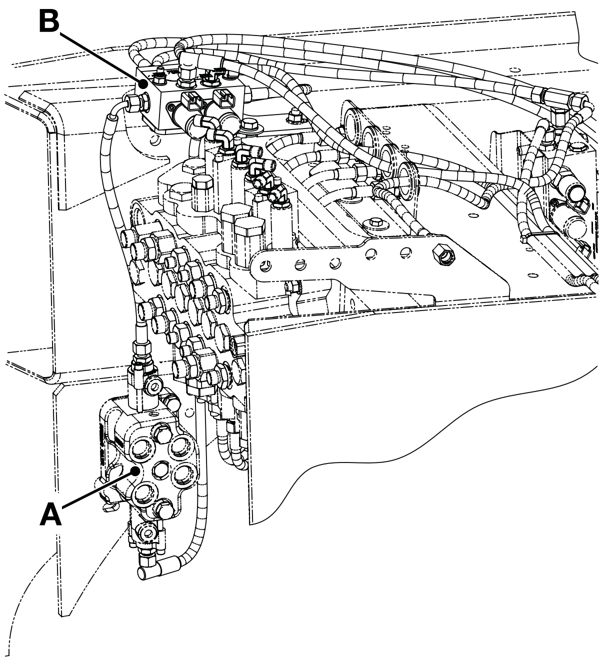


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Fig 2.

Cab Seat

Introduction

This topic contains information about a machine DEVICE. Make sure you are referring to the correct device.

This topic is intended to help you understand what the device does and how it works. Where applicable it also includes procedures such as removal and replacement and dismantle and assemble.

⇨ ***Service Procedures (L-343)***

⇨ ***Seat Position Sensors - Adjustment (L-343)***

⇨ ***Removal and Replacement (L-344)***

Service Procedures

Seat Position Sensors - Adjustment

There are two position sensor switches **A** mounted on the seat pedestal to detect whether the seat is locked in the forward, or rear facing position. The position sensor switches are the reed type, which operate when the metal vane **B** moves between the switch faces. The switches are not adjustable.

If a switch is suspected as being faulty, check the associated wires and electrical connectors for damage. Ensure that the vane **B** moves between the faces of the relevant switch, when the seat is locked in the forward, or rear facing position. If a switch has failed it must be renewed.

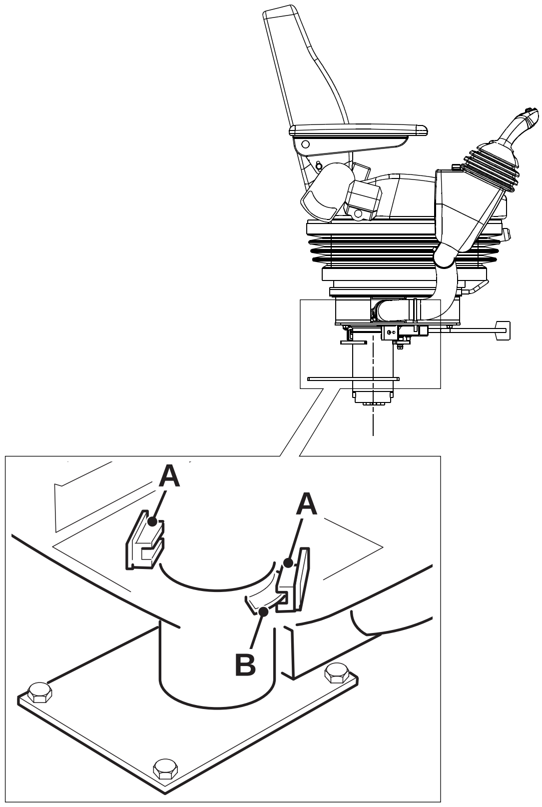

Fig 3.

Removal and Replacement

⇨ Fig 4. (L-345). On joystick control (Servo) machines, the servo pilot hoses **A** from the joystick controllers are routed through the centre of the seat pedestal **B** as shown. The pilot hoses are an integral part of the seat assembly, therefore the seat is removed complete with the pilot hoses attached.

⚠ WARNING

Make the machine safe before working underneath it. Park the machine on level ground, lower the attachments to the ground. Apply the park brake, put the transmission in neutral and stop the engine. Block both sides of all four wheels.

Disconnect the battery, to prevent the engine being started while you are beneath the machine.

GEN-4-1_1

Removal

1 Vent the hydraulic services and pilot circuit accumulator hydraulic pressure:

Switch the starter to ON without starting the engine. Activate the joystick controls, operate the joysticks several times to vent the hydraulic pressure from the servo system and service rams. Turn the starter switch to the OFF position and remove the key.

2 Working beneath the machine, identify the bundles of pilot hoses **A**. There are twelve separate hoses, which are divided into bundles and tied with cable ties. Follow the routing of the pilot hoses to the rear of the machine and note where they connect to. Some hoses will connect to the servo pressure supply valve, and the others will connect to either manifold blocks, or changeover valves mounted on the chassis rear box section, depending on the machine variant.

Disconnect all the pilot hoses **A** at their respective valve blocks. Label each hose before disconnecting to ensure correct replacement. Plug the open ports and cap the hose ends to prevent loss of fluid and ingress of dirt.

Note: *Some pilot hoses have quick-connect couplings. This type of coupling requires a special tool to release it. Refer to the applicable machine* ***SYSTEM - Service Procedures****.*

3 Uncouple the seat harness electrical connector **C**. Label the connector before disconnecting to ensure correct replacement.

4 In the cab, with the seat suitably supported, undo the four mounting bolts **D**.

⚠ WARNING

This component is heavy. It must only be removed or handled using a suitable lifting method and device.

BF-4-1_1

The seat weighs approximately 50 kg (110 lb).

5 Using suitable lifting equipment, carefully manoeuvre the seat assembly with the pilot hoses attached clear of the cab. Take care not to damage the pilot hoses when lifting them through the floor aperture.

Important: *There may be spacers* ***E*** *fitted under the seat base. Record the positions of the spacers before removing them to ensure they are returned to their original positions.*

Replacement

Replacement is the reverse of the removal sequence, but note the following:

Ensure the hoses are correctly installed, and phased in the same position as removal to prevent chafing.

Torque tighten the bolts **D**.

On completion, operate the machines hydraulic system and check that the joysticks and switches function correctly.

Test the seat heater, and air suspension (if fitted).

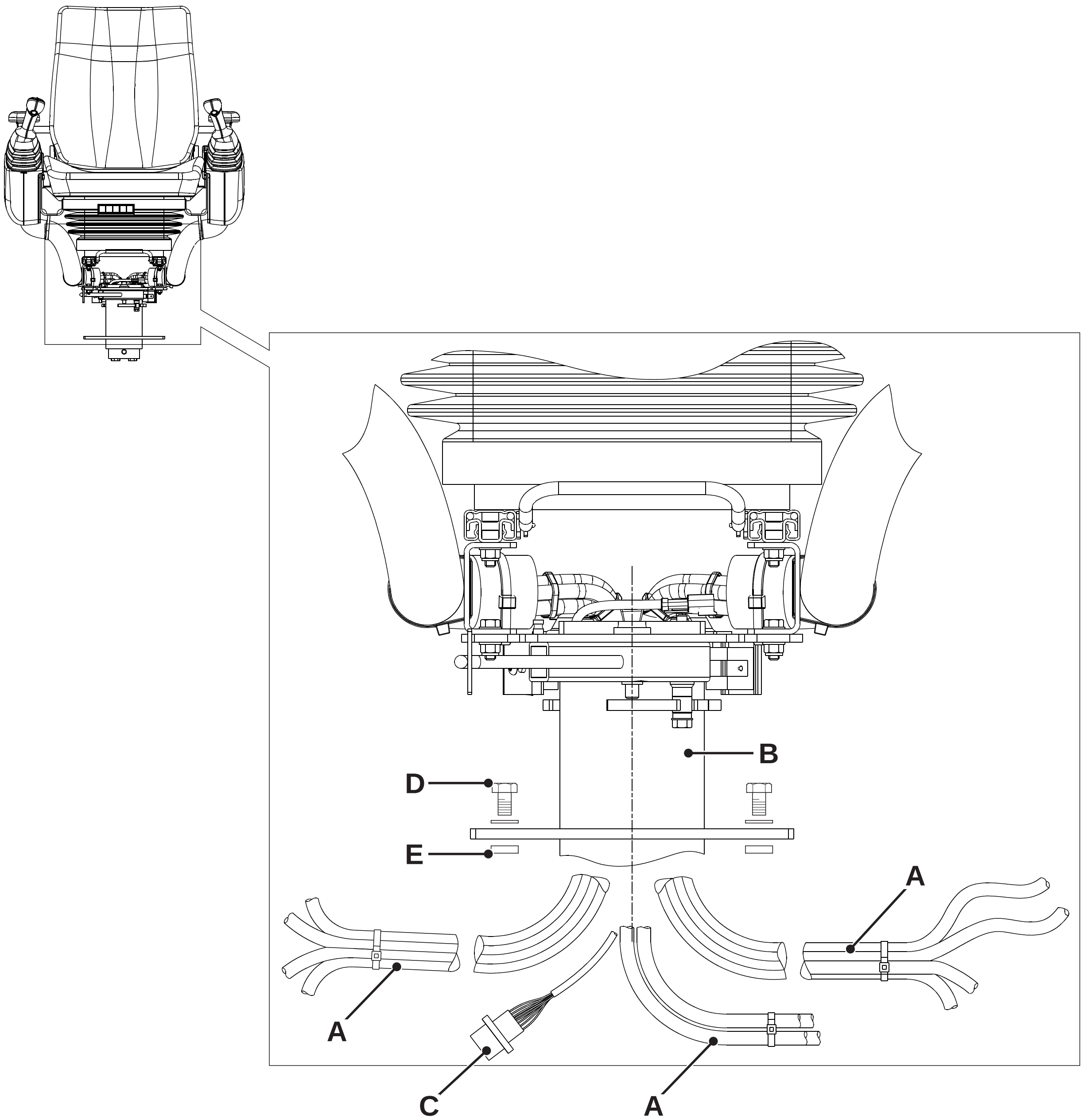

Fig 4.

Table 1. Torque Settings

Item	Nm	kgf m	lbf ft
D	47	4.8	35

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