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Section E

Hydraulics

Service Manual - 527-58

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Schematics

527-58

The schematics show a number of options, check the machine to see which options apply.

Table 1. Component Key:

⇒ *Fig 1. (E1-3)*

1	Pressure cap breather
2	Return line filter
2A	Filter by-pass
3	Suction strainer
4	Hydraulic tank
5	Check Valve
6	Pump Pressure test point
6a	LS Pressure test point
7	**Pump Assembly**
7A	Main pump
7B	Fan pump
8	**Control Valve Block**
8A	By pass compensator
8B	Load sense relief valve
8C	Magnom Filter
8D	Raise/lower spool
8E	Extend/retract spool
8F	Tilt spool
8G	Auxiliary spool
8H	Auxiliary relief valve (ARV)
8J	Auxiliary relief valve (ARV)
8K	Mesh filter - 100 micron
8L	Accumulator
8M	Auxiliary relief valve (ARV)
8N	Auxiliary relief valve (ARV)
8P	Pressure compensator valve
9	**Steer Unit Assembly**
9A	Steer valve
9B	Main relief valve
10	**Cooling Fan Motor** (non-reversible)
10A	Relief valve
11	Reversible cooling fan motor (option) - if fitted
11A	Relief valves
11B	Fan direction changeover valve
13	Steer Priority Valve
14	**Lift Cylinder**
14A	Counterbalance valve
14B	Counterbalance valve
14C	Lift Assist Valve
15	**Displacement Cylinder(s)**
16	**Tilt Cylinder**
16A	Counterbalance valve
17	**Extension Cylinder(s)**
17A	Counterbalance valve(s)
18	**Auxiliary 1 Circuit**
18A	Solenoid diverter valve (boom mounted)
18B	Single auxiliary with hydraulic pin locking (option) - if fitted
18C	Solenoid diverter valve (boom mounted)
19	**Twin Auxiliary** (option) - if fitted
19A	Solenoid diverter valve (boom mounted)
20	**Twin Auxiliary** (option) with Hydraulic pin Locking (option) - if fitted
20A	Solenoid diverter valve (boom mounted)
22	**Hydraulic Pick-up Hitch** (option) - if fitted
22A	Shut off valve (chassis mounted)
22B	Restrictor
22C	Quick release coupling
23	**Permanent 4WS circuit** (if fitted)
23A	Isolation valve
23B	**Steer Mode Valve - manual** (if fitted)
23C	**Steer Mode Valve - Auto** (if fitted)
23D	4WS/Crab solenoid valve
23E	2WS/AWS solenoid valve
24	**Trailer Brake Valve** (option) - if fitted
24A	Trailer brake coupling
24B	Brake valve
24C	Pilot valve
24D	Brake circuit connection
25	**Lift Circuit with optional Smooth Ride System (SRS)** - if fitted
25A	Solenoid valve
25B	Solenoid valve
25C	Accumulators
25D	Pressure switch
26A	Rear power track rod
26B	Front power track rod

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27 **Oil Cooler**

28 Brake master cylinder

29 Service brake calliper

30 Brake fluid reservoir

31 Transmission Motor(1)

32 Transmission Pump(1)

33 Transmission Accumulator Manifold(1)

34 Transmission Accumulator(1)

35 Boosted Brake master cylinder (if fitted)(2)

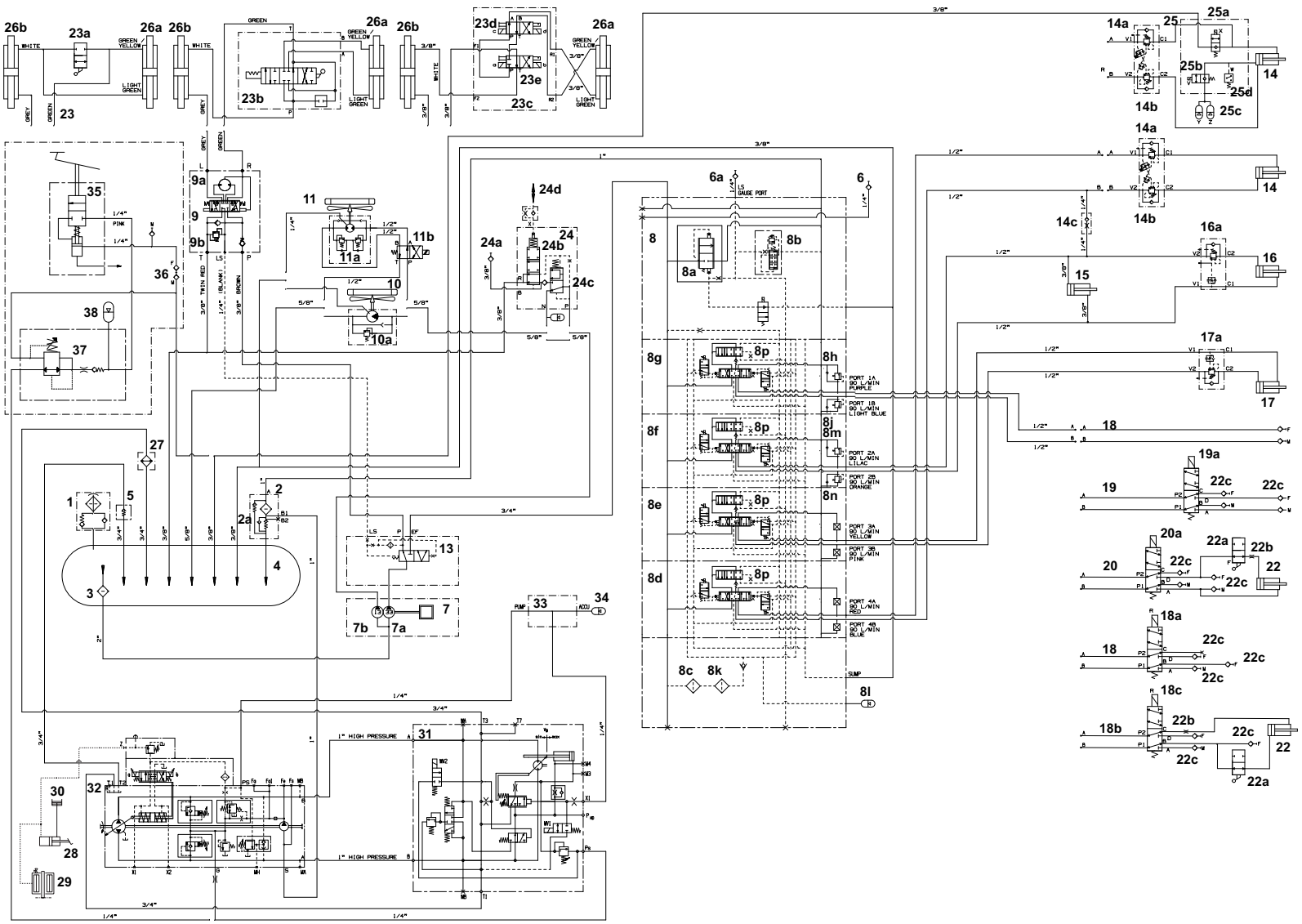
36 Boosted Brake Quick release coupling (if fitted)(2)

37 Boosted Brake manifold (if fitted)(2)

38 Boosted Brake accumulator (if fitted)(2)

(1) For component and circuit details refer to Section F - Hydrostatic Drive System.

(2) For component and circuit details refer to Section G - Brakes.



332-d6641-12-sheet1

Fig 1. 527-58

⇒ *Table 1. Component Key: (🗋 E1-1)*

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LSP Electro Servo Hydraulic SYSTEM

Introduction

This topic contains information about a machine SYSTEM. The system has some devices that connect either mechanically, hydraulically or electrically. Make sure you are referring to the correct system. Refer to the applications table. ⇨ *Related Topics (E2-3)*.

Descriptions and procedures relate to the system and not the individual devices. For information about the devices refer to the relevant topics. ⇨ *Related Topics (E2-3)*

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

⇨ *Related Topics (E2-3)*
⇨ *Specifications (E2-4)*
- ⇨ *Control Valve Block (E2-4)*
- ⇨ *Pump (E2-5)*
- ⇨ *Cooling Fan Motor (E2-5)*
- ⇨ *Trailer Brakes (E2-5)*

⇨ *Operation Overview (E2-6)*
- ⇨ *Component Location and Identification (E2-6)*
- ⇨ *Hydraulic Pump (E2-8)*
- ⇨ *Pressure Compensation (Flowshare) (E2-11)*
- ⇨ *Electronic Servo Proportional Control (E2-9)*
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⇨ *Electrical Operation and Schematics (E2-27)*
- ⇨ *Electro Servo Control (E2-27)*

⇨ *Fault Finding (E2-41)*

⇨ *Test Procedures (E2-46)*
- ⇨ *Checking Pump Flow (E2-46)*
- ⇨ *Load Sense Relief Valve (LSRV) (E2-48)*
- ⇨ *Auxiliary Relief Valve Pressure (ARV) - ARV's set lower than the LSRV (E2-50)*
- ⇨ *Auxiliary Relief Valve Pressure (ARV) - ARV's set higher than the LSRV (E2-51)*
- ⇨ *Auxiliary Relief Valve Replacement (E2-52)*

Related Topics

Table 1. Related Topics in This Publication

The table lists other topics in the manual that contain information related to this topic. Refer to the applicable topics to complete your procedures. Where applicable the text in this section contains cross references to this page to help you find the correct information. Some machines have different systems and devices. Make sure you refer to the correct topic, refer to ***Section 1 - Applications***.

Sections	Topic Titles	Sub Titles
1	***Applications***	ALL
1	***Service Tools***	ALL
2	ALL (Care and Safety)(1)	ALL
3	***Hydraulic System***	***Checking the Hydraulic Fluid Level***
C	***Fuses and Relays***	ALL
C	***Electrical Harness SYSTEM***	ALL
E	***⇨ Schematics (E1-1)***	ALL
E	***⇨ Electro Servo (LSP) Control Valve (E4-1)***	ALL
E	***⇨ Main Pump - Gearpump (E5-1)***	ALL
E	***⇨ Control Lever - Electro Servo (E6-1)***	ALL
E	***⇨ Cooling Fan Motor (E7-1)***	ALL
E	***⇨ Hydraulic Control ECU (E13-1)***	ALL
H	***Manual Steer Mode SYSTEM***	ALL
H	***Auto Steer Mode SYSTEM***	ALL
M	***Fault Code SYSTEM***	ALL
M	***PWM Theory***	ALL
M	***Servicemaster SYSTEM***	ALL
M	***Servicemaster Tools***	ALL

(1) You must obey all of the relevant care and safety procedures.

Table 2. Service Tools

The table lists the service tools you will need to do some of the procedures in this topic. Make sure you have the correct service tools BEFORE you start the procedures

Tool Part Number	Description
892/00268(1)	Flow Monitoring Kit and Relevant Adaptors
892/00253(1)	Hydraulic Pressure Test Kit and Relevant Adaptors
892/00270(1)	Load Valve

(1) Tool available from JCB Service, refer to Section 1 - Service Tools

Specifications

Control Valve Block

Type:	4 Spool, load sense - pressure compensated, double acting spools	
Spool 1	Auxiliary Service	Integral proportional electro servo pilot operated
Spool 2	Carriage Tilt Service	Integral proportional electro servo pilot operated
Spool 3	Boom Extend & Retract Service	Integral proportional electro servo pilot operated
Spool 4	Boom Raise & Lower Service	Integral proportional electro servo pilot operated

Pressures: ⇒ *Fig 1. (E2-4)*			
	bar	**kgf/cm²**	**lbf/in²**
5 - Load Sense Relief Valve (1)	245	249	3553
Auxiliary Relief Valves (ARV's)(2)			
6 - Auxiliary Service	220	224	3190
7 - Carriage Tilt Ram Rod Side	260	265	3770
8 - Carriage Tilt Ram Head Side	290	295	4206

(1) Before testing the Load Sense Relief Valve pressure, allow the hydraulic system to warm up to 50 °C (122 °F) to ensure an accurate reading.

(2) The ARV's are not adjustable. If the pressure setting is incorrect the ARV must be replaced.

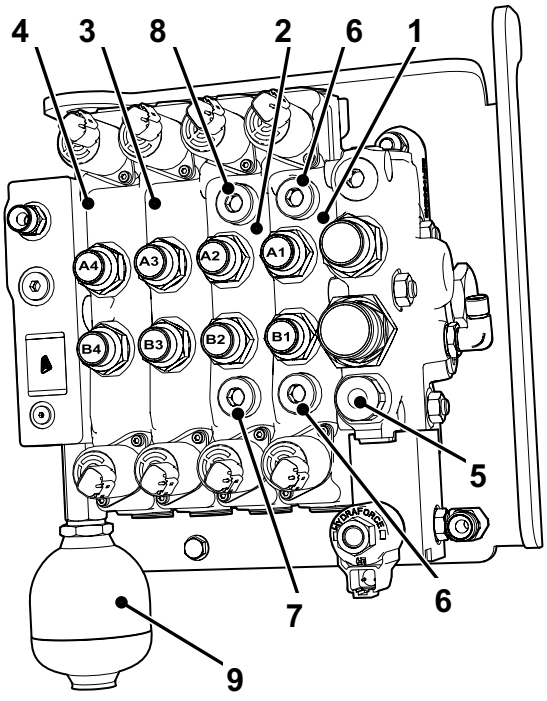


Fig 1.

Pump

Table 3.

Type:	Double gear pump		
Mounting:	2 bolt flange on HDPTO of engine		
Direction of Rotation:	Anti-clockwise		
Theoretical displacement:	**cc/rev**	**cu in/rev**	
Main services pump (mounting flange end)	33	2	
Cooling fan pump	13	0.8	
Flow at 2200 rev/min and system pressure (90% min. displacement):	**litres/min**	**UK gal/min**	**US gal/min**
Main services pump (mounting flange end)	87.5	19.2	23.1
Cooling fan pump	34.5	7.6	9.1
Maximum Pressure:	**bar**	**kg/cm²**	**lb/in²**
port EF (LSRV)	265	270	3843
port P (Steering Relief)	190	194	2755
Maximum Speed:	2700 rev/min		
Minimum Speed:	500 rev/min		
Weight:	16.4 kg (36 lbs)		

Cooling Fan Motor

Machines up to January 2011

Table 4.

Type:	Gear Motor
Direction of Rotation:	Clockwise or Bi directional
Motor Displacement	10 cc/rev
Fan Speed (at maximum engine rev/min):	2300
Maximum Pressure Setting	195 bar

Machines from January 2011

Table 5.

Type:	Gear Motor
Direction of Rotation:	Clockwise or Bi directional
Motor Displacement	11 cc/rev
Fan Speed (at maximum engine rev/min):	2300
Maximum Pressure Setting	100 bar

Trailer Brakes

Coupling	150 bar
Accumulator	12 bar

Operation Overview

Table 6. Component Location and Identification

Item	Description		
⇨ *Fig 2. (E2-7)*			
1	Emergency Isolation Switch		⇨ *Electrical Operation and Schematics (E2-27)*
2	Fan motor	Driven by pump section **3B**	⇨ *Cooling Fan Motor (E7-1)*
3	Pump assembly	A main services gear pump **A** with an additional gearpump section **B** for the fan drive	⇨ *Hydraulic Pump (E2-8)*
4	Electro Servo Control Lever	Two axis control lever	⇨ *Electro Servo Control Lever (E2-12)*
5	PWM ECU Power Base	Electronic control for control valve solenoids	⇨ *Electronic Servo Proportional Control (E2-9)*
6	Control valve block	Flowshare valve with electro servo spools	⇨ *Electro Servo Control Valve (E2-10)*
6A	Load Sense Relief Valve	Controls maximum system pressure	⇨ *Load Sensing (E2-8)*
7	Priority Valve	Gives priority flow to the steer system.	See ***Section H - Steering***. ⇨ *Related Topics (E2-3)*
8	Hydraulic Oil Filter	Positioned in the return line to tank	
9	Hydraulic Tank		
10	Proportional Control Thumbwheels		⇨ *Electronic Servo Proportional Control (E2-9)* ⇨ *Electro Servo Control Lever (E2-12)*
11	Hydraulic control ECU		⇨ *Hydraulic Control ECU (E13-1)*
12a	Hydraulic Pump Test Point		⇨ *Test Procedures (E2-46)*
12b	Hydraulic Load Sense Test Point		⇨ *Test Procedures (E2-46)*
13	Steer Valve Feed		See ***Section H - Steering***. ⇨ *Related Topics (E2-3)*
14	Joystick Isolation Switch		⇨ *Electrical Operation and Schematics (E2-27)*

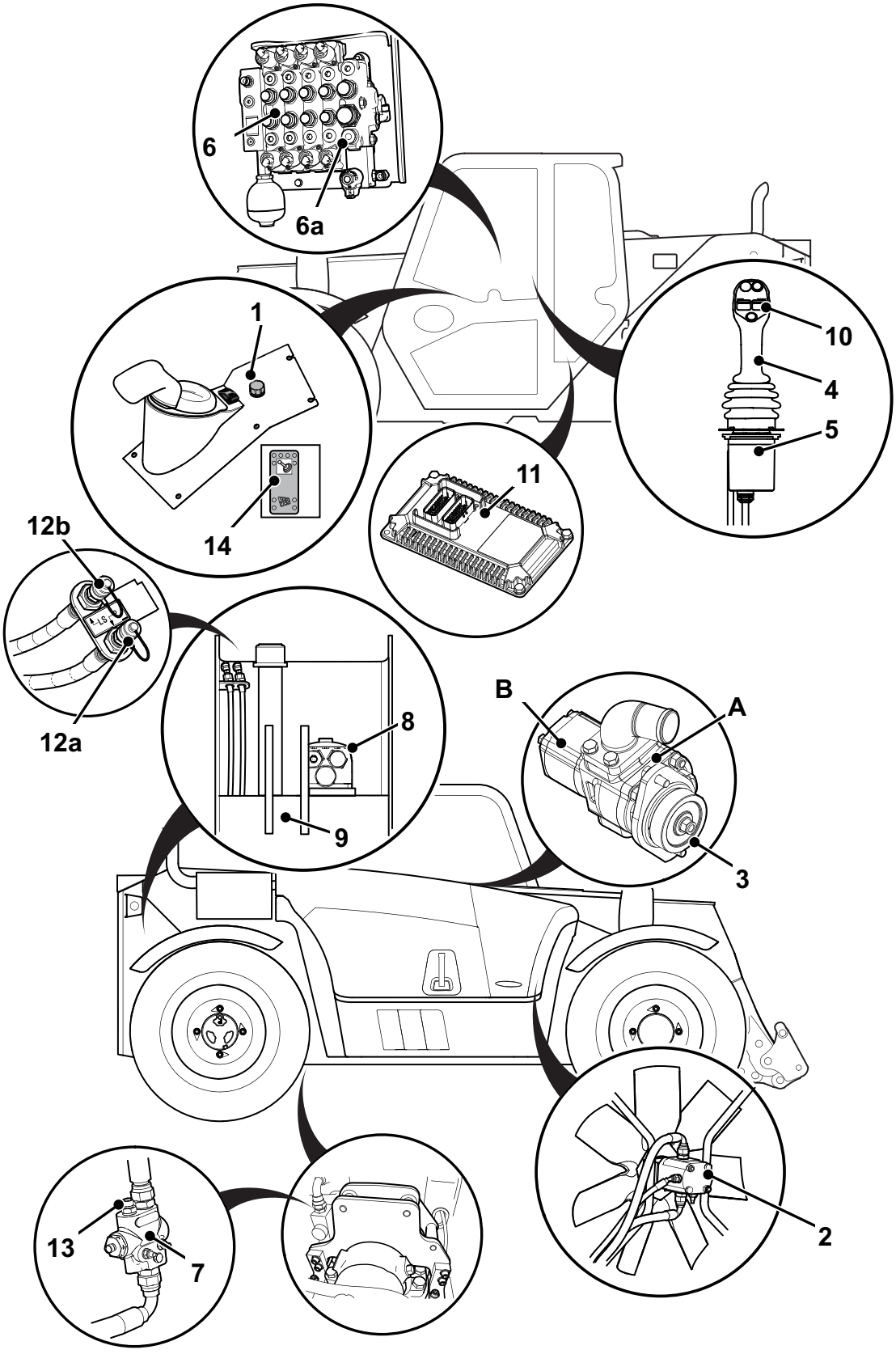


Fig 2. Component Location

Hydraulic Pump

⇨ *Fig 2. (E2-7)*

The hydraulic pump **3** pulls oil from the hydraulic tank **9**. The engine operates the pump.

The pump has two sections, **3A** and **3B**. Oil from the larger pump section **3A** flows direct to the control valve block **6**. Oil from pump section **3B** flows through the priority valve **7** and joins with the flow from **3A** to feed the control valve block **6**. Pump section **3B** also supplies the cooling fan motor **2**.

In neutral circuit conditions (i.e. no service selected), the oil flows through the control valve block neutral gallery into the return or exhaust line and back to tank **9** through an in-tank filter **8**.

Load Sensing

⇨ *Fig 2. (E2-7)*

The hydraulic system incorporates 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 control valve **6** and directly back to tank **9**.

When a service is operated, the system senses the demand and responds by increasing the pump operating pressure to a value slightly above that required to move the load. The load sense feature also incorporates the main pressure relief function, which is controlled by the load sense relief valve **6a**.

Electronic Servo Proportional Control

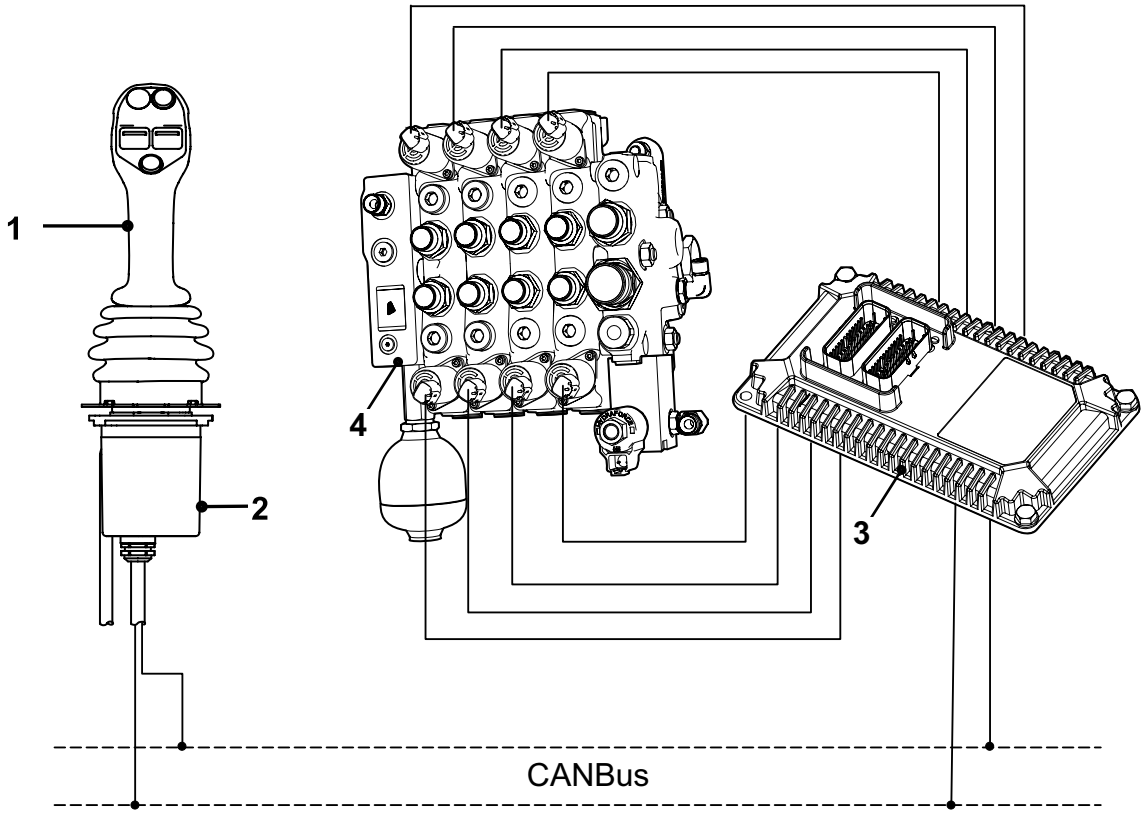


Fig 3. Electro Servo Control Lever

The control lever **1** and attached thumbwheels operate the hydraulic services using electrical signals.

This type of lever has two functions, Proportional thumbwheel control and electro servo lever control.

The control lever moves in two axis and also includes two thumbwheel switches. The control lever and thumbwheel switches control eight electro proportional solenoid valves which operate the four service spools in the valve block **4**.

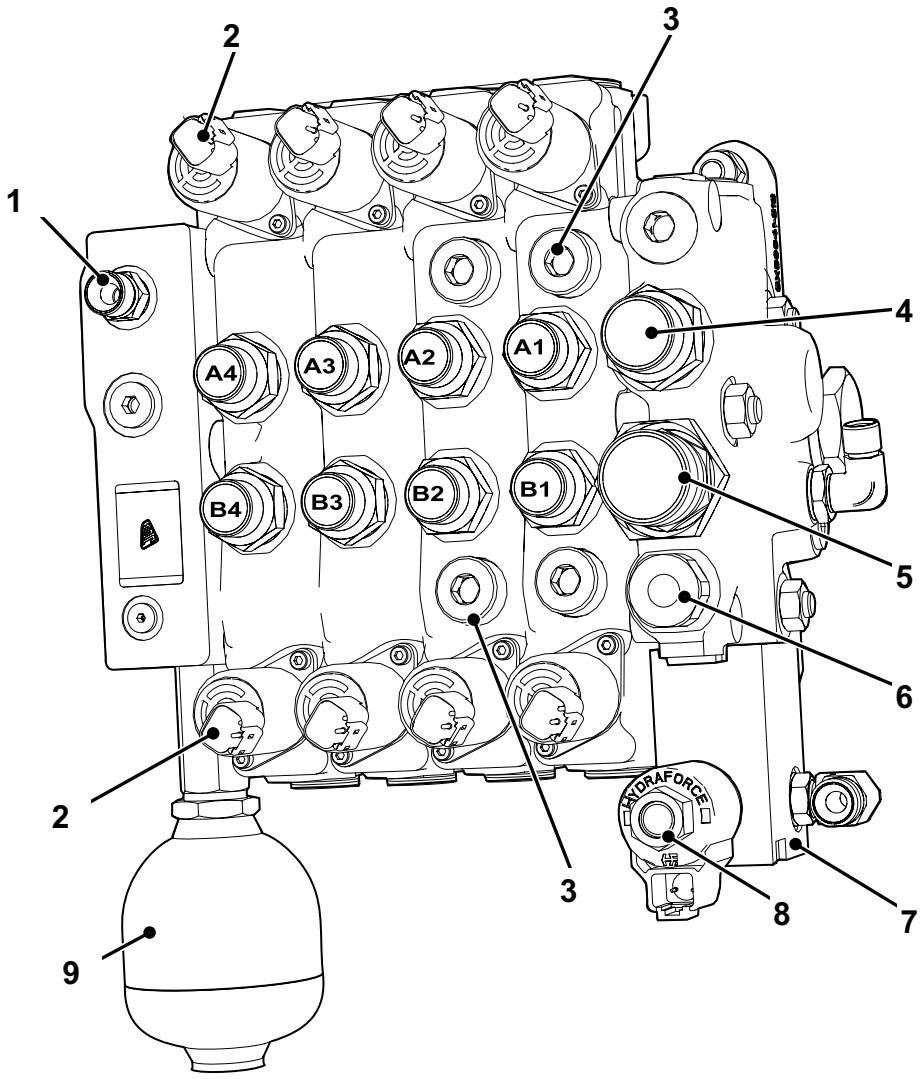
In the control lever assembly is the powerbase ECU **2**. The ECU receives analogue electrical inputs in relation to the movement of the lever or thumbwheel switches. The ECU changes the analogue signals and broadcasts messages on the machine CANbus.

The hydraulic control ECU **3** recognises the CAN messages and generates the correct PWM signal for operation of the proportional solenoids in the control valve block **4**.

The proportional solenoid valves operate as pressure reducing valves. These supply servo pilot oil to move the auxiliary, or extend retract service spool. The supply is at a pressure in relation to the amount the operator moves the joystick or thumbwheel switch. ⇨ ***Electro Servo Control Lever (E2-12)***

Electro Servo Control Valve

Component Identification



C093980-C1

Fig 4.

Item	Description
1	Sump Port
2	Proportional Solenoid
3	ARV
4	Inlet Port
5	Tank Return Port

Item	Description
6	LSRV
7	Unloader Block
8	Dump Solenoid
9	Accumulator

Pressure Compensation (Flowshare)

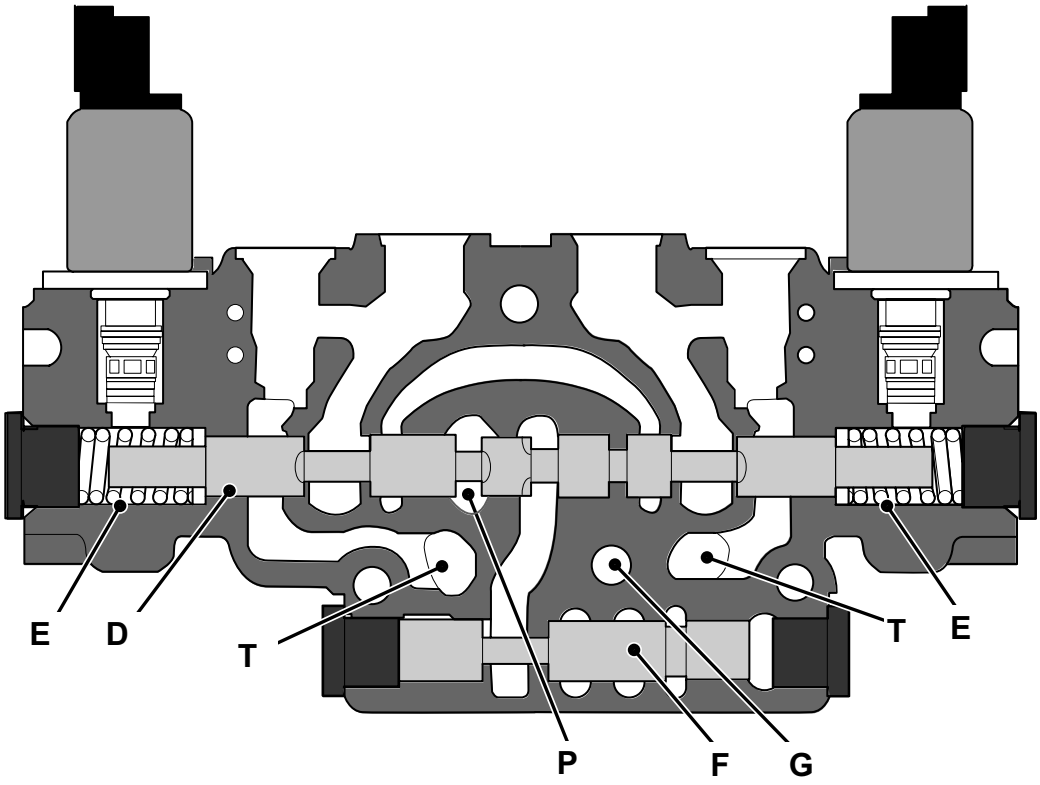


Fig 5. Servo Pilot Operated Spool

Each service spool incorporates a pressure compensator valve **F**. 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.

Oil from the main hydraulic pump arrives at the inlet gallery **P**. When the relevant service spool **D** is selected, the spool moves against the force of the centring spring **E**, allowing the oil to flow to move the required service. When the service spool **D** is de-selected the centring spring returns the spool to the neutral position.

When one or more services are selected the pressure compensator valve **F** detects the service generating the highest pressure and allows the pump to deliver oil at sufficient pressure to move the load. The load hold check valve **G** prevents the load falling back if the load pressure is greater than the pump pressure.

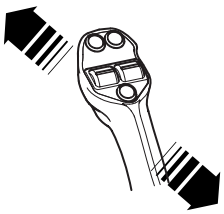
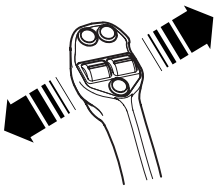
The closed centre design ensures consistent service operation regardless of load.

For a full description of service spool and pressure compensator valve operation. ⇨ ***Pressure Compensator Valves Operation (E2-20)***

Note: *Any pressure values stated are for illustration only, please see relevant specifications or schematic layout for correct pressures for the vehicle variant.*

Electro Servo Control Lever

The control lever **1** operates in two axis. It also includes two thumbwheel switches.

	Control Mode	Control System	Actuation
	Control lever - AXIS One	Proportional analogue electrical signal	Hydraulic control ECU via CAN message from the powerbase ECU
	Control lever - AXIS Two	Proportional analogue electrical signal	Hydraulic control ECU via CAN message from the powerbase ECU
	Thumbwheel One	Proportional analogue electrical signal	Hydraulic control ECU via CAN message from the powerbase ECU
	Thumbwheel Two	Proportional analogue electrical signal	Hydraulic control ECU via CAN message from the powerbase ECU

Note: *The control lever also incorporates switches for transmission control. Refer to* ***Section F****.* ⇨ ***Related Topics (E2-3)***

Hose and Pipework

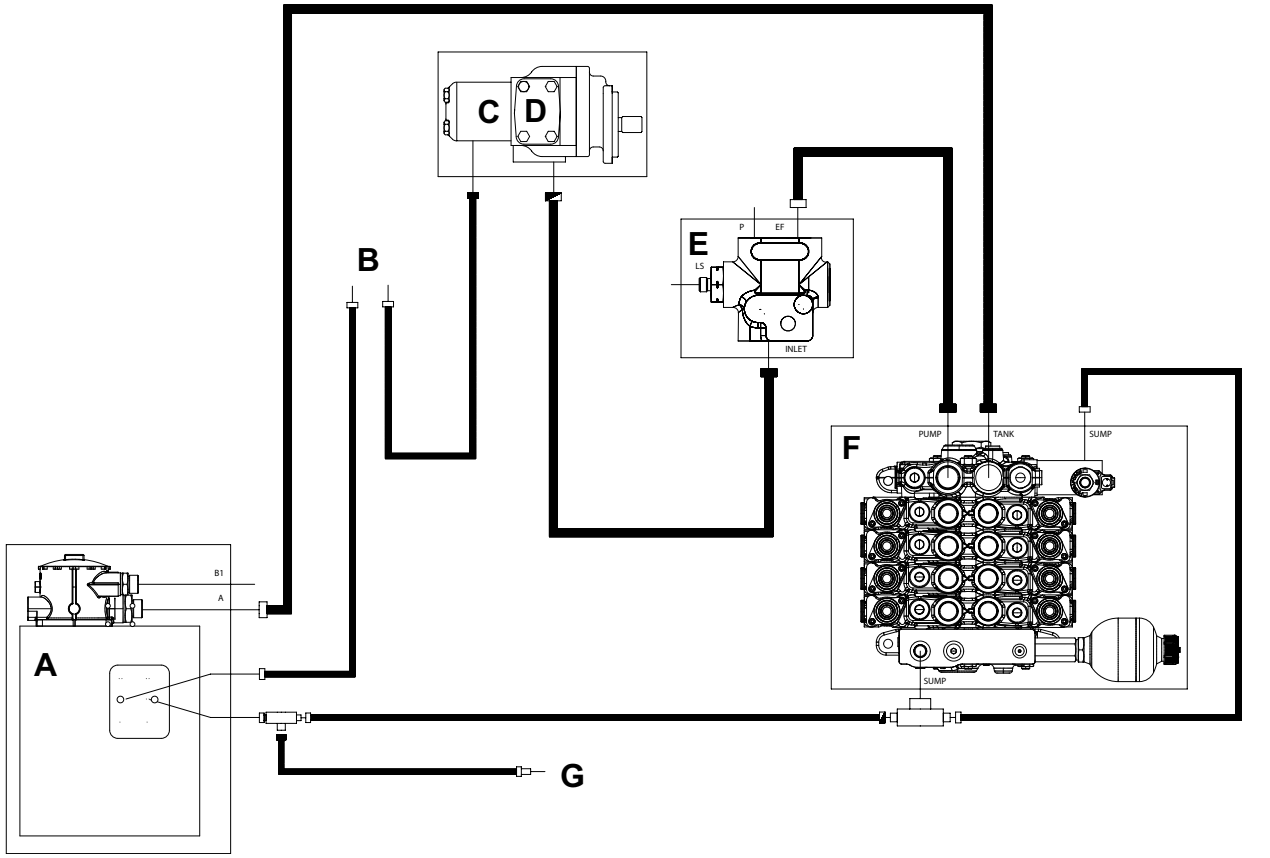


Fig 6.

A Hydraulic tank
B Steer valve pipework
C Fan supply pump
D Main hydraulic supply pump
E Priority Valve
F Control Valve
G Fan motor case drain

Hydraulic Operation and Schematics

To make the description as clear as possible the diagram shows only part of the full hydraulic system. For the full hydraulic schematics refer to the schematics topic. ⇨ *Related Topics (E2-3)*

No Services Operated

⇨ *Fig 7. (E2-15)*

Oil from the primary pump **1a** flows to the steer priority valve **1c**. When there is no demand from the steering system the hydraulic oil flows to the inlet section of the control valve **3**. As there is no load sense pressure the by-pass valve **3a** opens and the main pump flow is dumped to tank.

Return flow is dumped to tank **2** via return filter **5**.

Oil from pump **1B** flows to the hydraulic fan motor **4**.

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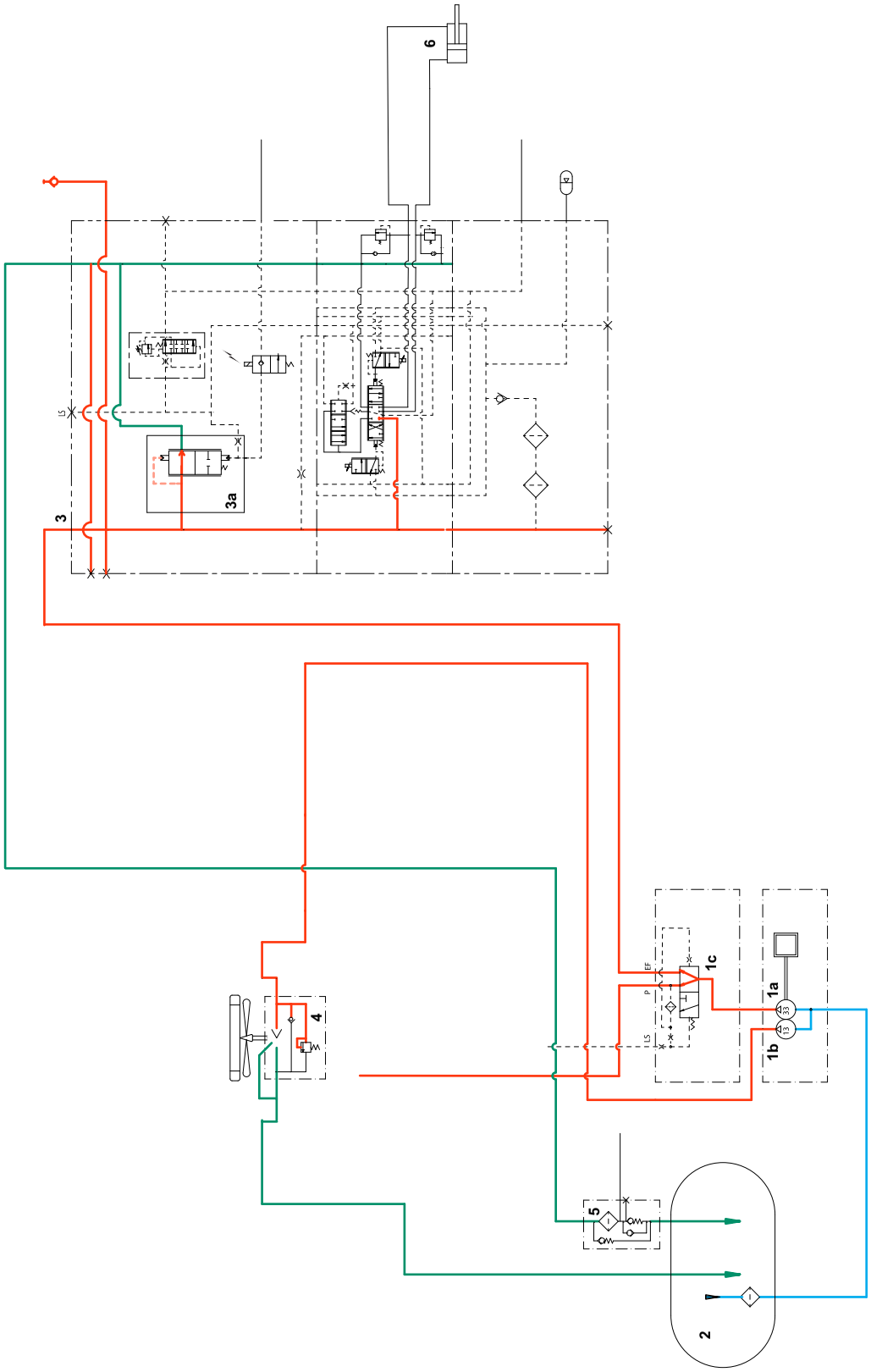


Fig 7. No Services Operated

Service Operation

⇨ *Fig 8. (E2-17)*

When a service is operated, the boom extend for example, movement of the control lever sends a signal to the ECU. The ECU energises the related proportional solenoid valve **3b** which operates and causes pilot oil to move the spool **3c**. Oil flows across the service spool to the pressure compensator valve **3e**. The valve opens and sends oil to the load sense gallery and load hold check valve **3f**.

During service operation the main system pressure continues to increase until the load hold check valve **3f** opens and the boom extend ram **6** operates.

Oil from the other side of the ram **6** flows across the service spool and back to the tank in the normal way.

Multiple Service Operation

⇨ *Fig 8. (E2-17)*

In the normal hydraulic system the services are connected in parallel. When multiple services are operated at the same time, the operating pressure of one service can have an effect on the speed of another service. This does not occur with this system.

The pressure compensator valves for each service adjust in relation to the differing load pressures. For example, when a pressure compensator valve **3e** senses a higher load sense pressure from another service, it decreases the flow to its own service. The decrease in flow makes sure that all the services operate at a stable speed independently of the main system pressure.

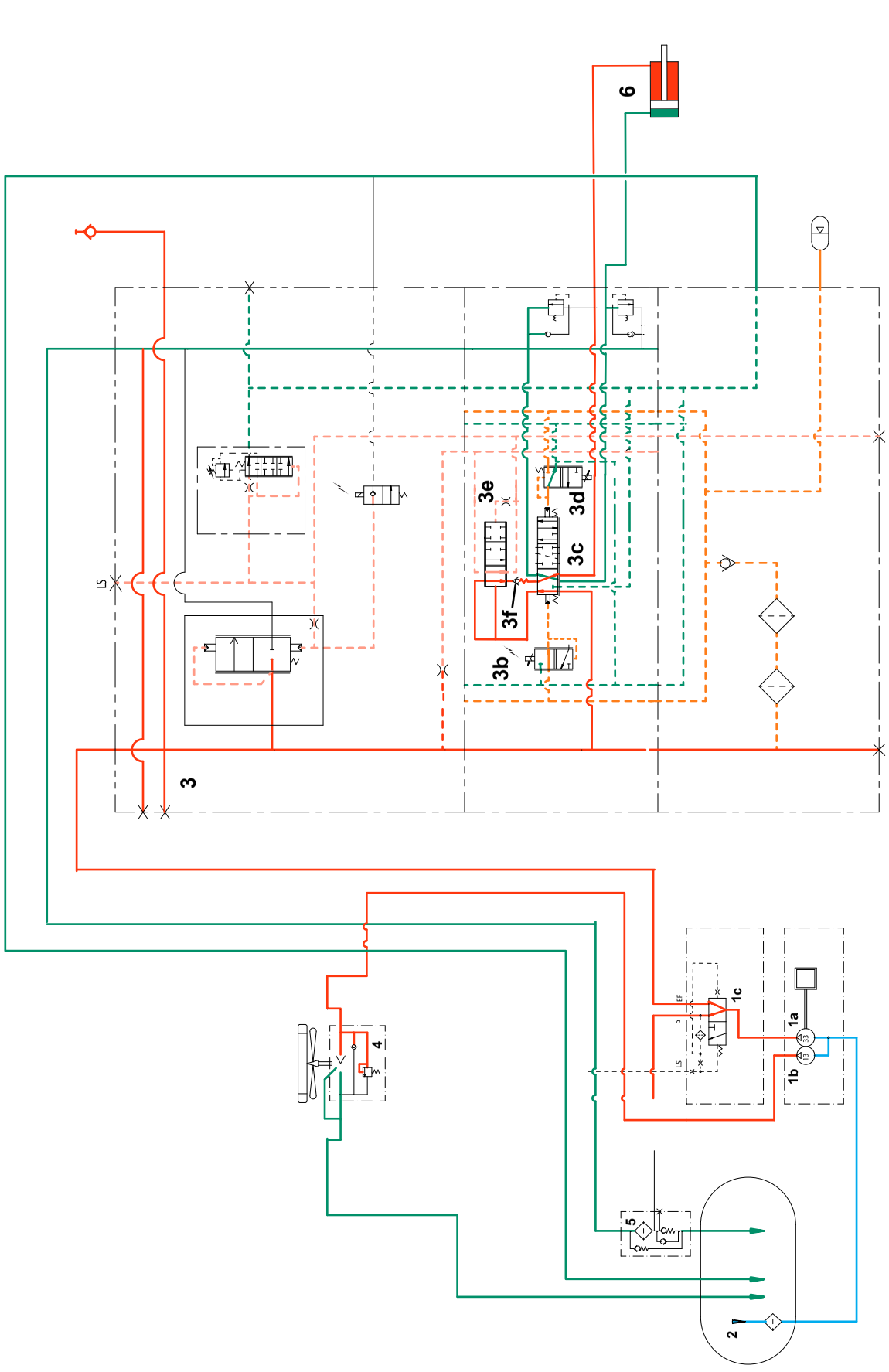


Fig 8. Service Operation

Main System Pressure Relief

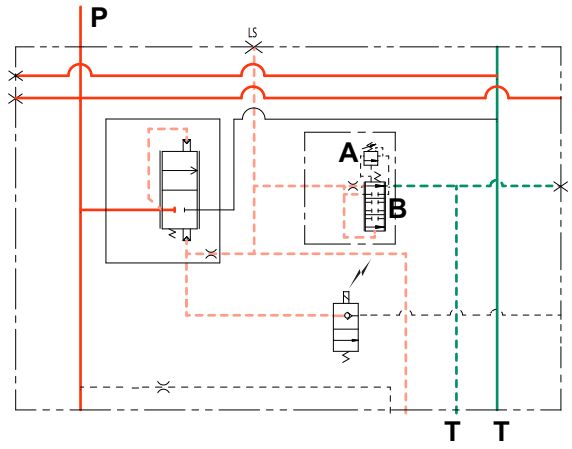


Fig 9. Main System Pressure Relief

When a service ram is at the end of its stroke or there is a resistance, the pressure in the load sense line increases. When this pressure is above 245 bar, the load sense relief valve (LSRV) **A** opens and load sense oil is sent to tank, to stop an increase in pressure.

The LSRV unit includes a drain regulator valve **B**. The drain regulator valve allows the excess load sense pressure to drain to tank when no spools are operated. The valve will close the drain line when the service spools are in operation.

Note: *Note: The pressure values given are examples for the purpose of explanation only. For the correct values see Technical Data. The load sense pressure relief valve is factory set and sealed with a plastic tamper proof cap. No adjustment is normally necessary.*

Auxiliary Relief Valve (ARV) Operation

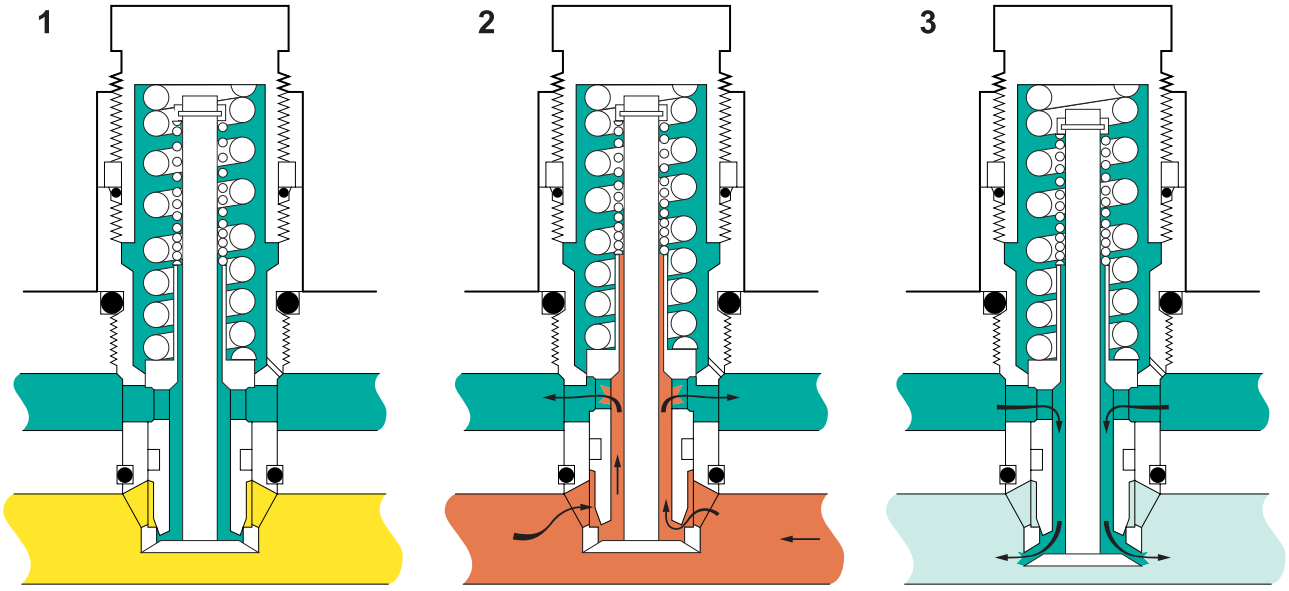


Fig 10.

The Auxiliary Relief Valves (A.R.V.'s) are situated in the control valve to limit potentially damaging pressures within specified services due to external loadings.

A.R.V.'s may also be used to limit the maximum pressure in a specified service to less than the L.S.R.V. setting.

1 Valve at Rest:

A service is selected but pressure in the service gallery (yellow) has not reached the setting of the A.R.V. which is held closed by its spring.

2 Poppet Opens:

The setting of the A.R.V. is exceeded by the service pressure which causes the poppet to rise against spring force allowing the pressure to be vented into the exhaust gallery (green).

3 Anti-cavitation Mode:

When a service is operated in such a way that low pressure, or cavitation, exists in the service line (light green), the relatively high pressure oil in the exhaust gallery (darker green) acts on the lower poppet and flows into the service gallery to make up the deficiency.

Pressure Compensator Valves Operation

No Service Selected (All Spools in Neutral)

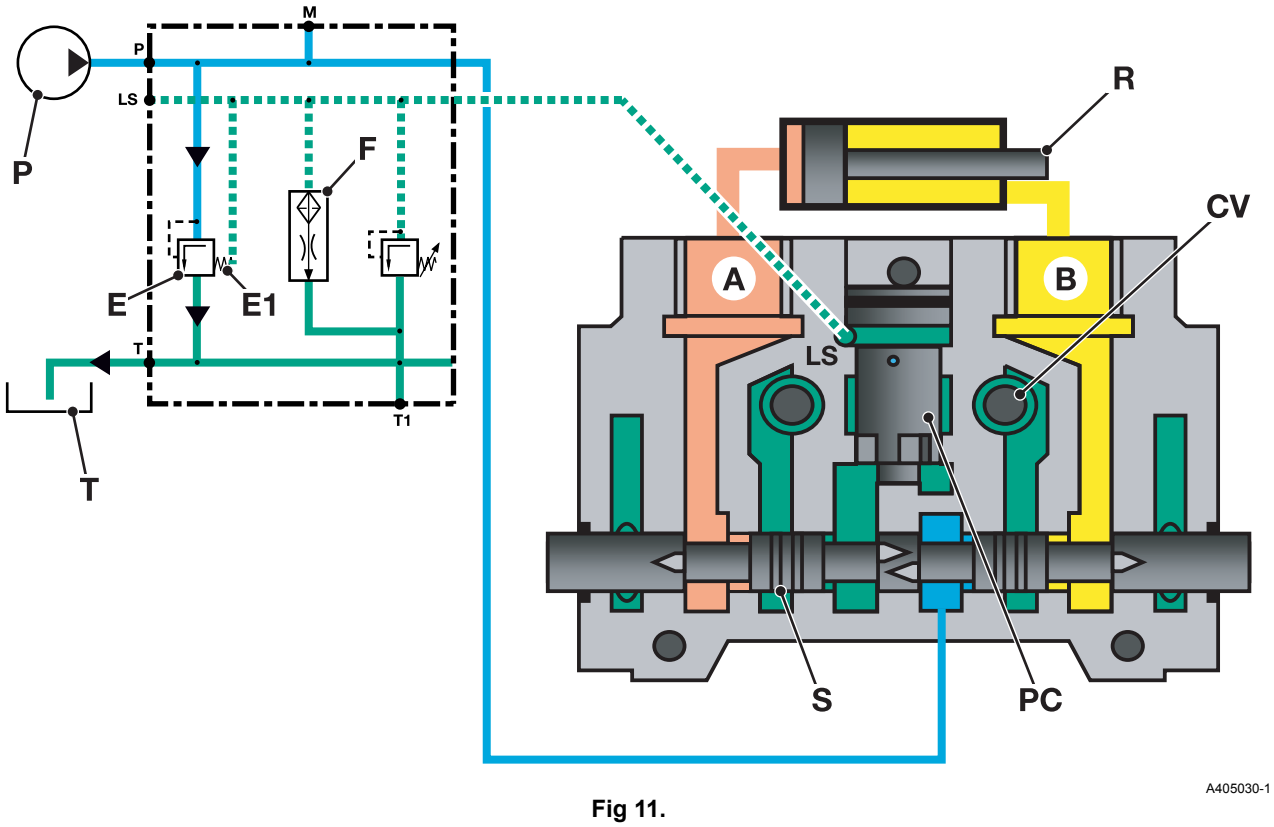


Fig 11.

With the spools in the neutral position oil from the pump **P** flows to each service spool **S** and is dead ended. This generates sufficient pressure (about 15 bar) to overcome the spring **E1** and oil flows across the flushing valve spool assembly **E** to tank **T**. Any load acting on the service ram **R** is held by the service spool **S**.

Oil in the load sense gallery **LS** is vented to tank across the flow regulator valve **F**. This allows the load sense pressure to decay when no service is selected. If the flow regulator valve is blocked, a reduced flow rate will be evident.

The pressure compensator valve **PC** and load hold check valves **CV** are closed.

Operating a Service

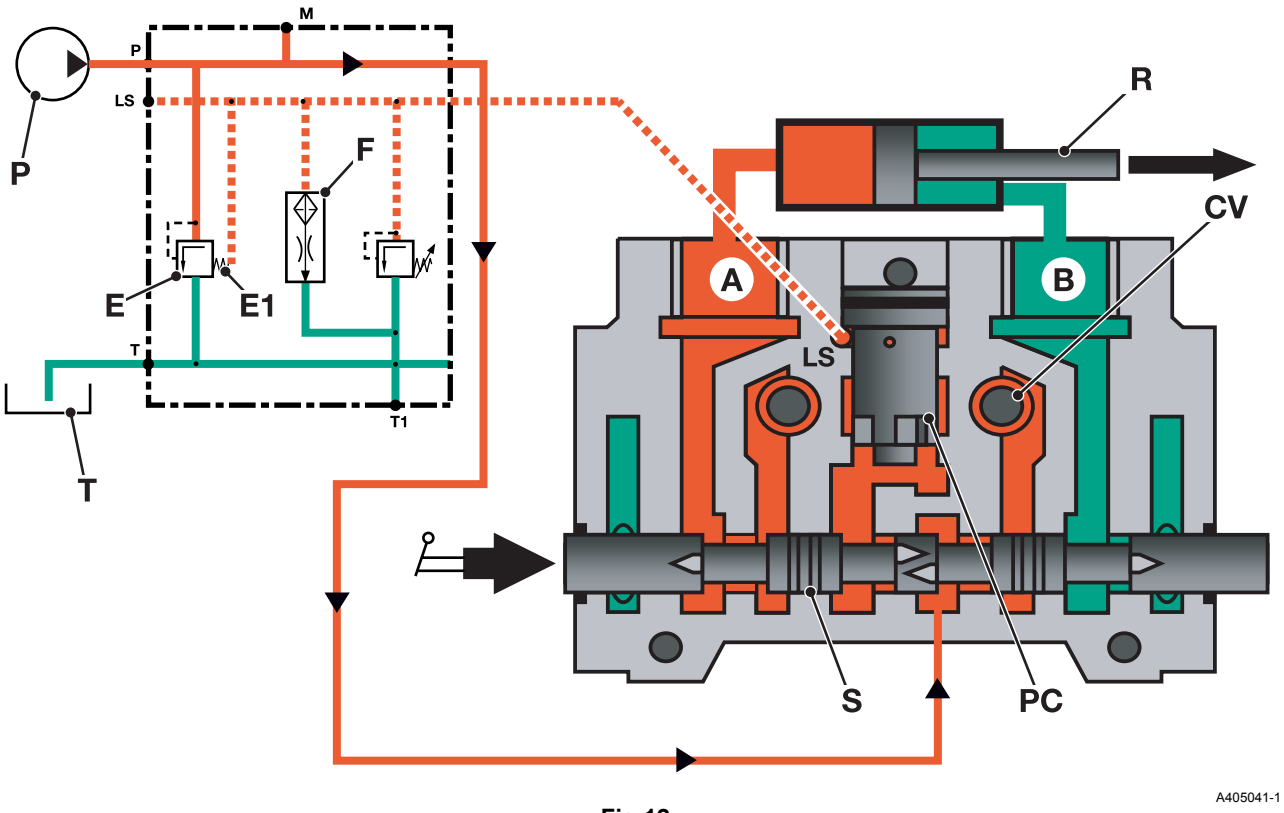


Fig 12.

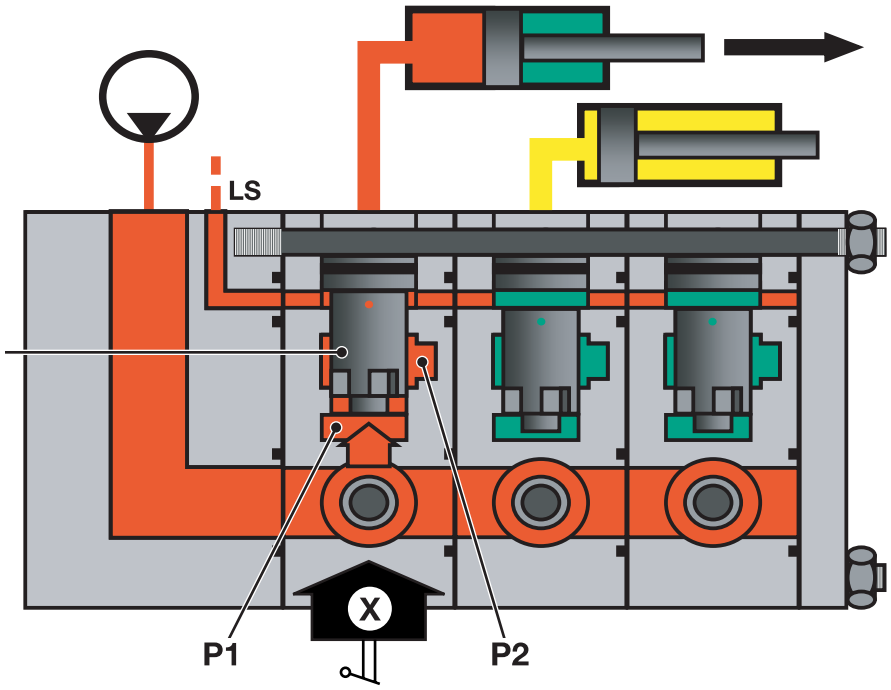
Pump pressure = Pressure in load sense gallery **LS** + pressure from spring **E1**.

When the service spool **S** is moved the oil from the pump **P** is connected to the gallery **P1**. The pressure in this chamber opens the pressure compensator valve **PC** allowing oil into the load sense gallery **LS**. Oil pressure builds in the gallery **LS** and the flushing valve spool **E** begins to close under the combined action of the oil pressure and spring force, causing the pump pressure to rise as follows:

When the pump pressure has risen sufficiently i.e. to a pressure equal to the load + spring pressure (15 bar) the load hold check valve **CV** moves off its seat and allows oil to flow into the service gallery **A**, initiating movement of the service ram **R**. Exhaust oil from the other side of the service ram is directed by the service spool **S** to tank.

The maximum load sense pressure and hence pump pressure is set by the load sense relief valve **G**.

Operating an Individual Service



714761-1

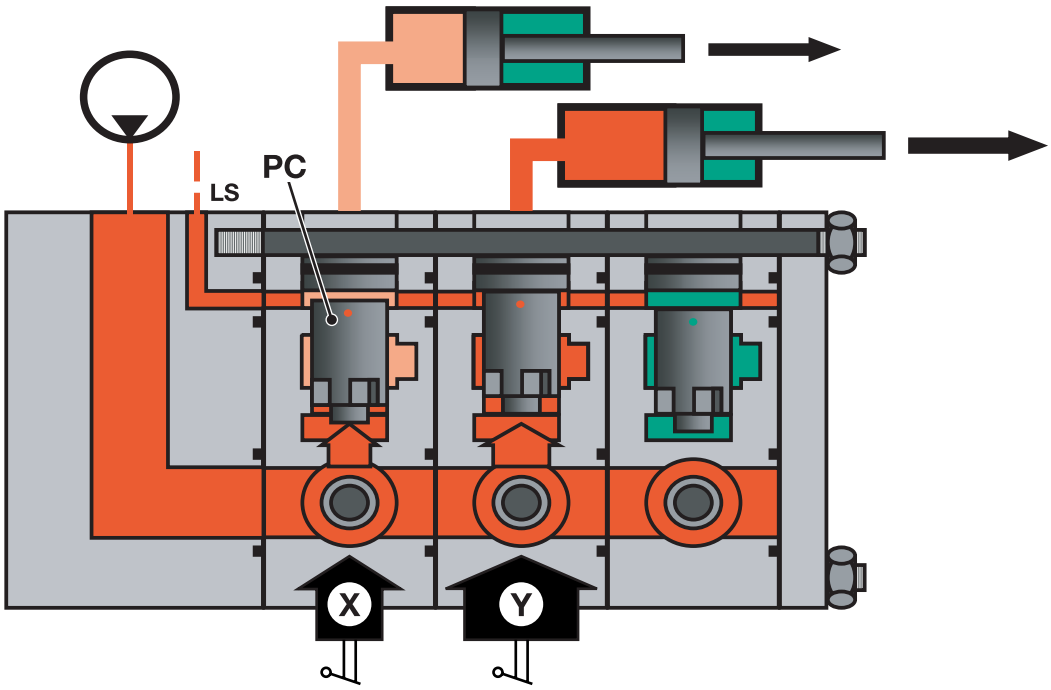
Fig 13.

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. 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 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.

Operating Multiple Services



714771-1

Fig 14.

Normal Condition

When another service with a higher load is operated simultaneously, a typical example is the lifting of the boom **X** and simultaneous operation of the tilt **Y** as shown. ⇨ *Fig 14. (E2-23)*

The higher load pressure in the tilt service causes the pressure compensator valve **PC** in the boom 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 boom service spool.

In this example, because of the action of the pressure compensator valve the boom service is always kept independent of the other services, the boom ram speed remains constant (as controlled by the boom service spool) and is not affected by the greater operating pressure in the tilt 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.

Parallel Lift

Ram Operation

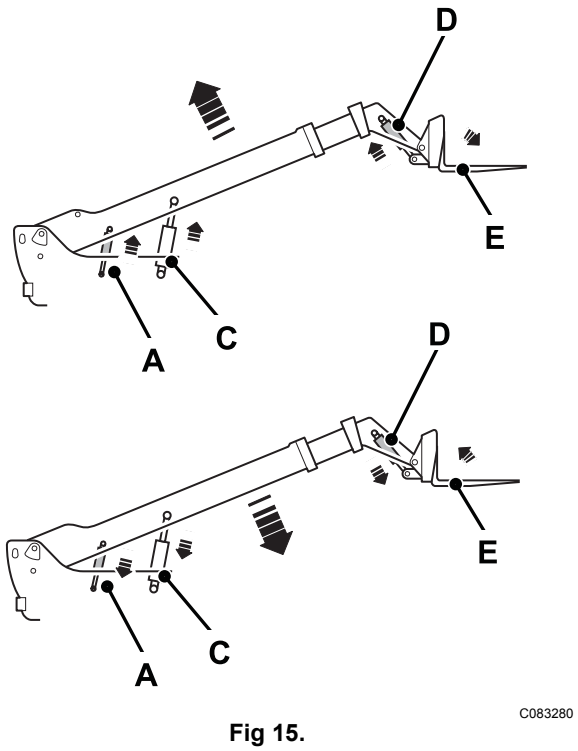


Fig 15.

The parallel lift system operates when the boom raises or lowers.

When the boom ram **C** raises or lowers the boom displacement ram **A** extends or retracts. Oil displaced by the ram **A** flows to the tilt ram **D** which extends or retracts keeping the forks **E** parallel with the ground.

Boom Raise Cycle

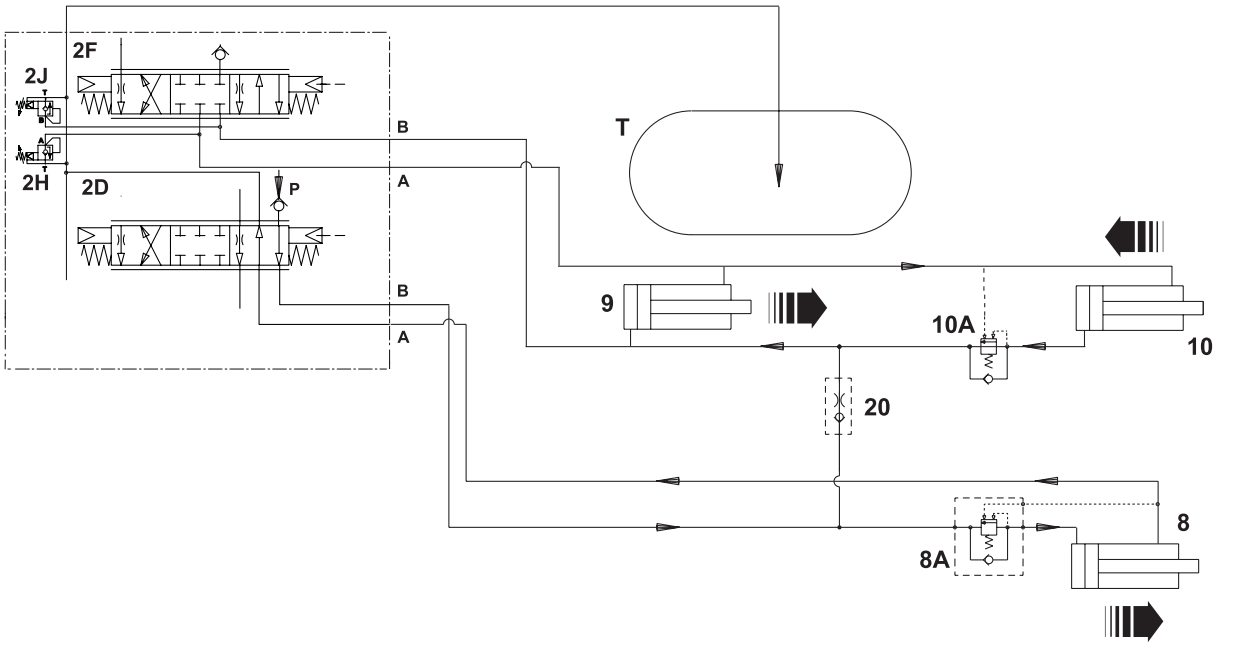


Fig 16. Boom Raise Cycle

When lift spool **2D** is selected, the neutral circuit is blocked and oil feeds lift ram hose-burst check-valve **8A**. Oil flows through free flow direction of hose burst check valve (HBCV) **8A** and lifts the boom.

Oil is forced out of the rod side of displacement ram **9** as the boom rises. The oil cannot flow past the tilt spool **2F**, as the spool is not selected. Instead, it flows to the rod side of tilt ram **10**. Oil displaced from the head side of the tilt ram raises pilot pressure in HBCV **10A**. This allows oil to feed back to the head side of the displacement ram.

Displacement/lift link valve **20** is fitted between lift spool **2D** and tilt spool **2F.** The function of this valve is to allow a restricted flow of oil into the tilt circuit to increase the lift force available by utilising the displacement ram.

Auxiliary relief valve (ARV) **2J** opens to protect the tilt ram from over pressurisation. The anti-cavitation feature of valve **2H** ensures that, in these circumstances, the tilt and displacement rams will not cavitate.

Boom Lower Cycle

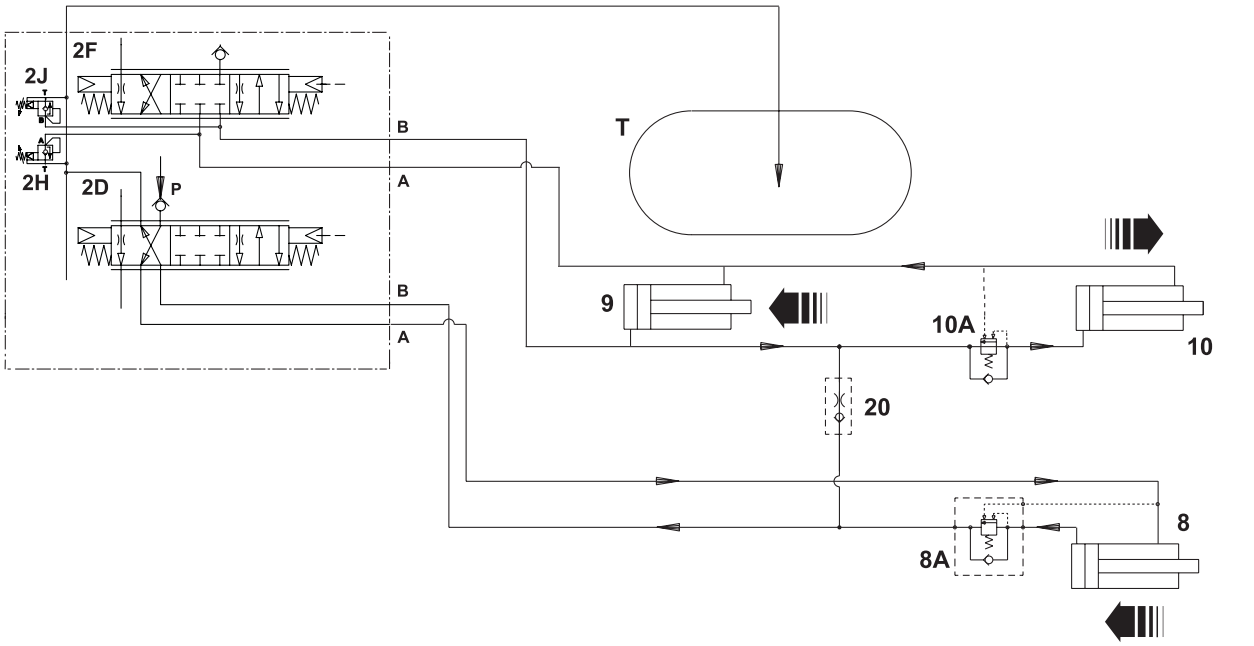


Fig 17. Boom Lower Cycle

When raise/lower spool **2D** is selected, the neutral circuit is blocked and oil feeds the rod side of lift ram **8**. Oil displaced from the head side of the lift ram raises pilot pressure in HBCV **8A** and allows oil out of the lift ram back to tank, lowering the boom.

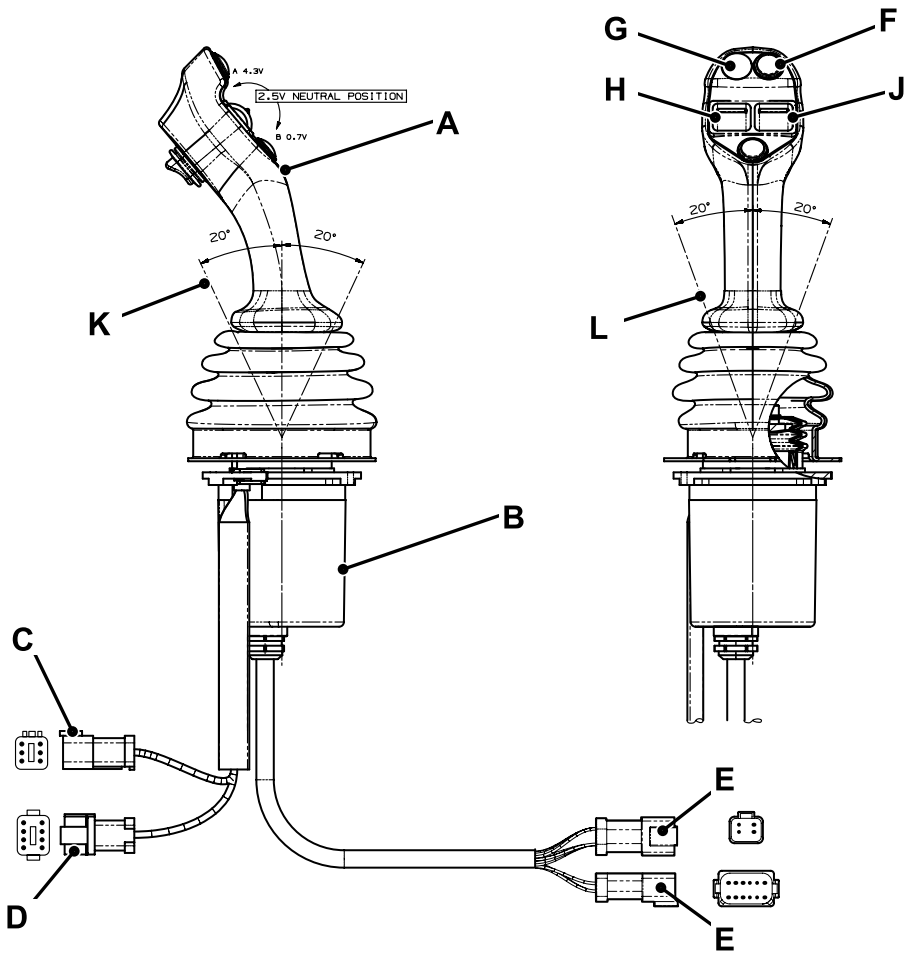
As the boom lowers, oil is forced from the head side of the displacement ram **9**. The oil cannot flow past tilt spool **2F**, as the spool is not selected. Instead, it flows through free flow direction of HBCV **10A** to the head side of the tilt ram **10**.

Displaced oil from the displacement ram closes the check valve in displacement/lift link valve **20**.

Auxiliary relief valve (ARV) **2H** opens to protect the tilt ram from over pressurisation. The anti-cavitation feature of valve **2J** ensures that, in these circumstances, the tilt and displacement rams will not cavitate.

Electrical Operation and Schematics

Electro Servo Control



C048030-C3

Fig 18.

All of the machine hydraulic services are actuated electrically. Electronic control units and proportional solenoid valves are central to the system.

A	Main control lever handle
B	Powerbase PWM ECU
C	Electrical connector - Thumbwheels and auxiliary II button
D	Electrical connector - Constant auxiliary button
E	Electrical connectors - Powerbase PWM ECU
F	Constant flow button
G	Auxiliary II button
H	Axis 3 - Thumbwheel
J	Axis 4 - Thumbwheel
K	Axis 1 - Raise Lower
L	Axis 2 - Carriage tilt

⇨ *Fig 19. (E2-28)*

Movement of the control lever **A** causes an electrical signal proportional to the lever movement. The Powerbase ECU **E** monitors these signals (inputs) and converts the voltage into a corresponding valve current signal (output) to the relevant solenoid valve coil.

Electro Servo Control - Proportional Signal Generation

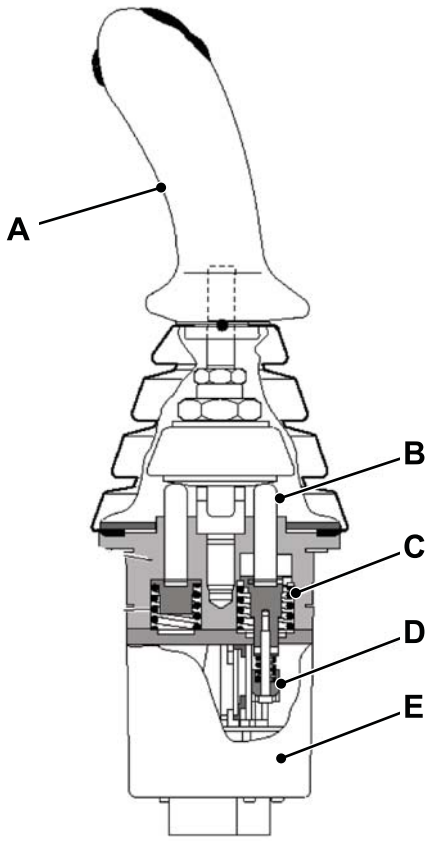


Fig 19.

⇨ *Fig 19. (E2-28)*

When the control lever **A** is operated, the plunger **B** pushes against the return spring **C**. A variable resistor position sensor is allocated to each axis. Slider **D** moves up or down when the lever is moved changing the electrical voltage depending on lever position.

Note: *The position sensors are integral with the Powerbase ECU. If a sensor is defective the Powerbase must be renewed.*

Electro Servo Control - Operator Interface

Electrical schematics are provided for several operational states of the electro servo control. A description and cross reference for the applicable schematic is given in the table.

Operator Interface	Electrical Schematic	Control/Indicator Function
Joystick control lever	⇒ *Electro Servo Control Lever (E2-12)*	Proportional control of all the hydraulic services by means of moving the lever and thumbwheel switches.
Constant auxiliary system enable switch	⇒ *Constant Auxiliary (E2-33)*	Momentary switch. Press to enable the constant auxiliary system. The system will not enable until the engine is running.
Constant auxiliary set button	⇒ *Constant Auxiliary (E2-33)*	Momentary button. Press to set the constant auxiliary flow setting. For the switch to function first enable the constant auxiliary system.
Auxiliary II select button	⇒ *Second Auxiliary Changeover (E2-30)*	Momentary button. Press to change between Auxiliary I and Auxiliary II. The system will not function until the engine is running. The system will not function if the constant auxiliary system is enabled.
LED indicator - constant auxiliary mode	⇒ *Constant Auxiliary (E2-33)*	LED is ON when the constant auxiliary system is enabled.
LED indicator - Auxiliary II mode	⇒ *Second Auxiliary Changeover (E2-30)*	LED is ON when Auxiliary II is enabled.
Hydraulic system Isolation	⇒ *System Isolation (E2-35)*	System isolation switches.

Second Auxiliary Changeover

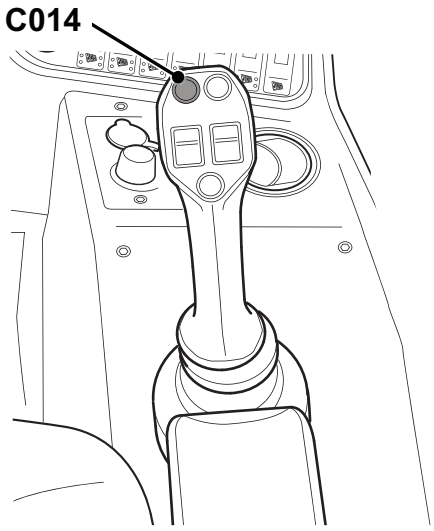


Fig 20.

When momentary switch **C014** is pressed the joystick powerbase ECU **C016** senses the switch input. It responds by broadcasting a message on the machine CAN bus. The CAN message is read by the hydraulic control ECU CAN bus interface on connector **C049**. The ECU responds by energising the relay **P09**. Auxiliary changeover solenoid valve coil **B003** is energised and oil is diverted to the Auxiliary II circuit.

A CAN message causes the LMS display AUX II indicator LED to come ON.

When momentary switch **C014** pressed again the hydraulic control ECU responds by de-energising the relay **P09**. Auxiliary changeover solenoid valve coil **B003** is de-energised and oil is diverted to the Auxiliary I circuit.

A CAN message causes the LMS display AUX II indicator LED to go OFF.

Component Key:	
B003	Auxiliary 2 Solenoid
C010	Chassis Earth Point
C013	Joystick Lever connector 1
C014	Joystick Lever connector 2
C016	Joystick Powerbase ECU
C032/ B001	Chassis Harness to Boom Harness connector
C049 - J2	Hydraulic Control ECU connector J2
P09	Auxiliary Changeover Relay
P15 - J2	LMS ECU connector J2
P36	Earth Point
P44/C044	Chassis Harness to Panel Harness connector 3

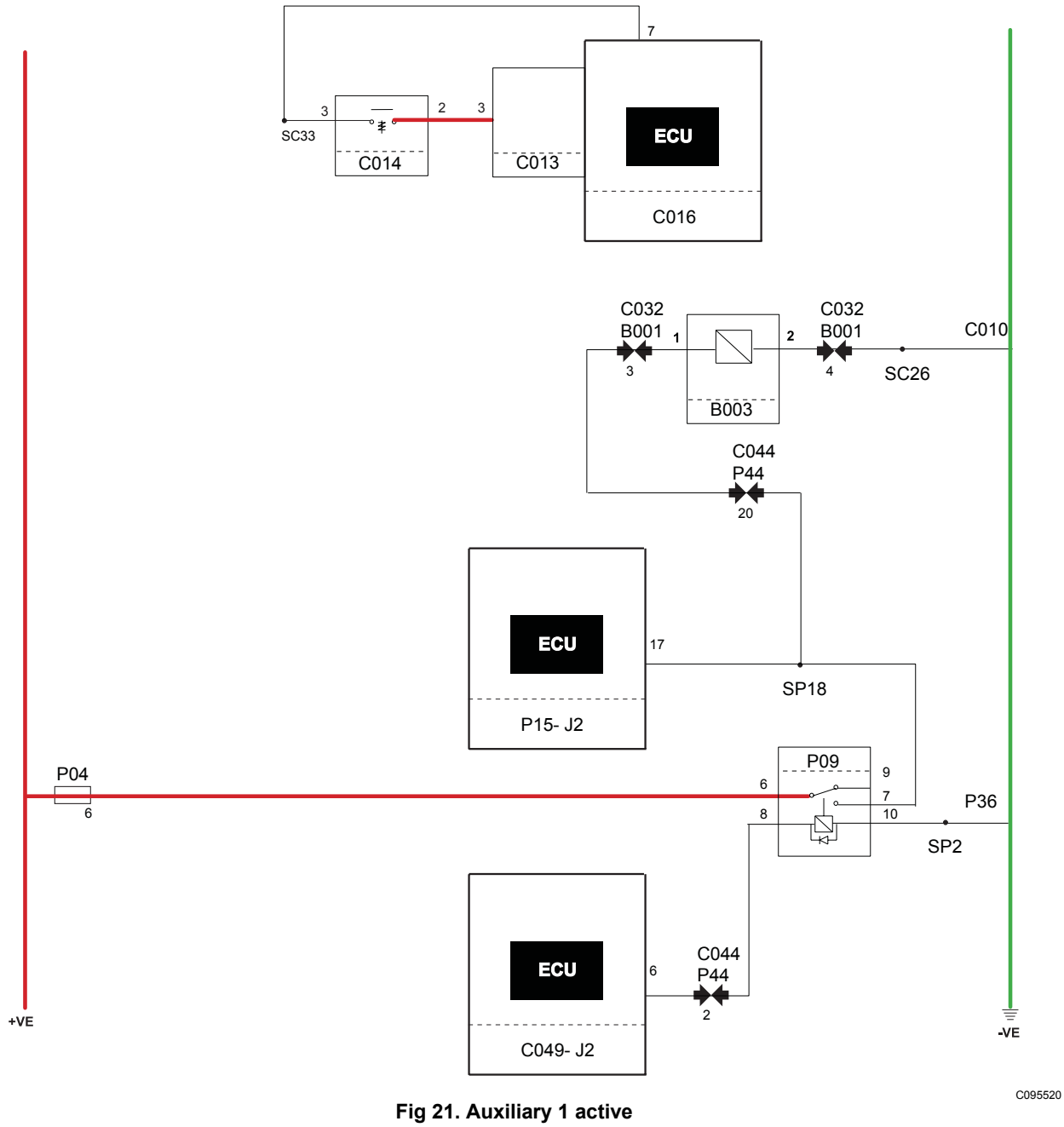


Fig 21. Auxiliary 1 active

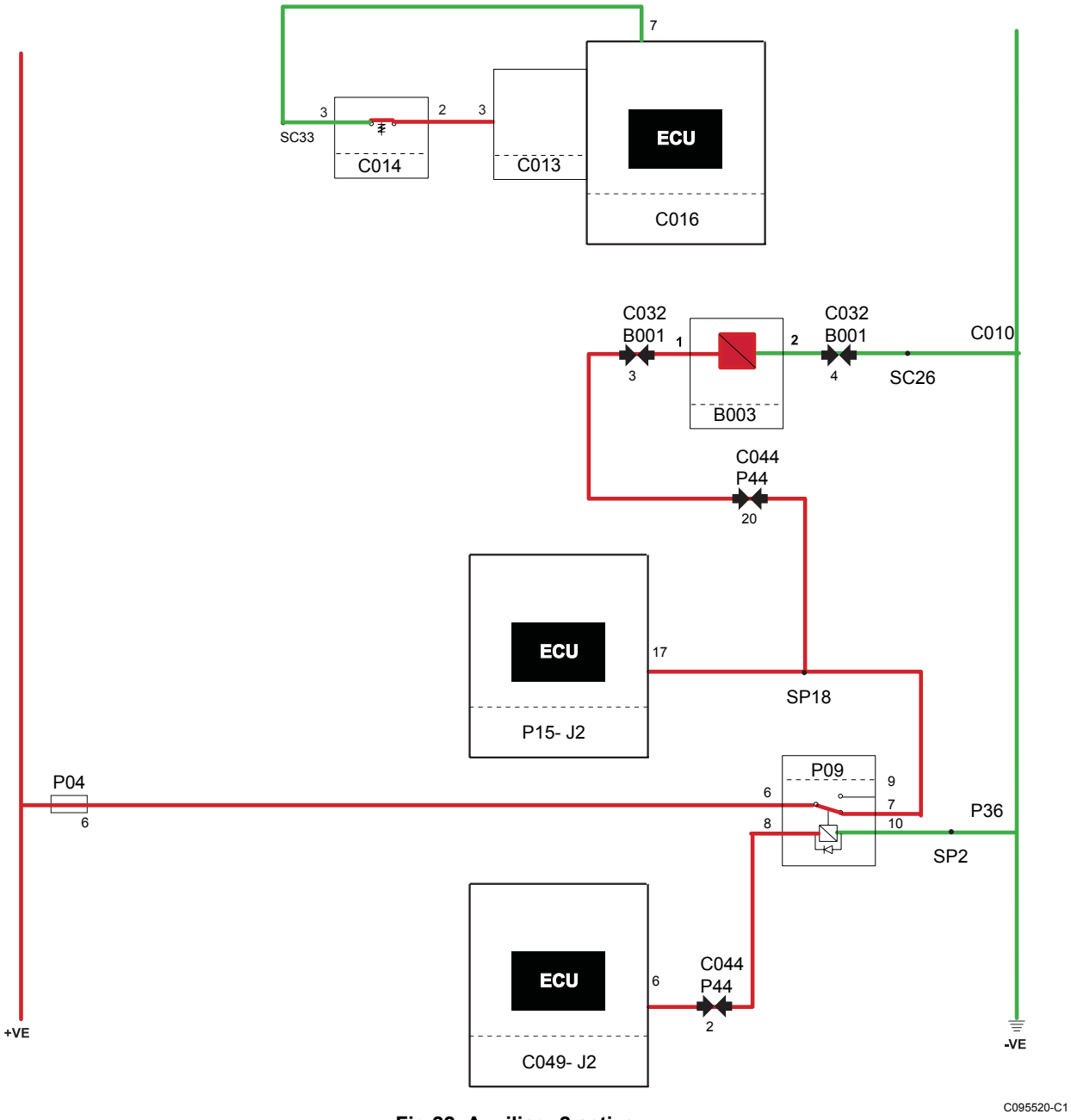


Fig 22. Auxiliary 2 active

Constant Auxiliary

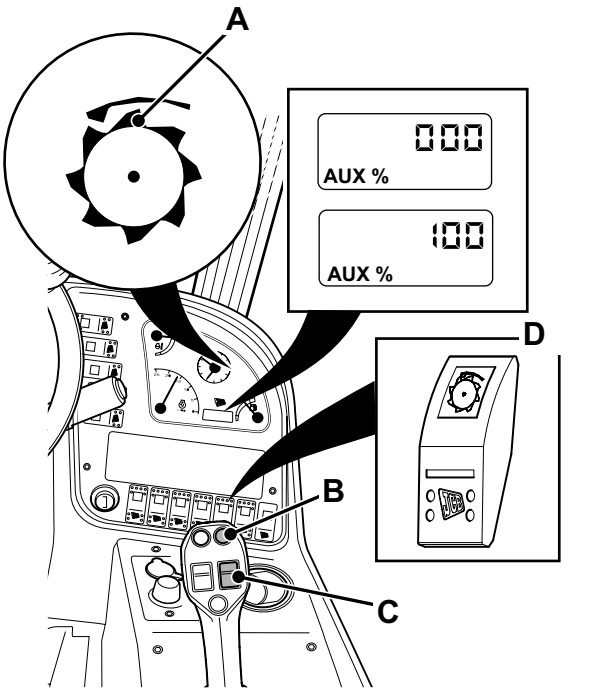


Fig 23.

To enter constant auxiliary mode the switch **D** is pressed which sends a signal to the hydraulic control ECU to activate the constant auxiliary circuit.

The constant auxiliary mode is controlled by the On/Off switch **B** and the thumbwheel **C**.

A CAN message causes the LMS display constant auxiliary indicator LED **A** to come ON.

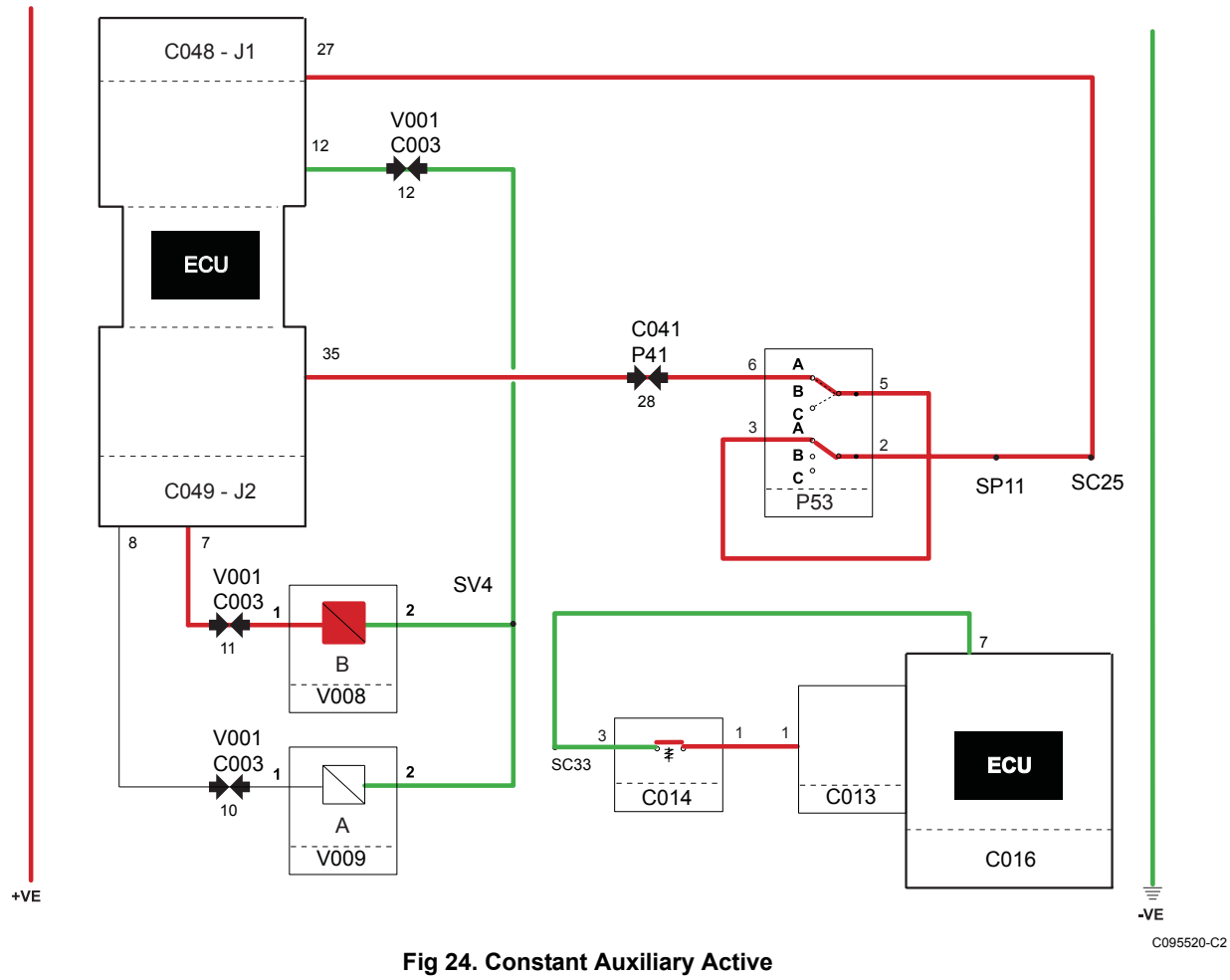


Fig 24. Constant Auxiliary Active

When the switch **P53** is pressed the machine enters constant auxiliary mode. This will not activate if the machine is in second auxiliary mode. ⇨ *Second Auxiliary Changeover (E2-30)*

When the momentary switch **C014** is pressed the powerbase ECU **C016** senses the switch input. It responds by broadcasting a message on the machine CAN bus. The CAN message is read by the hydraulic control ECU CAN bus interface on connector **C048**. The ECU responds by holding the auxiliary spool V**008/V009** in the position set by the operator (thumbwheel switch position). The selected spool position is also stored by the ECU and is automatically re-selected when the operator selects the constant auxiliary function again.

Component Key:	
C003/ V001	Chassis Harness to Valve Block Harness connector
C013	Joystick Lever connector 1
C014	Joystick Lever connector 2
C016	Joystick Powerbase ECU
C048 - J1	Hydraulic Control ECU connector J1
C049 - J2	Hydraulic Control ECU connector J2
P41/C041	Chassis Harness to Panel Harness connector 3
P53	Constant Auxiliary Switch
V008	Auxiliary B Solenoid
V009	Auxiliary A Solenoid

System Isolation

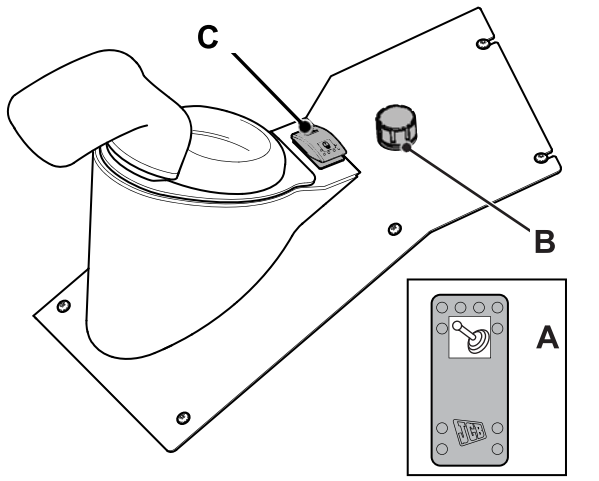


Fig 25.

The joystick isolation switch **A** when operated isolates all of the hydraulic functions.

If this fails to isolate the controls an emergency isolation switch is fitted **B**.

The tilt lock switch **C** when operated isolates the tilt hydraulic service.

Component Key:	
C003/ V001	Chassis Harness to Valve Block Harness connector
C022	Tilt Isolation Switch
C037	Earth Point
C048 - J1	Hydraulic Control ECU connector J1
C049 - J2	Hydraulic Control ECU connector J2
C057	Emergency Isolation Switch
P01/C001	Chassis Harness to Panel Harness connector 1
P44/C044	Chassis Harness to Panel Harness connector 2
P57	Lever Isolation Switch
V010	Isolation Solenoid

When switch **C057** is operated its input is sensed by hydraulic control ECU via connector **C049**. The ECU energises the isolation solenoid coil **V010**.

Tilt isolation switch **C022** state is sensed by inputs at the hydraulic control ECU connector via **C048**. The ECU isolates the joystick control by switching off the PWM signals to the control valve tilt spool proportional solenoids.

Joystick isolation switch **P57** state is sensed by inputs at the hydraulic control ECU via connector **C049**. The ECU isolates the joystick controls by switching off the PWM signals to the control valve proportional solenoids.

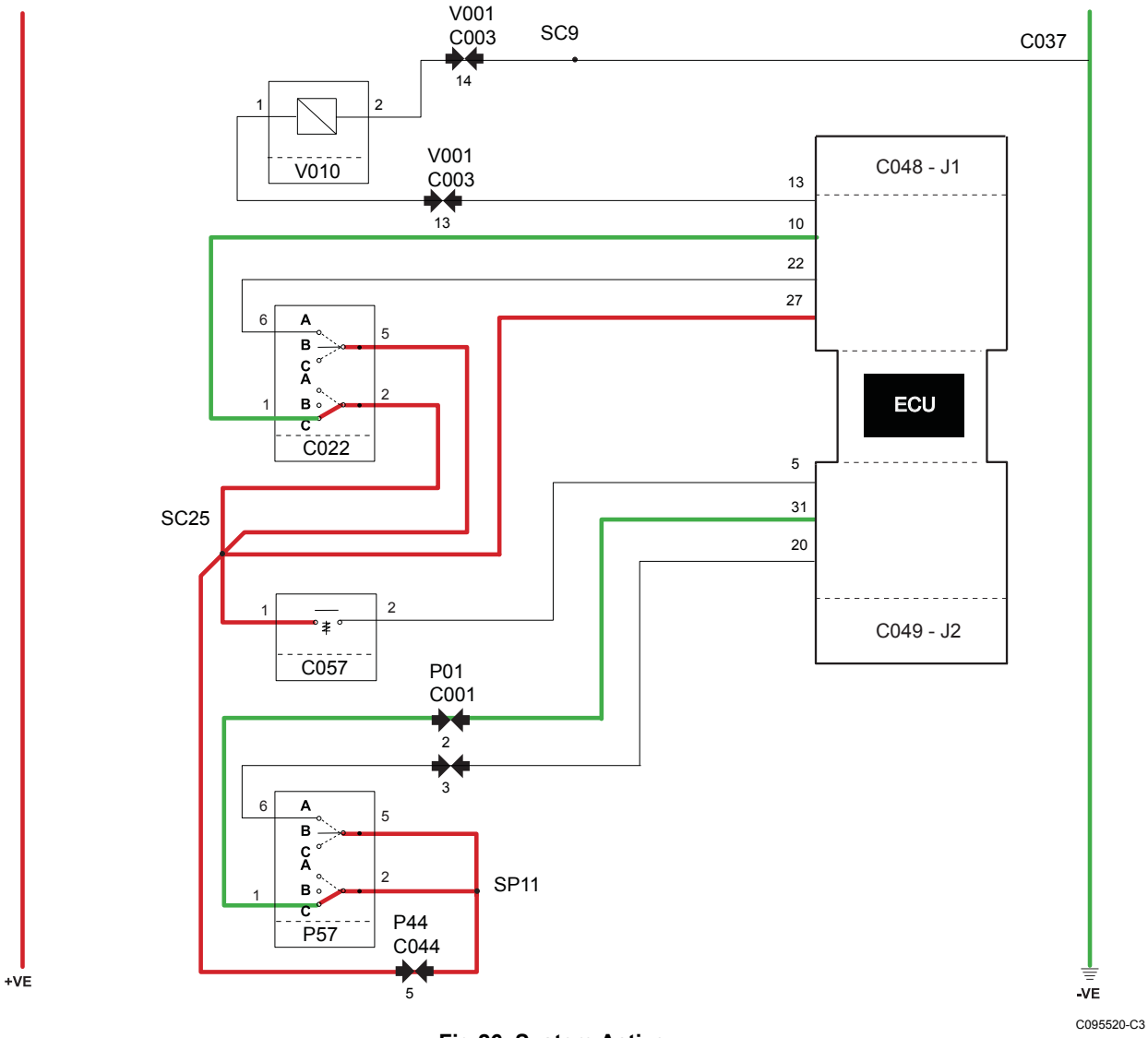


Fig 26. System Active

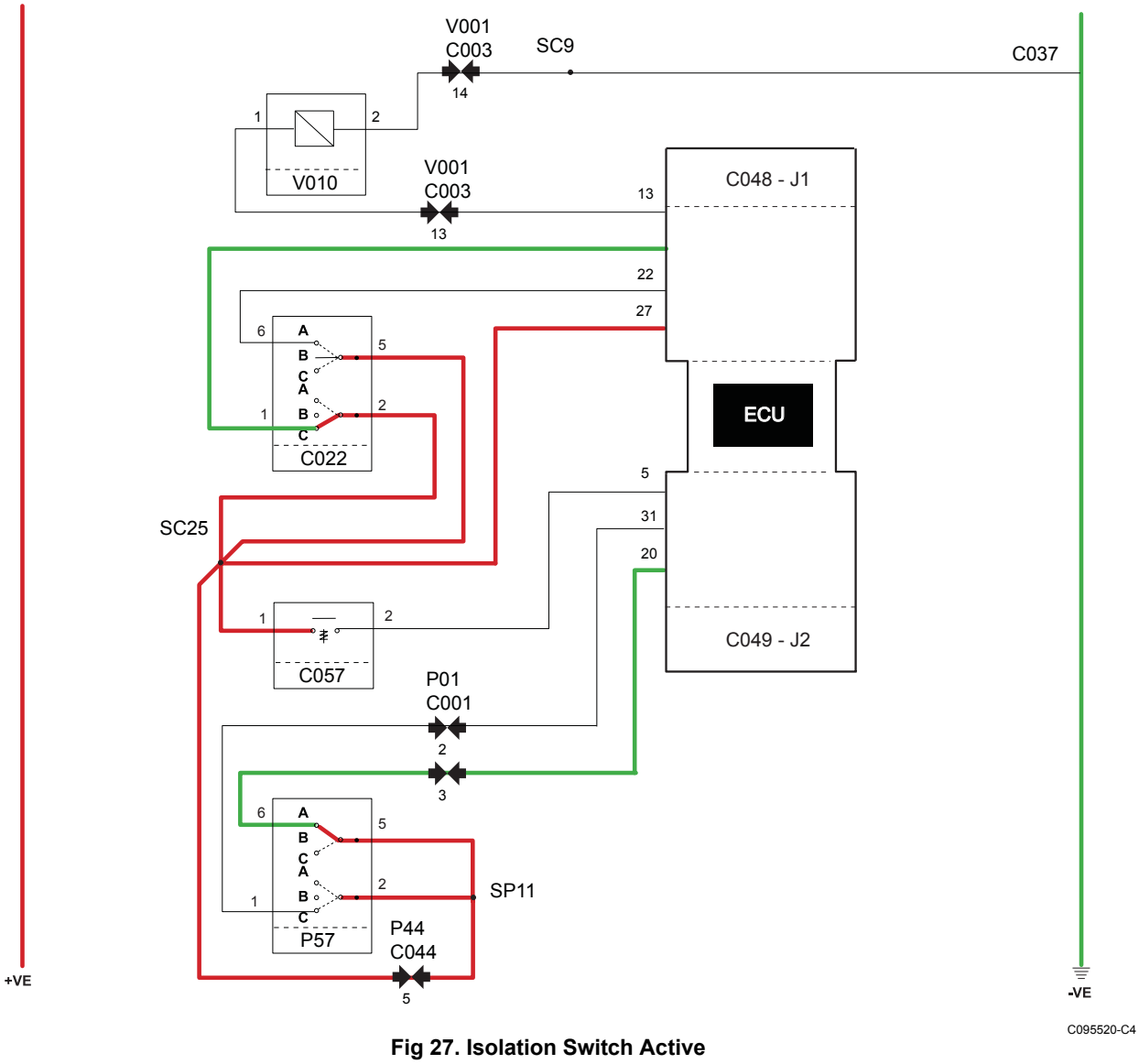


Fig 27. Isolation Switch Active

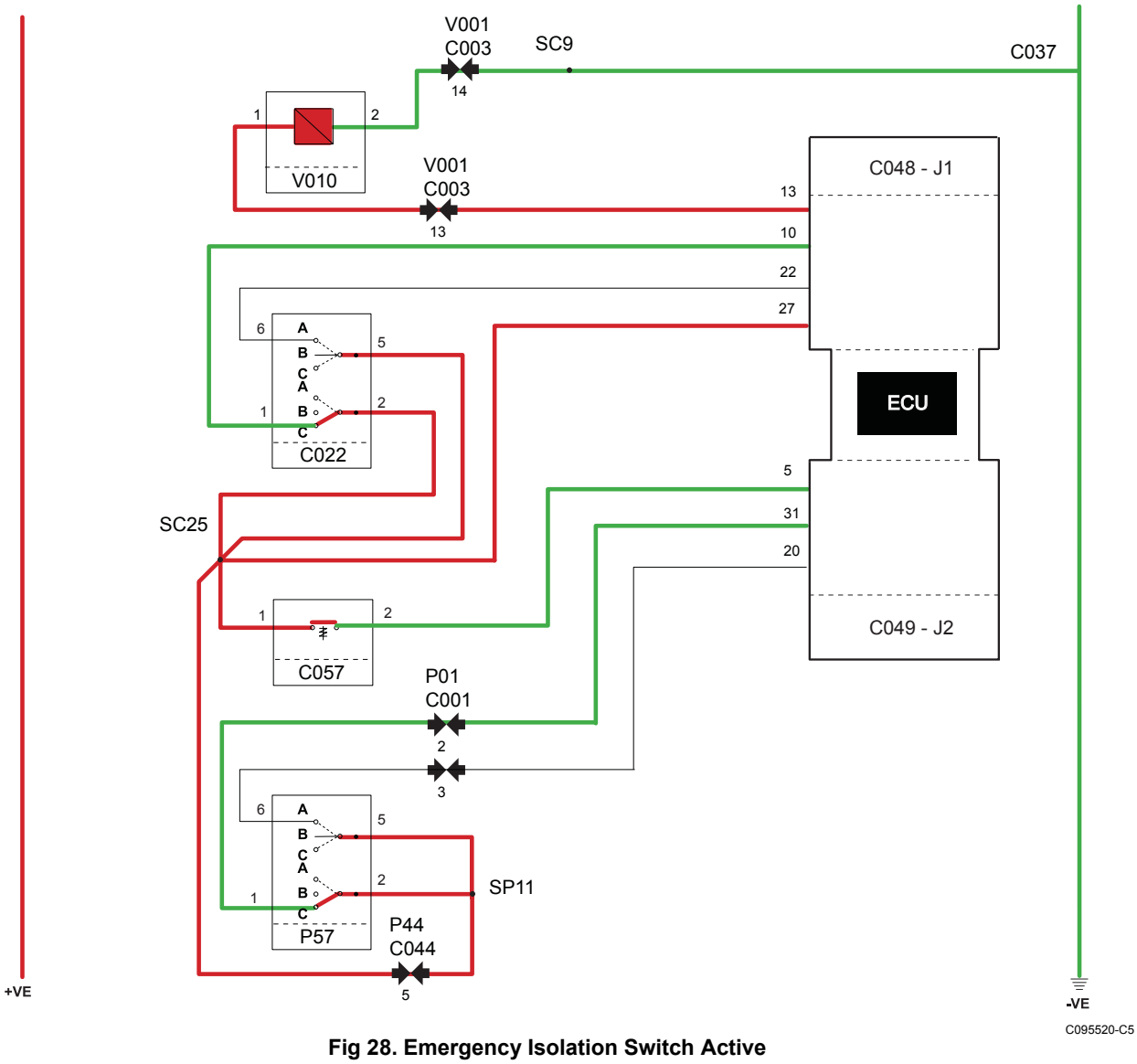


Fig 28. Emergency Isolation Switch Active

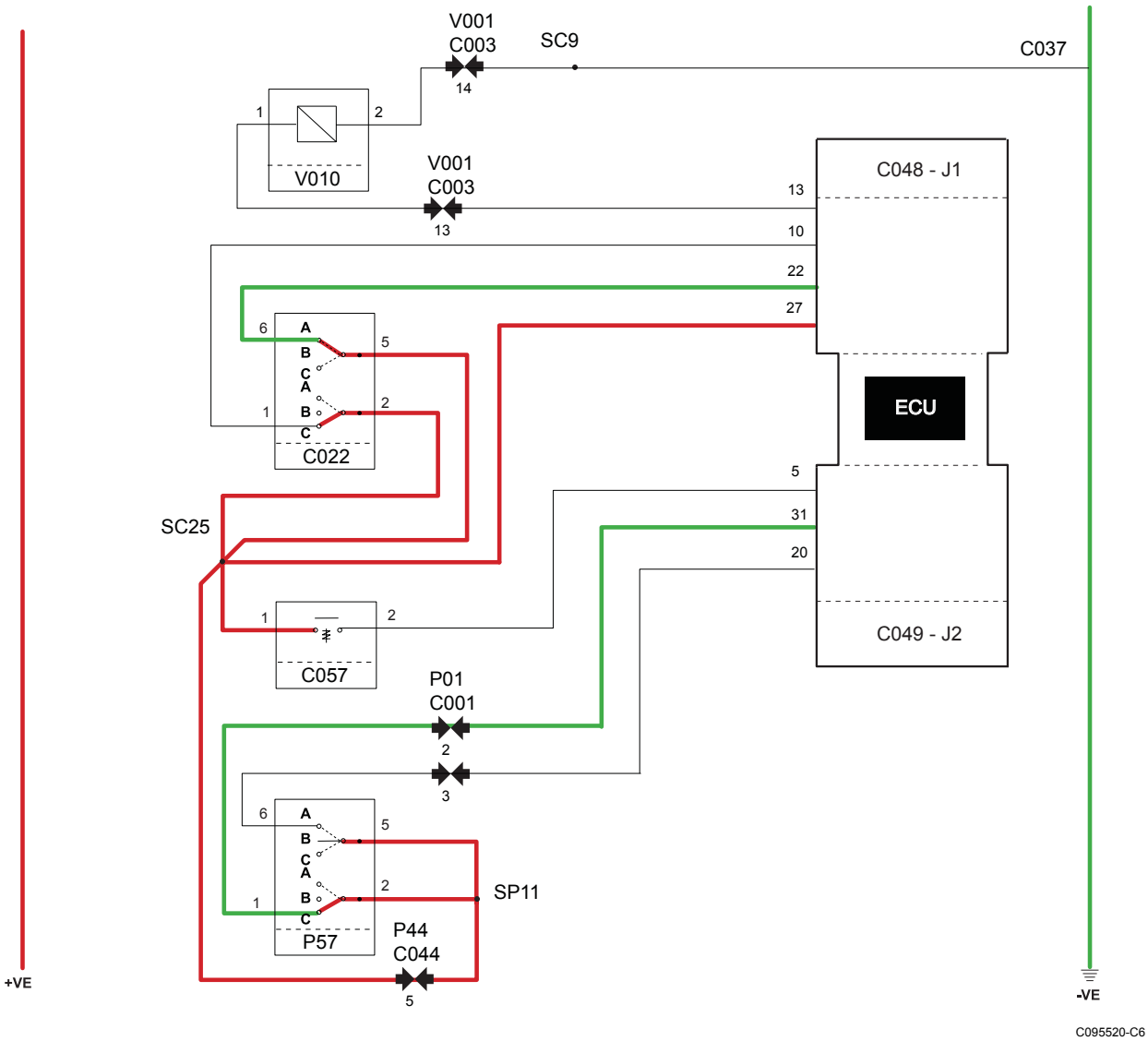


Fig 29. Tilt Isolation Switch Active

Hydraulic Control ECU

Power Supply and Earths

Component Key:	
C043	Hydraulic ECU Supply
C048 - J1	Hydraulic Control ECU connector J1
C049 - J2	Hydraulic Control ECU connector J2
C050	Earth Point
C056	Auxiliary Fuse Supply
P02	Secondary Fusebox A
P44/C044	Chassis Harness to Panel Harness connector 2

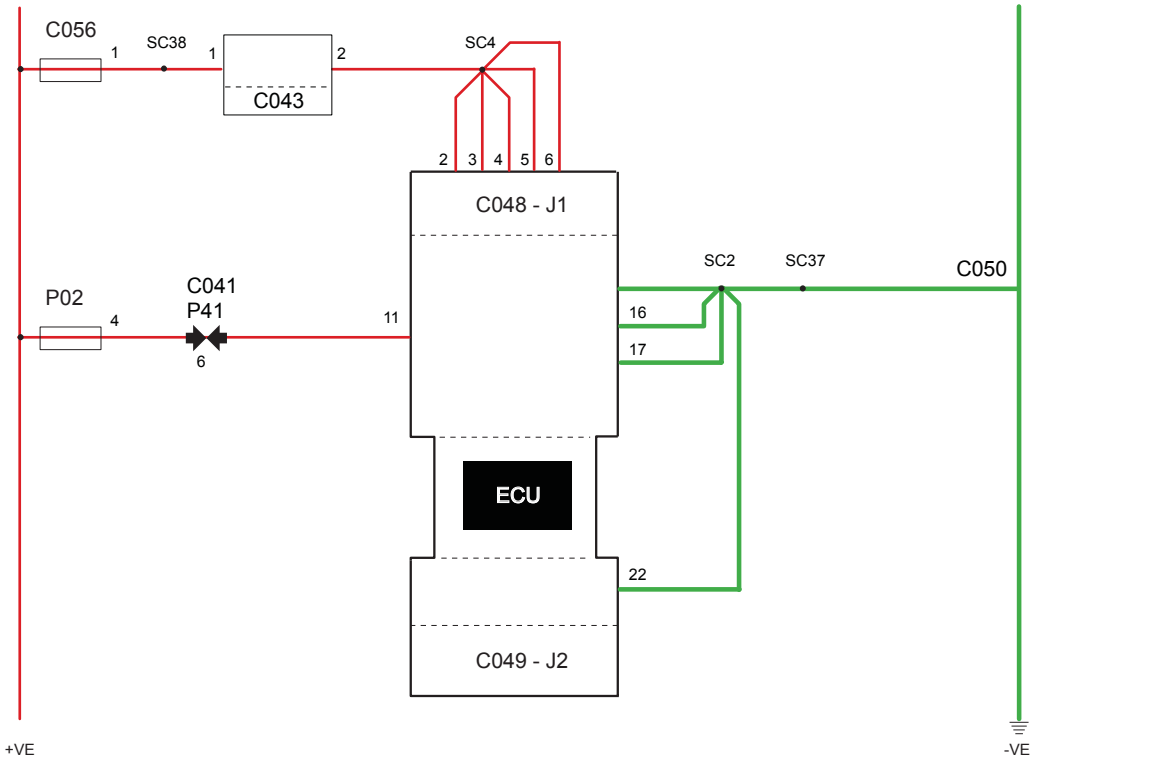


Fig 30.

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.

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 (50ºC, 122ºF).

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.

Electronic Fault Codes

The machine will log some system faults as an error code. These error codes can be accessed with the correct diagnostics software tool, using a laptop computer connected to the machine CAN system.

For the fault code descriptions refer to ***Section M - Fault Code SYSTEM***. ⇨ *Related Topics (E2-3)*

To access the fault codes and diagnostic software use the Servicemaster program. Refer to ***Section M - Servicemaster System*** and ***Section M - Servicemaster tools***. ⇨ *Related Topics (E2-3)*

Tables

Fault Descriptions:

⇨ *Table 7. ALL services lack power. (E2-42)*
⇨ *Table 8. ALL services slow to operate. (E2-43)*
⇨ *Table 9. ONE service fails, or is slow to operate. (E2-43)*
⇨ *Table 10. The system pressure is too high (E2-44)*
⇨ *Table 11. A service stays selected (E2-44)*
⇨ *Table 12. System isolation not working (E2-44)*
⇨ *Table 13. All services inoperative (E2-44)*
⇨ *Table 14. The engine tends to stall when hydraulics are under load. (E2-44)*
⇨ *Table 15. Forks creep down (E2-45)*
⇨ *Table 16. Parallel lift faulty (E2-45)*

Table 7. ALL services lack power.

Possible Cause	Action
Insufficient hydraulic fluid.	Check for leaks and top up as required.
Load sense relief valve (LSRV) out of adjustment or defective.	Check and adjust as required. Replace if defective.
Internal leakage fault in the load sense circuit.	Measure the load sense pressure.
Contamination in proportional solenoid valves, check valve or mesh filters.	Dismantle and inspect valve block components. ⇨ *Dismantle and Assemble (E4-7)*
Service spool, check valve or compensator valve sticking due to contamination.	Dismantle and inspect valve block components. ⇨ *Dismantle and Assemble (E4-7)*
Electronic fault	Use servicemaster to determine the problem. Refer to ***Section M - CANbus System.*** ⇨ *Related Topics (E2-3)*

Table 8. ALL services slow to operate.

Possible Cause	Action
Insufficient hydraulic fluid.	Check for leaks and top up as required.
Service spool, check valve or compensator valve sticking due to contamination.	Dismantle and inspect valve block components. ⇨ *Dismantle and Assemble (E4-7)*
Low pump flow.	– Check pump flow. – Check for external leaks, renew seals. – Priority valve sticking, see ***Section H - Steering***. ⇨ *Related Topics (E2-3)* – Renew pump.
Fault in electrical circuit wiring, or joystick powerbase ECU: – Thumbwheel switch defective. – Solenoid at the pilot pressure supply valve not energising. – Solenoid coil faulty. – Faulty powerbase ECU.	Check the condition of the associated electrical wiring for damage and that the fuses are intact. – Check the function of the applicable thumbwheel switch. – Check the condition of the associated electrical wiring for damage. – Check the applicable solenoid coil for open or short circuits. Measure the solenoid coil resistance. Renew the solenoid coil. – Renew the joystick powerbase ECU.

Table 9. ONE service fails, or is slow to operate.

Possible Cause	Action
Associated service pipework or hoses leaking, damaged, trapped or kinked.	Check pipework and hoses, replace as required.
Auxiliary relief valve (ARV) out of adjustment or defective.	Check and replace if necessary.
Associated ram leaking.	Carry out ram leakage checks, renew seals as required.
Associated service spool not operating correctly. – Due to faulty service spool solenoid. – Due to a fault with the electronic control lever assembly.	– Check the condition of the related harness wiring and connectors for damage. Check the solenoid coil for open or short circuits. Measure the solenoid coil resistance. Renew the solenoid coil. – Check the condition of the related harness wiring and connectors for damage. Renew the electronic control lever assembly.
Electronic fault	Use servicemaster to determine the problem. Refer to ***Section M - CANbus System.*** ⇨ *Related Topics (E2-3)*
Service spool, check valve or compensator valve sticking due to contamination.	Dismantle and inspect valve block components. ⇨ *Dismantle and Assemble (E4-7)*

Table 10. The system pressure is too high

Possible Cause	Action
Load sense relief valve (LSRV) out of adjustment or defective.	Check and adjust as required. Replace if necessary.
Contamination in proportional solenoid valves, check valve or mesh filters.	Dismantle and inspect valve block components. ⇨ *Dismantle and Assemble (E4-7)*

Table 11. A service stays selected

Possible Cause	Action
Load sense relief valve (LSRV) out of adjustment or defective.	Check and adjust as required. Replace if necessary.
Service spool or associated load hold check valves damaged or sticking due to contamination.	Dismantle and inspect the associated service spool or load hold check valves. ⇨ *Dismantle and Assemble (E4-7)*

Table 12. System isolation not working

Possible Cause	Action
Poor electrical connection.	Check dump solenoid wiring connections.
Contaminated or faulty dump solenoid.	Replace. ⇨ *Dismantle and Assemble (E4-7)*
Blockage in unloader drain port.	Clean port, replace inlet section if necessary. ⇨ *Dismantle and Assemble (E4-7)*
Electronic fault	Use servicemaster to determine the problem. Refer to ***Section M - CANbus System.*** ⇨ *Related Topics (E2-3)*

Table 13. All services inoperative

Possible Cause	Action
Poor electrical connection.	Check dump solenoid wiring connections.
Contaminated or faulty dump solenoid.	Replace. ⇨ *Dismantle and Assemble (E4-7)*
Electronic fault	Use servicemaster to determine the problem. Refer to ***Section M - CANbus System.*** ⇨ *Related Topics (E2-3)*

Table 14. The engine tends to stall when hydraulics are under load.

Possible Cause	Action
Load sense relief valve (LSRV) out of adjustment or defective.	Check and adjust as required.
Poor engine performance.	– Check engine performance. – Check engine High and Low idle speeds. – Check LSRV setting and adjust as required. – Check ARV setting and adjust as required.

Table 15. Forks creep down

Possible Cause	Remedy
Circuit hosed incorrectly. Has any work been completed on the machine recently?	Check circuit. Re-route the hoses if necessary.
Tilt ram HBCV leaking, tilt ram seals leaking, control valve spool leaking or valve block section leaking internally.	Check for leakage in the tilt ram circuit.

Table 16. Parallel lift faulty

Possible Cause	Remedy
Displacement/lift link valve broken or leaking.	– Examine valve; is ball OK? Fit blank to isolate valve from circuit. – Fit latest type valve. – Check pipes, tilt spool, HBCV for missing ball.
Tilt section ARVs set incorrectly, causing oil to exit from tilt/ compensating ram circuit.	Check tilt ARV setting. Adjust if required.
Tilt section ARVs could be sticking open due to contamination.	Clean or new as required.
Leaking seals in tilt ram or compensation ram.	Check tilt/compensation rams for leakage (use hand pump if available). Renew seals as required.

Test Procedures

Checking Pump Flow

The separate sections of the gear pump assembly supply hydraulic oil to the main services circuits, to the steering circuit and to the hydraulic cooling fan circuit. To determine the source of a problem i.e pump, steer circuit or services circuit, measure the output flow at system pressure from each pump outlet port in turn.

⚠ 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 Carry out General Safety procedures, see ***Section 2 - General Procedures.*** ⇨ *Related Topics (E2-3)*

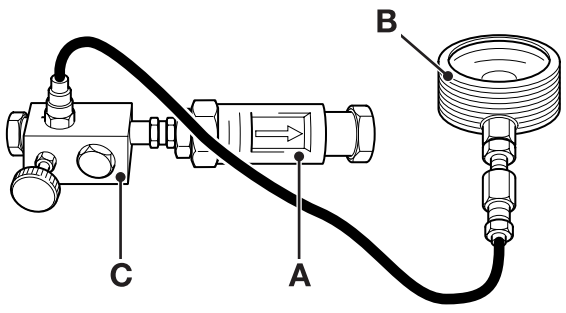
⚠ WARNING

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 Vent the hydraulic pressure, see ***Section 2 - General Procedures.*** ⇨ *Related Topics (E2-3)*



A326060-1

Fig 31. Test Equipment

3 Connect a flow meter **A**, 0-400 bar (0-6000 lbf/in²) pressure gauge **B** and load valve **C** into the discharge line from each pump section in turn as described below:

Main Services Pump (Section 1): Disconnect the hose from the pump adaptor **E**. Fit the flow meter and load valve between the hose and the pump.

Cooling Fan Pump (Section 2): Disconnect the hose from the pump adaptor **D**. Fit the flow meter and load valve between the hose and the pump.

Note: *Make sure the load valve and flow meter is installed the correct way round i.e. with the direction arrow pointing away from the pump.*

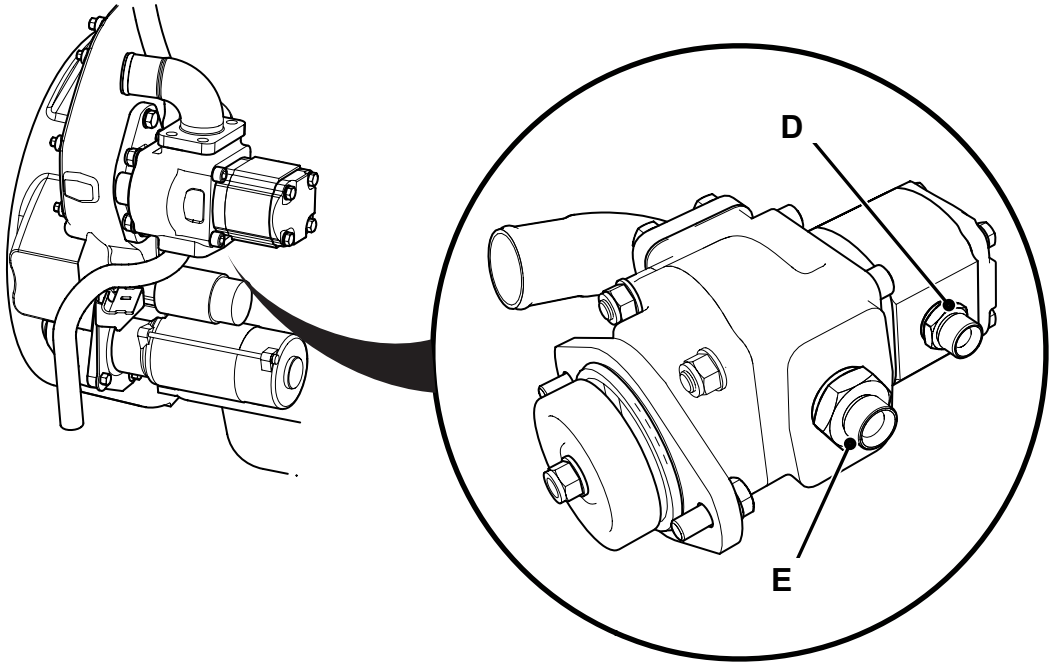
⚠ CAUTION

Make sure the load valve is in the OPEN position, (the adjusting knob screwed fully OUT), before starting the following pressure test. Failure to do this could damage the pump.

HYD-4-4_1

4 Start the engine and bring the hydraulic system up to working temperature 50° C (122° F).

5 Select the steering and control valve block spools to the neutral position.



C095770-C1

Fig 32.

6 Set the engine speed to 2200 rev/min., then carefully adjust the load valve **C** so that the gauge reading increases to 245 bar (3553 lbf/in²).

7 Check the flow reading which should be as stated in ***Specifications***. ⇨ *Specifications (E2-4)*

If the flow reading is low or you are unable to obtain the pressure required, ⇨ *Fault Finding (E2-41)*.

For testing the Priority Valve, see ***Section H - Steering***. ⇨ *Related Topics (E2-3)*

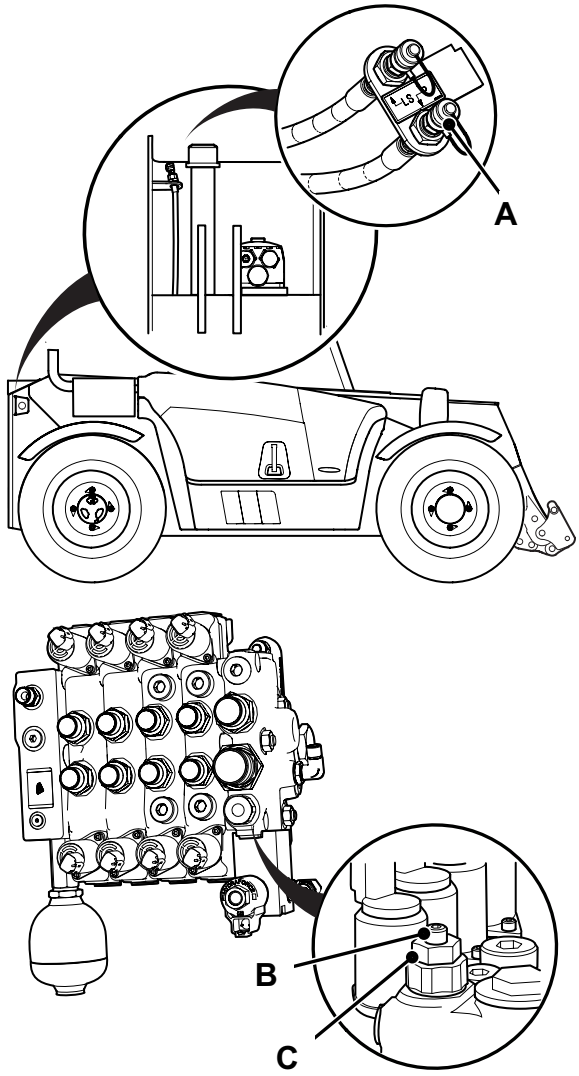
⚠ WARNING

Take care when disconnecting hydraulic hoses and fittings as the oil will be HOT.

TRANS-1-2

8 After completing the test, switch OFF the engine and allow to cool before disconnecting the test equipment and reconnecting the hydraulic hoses.

Load Sense Relief Valve (LSRV)



C093980-C2

Fig 33.

⚠ 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

The maximum pressure that can be achieved within the main hydraulic system is set by the load sense relief valve (LSRV) **B** at the control valve block inlet section. To check the load sense relief valve setting carry out the procedure described below:

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

1 Connect a 0 - 400 bar (0 - 6000 lbf/in^2) pressure gauge to the main system pressure (pump) test point **A** (at the rear of the machine as shown).

2 With the engine running at 1500 rpm, check the load sense relief valve setting by operating the boom lower service and hold the boom ram fully closed. Note the maximum reading on the pressure gauge. The maximum pressure should be as stated in ***Specifications***. ⇨ *Specifications (📄 E2-4)*

Relief Valve Adjustment

3 If the maximum pressure is incorrect, adjust the relief valve as described below:

a Position the boom and fit the Safety Strut, see ***Section 2 - General Procedures.*** ⇨ *Related Topics (📄 E2-3)*

b Switch OFF the engine and vent residual hydraulic pressure.

c Remove the plastic cap from the load sense relief valve. Loosen the locknut **C** and turn the adjuster screw **B** clockwise to increase pressure and counter-clockwise to decrease the pressure. When the pressure is correct, tighten the locknut and check the pressure again. Adjust as required.

d When the pressure setting is correct torque tighten the locknut **C**. ⇨ *Torque Settings (E2-49)*

Table 17. Torque Settings

Item	Nm	kgf m	lbf ft
C	9.5	0.96	7

Auxiliary Relief Valve Pressure (ARV) - ARV's set lower than the LSRV

ARV's which are set below the LSRV pressure can be tested simply by operating the relevant service. For tilt ram ARV's which are set above the LSRV pressure a different procedure is required. ⇒ *Auxiliary Relief Valve Pressure (ARV) - ARV's set higher than the LSRV (E2-51)*

Important: *The engine must not be run at maximum speed as a significant increase in pressure will be recorded.*

1 Operate the controls back and forth several times to vent residual hydraulic pressure.

2 Connect a 0 - 400 bar (0 - 6000 lbf/in²) pressure gauge to the test point **A**.

3 Start the engine and bring the hydraulic system upto working temperature 50º C (122º F).

4 Set the engine to idle rev/min. and operate the relevant service to full travel. Hold while checking the maximum gauge reading which should be as stated in ***Specifications***. ⇒ *Specifications (E2-4)*

5 If the pressure is incorrect, replace the relevant A.R.V. ⇒ *Auxiliary Relief Valve Replacement (E2-52)*

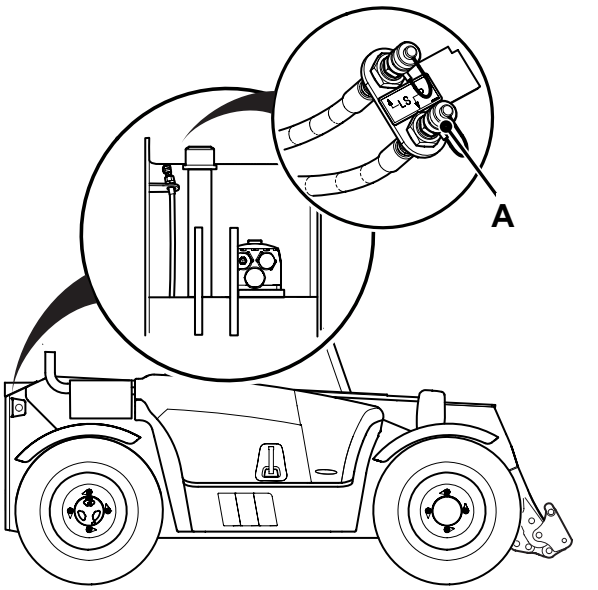


Fig 34.

Auxiliary Relief Valve Pressure (ARV) - ARV's set higher than the LSRV

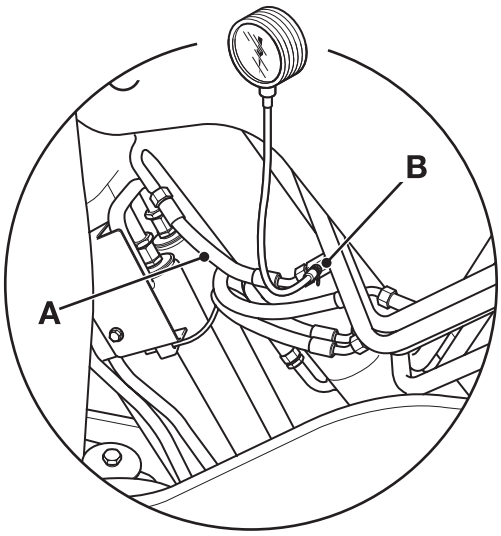
Some ARVs are set at a higher pressure than the LSRV. This is usually one of the tilt ram ARVs. Because the tilt ram is smaller than the lift ram, higher hydraulic pressure is required on one side of the tilt ram to prevent the load tilting the forks forward.

Check the pressure setting and ARV location for the applicable machine. ⇒ *Specifications (E2-4)*

1 Park the machine and make it safe. Raise the boom and fit the safety strut. Tilt the forks fully forward. Obey the care and safety procedures. ⇒ *Related Topics (E2-3)*

2 Vent residual hydraulic pressure. Obey the care and safety procedures. ⇒ *Related Topics (E2-3)*

3 Locate the hydraulic line for the high pressure side of the tilt ram. Fit a tee piece in the hydraulic line. Connect a 0 - 400 bar (0 - 6000 lbf/in^2) pressure gauge to the tee piece.



717071-1

Fig 35.

4 Start the engine and dead end the tilt ram. Remove the safety strut and slowly lower the boom. As the boom is lowered the pressure gauge will show the ARV pressure, which should be as stated. ⇒ *Specifications (E2-4)*

5 If the pressure is incorrect, replace the ARV. ⇒ *Auxiliary Relief Valve Replacement (E2-52)*

⚠ WARNING

Take care when disconnecting hydraulic hoses and fittings as the oil will be HOT.

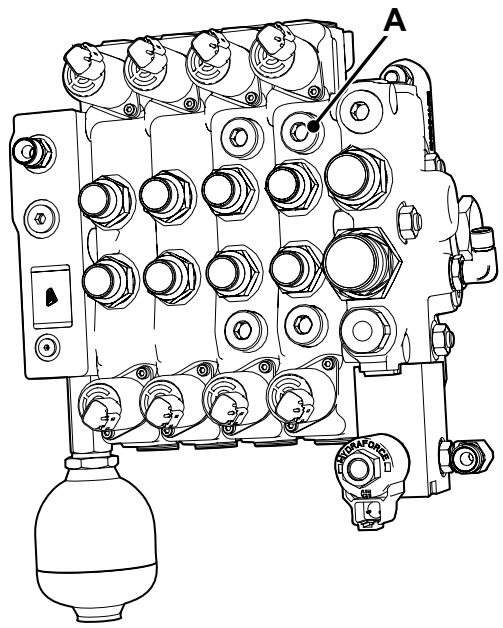
TRANS-1-2

6 After completing the test, raise the boom and fit the safety strut. switch OFF the engine and vent residual hydraulic pressure. Disconnect the pressure gauge and remove tee piece **B**. Reconnect the tilt ram rod side hose **A**.

Auxiliary Relief Valve Replacement

Important: *The ARV's are not adjustable. If the pressure is incorrect the valve must be replaced. Each ARV has its pressure setting stamped on the top face, make sure to replace the ARV with one of the same pressure setting.*

Note: *The ARV shown is for illustration purposes - make sure to select the correct ARV. Refer to* ***Specifications****.* ⇒ *Specifications (E2-4)*



C093980-C3

Fig 36.

1 Position the boom and fit the Safety Strut, see ***Section 2 - General Procedures.*** ⇒ *Related Topics (E2-3)*

2 Vent the hydraulic pressure, see ***Section 2 - General Procedures.*** ⇒ *Related Topics (E2-3)*

3 Remove the ARV **A** by unscrewing it from the valve block.

4 Install a new ARV into the valve block and torque tighten. ⇒ *Torque Settings (E2-52)*

Table 18. Torque Settings

Item	Nm	kgf m	lbf ft
A	44.7	4.5	33

Smooth Ride SYSTEM (SRS) - Electro Servo

Introduction

This topic contains information about a machine SYSTEM. The system has some devices that connect either mechanically, hydraulically or electrically. Make sure you are referring to the correct system. Refer to the applications table. ⇨ *Related Topics (E3-2)*.

Descriptions and procedures relate to the system and not the individual devices. For information about the devices refer to the relevant topics. ⇨ *Related Topics (E3-2)*

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

⇨ *Related Topics (E3-2)*
⇨ *Specifications (E3-3)*
⇨ *Operation Overview (E3-5)*
⇨ *Hydraulic Operation and Schematics (E3-6)*
⇨ *Electrical Operation and Schematics (E3-7)*
⇨ *Fault Finding (E3-9)*
⇨ *Accumulator Charging and Discharging (E3-12)*
⇨ *Accumulator Removal and Replacement (E3-14)*

Related Topics

Table 1. Related Topics in This Publication

The table lists other topics in the manual that contain information related to this topic. Refer to the applicable topics to complete your procedures. Where applicable the text in this section contains cross references to this page to help you find the correct information. Some machines have different systems and devices. Make sure you refer to the correct topic, refer to ***Section 1 - Applications*.**

Sections	Topic Titles	Sub Titles
1	***Applications***	ALL
2	ALL (Care and Safety)(1)	ALL
C	***Fuses and Relays***	ALL
C	***Electrical Harness SYSTEM***	ALL
E	***⇨ LSP Electro Servo Hydraulic SYSTEM (E2-1)***	ALL

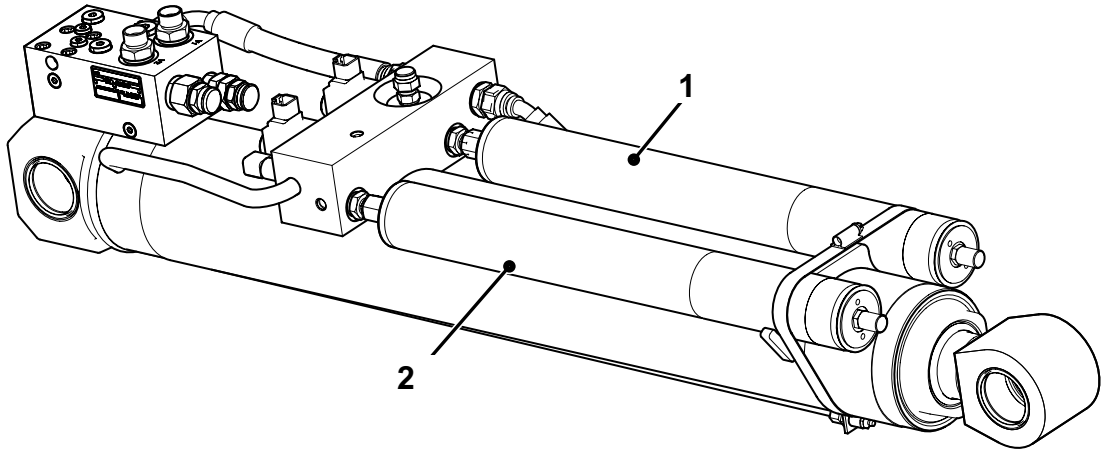
(1) You must obey all of the relevant care and safety procedures.

Specifications

Accumulators

Charging Gas	Air Free Dry Nitrogen
Accumulator Capacity	1.0 litre (58 cu/in)

Although identical in appearance, the accumulators are charged to different pressures. When renewing an accumulator make sure that it is charged to the correct pressure.



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Fig 1.

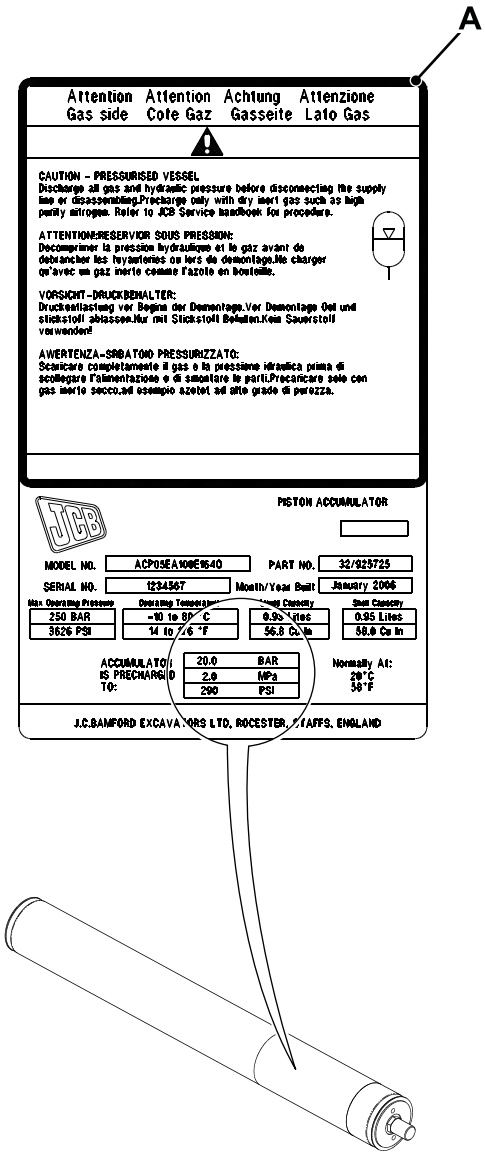
Accumulator Charge Pressures		
	Bar	**Psi**
- Accumulator 1	6.9	100
- Accumulator 2	18.6	270

Replacement Accumulators

Note: *Replacement accumulators will only be supplied in an uncharged, non pressurised condition to meet Health and Safety, and Air freight hazardous goods requirements.*

Important: *Upon installation of new accumulator the correct decal stating charge pressure must be attached. Remove original decal which states a zero charge pressure. Decals may be in the form of a large plate or small plate.* ⇨ ***Fig 2. (E3-4)***, ⇨ ***Fig 3. (E3-4)***.

Important: *When replacing the lift ram or hose burst check valve on machines fitted with SRS, it is important that all the hydraulic pressure in the accumulators is vented. Failure to do this may result in the valve being forced out of the cavity as it is unscrewed.* ⇨ ***Removal (E3-14)***



C033720

Fig 2.



C047780-C1

Fig 3.

Operation Overview

⇒ *Fig 4. (E3-5)*

The Smooth Ride System (SRS) enhances the comfort of the ride by damping the forces imposed on the machine by the movement of the boom as the machine travels over uneven surfaces. This is achieved by connecting the head side of the lift ram **1** to pressurised piston type accumulators **2**.

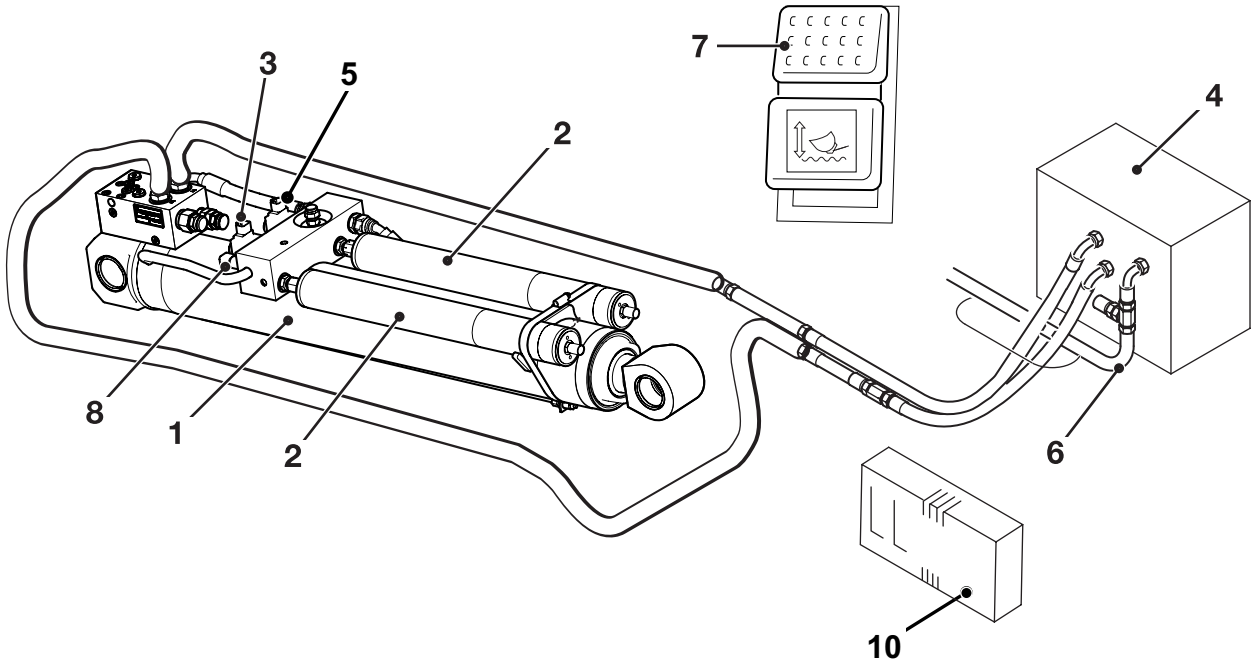
Piston type accumulators operate as a liquid springs absorbing displaced fluid from the lift ram.

The system is controlled by the hydraulic control ECU **10**.

To activate the SRS system, the pressure in the lift ram must be less than 40 bar (580 psi), typically when the boom is fully lowered. This is sensed by the pressure transducer **8**. Pressing the SRS switch **7** in the cab will then energise the accumulator solenoid valve **3**, connecting the piston head side of the lift ram with accumulators **2**. The drain solenoid valve **5** will also energise and connect the rod side of the lift ram to the valve block return line **6** to make up or dissipate oil as required.

Note: *If the pressure in the lift ram is greater than the specified limit when the SRS switch is pressed, the system will not be activated (the solenoid valves will not energise).*

Once the SRS system is activated, the boom can then be raised to the travelling position as required.



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Fig 4.

Hydraulic Operation and Schematics

Hydraulic Schematic

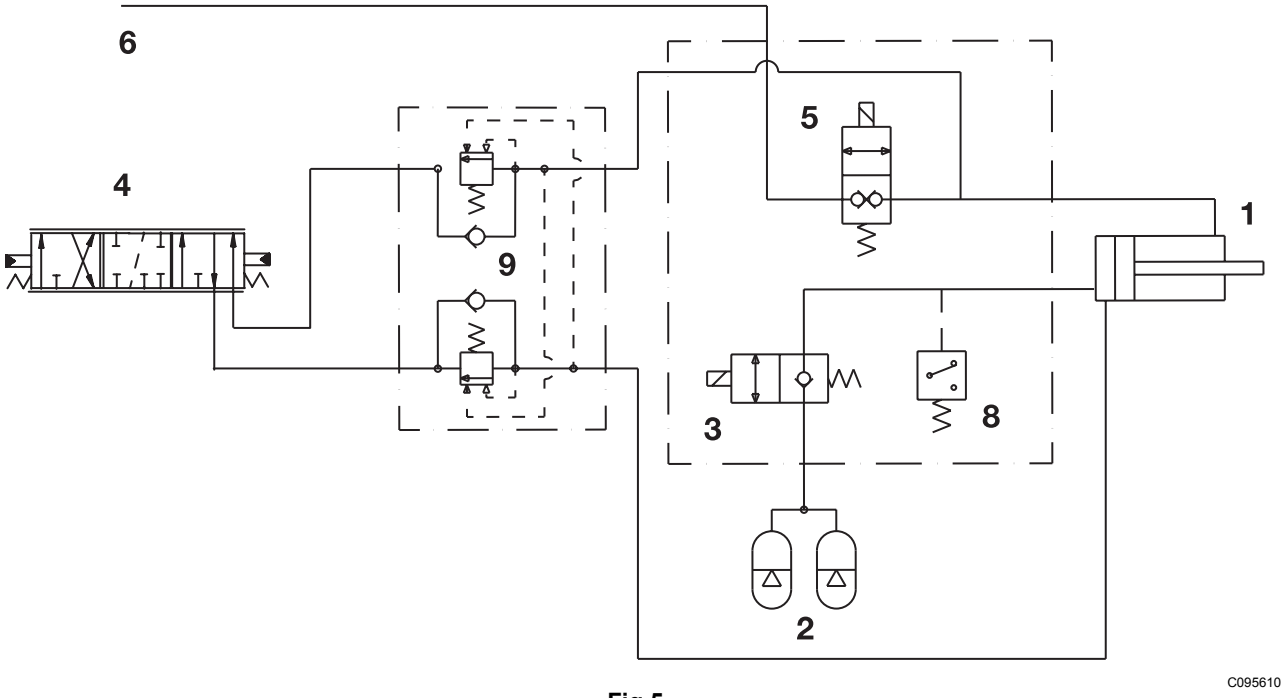


Fig 5.

Component Key: ⇨ *Fig 5. (E3-6)*	
1	Lift ram
2	Accumulators
3	Accumulator solenoid valve
4	Control valve block
5	Road Side Drain solenoid valve
6	Tank return line
8	Pressure transducer
9	Hose burst check valve

Electrical Operation and Schematics

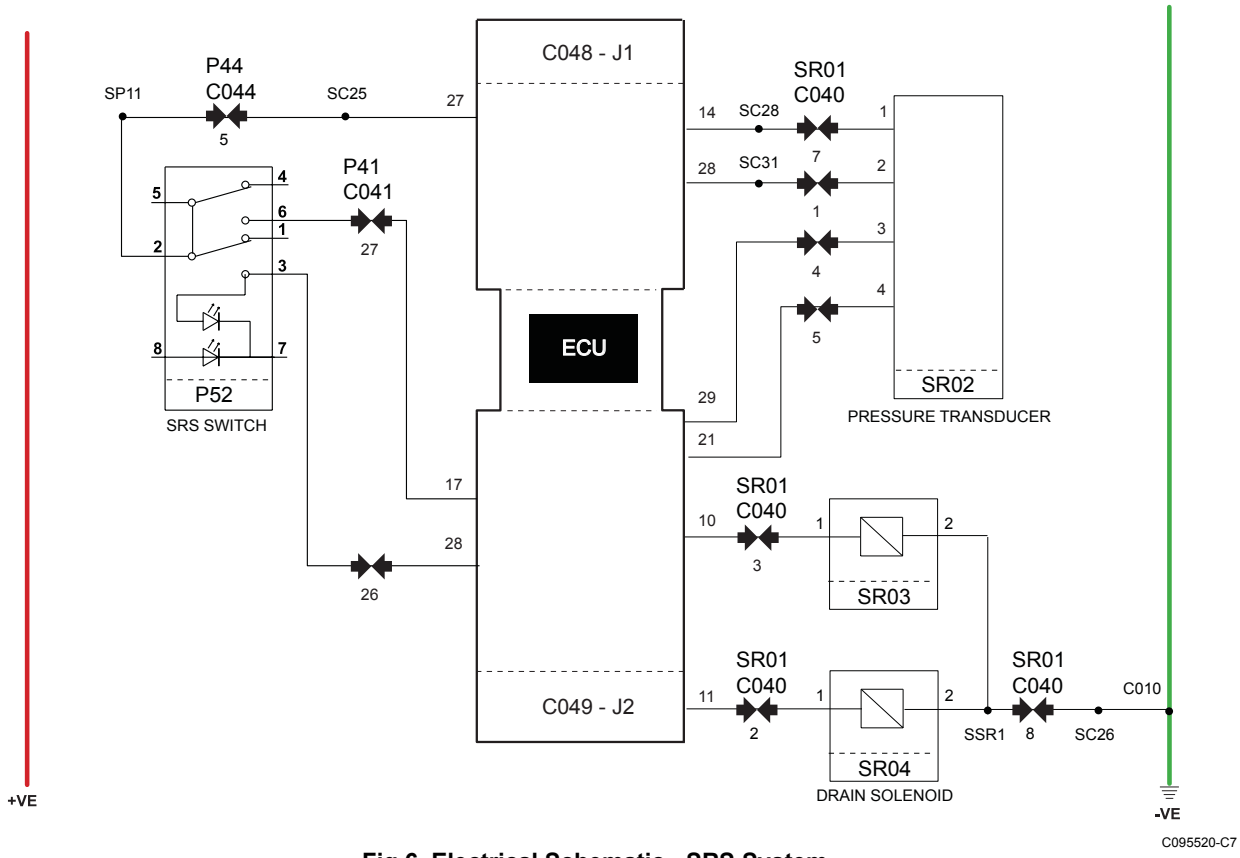


Fig 6. Electrical Schematic - SRS System

Note: *For ECU power supply and earths refer to the* ***LSP Electro Servo Hydraulic SYSTEM*** *topic.* ⇒ ***Related Topics (E3-2)***

Central to the system is the hydraulic control ECU (**C048**/**C049**). The ECU monitors the status of the lift and tilt (crowd/dump) spools, pressure transducer **SR02** and SRS on/off switch **P52**. The ECU energises and de-energises drain and accumulator solenoids **SR04** and **SR03** to control the smooth ride system as applicable.

Control Lever in Neutral: When the SRS system is switched ON, if the pressure in the lift ram is within limits, ECU **C049** energises the drain valve solenoid **SR04**, and the accumulator valve solenoid **SR03**.

The ECU **C048** sends a message via the CANbus and the SRS indicator light comes ON.

Crowd or Dump Selected: When the control lever is moved from neutral, to either crowd or dump ECU **C049** de-energises drain valve solenoid **SR04**.

Boom Lower Selected: When the control lever is moved from neutral to lower the boom, ECU **C049** de-energises drain valve solenoid **SR04** and accumulator valve solenoid **SR03**.

Component key: ⇒ ***Electrical Schematic - SRS System (E3-7)***	
C048	Hydraulic control ECU - connector J1
C049	Hydraulic control ECU - connector J2
P52	SRS On/Off switch
SR02	Pressure transducer
SR03	Accumulator valve solenoid
SR04	Drain valve solenoid

Table 2. SRS Status Table

SRS ON/ OFF Switch Position	Lower Service Operation	Crowd/ Dump Service Operation	Accumulator Valve Solenoid (SR03):	Drain Valve Solenoid (SR04):	SRS Mode	SRS Indicator Light Status
ON	NO	NO	Energised	Energised	SRS Enabled - Active	ON
ON	YES	NO	De-energised	De-energised	SRS Enabled - Not active	ON
ON	NO	YES	Energised	De-energised	SRS Enabled - Active	ON
ON	YES	YES	De-energised	De-energised	SRS Enabled - Not active	ON
OFF	-	-	De-energised	De-energised	SRS Disabled	OFF

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.

The system is controlled by the hydraulic control ECU. Use Servicemaster to check the fault code log for related faults.
⇨ *Related Topics (E3-2)*

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 (50ºC, 122ºF).

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.

Tables

⇒ *Table 3. System Will Not Activate (E3-10)*
⇒ *Table 4. Unable to Lower the Boom (E3-10)*
⇒ *Table 5. Restricted Boom Suspension Movement When System Switched ON (E3-10)*
⇒ *Table 6. Springy Boom Operation With System Switched OFF (E3-10)*
⇒ *Table 7. No Suspension When System Switched ON (E3-10)*
⇒ *Table 8. Suspension Feels `Hard' (Gas Charge Pressure Increase) (E3-10)*
⇒ *Table 9. Suspension Feels `Soft' (Gas Charge Pressure Decrease) (E3-11)*

Table 3. System Will Not Activate

Possible Cause	Remedy
Excessive pressure in lift ram.	Ensure weight of boom is fully supported when activating system.
Faulty pressure transducer.	Check transducer. Replace as necessary

Note: *The system will not engage until the lift ram is fully closed or the weight of the boom is fully supported.*

Table 4. Unable to Lower the Boom

Possible Cause	Remedy
Rod side (drain) solenoid valve open.	– Check if solenoid operating, replace as required. – Check electrical feed to solenoid/switch on back of lift spool.

Table 5. Restricted Boom Suspension Movement When System Switched ON

Possible Cause	Remedy
Rod side (drain) solenoid valve closed.	– Check if solenoid operating, replace as required. – Check electrical feed to solenoid.

Table 6. Springy Boom Operation With System Switched OFF

Possible Cause	Remedy
Head side (accumulator) solenoid valve open.	Check if solenoid operating, replace as required.

Table 7. No Suspension When System Switched ON

Possible Cause	Remedy
Head side (accumulator) solenoid valve closed.	– Check if solenoid operating, replace as required. – Check electrical feed to solenoid.

Table 8. Suspension Feels `Hard' (Gas Charge Pressure Increase)

Possible Cause	Remedy
Oil to gas leak across accumulator piston.	– Discharge, drain and recharge. – If frequent, replace seals in accumulator.

Table 9. Suspension Feels `Soft' (Gas Charge Pressure Decrease)

Possible Cause	Remedy
Leak across accumulator piston.	– Recharge. – If frequent, replace seals in accumulator.

Accumulator Charging and Discharging

Charging and Discharging

TE-003

Charging

1 Remove the accumulator(s) from the machine.

2 Remove gas valve guard **8-A** and gas valve cap **8-B**.

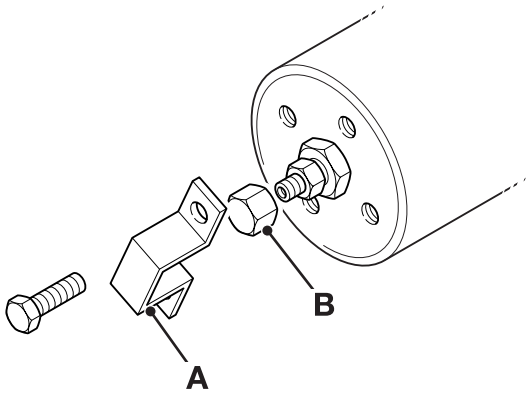


Fig 7.

3 Screw valve **8<-C** all the way out (counter clockwise) before attaching charging tool (part no. 892/00948) to accumulator gas valve.

4 Close bleed valve **8-D**.

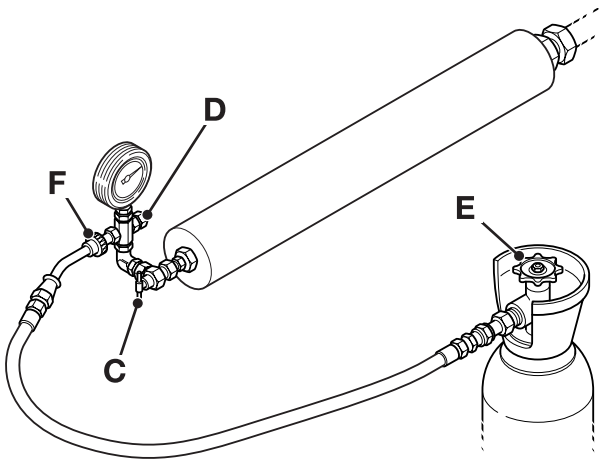


Fig 8.

5 Do not twist the hose, connect the charging tool to the gas valve. Tighten to 1.36 Nm (1.0 lbf ft).

6 Connect charging tool to a bottle of compressed nitrogen gas.

7 Screw valve **8-C** all the way in (clockwise), this will depress the core in the gas valve. Check charge pressure which should be set to suit the boom and the attachment fitted to the machine.

8 If charge pressure is low, release hand valve **8-E** on the nitrogen bottle and slowly fill the accumulators. Close valve **8-E** when the charge pressure is reached on the gauge.

9 Let the pressure settle for 10 to 15 minutes. This will allow the gas temperature to stabilise. If the charge pressure is exceeded, with the gas bottle closed, open bleed valve **8-D**. Reduce pressure as required, then close bleed valve.

⚠ CAUTION

To reduce pressure use the recommended charging tool or the charge valve could be damaged which may result in rapid discharge of the accumulator.

HYD-2-4

10 When complete screw valve **8-C** all the way out (counter clockwise) then open the bleed valve **8-D** to vent the hose.

11 Hold the gas valve to keep from turning, loosen the nut and remove charging tool.

12 Refit gas valve cap and valve guard.

13 Install the accumulator(s) to the machine.

Discharging

1 Remove the accumulator(s) from the machine.

2 Remove gas valve guard **8-A** and gas valve cap **8-B**.

3 Screw valve **8-C** all the way out (counter clockwise) before attaching charging tool (part no. 892/00948) to accumulator gas valve.

4 Close bleed valve **8-D**.

5 Either connect charging tool to a bottle of compressed nitrogen gas which is turned off or remove hose **8-F** and fit a suitable blank on charging tool.

6 Screw valve **8-C** all the way in (clockwise), this will depress the core in the gas valve.

7 Open bleed valve **8-D** until all the gas charge is relieved from the accumulators. Remove the charging tool.

8 Install the accumulator(s) to the machine.

Accumulator Removal and Replacement

Removal

⚠ CAUTION

You must vent all the hydraulic pressure from the accumulators before disconnecting them from the hydraulic system.

0043

1 Switch OFF the SRS and lower the boom to the ground.

2 Power the boom down for three minutes with the engine at approximately 1000 rev/min. The accumulators will gradually drain to tank during this time.

3 Raise the boom and install the safety strut, see ***Section 2 - General Procedures***. ⇨ *Related Topics (E3-2)*

4 Loosen the four nuts **9-2**.

5 Disconnect hydraulic connections **9-1** and plug the ends.

6 Remove the four nuts **9-2** and four washers **9-5** and remove the two `U' clamps **9-3**. Remove the accumulators **9-4** from their mounting brackets.

Replacement

Replacement is the opposite of the removal procedure.

During the replacement procedure do this work also:

- Check the accumulator nitrogen pre-charge pressure. ⇨ *Specifications (E3-3)*
- Operate the machines hydraulic system. Check for correct operation and leaks.
- Replenish the hydraulic system with the recommended hydraulic fluid as required, see ***Section 3 - Routine Maintenance***. ⇨ *Related Topics (E3-2)*

Important: *It is not possible to dismantle the accumulators. The extent of permissible servicing is limited to checking the nitrogen gas pre-charge pressure. If an accumulator is suspected as being faulty it must be renewed as a complete assembly.*

Important: *Although identical in appearance, the accumulators are charged to different pressures. When renewing an accumulator make sure that it is charged to the correct pressure.*

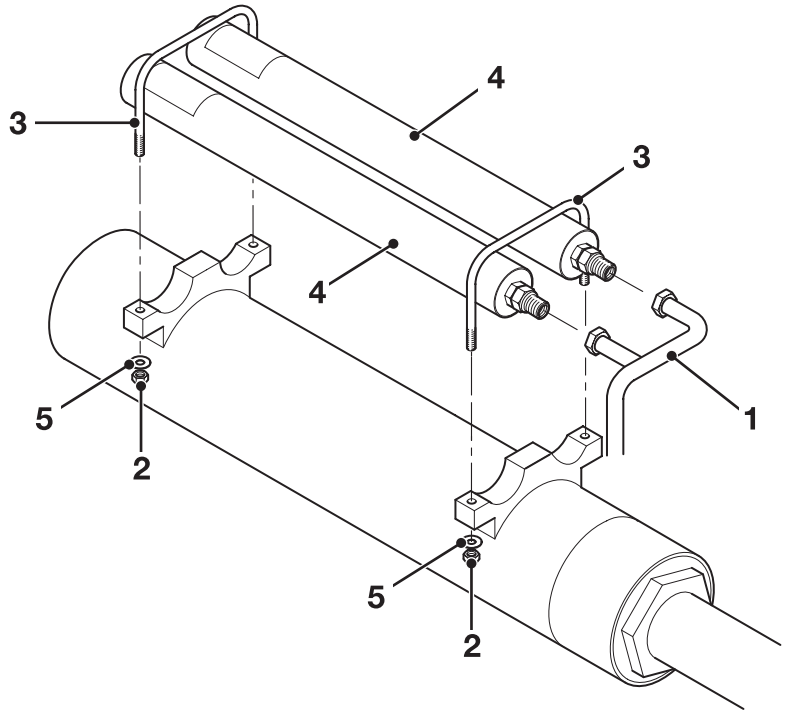


Fig 9. Typical Installation

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Electro Servo (LSP) Control Valve

Introduction

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

Descriptions and procedures relate to the device and not related systems. For information about the systems refer to the relevant topics.

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.

⇨ *Related Topics (E4-2)*
⇨ *Removal and Replacement (E4-3)*
⇨ *Dismantle and Assemble (E4-7)*
⇨ *Valve Block Sections (E4-7)*
⇨ *Proportional Solenoids (E4-8)*
⇨ *Load Sense Relief Valve (E4-9)*
⇨ *Auxiliary Relief Valves (ARV's) (E4-10)*
⇨ *Accumulator Check Valve and Filter (E4-11)*
⇨ *Dump Solenoid (E4-12)*

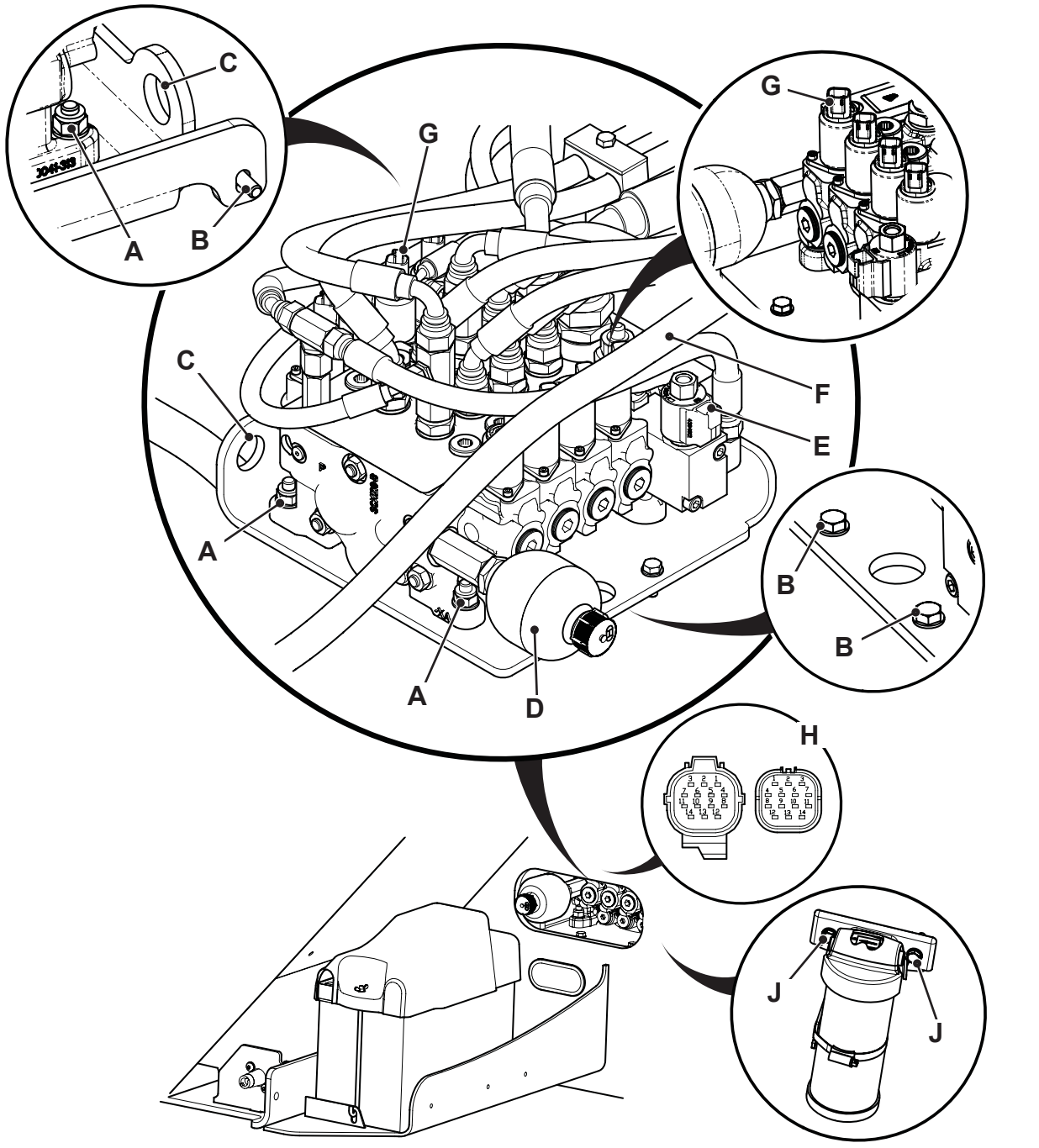
Related Topics

Table 1. Related Topics in This Publication

The table lists other topics in the manual that contain information related to this topic. Refer to the applicable topics to complete your procedures. Where applicable the text in this section contains cross references to this page to help you find the correct information. Some machines have different systems and devices. Make sure you refer to the correct topic, refer to ***Section 1 - Applications*****.**		
Sections	**Topic Titles**	**Sub Titles**
1	***Applications***	ALL
2	ALL (Care and Safety)(1)	ALL
3	***Hydraulic System***	ALL
3	***Access Panels***	***Deckplate Removal and Replacement***
E	***⇨ LSP Electro Servo Hydraulic SYSTEM (E2-1)***	ALL
E	***Hydraulic Control ECU***	***Removal and Replacement***
F	***Transmission ECU***	***Removal and Replacement***

(1) You must obey all of the relevant care and safety procedures.

Removal and Replacement



C096660-C1

Fig 1.

Handling

Incorrect handling will result in permanent damage to the valve assembly. The valve block should be lifted by holding either end of the valve body. Do not use the electric solenoids **E** or **G** to the lift the valve.

Extreme care should be taken to avoid damaging the electric solenoids **E** or **G** when handling the valve assembly.

Removal

Note: *Turn the steering to the full right hand lock (in 4 wheel steer mode) to aid access.*

1 Park the machine and make it safe with the boom raised. Vent the hydraulic pressure. Obey the care and safety procedures. ⇨ ***Related Topics (E4-2)***

⚠ 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 Remove the deckplate. Refer to ***Section 3 - Access Panels***. ⇨ ***Related Topics (E4-2)***

3 Put a label on the valve block hydraulic hoses and electrical connectors to aid replacement.

4 Disconnect the valve block hydraulic hoses. Plug the open ports and cap the hoses to prevent loss of fluid and ingress of dirt.

5 Disconnect the transmission pump suction hose **F**.

6 Disconnect the valve block harness connectors from the solenoids **E** and **G**.

7 Remove the transmission ECU. Refer to ***Section F - Transmission ECU***. ⇨ ***Related Topics (E4-2)***

8 Remove the Hydraulic Control ECU. Refer to ***Section E- Hydraulic Control ECU***. ⇨ ***Related Topics (E4-2)***

9 Disconnect the chassis harness to valve block harness connectors **H**.

Important: *Do not disconnect the hoses to the receiver drier.*

⚠ WARNING

The air conditioning system is a closed loop system and contains pressurised refrigerant. No part of the system should be disconnected until the system has been discharged by a refrigeration engineer or a suitably trained person. You can be severely frostbitten or injured by escaping refrigerant.

4-3-4-1_2

10 Remove the receiver drier securing bolts **J** (if fitted). Secure the receiver drier away from the accumulator.

11 Disconnect the valve block harness connector from the chassis harness connector.

12 Remove the accumulator **D** from the valve block.

13 Use a piece of wood to support the control valve and keep it horizontal.

14 Remove the 3 valve block mounting bracket bolts **B** from the chassis.

15 Attach lifting equipment to the valve block mounting bracket lifting eyes **C**.

⚠ WARNING

This component is heavy. It must only be removed or handled using a suitable lifting method and device.

BF-4-1_1

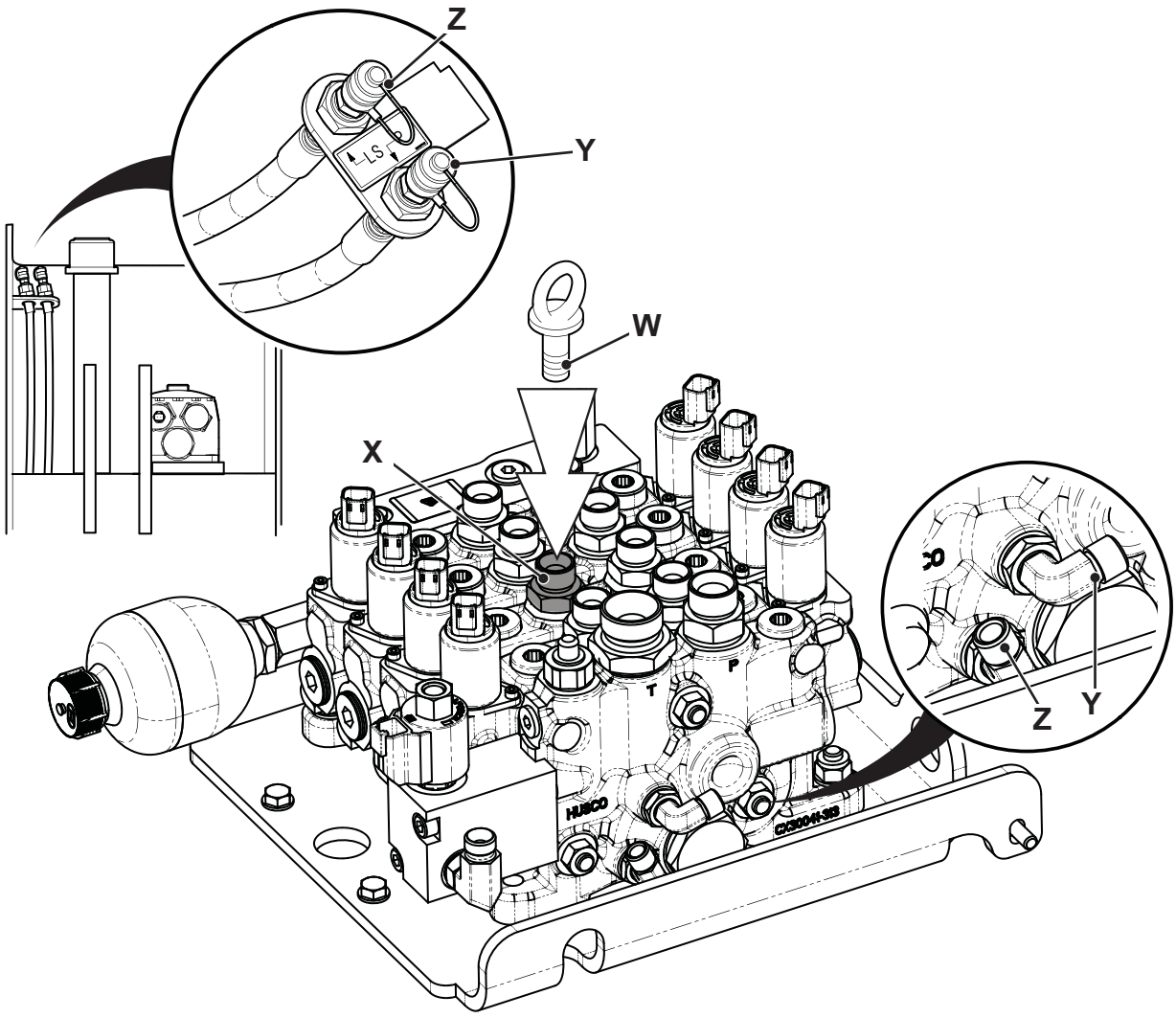
16 Using suitable lifting equipment remove the valve block from the chassis.

17 Remove the nuts and bolts **A**.

Note: *Only 3 of the 4 securing bolt holes are used.*

18 Remove the valve block from the mounting bracket.

Replacement



C096660

Fig 2.

1 Install the valve block mounting bracket on to the chassis. Install and torque tighten securing bolts **B**. ⇒ *Table 3. Torque Settings (E4-6)*

2 Remove the valve block adaptor **X**.

Note: *Make sure to remove the correct adaptor.*

3 Remove the blanking plug and install lifting eye **W** into the valve block. For lifting eye details refer to ***Section 1 - Service Tools***. ⇒ *Related Topics (E4-2)*

4 Attach suitable lifting equipment to the lifting eye.

⚠ WARNING

This component is heavy. It must only be removed or handled using a suitable lifting method and device.

BF-4-1_1

5 Install the valve block into the chassis - start with the valve block in a vertical position and then tilt it to its correct horizontal position.

6 Install the valve block mounting bolts and nuts **A**.

Note: *The bolts will need to be installed from below the valve block.*

Note: *Only 3 of the 4 securing bolt holes are used.*

7 With assistance torque tighten the valve block mounting bolts **A**. ⇒ *Table 3. Torque Settings (E4-6)*

8 Remove the lifting eye **W** and replace the valve block adaptor **X**

9 Connect the remote test point hoses and dump solenoid hoses to the valve block, a modified spanner will be required to tighten the hoses to the valve block adaptors.

Note: *Make sure that the test point hoses are connected to the correct valve block ports:* ⇒ *Table 2. (E4-6)*

Table 2.

Item	⇒ *Fig 2. (E4-5)*
Y	Pump Gauge Test Point/Port
Z	Load Sense Gauge Test Point/ Port

10 Replace the remaining control valve hoses but leave them loose.

11 Make sure to phase the hose elbows correctly to prevent damage or chafing.

12 When hoses are correctly phased use a modified spanner to tighten the hoses to the valve block adaptors.

13 Install the accumulator **D** and torque tighten. ⇒ *Table 3. Torque Settings (E4-6)*

14 Connect the valve block harness connectors to the valve block solenoids **E** and **G**.

15 Install the receiver drier using the securing bolts **J**.

16 Connect the chassis harness to valve block harness connectors **H**.

17 Replace the transmission pump suction hose **F**.

18 Replace the Transmission ECU. Refer to ***Section F - Transmission ECU***. ⇒ *Related Topics (E4-2)*

19 Replace the Hydraulic Control ECU. Refer to ***Section E- Hydraulic Control ECU***. ⇒ *Related Topics (E4-2)*

20 Check the LSRV pressure. ⇒ *Load Sense Relief Valve (LSRV) (E2-48)*

21 Check the ARV pressures. ⇒ *Test Procedures (E2-46)*

22 Check the hydraulic fluid level. ⇒ *Related Topics (E4-2)*

23 Operate the machines hydraulic system. Check for correct operation and leaks.

Table 3. Torque Settings

Item	Nm	kgf m	lbf ft
A	47	4.8	34.6
B	24	2.4	17.7
D	48	4.9	35.4
X	81	8.2	60

Dismantle and Assemble

Valve Block Sections

The valve block is made up of a number of sections. The illustration is intended as a guide to identifying the components.

Important: *Make sure that new valve section 'O' rings are available before dismantling the valve block.*

Be sure to record the location of all components when dismantling. Although some components look the same they are not interchangeable. The service spools for example are of two different types. Make sure that the components are assembled in the correct position.

Take care when dismantling and assembling a valve to prevent damage to seals and seal grooves. Damage or contamination can cause problems with valve operation.

Dismantle

1 Remove the valve block from the machine.

2 Remove the three tie rod nuts **A**.

3 Slide each valve section off the tie rods.

4 If the outlet section **G** is to be replaced, remove and retain the tie rods.

Assemble

Assembly is the opposite of the dismantling procedure.

During the assembly procedure do this work also:

1 Clean the valve components in an applicable solvent. Make sure that the mating faces of the valve sections are fully clean before assembly.

2 Replace the 'O' rings located between the valve sections. Install the 'O' rings correctly. Incorrectly installed 'O' rings will be damaged.

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

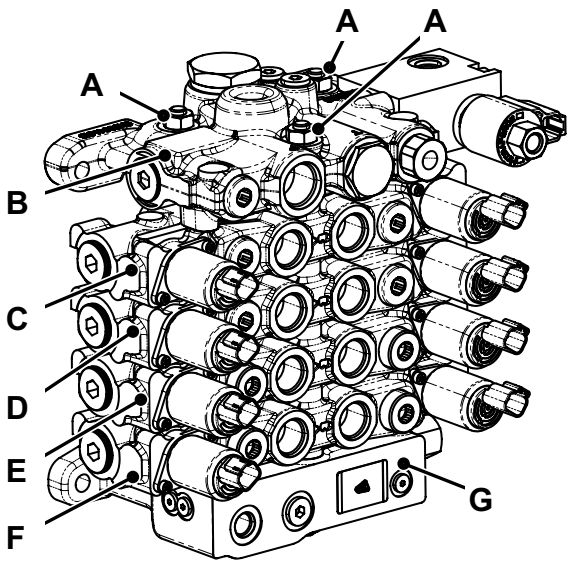
4 If the tie rods were removed, apply JCB Threadlocker and Sealer to the threads before installing.

5 Screw the tie rods into the valve block until they are tight. Unscrew them 1 turn. Once the valve block is fully assembled these rods may be adjusted to allow sufficient thread for the tie rod nuts **A** to tighten.

6 Torque tighten the tie rod nuts. ⇨ *Table 4. Torque Settings (E4-7)*

Table 4. Torque Settings

Item	Nm	kgf m	lbf ft
A	54	5.5	40



C094480

Fig 3.

Component Key:	
A	Tie Rod Nuts
B	Inlet Section
C	Auxiliary section
D	Tilt section
E	Extend / Retract Section
F	Lift / Lower Section
G	Outlet Section

Proportional Solenoids

The solenoids are not serviceable parts. Replace the solenoid valve assembly if it is defective.

Removal

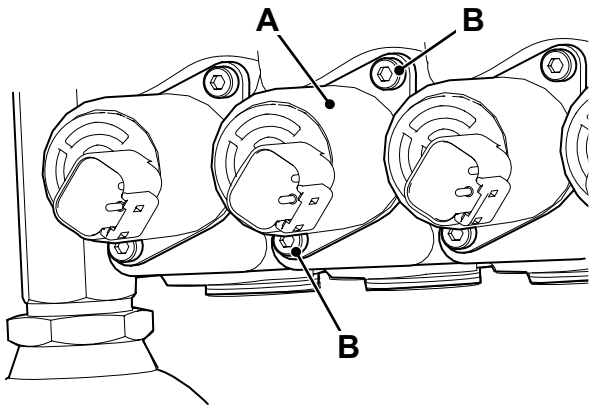
This procedure is the same for all of the solenoid valves.

1 Disconnect the solenoid valve electrical connections.

2 Using a 2.5 mm allen key, remove the screws **B**.

3 Lift the solenoid **A** out of the valve block.

Note: *The solenoids **A** are difficult to remove as the seals are a tight fit in the valve block. To aid removal turn the solenoid and use a flat bladed screwdriver to lever the solenoid from the valve block. Make sure not to damage the valve block.*



C094490

Fig 4.

Replacement

Replacement is the opposite of the removal procedure.

During the replacement procedure do this work also:

1 Clean the valve components in an applicable solvent.

2 Lubricate the parts with JCB Hydraulic Fluid before assembling.

3 Replace all 'O' rings and back-up rings.

4 Torque tighten the screws **B**. ⇨ *Table 5. Torque Settings (E4-8)*

Table 5. Torque Settings

Item	Nm	kgf m	lbf ft
B	2.0	0.2	1.5

Load Sense Relief Valve

The load sense relief valve is not serviceable. Replace the complete valve if it is defective.

Removal

1 Remove the valve assembly **A** from the valve block.

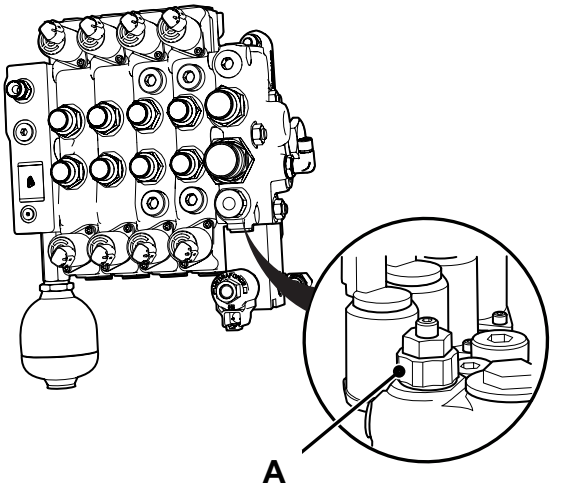


Fig 5.

Replacement

Replacement is the opposite of the removal procedure.

During the replacement procedure do this work also:

1 Torque tighten the valve. ⇨ *Table 6. Torque Settings (E4-9)*

2 Replace all 'O' rings and back-up rings.

3 Lubricate the parts with JCB Hydraulic Fluid before assembling.

4 Adjust the pressure setting as required. ⇨ *LSP Electro Servo Hydraulic SYSTEM (E2-1)*

Table 6. Torque Settings

Item	Nm	kgf m	lbf ft
A	65	6.6	48

Auxiliary Relief Valves (ARV's)

Refer to the hydraulic system topic for ARV removal and replacement procedure. ⇨ *Auxiliary Relief Valve Replacement (E2-52)*

Accumulator Check Valve and Filter

For this procedure refer to ***Section 3 - Hydraulic System***.
⇨ *Related Topics (E4-2)*

Dump Solenoid

The solenoid is not serviceable. Replace the complete valve if it is defective.

Removal

1 Disconnect the solenoid valve electrical connections.

2 Remove the nut **A**.

3 Pull the solenoid coil **B** off the valve stem **C**.

4 Using a suitable open ended spanner unscrew the valve stem **C** from the valve block.

Replacement

Replacement is the opposite of the removal procedure.

During the replacement procedure do this work also:

1 Clean the valve components in an applicable solvent.

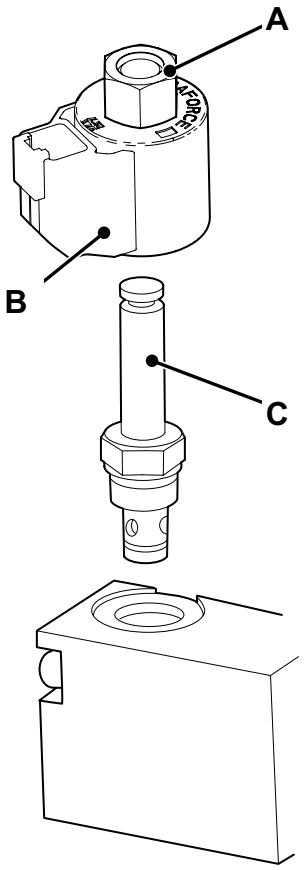
2 Lubricate the parts with JCB Hydraulic Fluid before assembling.

3 Replace all 'O' rings and back-up rings.

4 Torque tighten the nut **A** and the valve stem **C**. ⇨ *Table 7. Torque Settings (E4-12)*

Table 7. Torque Settings

Item	Nm	kgf m	lbf ft
A	6.8	.69	5
C	27.1	2.76	20



C094510

Fig 6.

Main Pump - Gearpump

Introduction

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

Descriptions and procedures relate to the device and not related systems. For information about the systems refer to the relevant topics.

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.

⇨ *Related Topics (E5-2)*
⇨ *Operation Overview (E5-3)*
⇨ *Hydraulic Operation and Schematics (E5-5)*
⇨ *Removal and Replacement (E5-6)*
⇨ *Dismantle, Inspection and Assemble (E5-8)*

Related Topics

Table 1. Related Topics in This Publication

The table lists other topics in the manual that contain information related to this topic. Refer to the applicable topics to complete your procedures. Where applicable the text in this section contains cross references to this page to help you find the correct information. Some machines have different systems and devices. Make sure you refer to the correct topic, refer to ***Section 1 - Applications***.

Sections	Topic Titles	Sub Titles
1	***Applications***	ALL
1	***Service Tools***	ALL
2	ALL (Care and Safety)(1)	ALL
3	***Hydraulic System***	***Checking the Hydraulic Fluid Level***
B	***Chassis Panels***	***Engine Cover***
E	***⇨ LSP Electro Servo Hydraulic SYSTEM (E2-1)***	ALL
E	***⇨ Cooling Fan Motor (E7-1)***	ALL
H	***Priority Valve***	ALL

(1) You must obey all of the relevant care and safety procedures.

Operation Overview

The pump is a gear type and driven by the engine. The separate sections of the gear pump assembly supply hydraulic oil to the main services circuits, to the steering circuit and to the hydraulic cooling fan circuit.

Table 2. Pump Configuration

1	Main Services Section
2	Cooling Fan Section

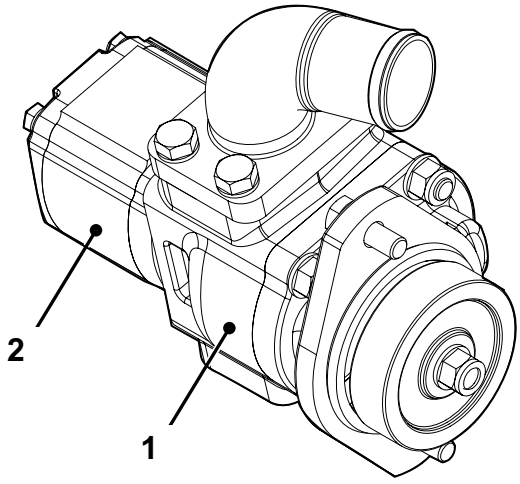
The separate sections of the gear pump operate individually as described below:

⇨ *Fig 2. (E5-4)*. The working principle of a gear pump depends on the meshing of two spur gears **A** and **B**. Oil is picked up on the suction side of the pump by the gears and carried round between the gear teeth and pump body. As the gears come into mesh the oil is forced through the outlet port, or through an internal port into the integral priority valve depending on the type of pump.

Some oil is allowed to circulate behind the bushes **C** and **D** to hold them in balance against the gears and minimise oil slippage.

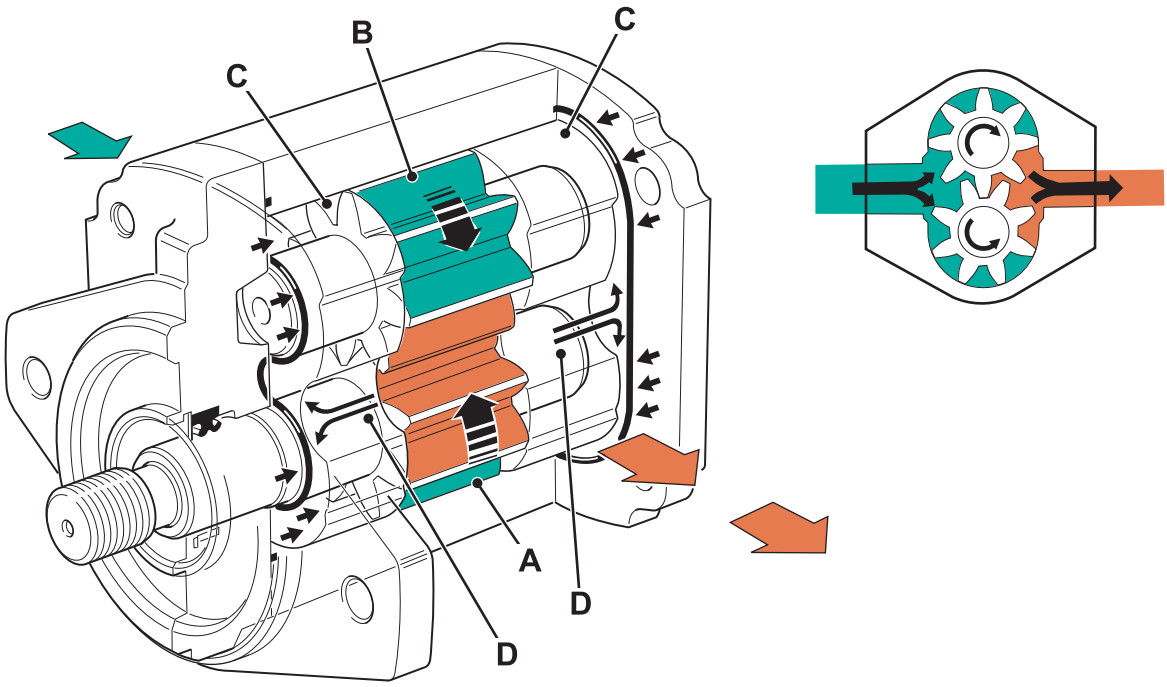
Lubrication is provided by hydraulic oil which is directed around the unit, via oilways, by the motion of the meshing gears.

For priority valve operation, refer to ***Section H - Steering***.
⇨ *Related Topics (E5-2)*



C094020-C1

Fig 1.



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Fig 2. Typical Gear Pump Section

Table 3. Key to Oil Flow and Pressure

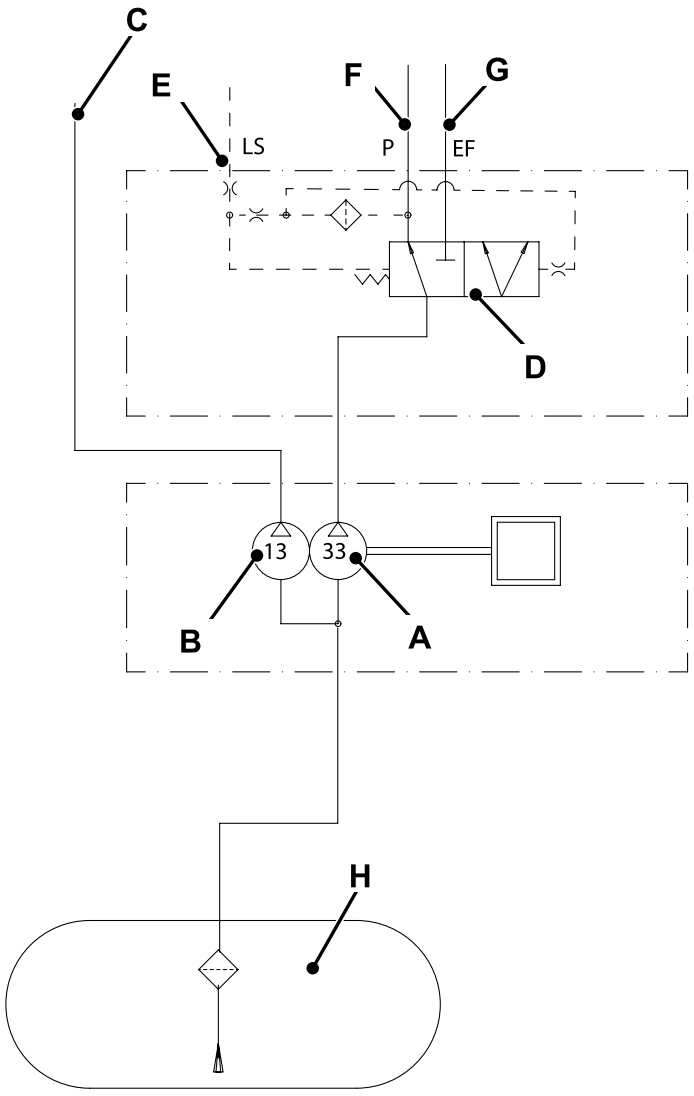
	Full Pressure
	Exhaust

Hydraulic Operation and Schematics

⇒ *Fig 3. (E5-5)*

Item	
A	Main Services Pump Section
B	Fan Pump Section
C	Fan Supply Line

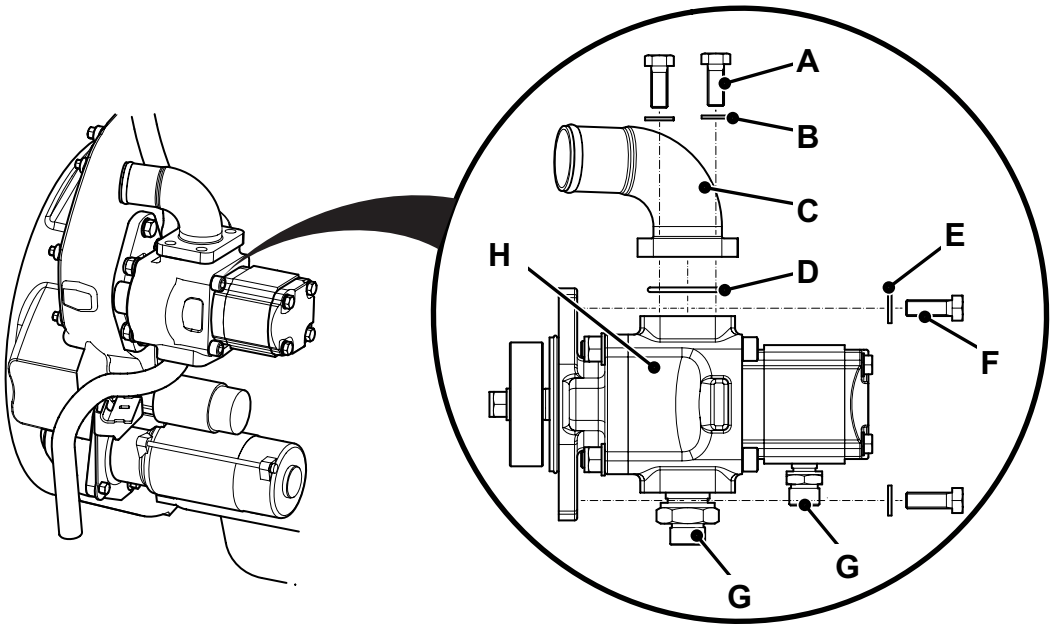
Item	
D	Priority Steer Valve
E	Steering Load Sense Line
F	Pump Main Output
G	Control Valve Block Feed
H	Hydraulic Tank



C065900-C1

Fig 3.

Removal and Replacement



C095770

Fig 4.

Carry out General Safety procedures, see ***Section 2 - General Procedures***. ⇨ *Related Topics (E5-2)*

Before removing and dismantling the pump, check the flow and pressure. If either of these are low and cannot be corrected at the relief valve, the appropriate pump section must be renewed completely.

Before removing or dismantling the pump, make sure the exterior of the pump and working area is thoroughly cleaned and free of possible sources of contamination.

Removal

1 Park the machine on firm level ground, engage the parking brake and set the transmission to neutral. Lower the boom to the ground. Stop the engine and remove the starter key, see ***Section 2 - General Procedures***. ⇨ *Related Topics (E5-2)*

⚠ 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

2 Release the hydraulic pressure, see ***Section 2 - General Procedures***. ⇨ *Related Topics (E5-2)*

3 If possible drain the hydraulic tank.

4 Remove the engine cover. Refer to ***Section B - Chassis Panels***. ⇨ *Related Topics (E5-2)*

5 Remove flange bolts **A** and washers **B** and disconnect the suction hose flange **C** from the pump body **H**.

6 Remove and discard the 'O' ring **D**.

7 Plug the open port and cap the hose to prevent loss of fluid and ingress of dirt.

8 Put a label on each hydraulic hose before disconnecting to aid replacement.

9 Disconnect the feed hoses from the adaptors **G**. Plug the open ports and cap the hoses to prevent loss of fluid and ingress of dirt.

⚠ WARNING

This component is heavy. It must only be removed or handled using a suitable lifting method and device.

BF-4-1_1

10 Secure the pump using a sling around the pump body. With the pump suitably supported, undo the mounting bolts **F** and washers **E** and carefully withdraw the pump clear of the engine.

Replacement

Replacement is the opposite of the removal procedure.

During the replacement procedure do this work also:

- Ensure the pump flange and gearbox mating face are clean and free from oil and grease prior to assembly.
- Use a new 'O' ring **D**.
- Support the pump until bolts **F** have been torque tightened. ⇨ *Table 4. Torque Settings (E5-7)*.

Note: *Mounting bolts **F** should be 10.9 grade M12 tuff lok, make sure the correct bolts are fitted.*

- Make sure that the hoses are correctly installed, and phased in the same position as removal to prevent chafing.
- Refill the hydraulic tank to the correct level with clean hydraulic fluid.
- After fitting a new or serviced pump and before starting the engine screw the Main Relief Valve (MRV) out 4 full turns. Adjust the MRV, refer to the applicable system topic. ⇨ *Related Topics (E5-2)*.
- Check the fan motor speed, refer to ***Parallel SYSTEM Specifications***. ⇨ *Related Topics (E5-2)*

Table 4. Torque Settings

Item	Nm	Kgf. m	lbf. ft
A	102	10.5	75
F	104	10.5	76.5

Dismantle, Inspection and Assemble

Do not attempt to dismantle the pump. If the pump is defective it must be renewed.

Control Lever - Electro Servo

Introduction

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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.

⇒ *Related Topics (E6-2)*

⇒ *Removal and Replacement (E6-3)*

Related Topics

Table 1. Related Topics in This Publication

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Sections	Topic Titles	Sub Titles
1	***Applications***	ALL
1	***Hydraulic Schematics***	ALL
2	ALL (Care and Safety)(1)	ALL
E	***⇨ LSP Electro Servo Hydraulic SYSTEM (E2-1)***	ALL

(1) You must obey all of the relevant care and safety procedures.

Removal and Replacement

Removal

1 Park the machine and make it safe. Lower the boom. Obey the General Safety procedures, see ***Section 2 - General Procedures***. ⇨ *Related Topics (E6-2)*

2 Vent the hydraulic pressure, see ***Section 2 - General Procedures***. ⇨ *Related Topics (E6-2)*

3 Remove gaiter screws **A**.

4 Remove the gaiter collar **B**.

5 Undo screws **E** and lift the control lever assembly **F** away from the housing **C** to get access to the connectors **G** and **H**.

6 Put a label on the electrical connectors to help identification when replacing.

7 Disconnect the lever electrical connectors **G**.

8 Disconnect the powerbase electrical connectors **H**.

9 Remove control lever from housing **C**.

Replacement

Replacement is the opposite of the removal procedure.

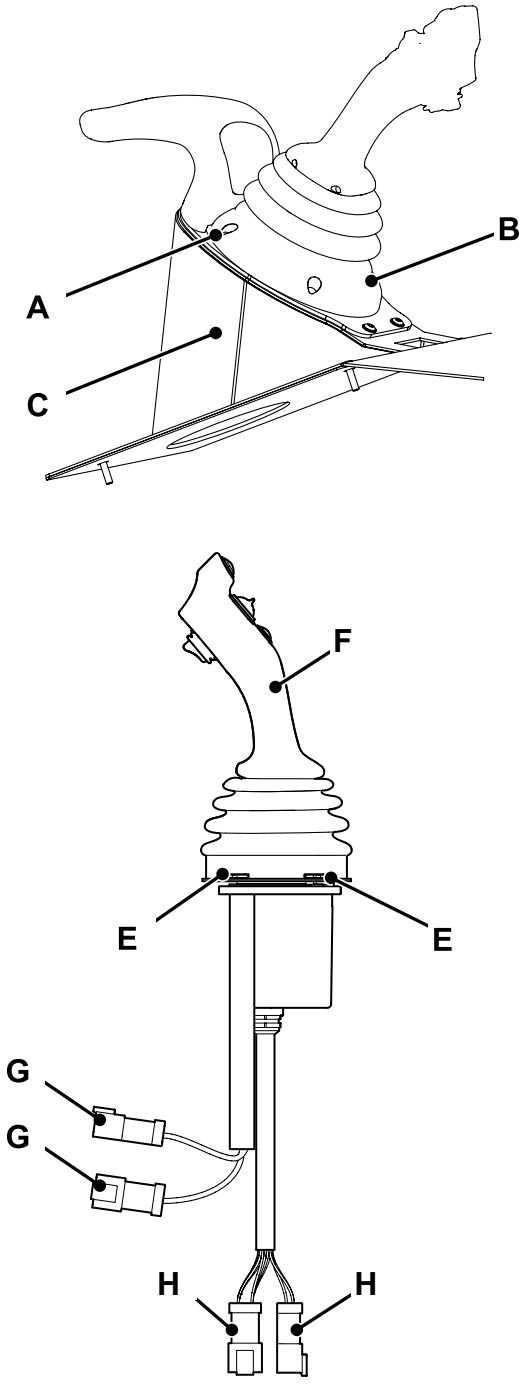


Fig 1.

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Cooling Fan Motor

Introduction

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Descriptions and procedures relate to the device and not related systems. For information about the systems refer to the relevant topics.

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.

⇨ *Related Topics (E7-2)*
⇨ *Operation Overview (E7-3)*
⇨ *Hydraulic Operation and Schematics (E7-4)*
⇨ *Removal and Replacement (E7-5)*
⇨ *Removal (E7-5)*
⇨ *Replacement (E7-6)*
⇨ *Dismantle, Inspection and Assemble (E7-7)*
⇨ *Machines built before January 2011 (E7-7)*
⇨ *Machines built after January 2011 (E7-10)*

Related Topics

Table 1. Related Topics in This Publication

The table lists other topics in the manual that contain information related to this topic. Refer to the applicable topics to complete your procedures. Where applicable the text in this section contains cross references to this page to help you find the correct information. Some machines have different systems and devices. Make sure you refer to the correct topic, refer to ***Section 1 - Applications*****.**		
Sections	**Topic Titles**	**Sub Titles**
1	***Applications***	ALL
2	ALL (Care and Safety)(1)	ALL
3	***Hydraulic System***	***Checking the Hydraulic Fluid Level***
E	***⇨ LSP Electro Servo Hydraulic SYSTEM (🗋 E2-1)***	ALL
E	***⇨ Main Pump - Gearpump (🗋 E5-1)***	ALL
K	***Engine***	***Cooling Pack***

(1) You must obey all of the relevant care and safety procedures.

Operation Overview

⇨ *Fig 1. (E7-4)*

The cooling fan motor is hydraulically driven. The motor turns the cooling fan and air is drawn through the radiators in the machine cooling pack.

Hydraulic oil from pump section **B**, supplies the fan motor **6** and trailer brake valve (if fitted).

Pressure relief valve **5** prevents component damage.

Hydraulic Operation and Schematics

Item	
1	Main Pump
2	Hydraulic Tank
3	Pump Pressure Supply
4	Fan Motor Case Drain Line
5	Fan Motor Pressure Relief Valve
6	Fan Motor

Table 2. Colour Key to Oil Flow and Pressure

	Full Pressure
	Neutral
	Exhaust

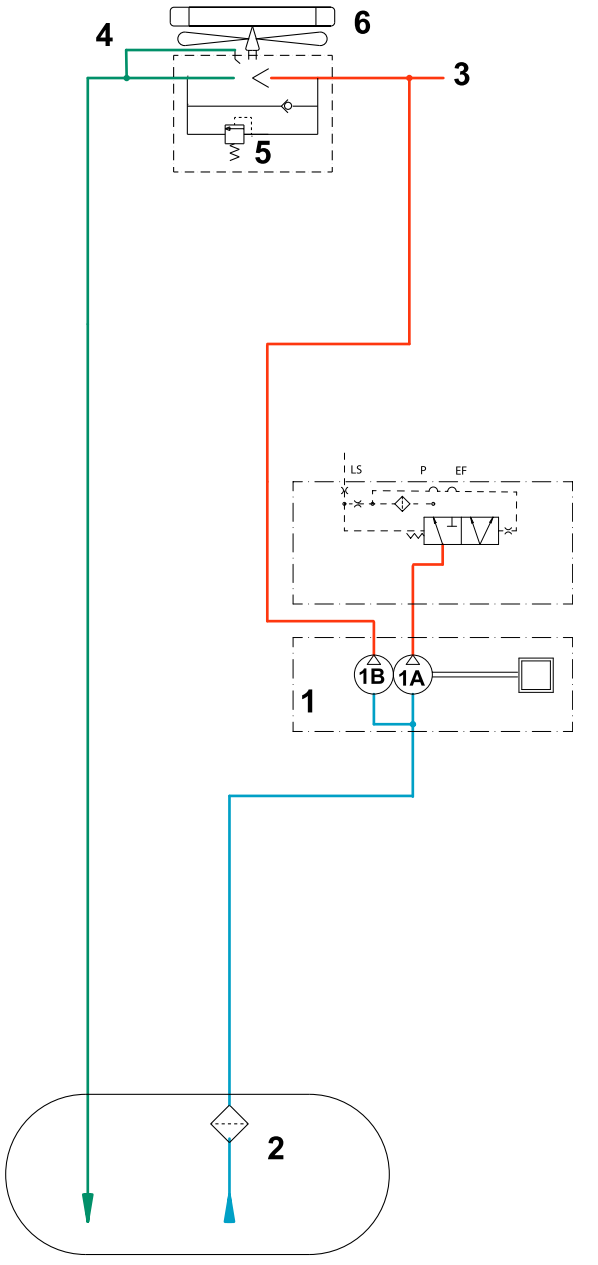


Fig 1.

Removal and Replacement

Before removing and dismantling the fan motor, check that its performance is as stated in the applicable SYSTEM topic. ⇨ *Related Topics (E7-2)*

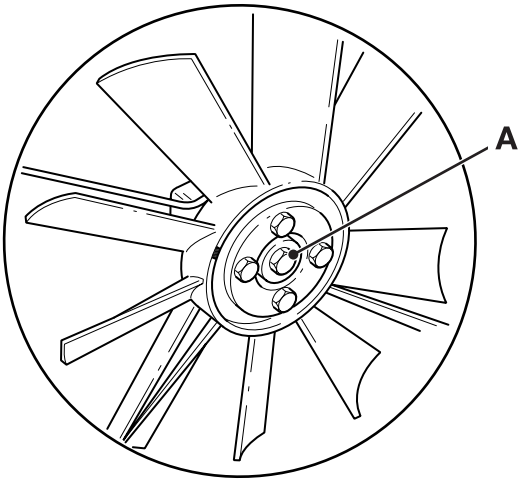
If the performance is below that specified, the motor should be renewed. Renewal of individual components such as gears, bearings and housings will not effect a permanent cure. If the motor performance is satisfactory but there is external leakage, it should be dismantled for re-sealing only.

Removal

1 Park the machine and make it safe. Fit the boom safety strut. Vent the hydraulic pressure. Obey the care and safety procedures. ⇨ *Related Topics (E7-2)*

2 Vent the hydraulic pressure, see ***Section 2 - General Procedures***. ⇨ *Related Topics (E7-2)*

3 Disconnect and plug the feed and return hoses **E** and **F**. Disconnect and plug the case drain hose **C** (reversible fan option only). Label each hose before disconnecting to ensure correct replacement.



764200-1

Fig 2.

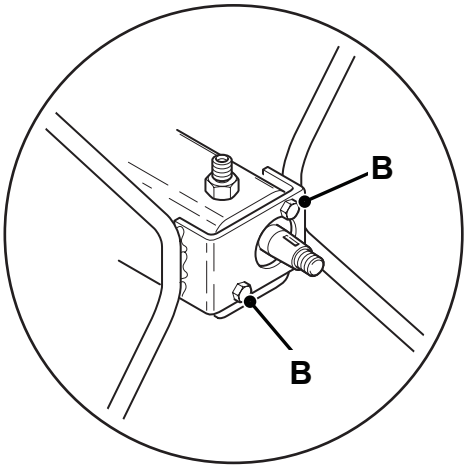
4 Remove the fan guard.

5 Undo 4 bolts **D** and lift away the fan and motor assembly.

6 Prevent the fan from turning, release the tab washer and then undo nut **A**.

7 Withdraw the fan from the motor shaft. Retain the drive key (not shown).

8 Undo motor retaining bolts **B** and remove the motor.



764210-1-C1

Fig 3.

Replacement

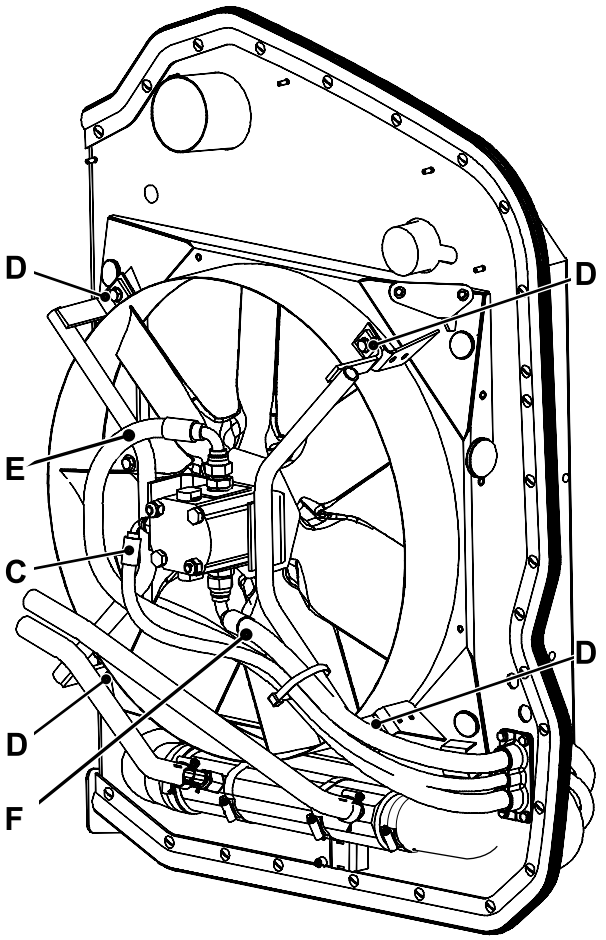
Replacement is the opposite of the removal procedure.

During the replacement procedure do this work also:

- Make sure all hoses are attached to the correct ports. The case drain hose **C** (reversible fan option only) must be fed in to a tank line otherwise damage to the motor will occur.
- Check the hydraulic fluid level. ⇨ *Related Topics (E7-2)*
- Install a new nut **A** and tab washer.

Table 3. Torque Settings

Item	Nm	kgf m	lbf ft
A	28	2.9	20.6
B	47	4.8	34.5



C025090-C3

Fig 4.

Dismantle, Inspection and Assemble

Machines built before January 2011

⇒ *Fig 5. (E7-9)*

Prior to dismantling the unit make sure that the exterior of the motor and the working area are thoroughly cleaned and free from possible sources of contamination.

Dismantle

Nut **1**, tab washer **2** and key **3** secure the fan and are replaced when the motor is re-installed in the machine. ⇒ *Removal and Replacement (E7-5)*

1 Remove sharp edges and burrs from the drive shaft **11** to avoid seal damage.

2 Remove relief valve **23**.

3 Mark end cover **20**, body **17** and flange **5** to ensure correct assembly.

4 Undo bolts **22** and spring washers **21** and remove end cover **20**. Take care not to damage the machined faces by prising them apart - use a soft faced hammer.

5 Remove back-up seal **15**, bush seal **14** and body 'O' ring **19**.

6 Remove flange **5**, slide the flange off square to the shaft. Take care not to damage the machined faces by prising them apart - use a soft faced hammer to free flange from dowels.

7 Remove back-up seals **7**, bush seal **8**, and body 'O' ring **16**.

8 Remove drive shaft **11**, bushes **13** and idler gear **10**. Push out bush **9** from the body. Note the position of bushes to ensure correct assembly.

9 Remove circlip **3** and shaft seal **4**. Take care not to damage the shaft seal recess.

Inspection

1 Inspect all 'O' ring grooves and shaft seal recesses in mounting flange **5**. Make sure they are free from burrs.

2 Check that the mating faces of the end cover 20, body **17** and flange **5** are not scored.

3 The motor must be renewed if any of the following faults are found:

a The PTFE coated bearing in the bushes are worn through so that the bronze base is visible.

b The gear side faces or bush faces are scored or chipped.

c The drive shaft has a noticeable wear groove where the shaft seal lips run.

Assemble

Nut **1**, tab washer **2** and key **3** secure the fan and are replaced when the motor is re-installed in the machine. ⇒ *Removal and Replacement (E7-5)*

1 Wash all components. Apply hydraulic oil immediately afterwards to prevent moisture collecting.

2 Renew all seals and 'O' rings using JCB Special Hydraulic fluid as a lubricant.

3 Fit shaft seal **4** into the mounting flange **5** with gaiter spring facing the motor. Fit circlip **3** and coat seal lips with JCB HP Grease.

4 Fit bush **9** in it's original positions. Place end cover **20** temporarily against main body **17** and stand assembly upright with dowels uppermost.

5 Fit drive shaft **11** and idler gear **10**. Fit bush **13** in it's original positions. Fit 'O' ring **16**, bush seal **8** and back-up seal **7**. Make sure that the flat face of back-up seal is uppermost.

6 Fit protective sleeve over drive shaft. Locate flange **5** to main body with a square fit on the dowels. Turn the assembly over and support on the flange, not on the drive shaft. Remove end cover.

7 Fit 'O' ring **19**, bush seal **14** and back-up seal **15**. Make sure that the flat face of back-up seal is uppermost. Fit end cover **20** with relief valve tapping on the same side as the outlet port. Secure with spring washers **21** and bolts **22**. Torque tighten to 47Nm (4.8 lbf ft., 36 lbf ft).

8 Fit relief valve **23**.

9 Put a small amount of clean hydraulic oil in the inlet port and check that the drive shaft can be turned by hand without undue force.

Table 4. Torque Settings

Item	Nm	kgf m	lbf ft
22(1)	47	4.8	36

(1) All four bolts must be torque tightened as above.

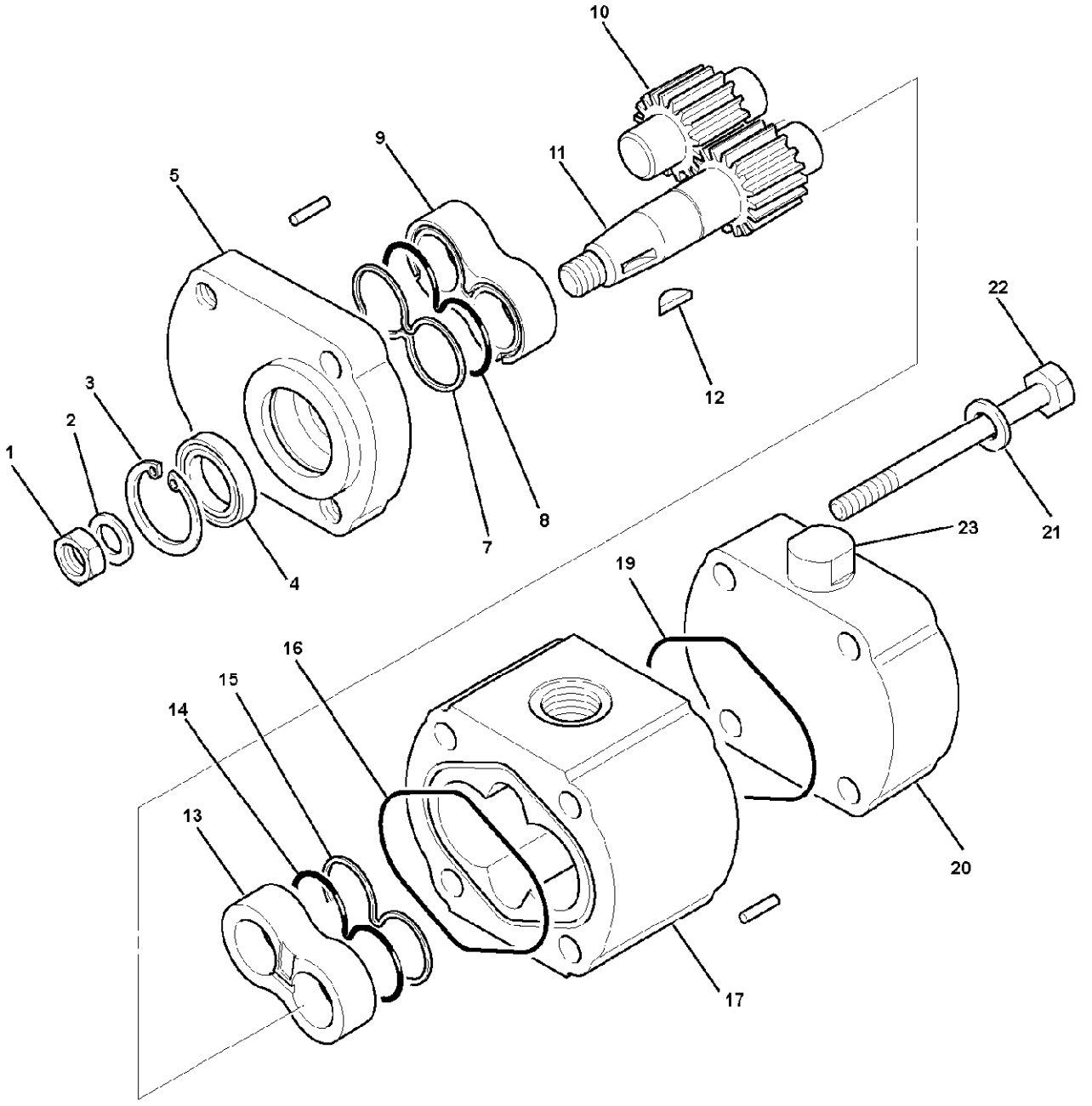


Fig 5.

Machines built after January 2011

Do not attempt to dismantle the motor. If the motor is defective it must be renewed.

Extension Ram

Introduction

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

Descriptions and procedures relate to the device and not related systems. For information about the systems refer to the relevant topics.

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.

⇨ *Related Topics (E8-2)*
⇨ *Removal and Replacement (E8-3)*
⇨ *Extension Ram (E8-3)*
⇨ *Hose Burst Check Valve (E8-5)*

Related Topics

Table 1. Related Topics in This Publication

The table lists other topics in the manual that contain information related to this topic. Refer to the applicable topics to complete your procedures. Where applicable the text in this section contains cross references to this page to help you find the correct information. Some machines have different systems and devices. Make sure you refer to the correct topic, refer to ***Section 1 - Applications*.**

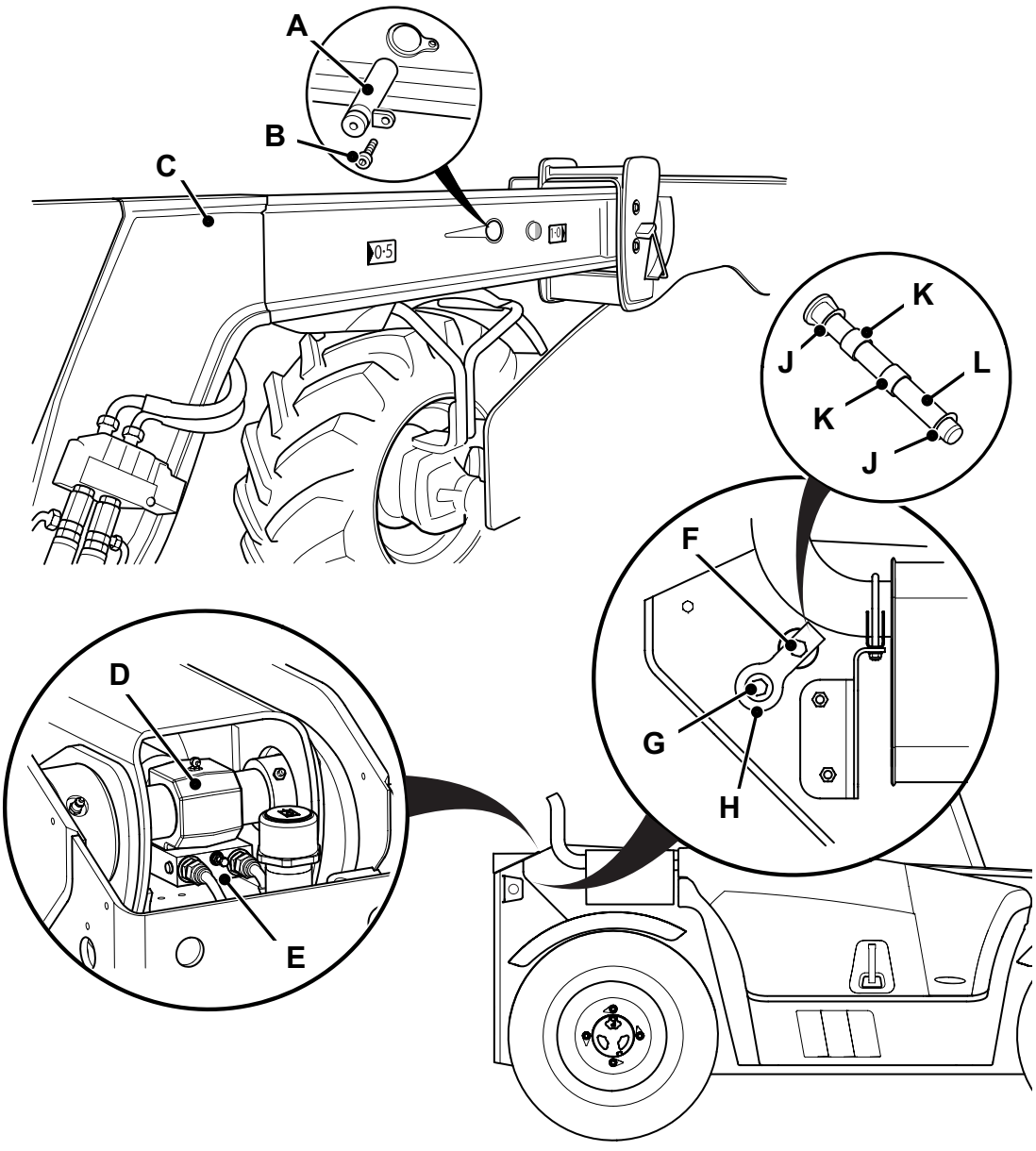
Sections	Topic Titles	Sub Titles
1	***Applications***	ALL
2	ALL (Care and Safety)(1)	ALL
3	***Hydraulic System***	***Checking the Hydraulic Fluid Level***
3	***Fluids, Lubricants and Capacities***	ALL
B	***Boom***	ALL
B	***Chassis Panels***	***Rear Cover***

(1) You must obey all of the relevant care and safety procedures.

Removal and Replacement

Extension Ram

Removal



C096330

Fig 1.

⇨ *Fig 1. (E8-3)*

1 Park the machine and make it safe. Vent the hydraulic pressure. Obey the care and safety procedures. ⇨ *Related Topics (E8-2)*

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 Remove any attachments from the carriage.

3 Extend the inner boom **C** to get access to the front pivot pin **A**.

4 Remove the bolt **B**.

5 Use a slide hammer to remove the pivot pin **A**, see ***Section 1 - Service Tools***.

6 Remove the hose burst check valve **E**. ⇨ *Hose Burst Check Valve (E8-5)*

7 Remove the bolts **F** and **G**.

8 Remove the pivot pin retaining plate **H**.

9 Use a slide hammer to remove the rear pivot pin **L**, see ***Section 1 - Service Tools***. Make sure not to lose the shims **J**.

10 Attach suitable lifting equipment and raise the rear of the boom to allow the extension ram **D** to be removed without obstruction.

11 Withdraw the extension ram **D** from the rear of the boom. Make sure to attach suitable lifting equipment to the ram.

WARNING

This component is heavy. It must only be removed or handled using a suitable lifting method and device.

BF-4-1_1

12 Remove the ram **D**.

Replacement

Replacement is the opposite of the removal procedure.

During the replacement procedure do this work also:

- Grease the ram pivot pins. ⇨ *Related Topics (E8-2)*
- Check the hydraulic fluid level. ⇨ *Related Topics (E8-2)*
- Check the boom pivot shim measurement. Refer to ***Section B - Boom***. ⇨ *Related Topics (E8-2)*

Hose Burst Check Valve

Removal

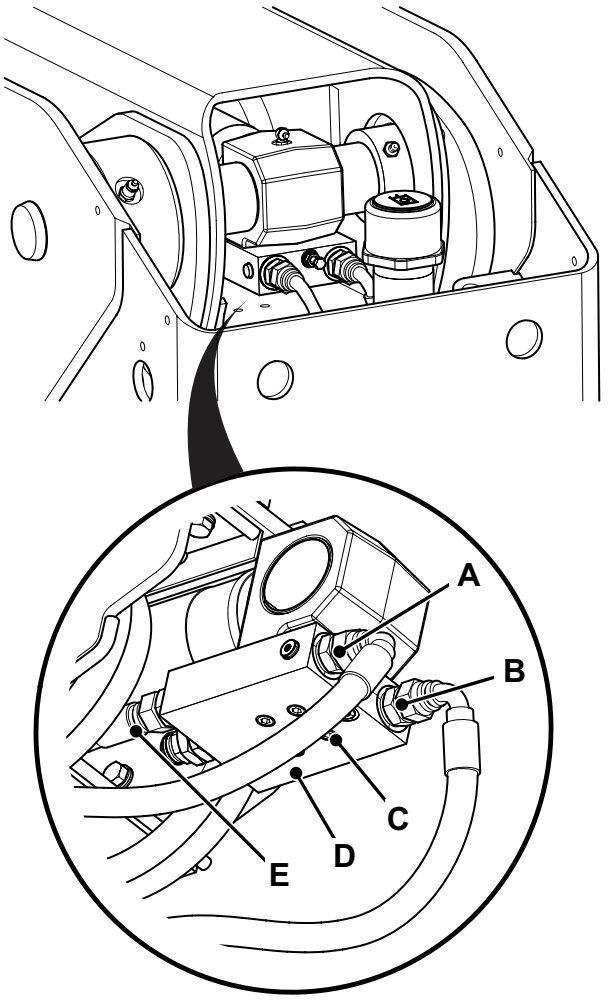


Fig 2.

1 Park the machine and make it safe. Vent the hydraulic pressure. Obey the care and safety procedures. ⇨ *Related Topics (E8-2)*

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 Remove any attachments from the carriage.

3 Remove the rear cover. Refer to ***Section B - Chassis Panels***. ⇨ *Related Topics (E8-2)*

4 Use a crows foot type spanner to slacken the hose connection **E** inside the boom.

5 Put a label on the hoses **A** and **B** to aid replacement.

6 Disconnect the outer hoses **A** and **B** from the valve **D**.

7 Use an allen key to remove the valve securing bolts **C**.

8 Pull the valve **D** out of the rear of the boom.

9 Disconnect the inner hose **E** from the valve.

10 Remove the valve **D** from the machine.

Replacement

Replacement is the opposite of the removal procedure.

During the replacement procedure do this work also:

– Check the hydraulic fluid level. ⇨ *Related Topics (E8-2)*

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Lift Ram

Introduction

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

Descriptions and procedures relate to the device and not related systems. For information about the systems refer to the relevant topics.

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.

⇒ *Related Topics (E9-2)*
⇒ *Removal and Replacement (E9-3)*

Related Topics

Table 1. Related Topics in This Publication

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Sections	Topic Titles	Sub Titles
1	***Applications***	ALL
2	ALL (Care and Safety)(1)	ALL
3	***Greasing***	***Every 50 Hours***
3	***Hydraulic System***	***Checking the Hydraulic Fluid Level***
B	***Boom***	ALL
E	***⇨ Ram Maintenance (E12-1)***	ALL

(1) You must obey all of the relevant care and safety procedures.

Removal and Replacement

Removal

⇨ *Fig 1. (E9-4)*

1 Park the machine and make it safe. Obey the care and safety procedures. ⇨ *Related Topics (E9-2)*

2 Remove any attachments from the carriage.

Important: *The lift ram will not be supporting the weight of the boom during this procedure therefore the safety strut will not work. Danger or injury will result if the boom is not supported fully.*

3 Lift the boom to approximately 45°, attach suitable lifting equipment and support the boom.

⚠ 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

4 Operate the controls back and forth several times to vent residual hydraulic pressure.

5 Support the lift ram **E**.

6 Remove the nut **A** and bolt **B**.

7 Using the slide hammer kit, remove the pivot pin **D**, see ***Section 1 - Service Tools***.

Note: *Make sure to retrieve washers **C**.*

8 Attach suitable lifting equipment to the ram rod eye end. Support the ram.

⚠ WARNING

This component is heavy. It must only be removed or handled using a suitable lifting method and device.

BF-4-1_1

9 Remove bolt **G**.

10 Using the slide hammer kit, remove the pivot pin **H**, see ***Section 1 - Service Tools***.

Note: *Make sure not to damage the remote grease point and pipe **F**.*

11 Remove ram **E** from the machine.

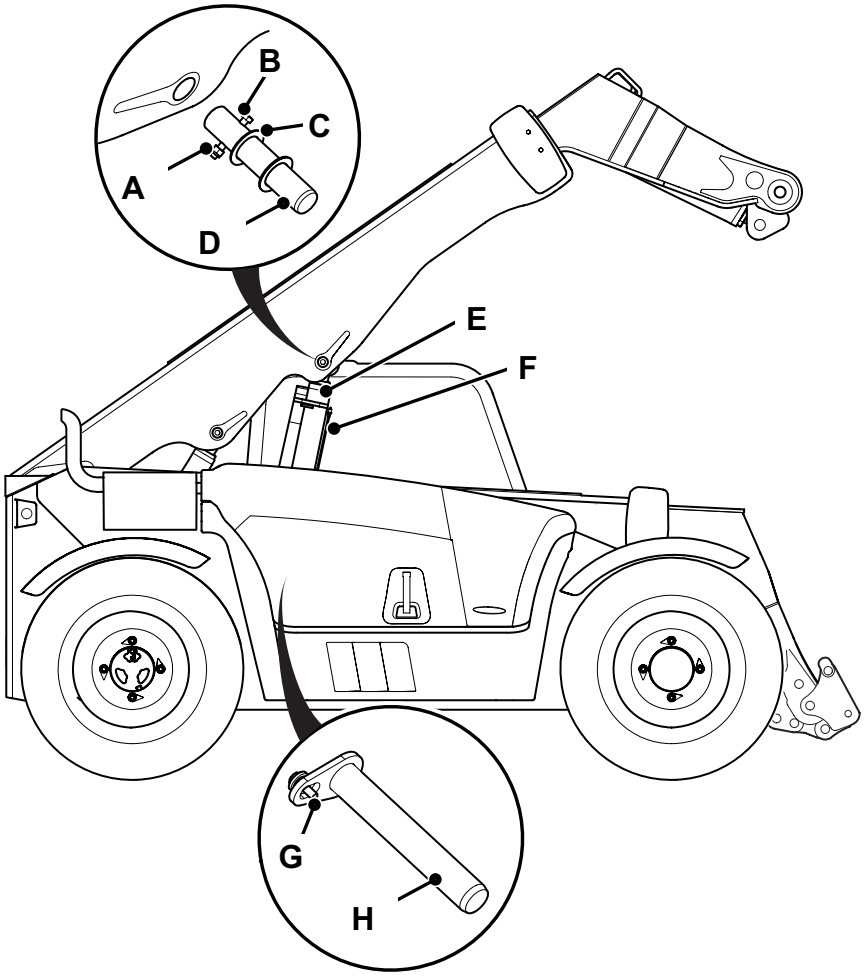
Replacement

Replacement is the opposite of the removal procedure.

During the replacement procedure do this work also:

– Grease the ram pivot pins. ⇒ *Related Topics (E9-2)*

– Check the hydraulic fluid level. ⇒ *Related Topics (E9-2)*



C094540-C1

Fig 1.

Tilt Ram

Introduction

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Descriptions and procedures relate to the device and not related systems. For information about the systems refer to the relevant topics.

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.

⇒ *Related Topics (E10-2)*

⇒ *Removal and Replacement (E10-3)*

Related Topics

Table 1. Related Topics in This Publication

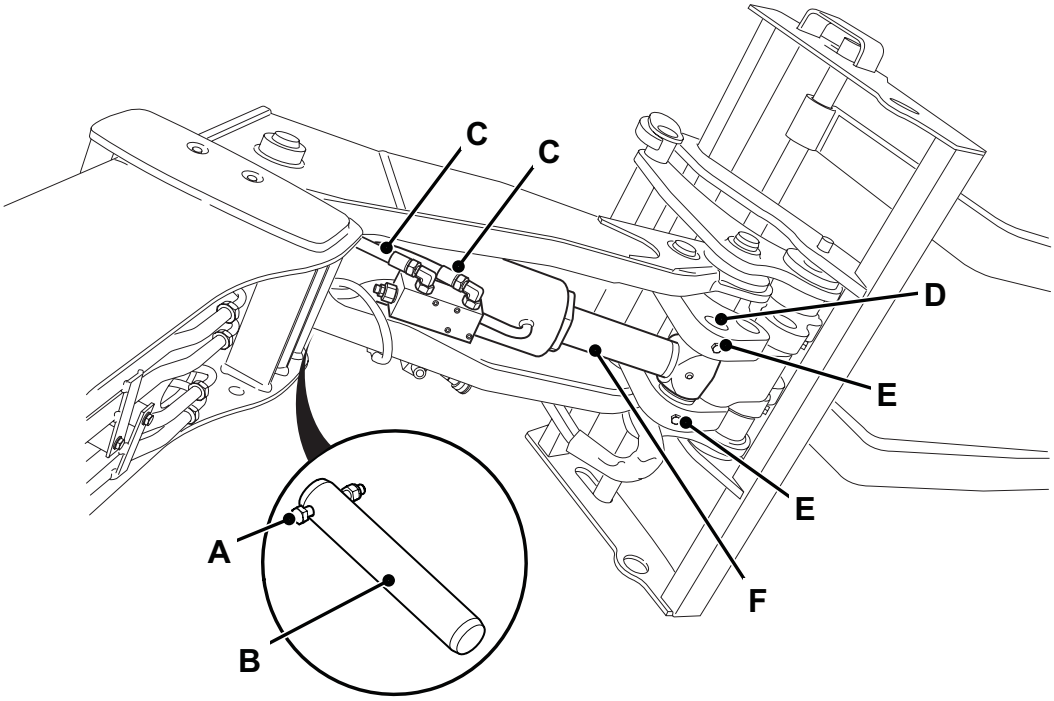
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Sections	Topic Titles	Sub Titles
1	***Applications***	ALL
2	ALL (Care and Safety)(1)	ALL
3	***Greasing***	***Every 50 Hours***
3	***Hydraulic System***	***Checking the Hydraulic Fluid Level***
E	***⇨ Ram Maintenance (E12-1)***	ALL

(1) You must obey all of the relevant care and safety procedures.

Removal and Replacement

Removal



C096490

Fig 1.

1 Remove attachments from the carriage.

2 Extend the tilt ram fully.

3 Lower the boom and carriage to the ground.

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

4 Park the machine and make it safe. Obey the care and safety procedures. Vent the hydraulic pressure. ⇒ *Related Topics (E10-2)*

5 Put a label on each hose before disconnecting to help identification when replacing.

6 Disconnect and plug tilt ram hydraulic hoses **C**.

7 Support the tilt ram **F**.

WARNING

This component is heavy. It must only be removed or handled using a suitable lifting method and device.

BF-4-1_1

8 Remove the bolts **E** and remove the pivot pin **D** from rod end.

9 Remove the bolt **A** and remove the pivot pin **B** from cylinder end.

10 Remove the ram from the machine.

Replacement

Replacement is the opposite of the removal procedure.

During the replacement procedure do this work also:

– Grease the ram pivot pins. ⇨ *Related Topics (E10-2)*
– Check the hydraulic fluid level. ⇨ *Related Topics (E10-2)*

Displacement Ram

Introduction

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Descriptions and procedures relate to the device and not related systems. For information about the systems refer to the relevant topics.

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.

⇒ *Related Topics (E11-2)*

⇒ *Removal and Replacement (E11-3)*

Related Topics

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Sections	Topic Titles	Sub Titles
1	***Applications***	ALL
2	ALL (Care and Safety)(1)	ALL
3	***Greasing***	***Every 50 Hours***
3	***Hydraulic System***	***Checking the Hydraulic Fluid Level***
B	***Boom***	ALL
E	***⇨ Ram Maintenance (E12-1)***	ALL

(1) You must obey all of the relevant care and safety procedures.

Removal and Replacement

Removal

1 Park the machine and make it safe. Vent the hydraulic pressure. Obey the care and safety procedures. ⇒ *Related Topics (E11-2)*

2 Remove the lift ram. ⇒ *Lift Ram (E9-1)*

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

3 Support the boom.

4 Lift the boom using the correct lifting equipment to get access to the displacement ram top pivot.

5 Put a label on each hose before disconnecting to help identification when replacing.

6 Disconnect and plug displacement ram hydraulic hoses.

7 Support the displacement ram **A**.

WARNING

This component is heavy. It must only be removed or handled using a suitable lifting method and device.

BF-4-1_1

8 Remove the nut **B** and bolt **C**.

9 Using the slide hammer kit, remove the pivot pin **D**, see ***Section 1 - Service Tools***.

10 Remove the nut **F** and bolt **E**.

11 Using the slide hammer kit, remove the pivot pin **G**, see ***Section 1 - Service Tools***.

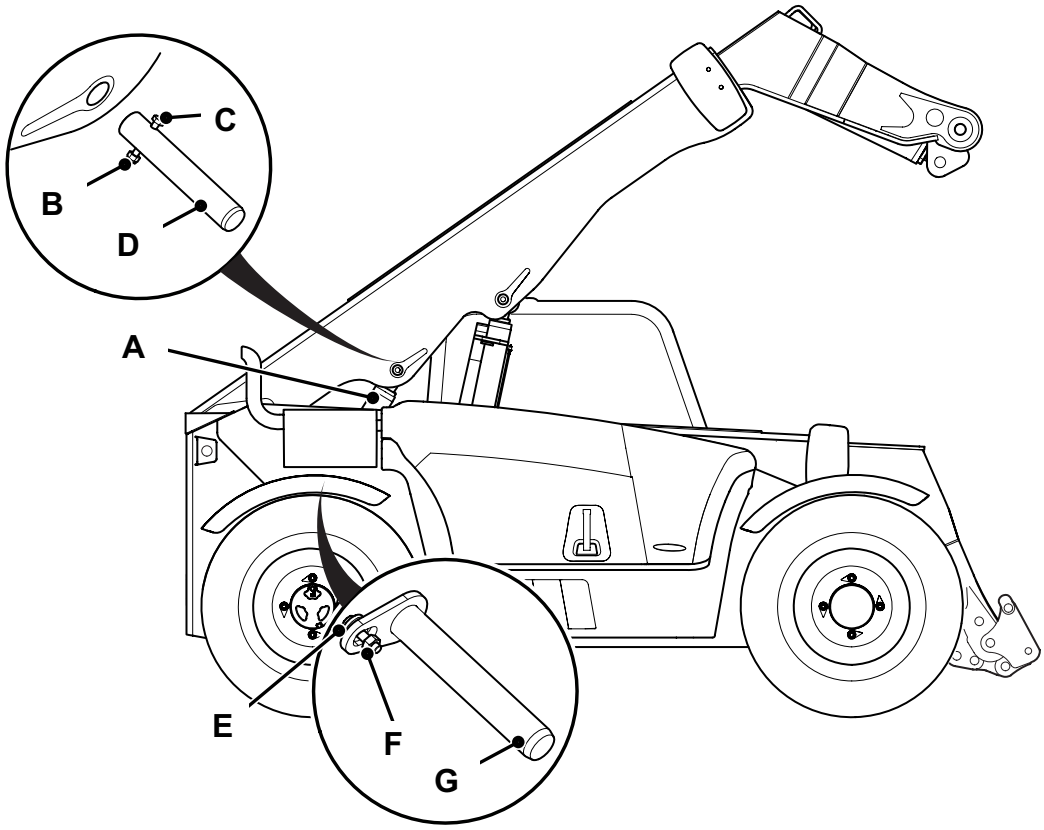
12 Remove the ram **A** from the machine.

Replacement

Replacement is opposite of the removal procedure.

During the replacement procedure do this work also:

– Grease the ram pivot pins. ⇒ *Related Topics (E11-2)*
– Check the hydraulic fluid level. ⇒ *Related Topics (E11-2)*



C094540-C2

Fig 1.

Ram Maintenance

Introduction

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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.

⇨ *Related Topics (E12-2)*
⇨ *Dismantle (E12-3)*
⇨ *Assemble (E12-5)*
⇨ *JCB Ram Sealing Procedure (E12-6)*
⇨ *Piston Head Retention (E12-8)*

Related Topics

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Sections	**Topic Titles**	**Sub Titles**
1	***Applications***	ALL
1	***Service Tools***	ALL
2	ALL (Care and Safety)(1)	ALL
E	⇨ ***Extension Ram (E8-1)***	ALL
E	⇨ ***Lift Ram (E9-1)***	ALL
E	⇨ ***Tilt Ram (E10-1)***	ALL
E	⇨ ***Displacement Ram (E11-1)***	ALL

(1) You must obey all of the relevant care and safety procedures.

Table 2. Service Tools

The table lists the service tools you will need to do some of the procedures in this topic. Make sure you have the correct service tools BEFORE you start the procedures	
Tool Part Number	**Description**
892/00334(1)	Ram Seal Fitting Tool
892/01027(1)	Piston Seal Assembly Tool
(2) Various	Ram Protection Sleeve ⇨ ***Table 4. Ram Protection Sleeve Sizes (E12-3)***
(2) Various	Hexagon Spanner ⇨ ***Table 3. End Cap Spanner Sizes (E12-3)*** and ⇨ ***Table 5. Piston Head Spanner Sizes (E12-3)***

(1) Tool available from JCB Service, refer to Section 1 - Service Tools
(2) For the applicable JCB part number refer to Section 1 - Service Tools

Dismantle

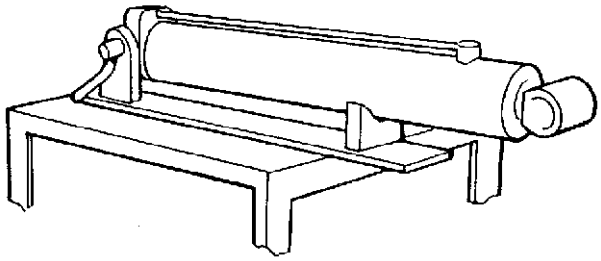
The dismantle and assemble procedures for many JCB hydraulic rams are the same. BEFORE you follow the procedures given in this topic make sure they are applicable. The applicable rams are given in the related topics table. ⇨ *Related Topics (E12-2)*

Important: *The ram must be removed from the machine before you dismantle it.* ⇨ *Related Topics (E12-2)*

⇨ *Fig 2. (E12-4)*

The illustration shows a ram which is not fitted with a hose burst check valve (HBCV). If a HBCV is fitted the ram dismantling/assembly procedures are unaffected and can be carried out without the need to remove the check valve.

1 Place ram assembly on a locally manufactured strip/rebuild bench. ⇨ *Fig 1. (E12-3)*



S263670-1

Fig 1.

2 Use the correct size spanner to release end cap **8** and remove the piston rod assembly (items **1** to **12**) from the cylinder **19**. ⇨ *Table 3. End Cap Spanner Sizes (E12-3)*

Table 3. End Cap Spanner Sizes

Ram	mm
Extend	65
Displacement	75
Lift	95
Tilt	125

⚠ WARNING

If air or hydraulic pressure is used to force out the piston assembly, ensure that the end cap is securely fitted. Severe injury can be caused by a suddenly released piston rod.

HYD-1-2

3 Position piston rod assembly on bench in place of ram cylinder. Discard seals (items **2**, **3**) and wear rings (items **1** and **4**) from piston head **6**.

4 Extract dowel **5** from the piston head using the appropriate sized screw threaded into the extractor hole.

Note: *To protect the internal faces of the piston fit the correct ram protection sleeve to the piston rod thread.* ⇨ *Table 4. Ram Protection Sleeve Sizes (E12-3)*

Table 4. Ram Protection Sleeve Sizes

Ram	mm	JCB Part No
Extend	50	892/01019
Displacement	50	892/01019
Lift	60	892/01021
Tilt	70	892/01024

5 Using the correct size spanner, remove piston head **6** from rod **12** and remove `O' ring **7**. ⇨ *Table 5. Piston Head Spanner Sizes (E12-3)*

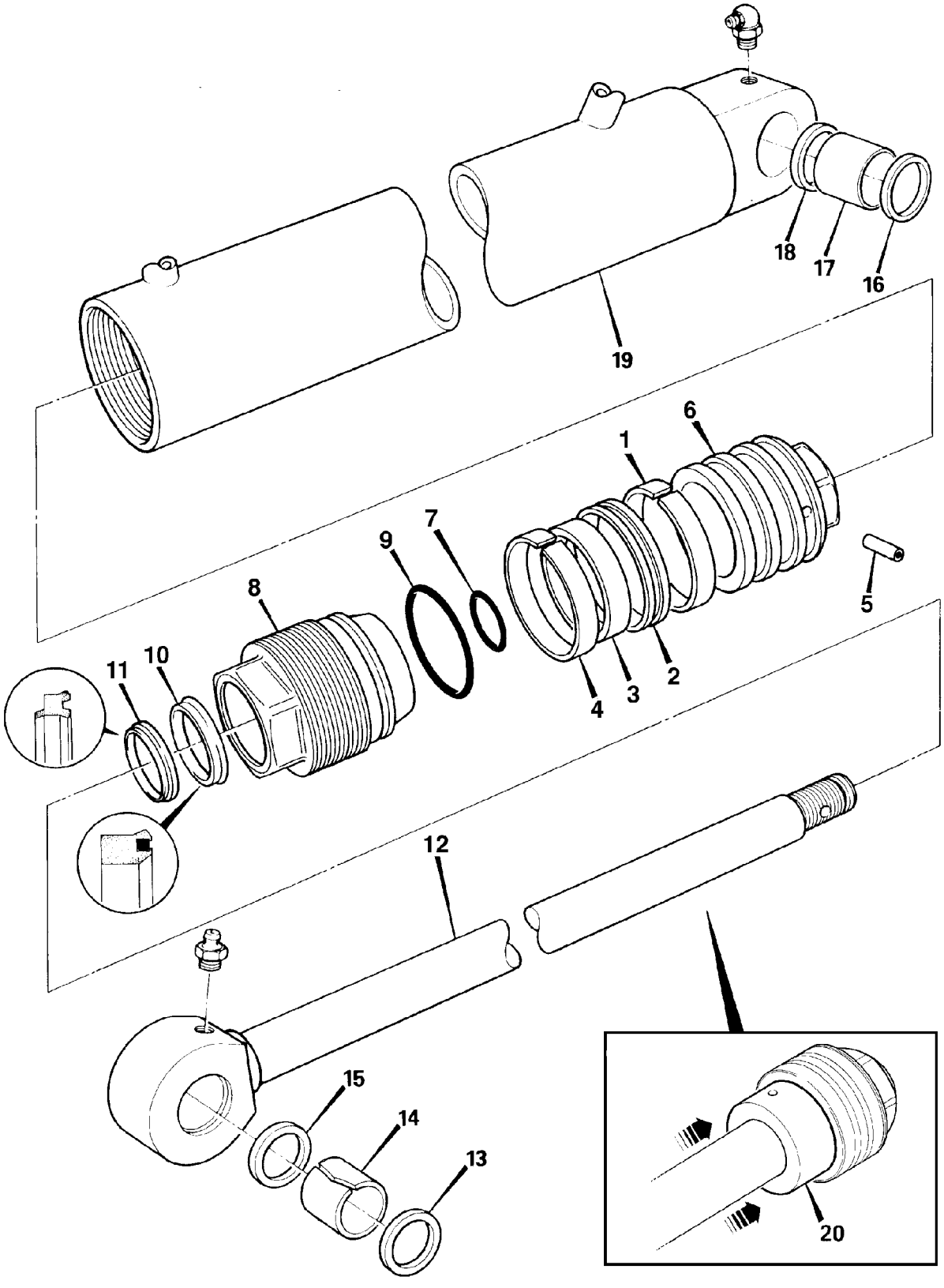
Table 5. Piston Head Spanner Sizes

Ram	mm
Extend	55
Displacement	75
Lift	85
Tilt	105

Extension rams only: Slide spacer **20** off piston rod **12**, after removal of piston **6**.

6 Remove gland bearing and end cap **8** from piston rod and remove the `O' ring **9**, wiper seal **11** and rod seal **10**. Check end cap bearing for damage, scores or nicks. If damaged, the bearing must be replaced as part of the end cap assembly.

7 Ensure that metal components are free from scoring, nicks and burrs. A damaged piston rod will impair the life of gland seals. Check the bore of the ram cylinder for damage.



S314091-1

Fig 2. Typical Ram

Assemble

⇨ *Fig 2. (E12-4)*

1 Clean threads of piston rod, piston head, end cap and cylinder using a wire brush. Use JCB Cleaner and De-greaser to ensure that all threads are free from grease, hydraulic oil and old sealing/retaining compounds. Allow 15 minutes for solvent to dry before applying JCB Threadlocker and Sealer (High Strength).

Important: *Ensure that seals or `O' rings do not come into contact with JCB Activator or anaerobic sealing and retaining compounds such as JCB Threadlocker and Sealer.*

2 Fit new seals, `O' rings and wear rings.

For the correct method of fitting seals to the end cap and piston head. ⇨ *JCB Ram Sealing Procedure (E12-6)*

Important: *Ensure that lubricants used during assembly do not come into contact with de-greased components or sealing/retaining compounds.*

3 Fit locking dowel **5** to piston **6**. ⇨ *Piston Head Retention (E12-8)*

4 Position cylinder **19** on the bench and install the piston rod assembly into the cylinder.

5 Apply JCB Activator to threads of end cap and cylinder. Allow JCB Activator to dry for 15 minutes before bringing into contact with JCB Threadlocker.

6 Apply JCB Threadlocker to threads of cylinder and torque tighten end cap **8**. ⇨ *Table 6. Torque Settings (E12-5)*

Note: *If hydraulic oil contacts uncured locking fluid a weakening of the bond will result. Cure times vary according to the ambient temperature. The following approximate cure time applies at 20ºC and is the minimum period between assembly and filling the ram with oil.*

JCB Threadlocker & Sealer (High Strength) or JCB Threadlocker with JCB Activator - 1 hour.

Note: *Cold weather operation. When operating in conditions which are consistently below freezing, it is recommended that the rams are operated slowly to their full extent before commencing normal working.*

Note: *The torque settings are different for each ram. Make sure to refer to the correct figure for the ram being assembled.*

Table 6. Torque Settings

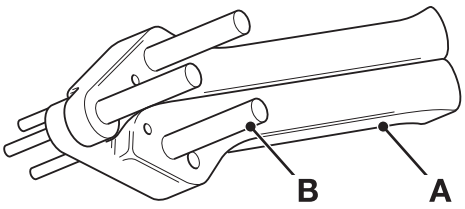
Ram	Item	Nm	Kgf m	lbf ft
Extend	**2-6**	405	41	300
	2-8	405	41	300
Displacement	**2-6**	405	41	300
	2-8	678	69	500
Lift	**2-6**	405	41	300
	2-8	678	69	500
Tilt	**2-6**	405	41	300
	2-8	678	69	500

JCB Ram Sealing Procedure

TE-005_2

1 Fit new rod seals.

Use seal fitting tool **3-A** to fit rod seals, the size (diameter) and position of pins **3-B** is determined by the diameter and radial width of the rod seal being fitted.

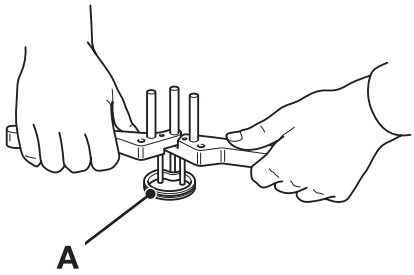


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Fig 3. Seal Fitting Tool

The pins are screwed into threaded holes in the tool body, the spacing of the holes is designed to suit small or large diameter rod seals.

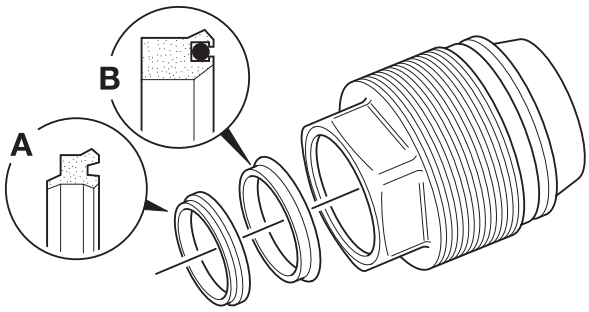
a Open the tool and insert the new rod seal **4-A**. The seal must be fitted behind the two front pins but in front of the rear pin as shown.



S161750 X-1

Fig 4.

Note: *Later ram end caps and piston heads are metric threads. The seals are also different, make sure the correct seals are fitted. On metric threaded rams make sure the seals are fitted the correct way round, as shown at **5-A** and **5-B**.*



153212-1

Fig 5.

b Close the tool. ⇨ *Fig 6. (E12-6)*. The seal must form a reniform (kidney shape).



S161750 Y-1

Fig 6.

c Before fitting the rod seals check the seal grooves are free of contamination and sharp edges.

d Locate the seal in the end cap groove. ⇨ *Fig 7. (E12-6)*. When the seal is in position, open the tool to release the seal. Make sure the seal is correctly installed in its grooved and remove the tool.



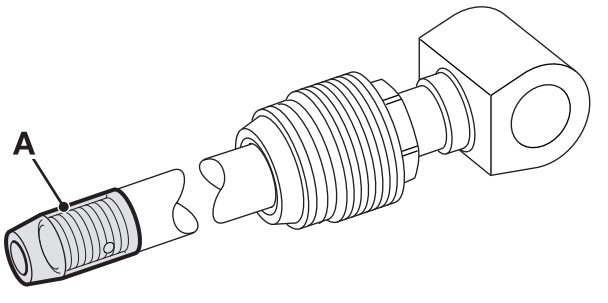
S161750 Z-1

Fig 7.

e Fit rod wiper seal **5-A** into seal groove. Make sure the seal is correctly installed as shown.

Note: *Some rod wipers, i.e. power track rod, may use a metal encased seal which is pressed into the housing. Care must be taken to ensure the seal is square before it is pressed in.*

f Sleeve **8-A** must be used to protect the rod seals from damage when fitting end cap onto the piston rod. There are various sizes of sleeve, see ***Service Tools, Section 1***. Make sure the hexagon on the end cap is towards the eye end of the rod.

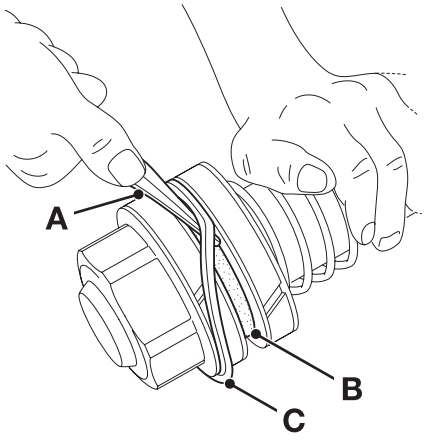


187361-1

Fig 8.

2 Fit new head piston seals.

a Use a blunt instrument **9-A** (Part no. 892/01027) to lever the inner seal **9-B** into the piston head seal groove. Do not let the seal twist. There are identification marks on the outer diameter of the seal, make sure the marks are visible and the seal is free to rotate, if not remove the seal and refit.



338480-1

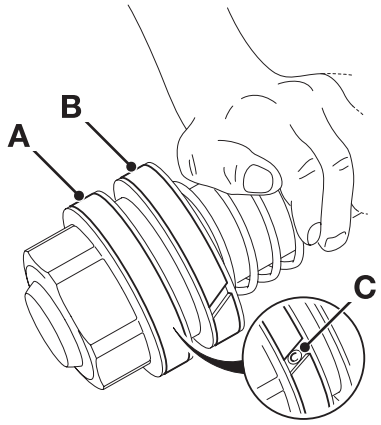
Fig 9.

b Fit outer seal **9-C** using the same procedure as stated for seal **9-B**. Check the external grooves are visible.

c Ensure the O-ring is fitted into the internal seal groove on the piston head. Screw the piston head onto the thread of the piston rod, refer to the relevant section for torque figure and completion of ram assembly.

d Fit the piston head retaining dowel, refer to the relevant section for torque figure and completion of ram assembly.

e Fit wear rings **10-A** and **10-B**. Rotate the wear rings so that the piston retention dowel is covered by the wear ring, Not as shown at **10-C**.



338490-1

Fig 10.

3 Fit the piston rod and head assembly into the cylinder.

a Insert the piston/rod assembly into the cylinder. Align the rod and head assembly until parallel with the cylinder then push the assembly into the cylinder.

b Fit the end cap, refer to the relevant section for torque figure and completion of ram assembly.

Piston Head Retention

Fit locking dowel to piston as follows:

Existing piston head and rod

Align holes so that dowel can be fitted with tapped extractor hole showing.

New piston head and rod

Drill and ream piston head and rod to the diameter and depth indicated. ⇒ *Drilling Dimensions (E12-8)* Remove all swarf and contamination and insert dowel with tapped extractor hole showing.

Note: *Ensure that the top of the dowel is below the level of the bearing ring groove and use an undersized pilot drill before drilling to the final size shown in the table.*

Existing piston head and new rod

Drill through existing hole in piston head to the diameter and depth indicated. ⇒ *Drilling Dimensions (E12-8)* Remove all swarf and contamination and insert dowel with tapped extractor hole showing.

Note: *Ensure that the top of the dowel is below the level of the bearing ring groove and use an undersized pilot drill before drilling to the final size shown in the table.*

New piston head and existing rod

Same as Existing piston head and new rod but at 90 degrees to existing hole in rod.

Drilling Dimensions

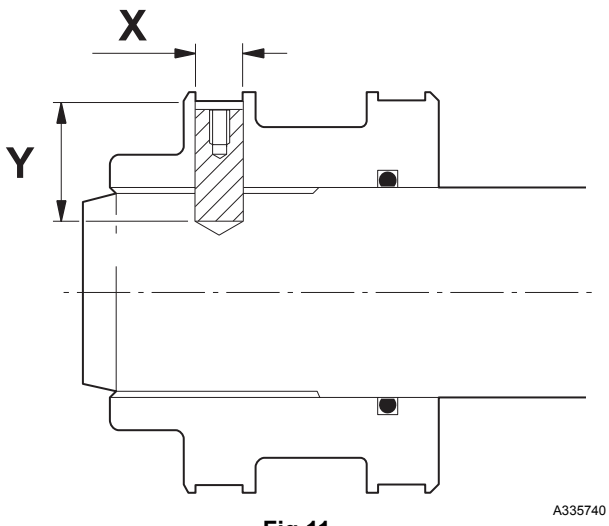


Fig 11.

Table 7. Drilling Dimensions

Ram Size	Diameter X	Depth Y
50 x 25	6.02mm - 6.10mm	23mm
70 x 50	6.02mm - 6.10mm	23mm
90 x 50	8.10mm - 8.02mm	28mm
100 x 60	12.10mm - 12.02mm	33mm
110 x 60	12.10mm - 12.02mm	33mm
120 x 60	12.10mm - 12.02mm	38mm
130 x 70	12.10mm - 12.02mm	38mm
130 x 75	12.10mm - 12.02mm	38mm
140 x 75	12.10mm - 12.02mm	48mm
160 x 80	12.10mm - 12.02mm	48mm

Hydraulic Control ECU

Introduction

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

Descriptions and procedures relate to the device and not related systems. For information about the systems refer to the relevant topics.

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.

⇒ *Related Topics (E13-2)*

⇒ *Removal and Replacement (E13-3)*

Related Topics

Table 1. Related Topics in This Publication

The table lists other topics in the manual that contain information related to this topic. Refer to the applicable topics to complete your procedures. Where applicable the text in this section contains cross references to this page to help you find the correct information. Some machines have different systems and devices. Make sure you refer to the correct topic, refer to ***Section 1 - Applications*.**

Sections	Topic Titles	Sub Titles
1	***Applications***	ALL
2	ALL (Care and Safety)(1)	ALL
3	***Routine Maintenance***	***Access Panels***
E	***⇨ LSP Electro Servo Hydraulic SYSTEM (🗋 E2-1)***	ALL
M	***Servicemaster Tools***	ALL

(1) You must obey all of the relevant care and safety procedures.

Removal and Replacement

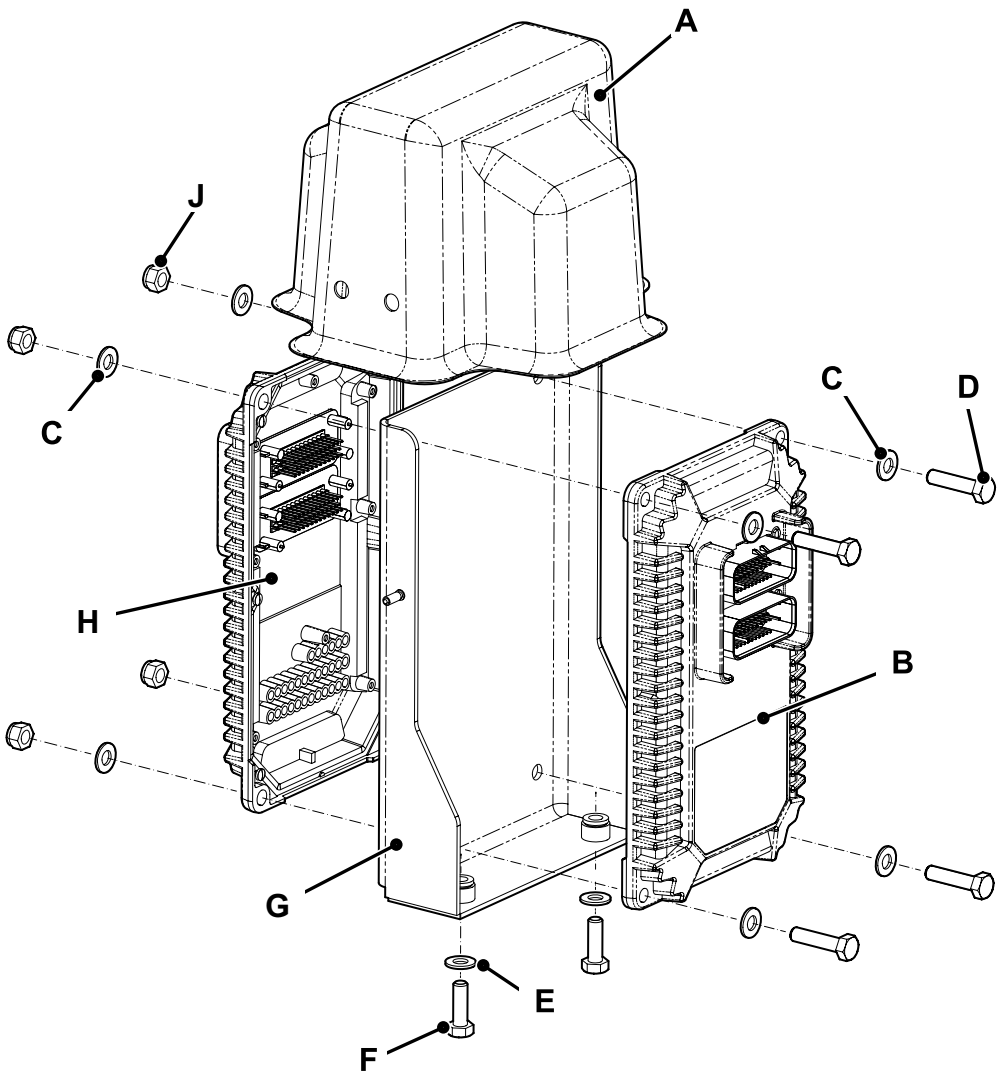


Fig 1.

Removal

1 Park the machine and make it safe. Obey the general safety procedures, see ***Section 2 - General Procedures.*** ⇨ *Related Topics (E13-2)*

2 Remove the battery covers. Refer to ***Section 3 - Access Panels***. ⇨ *Related Topics (E13-2)*

3 Remove the ECU cover **A**.

4 Put a label on the ECU electrical connectors to aid replacement.

5 Disconnect the ECU electrical connectors.

6 Remove the bracket securing bolts **F** and washers **E**.

7 Remove the ECUs **B** and **H** and bracket **G** from the machine.

8 Support the transmission ECU **H**.

9 Remove the nuts **J**, bolts **D** and washers **C** and remove the hydraulic ECU **B** from the bracket.

Replacement

Replacement is the opposite of the removal procedure.

During the replacement procedure do this work also:

– If a new ECU is installed make sure to set the software up correctly. Refer to ***Section M - Servicemaster Tools***. ⇨ *Related Topics (E13-2)*