

SERVICE MANUAL

COMPACT EXCAVATOR
48Z-1, 51R-1

EN - 9813/6200 - ISSUE 1 - 0H/2016


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Foreword

The Operator's Manual


You and others can be killed or seriously injured if you operate or maintain the machine without first studying the Operator's Manual. You must understand and follow the instructions in the Operator's Manual. If you do not understand anything, ask your employer or JCB dealer to explain it.

Do not operate the machine without an Operator's Manual, or if there is anything on the machine you do not understand.

Treat the Operator's Manual as part of the machine. Keep it clean and in good condition. Replace the Operator's Manual immediately if it is lost, damaged or becomes unreadable.

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Working Under the Machine

Make the machine safe before getting beneath it. Make sure that any attachments on the machine are correctly attached. Engage the park brake (if installed), remove the ignition key, disconnect the battery. If the machine has wheels use blocks to prevent unintentional movement.

Lifting the Machine

Under no circumstances must the engine be run with the transmission in gear and only one driving wheel jacked clear of the ground, since the wheel on the ground will move the machine.

Chemicals

Certain seals and gaskets (e.g. crankshaft oil seal) on JCB machines contain fluoroelastomeric materials such as Viton®, FluorelTM and Technoflon®. Fluoroelastomeric materials subjected to high temperatures can produce highly corrosive hydrofluoric acid. This acid can severely burn. New fluoroelastomeric components at ambient temperature require no special safety precautions. Used fluoroelastomeric components whose temperatures have not exceeded 300°C (571.6°F) require no special safety precautions. If evidence of decomposition (e.g. charring) is found, refer to the next paragraph for safety instructions. Do not touch component or surrounding area. Used fluoroelastomeric components subjected to temperatures greater than 300°C (571.6°F) (e.g. engine fire) must be treated using the following safety procedure. Make sure that heavy duty gloves and special safety glasses are worn: Thoroughly wash contaminated area with 10% calcium hydroxide or other suitable alkali solution, if necessary use wire wool to remove burnt remains. Thoroughly wash contaminated area with detergent and water. Contain all removed material, gloves etc. used in this operation in sealed plastic bags and dispose of in accordance with Local Authority Regulations. Do not burn fluoroelastomeric materials.

Hydraulic Hoses

Never re-use hydraulic hose end crimps or use reusable hose end crimps.

Personal Protective Equipment

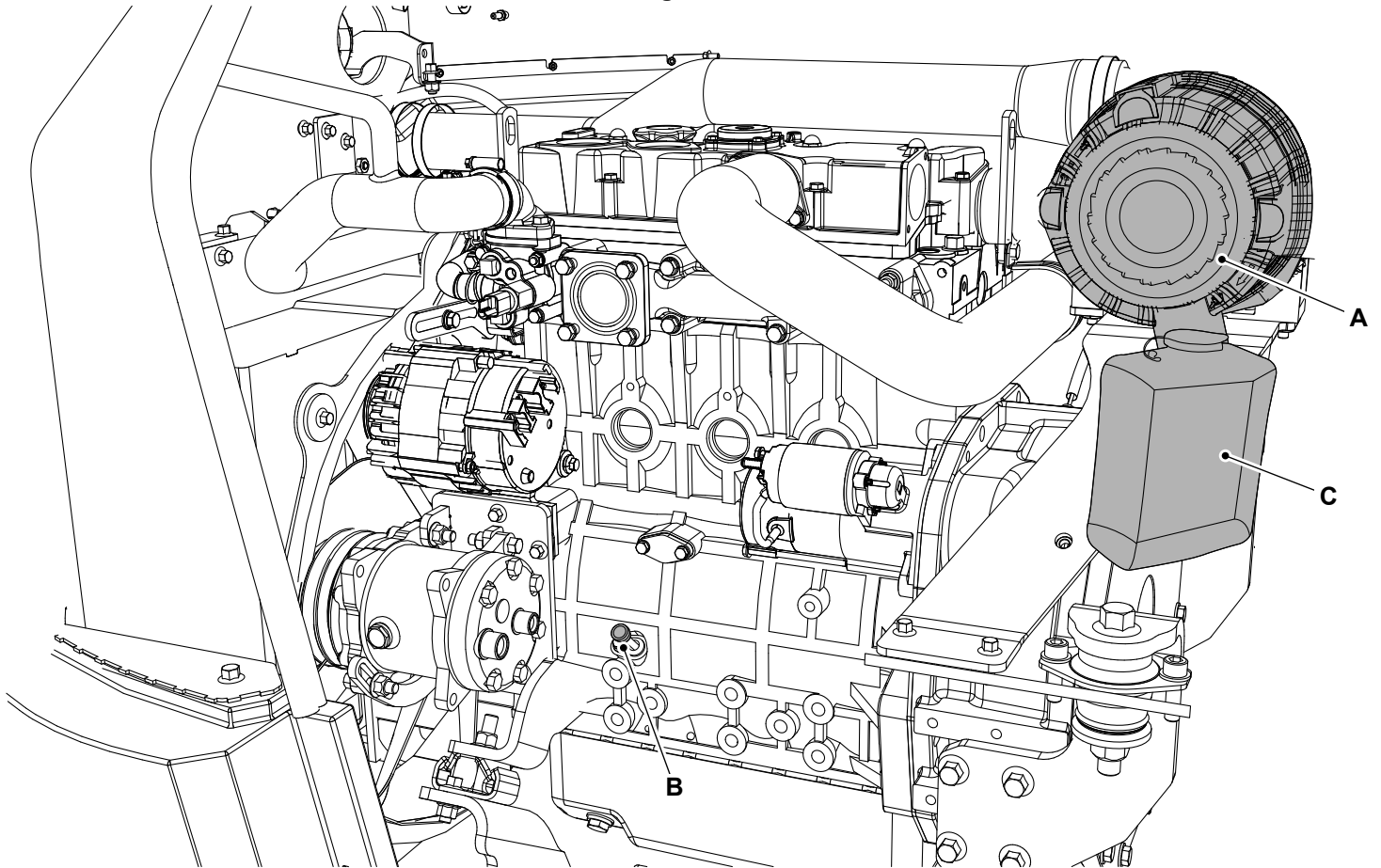
Use the appropriate personal protective equipment before performing maintenance on the machine, otherwise you could be injured.

Working at Height

Use appropriate access equipment such as ladders or a working platform if it is necessary to work at height to perform maintenance tasks on the machine. If you do not use suitable access equipment there is a risk of falling, resulting in personal injury.

Engine Compartment

Figure 5.

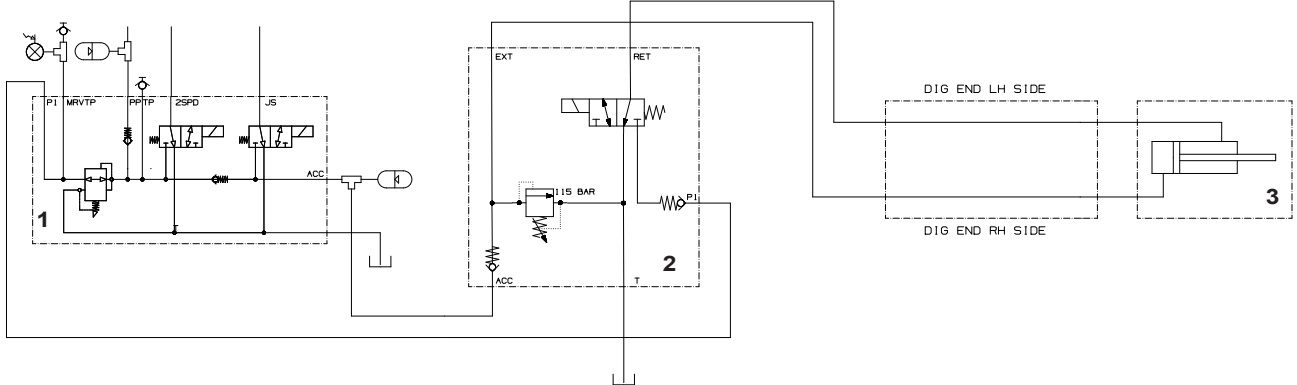


A Air filter
C Washer bottle

B Engine oil dipstick

Diagram

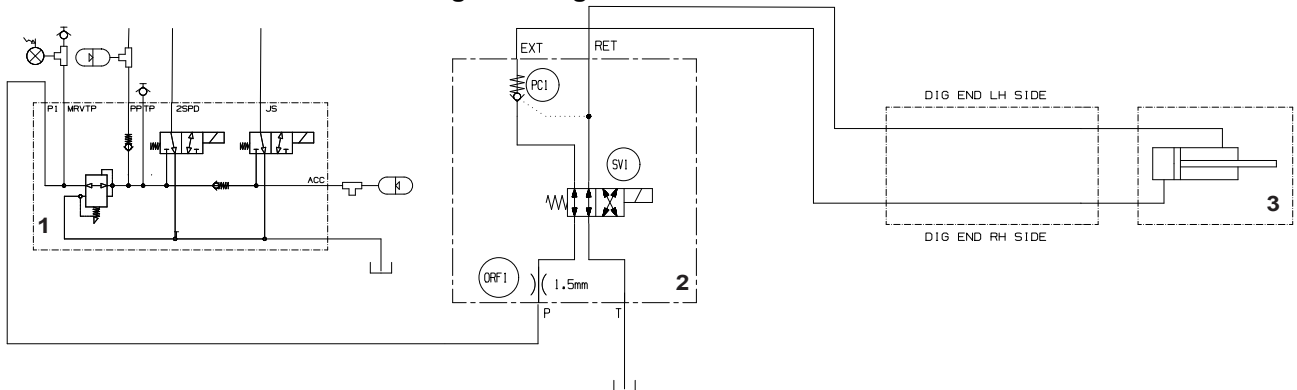
Figure 6. Low Pressure Quickhitch



- 1 PMV (Pressure Maintenance Valve)
- 3 Quickhitch

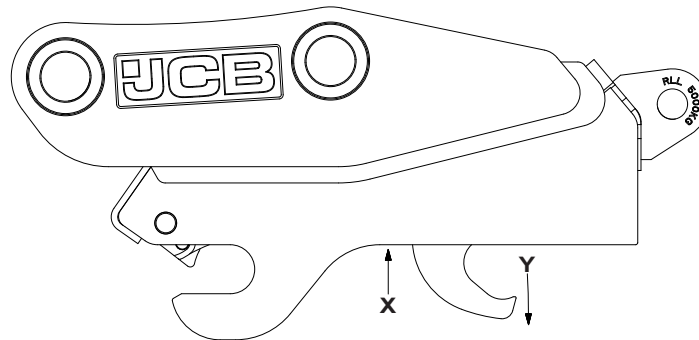
- 2 Quickhitch valve

Figure 7. High Pressure Quickhitch



- 1 PMV
- 3 Quickhitch
- Y Extend

- 2 Quickhitch valve
- X Retract





00 - General

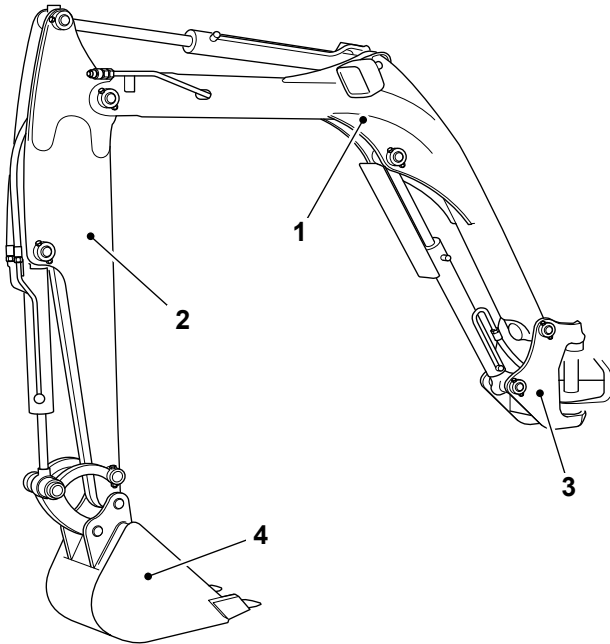
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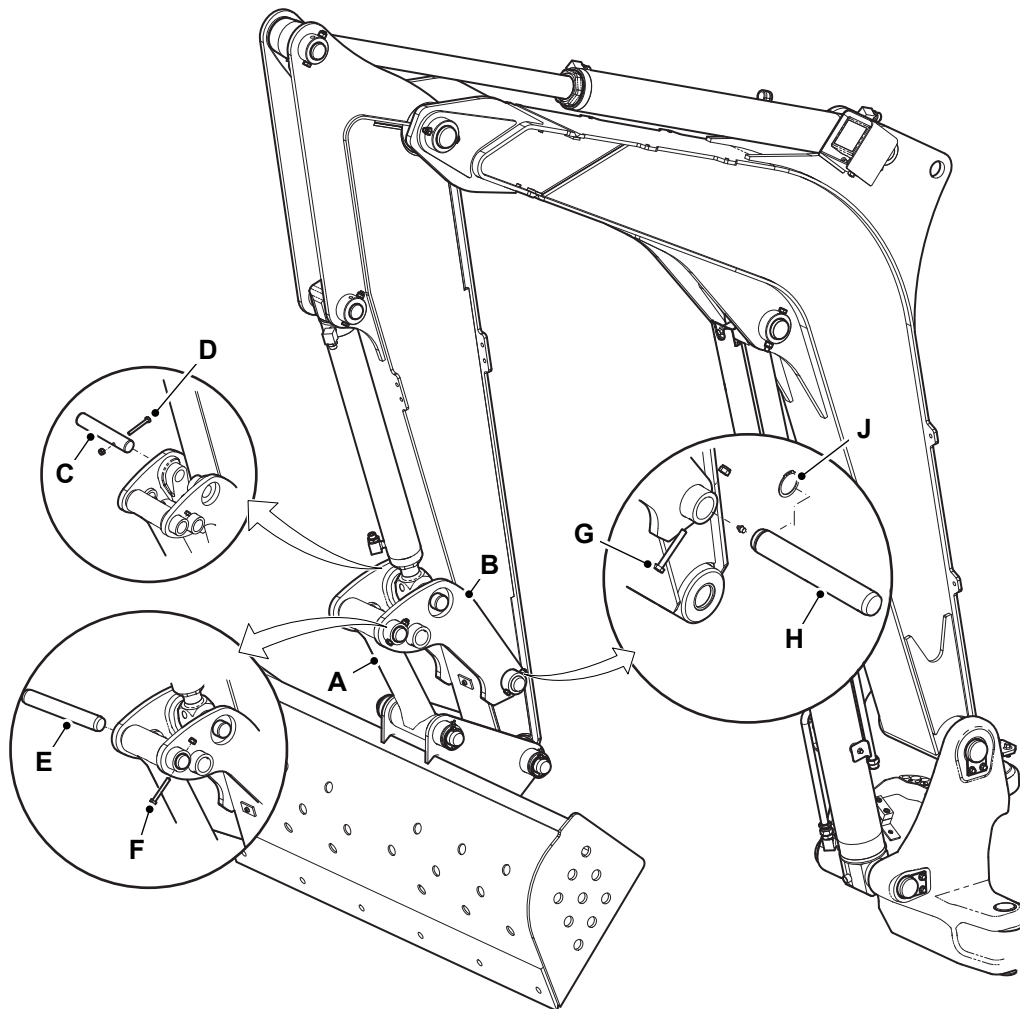
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Component Identification

Figure 12.



- 1 Boom
- 2 Dipper
- 3 Kingpost
- 4 Bucket

Figure 15.


- A** Bucket link
- C** Pivot pin - ram
- E** Pivot pin - bucket link
- G** Bolt
- J** Circlip

- B** Tipping link
- D** Bolt
- F** Bolt
- H** Pivot pin - ram link

CAUTION! Do not use your fingers through the holes to align the links.

Install

1. Installation is the opposite of the removal procedure.
2. Apply grease to all the pivot pins before assembly.
 - 2.1. Apply grease to the pivot points through the grease nipples.

Consumable: [Special MPL-EP Grease](#)



00 - General

Introduction

Make sure that all machine locks are in the transport position before you transport the machine.



00 - General

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Health and Safety 06-50

Introduction

The counterweight is an equivalent counterbalancing weight that balances the load.

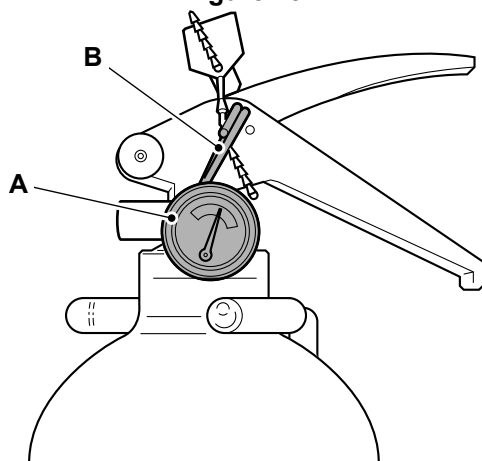
00 - General

Introduction

In addition to the operator check the extinguisher must be serviced every 12 months by a suitably qualified person.

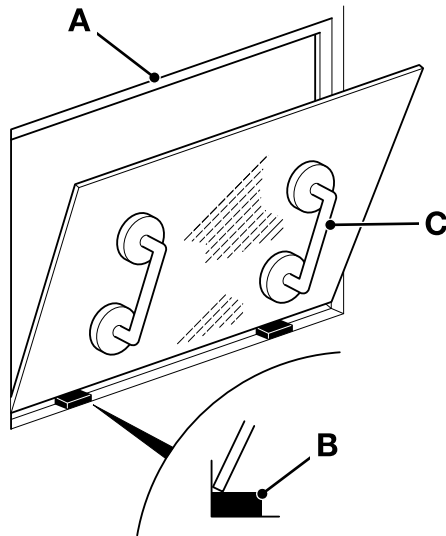
1. Examine the fire extinguisher for damage and leaks.
2. Make sure the fire extinguisher is correctly attached.
3. Make sure that the gauge indicates that the extinguisher is charged i.e. the needle is in the green segment
 - 3.1. If the needle is in or very near the red segment at either end of the gauge, the extinguisher must be serviced or replaced.
4. Make sure the safety pin is correctly installed.

Figure 25.



- A** Gauge
B Safety Pin

Figure 28.



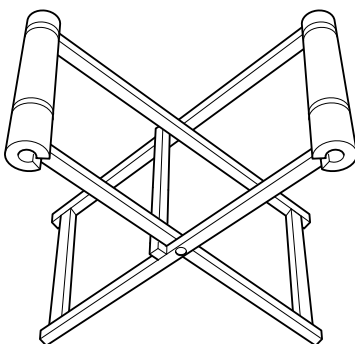
- A Frame aperture
- B Spacer blocks
- C Glass lifters

2. After checking for size, remove the new glass and place it on a purpose made glass stand. Small panes of glass will need locating on a 600 x 700 mm x 15 to 19 mm thick plywood board, sourced locally to fit the glass stand. It is recommended that an access hole is cut in the board to accommodate the glass lifter, making it easier and safer to handle small panes of glass. The board should be covered with felt or carpet to give an anti-scratch surface. Resting the glass on four spacer blocks will ensure clearance of the cartridge nozzle tip during application of the polyurethane sealant.

Special Tool: Rubber Spacer Blocks (Qty.: 4)

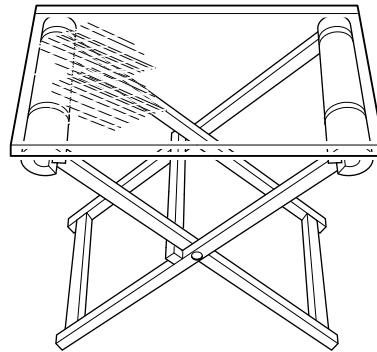
Special Tool: Folding Stand (Qty.: 1)

Figure 29.



3. Make sure the glass is positioned on the stand the correct way up (i.e. with the black ceramic ink band upwards) ready for application of primer etc.

Figure 30.



4. Clean the glass.

- 4.1. Use surface cleaner to thoroughly clean and prime the black ceramic ink band printed on the glass (see Note). Use a lint free cloth to apply the cleaner, allow to dry. Important: Do not touch the glass after cleaning with the surface cleaner.

Duration: 5min

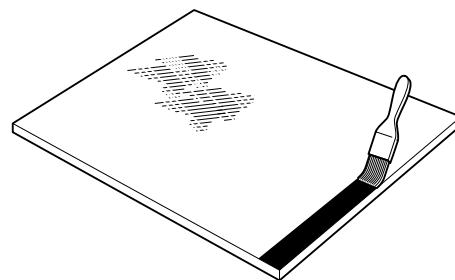
Consumable: Surface Cleaning Fluid

- 4.2. If the glass does not have a black ceramic ink band, paint a band on the glass using Black Primer. Make sure that the band measures the correct width and that the edge is a neat straight line.

Dimension: 25mm

Consumable: Black Primer/Activator

Figure 31.



5. Install the Ultra Fast Adhesive cartridge into a suitable applicator gun:

Special Tool: Static Oven (240V) (Qty.: 1)

Special Tool: Mobile Oven (12V) (Qty.: 1)

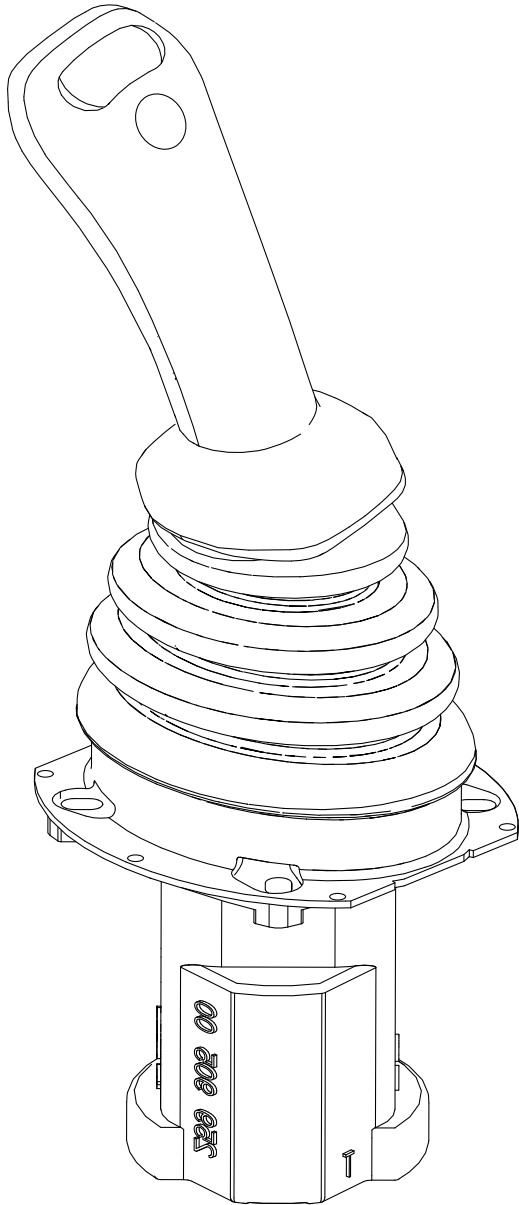
Special Tool: Cartridge Gun (Qty.: 1)

Consumable: Polyurethane Adhesive

- 5.1. Remove the aluminium disc cover from the base of the cartridge and discard the dessicant capsule.

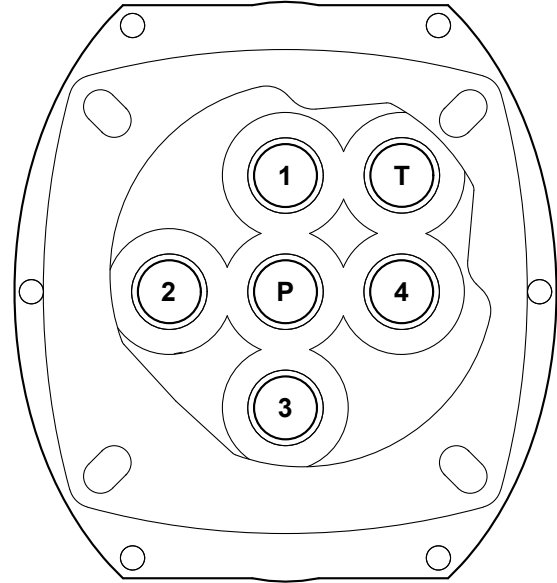
- 5.2. Make sure that the rolled edge of the cartridge is not damaged - if necessary, the

Figure 41. Excavator arm control assembly



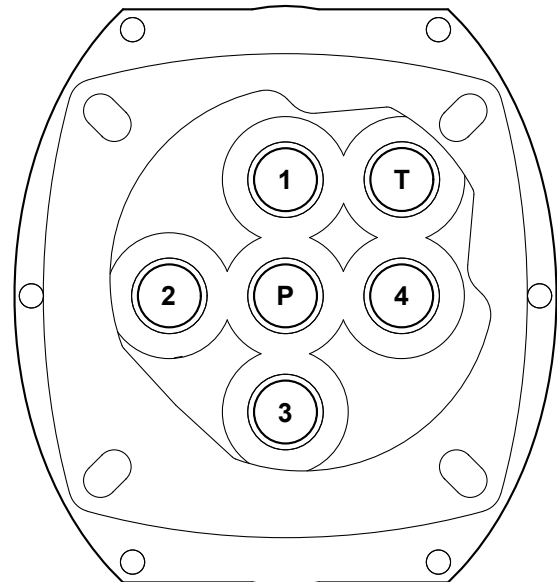
Component Identification

Figure 42. Right Hand Side Servo Control Joystick - Hydraulic ports



- 1 Boom
- 2 Bucket
- 3 Boom
- 4 Bucket
- P Pilot supply port
- T Tank return port

Figure 43. Left Hand Side Servo Control Joystick - Hydraulic ports



- 1 Dipper
- 2 Slew
- 3 Dipper
- 4 Slew
- P Pilot supply port
- T Tank return port



00 - General

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Introduction

The safety labels are strategically placed around the product to remind you of possible hazards.

If you need eye-glasses for reading, make sure you wear them when reading the safety labels. Do not over-stretch or put yourself in dangerous positions to read the safety labels. If you do not understand the hazard shown on the safety label, then refer to Safety Label Identification.

Keep all of the safety labels clean and readable. Replace a lost or damaged safety label. Make sure the replacement parts include the safety labels where necessary. Each safety label has a part number printed on it, use this number to order a new safety label from your JCB dealer.



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Check (Operation)	12-17

Introduction

To maintain optimum operator comfort in warm climates or during seasons of high ambient temperature, the air conditioning system delivers cool, dehumidified air into the cab. Cooling is provided by passing the warm ambient air, together with recirculated air, over an evaporator matrix in the air conditioning unit.

The air conditioning system is a closed circuit through which the refrigerant is circulated, its state changing from gas to liquid and back to gas again, as it is forced through the system. The major components of the system are the:

- Compressor
- Condenser matrix
- Receiver drier
- Expansion valve
- Evaporator matrix

Check (Leaks)

The refrigerant is heavier than air and will leak downwards from the defective component. Check in still conditions but in a well ventilated area.

Hose or pipe connections are likely leakage points of any refrigerant circuit.

It is essential that an electronic leak detector is used to locate leaks accurately. However, if a leak detector is not available, an approximate source can be found by applying a soap solution to the suspect area.

To test for leaks in the high pressure side of the system i.e. from the compressor output to the expansion valve, run the air conditioning for a few minutes then switch off the engine and test for leakage using an electronic leak detector or soapy water.

To test for leakage in the low pressure side of the system, switch off the air conditioning and leave for a few minutes before testing.

Leaking Hoses

The refrigerant hoses have crimped ferrule end fittings. The hose connectors have an O-ring seal which compresses when the connection is tight, creating an air tight seal.

Hoses are used to connect the inlets and outlets of the compressor, condenser, receiver drier and expansion valve (the evaporator coil is connected to the expansion valve within the air conditioning unit using rigid pipes).

If leakage is detected from a hose connector, either by means of an electronic leak detector or soapy water, tighten the connector up and repeat the leakage test. If leakage is still evident, it will be necessary to discharge the system and renew the connector O-ring seal. Refer to (PIL 12-00).



09 - Compressor

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Remove and Install

IMPORTANT: This procedure requires specialist air conditioning equipment for refrigerant charging and discharging and must only be carried out by qualified service personnel who have received specialist training on the air conditioning system. Refer to the Health and Safety section (PIL 12-00) [Refer to: Heating, Ventilating and Air-Conditioning \(HVAC\) > General > General > Health and Safety \(Page 12-4\).](#)



Acronyms Glossary

BDC	Bottom Dead Centre
CAN	Controller Area Network
DC	Direct Current
DTI	Dial Test Indicator
ECM	Engine Control Module
ECU	Electronic Control Unit
ESOS	Engine Shut-Off Solenoid
FEAD	Front End Accessory Drive
RPM	Revolutions Per Minute
TDC	Top Dead Centre

Drain and Fill

Oil

Oil is toxic. If you swallow any oil, do not induce vomiting, seek medical advice. Used engine oil contains harmful contaminants which can cause skin cancer. Do not handle used engine oil more than necessary. Always use barrier cream or wear gloves to prevent skin contact. Wash skin contaminated with oil thoroughly in warm soapy water. Do not use petrol, diesel fuel or paraffin to clean your skin.

WARNING! Hot oil and engine components can burn you. Make sure the engine is cool before doing this job. Used engine crankcase lubricants contain harmful contaminants. In laboratory tests it was shown that used engine oils can cause skin cancer.

CAUTION! Keep your face away from the drain hole when removing the drain plug.

CAUTION! The oil filter canister will contain some oil which could spill out when you remove the canister.

CAUTION! Oil will gush from the hole when the drain plug is removed. Keep to one side when you remove the plug.

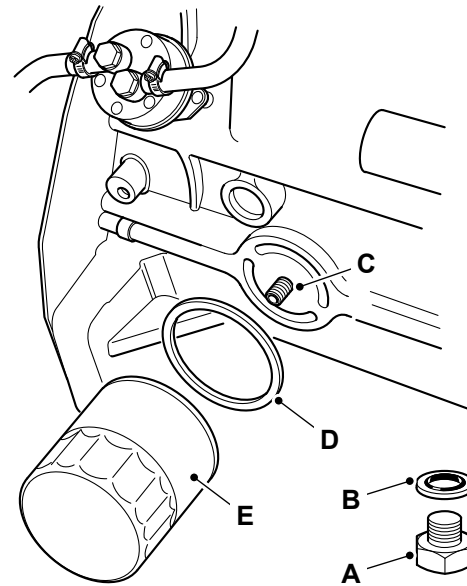
Drain

Engine oil replacement must be completed in accordance with the service schedules. Failure to replace the oil replacement at the recommended interval could cause serious engine failure.

Drain the oil when the engine is warm as contaminants held in suspension will then be drained with the oil.

1. Make the machine safe. Refer to (PIL 01-03).
2. Get access to the engine.
3. Place a container of suitable size beneath the drain plug.
4. Remove the filter cap.
5. Remove the oil filler canister. If necessary use a chain or strap wrench.
6. Remove the oil dipstick.
7. Put a suitable container beneath the drain plug.
8. Remove the oil sump drain plug and O-ring from both sides of the oil sump.
9. Drain the engine oil.

Figure 66.



- A Drain plug
- B O-ring
- C Filter mounting face
- D Seal
- E Filter canister

Fill

1. Clean and install the drain plug with a new O-ring.
2. Tighten the plug to the correct torque value.
3. Through one of the filler points, fill the engine with the recommended oil to the MAX mark on the dipstick. The oil must be added slowly.
4. Wipe off any spilt oil.
5. Apply a thin layer of oil around the seal on the filter canister.
6. Install the filler canister. Tighten the filter canister with hand then an additional one quarter turn.
7. Install the filter cap.
8. Operate the engine, until the oil pressure low warning light has extinguished.
9. Check for oil leakage.
10. When the oil has cooled, check the oil level again, and if necessary top up with clean engine oil.

Table 33. Torque Values

Item	Description	Nm
A	Drain plug	35



06 - Jet

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Remove and Install 15-24

Introduction

The cooling spray jets are mounted on the crankcase, they provide lubrication to the internal components of the crankcase when the engine is running.



00 - General

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Introduction

The crankshaft is housed inside the crankcase. It is connected to the piston via a connecting rod, they form a simple mechanism that converts reciprocating motion into rotating motion. Refer to Engine- General, Operation, The Four Stroke Cycle (PIL 15-00).



15 - Camshaft

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Introduction

A crankshaft pulley is used to drive a FEAD (Front End Accessory Drive) belt. The belt drives the coolant pump. Depending on the machine application, the belt is configured to drive engine mounted accessories, such as the alternator and cooling fan.

Some applications have a second pulley on the crankshaft which drives a dedicated fan belt. The belt drives an engine mounted cooling fan.

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Introduction

Introduction

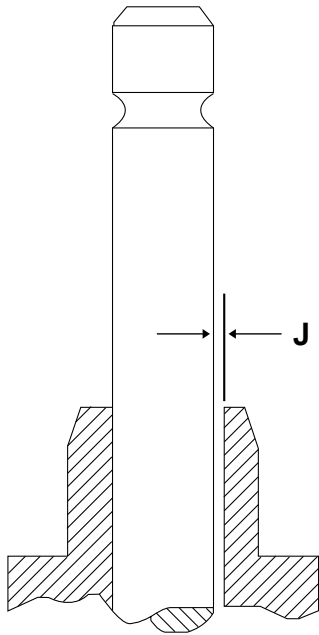
Engine performance and durability will be severely affected if the quality of the air intake is poor.

A dirty and blocked air filter will reduce the amount of air entering the combustion chamber which can cause engine misfiring, black smoke and low output power.

A dirty and blocked air filter can also lead to abrasion of the cylinder bores and valves (referred to as dusting). This will cause excessive oil consumption, black smoke, low output power and a reduced engine life. [Refer to: Engine > Air Filter \(Page 15-70\)](#).

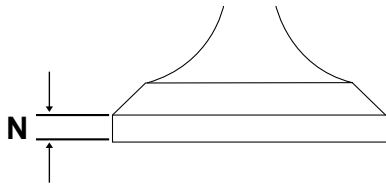
This is a dry-type air filter with a replaceable paper filter cartridge.

Figure 115.



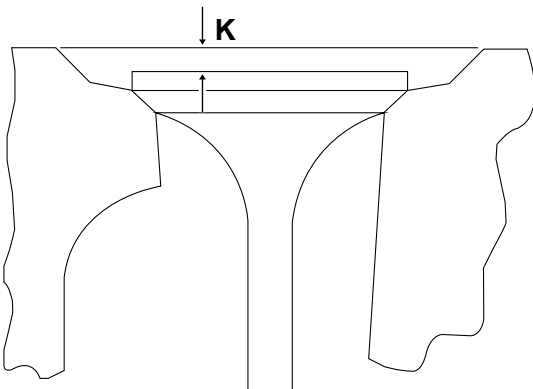
J Valve - valve guide clearance

Figure 116.



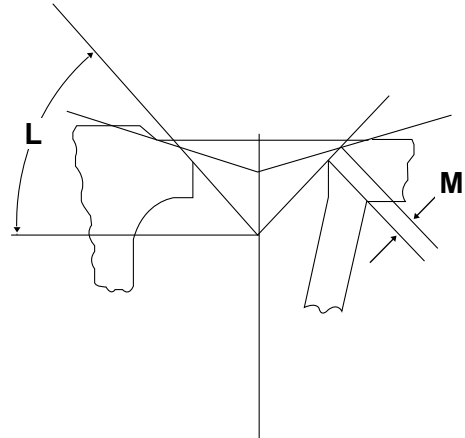
N Valve head thickness

Figure 117.



K Valve depth

Figure 118.



L Valve seat angle
M Contact face

00 - General

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Introduction

The connecting rod connects the piston to the crankshaft. They form a simple mechanism that converts reciprocating motion into rotating motion.

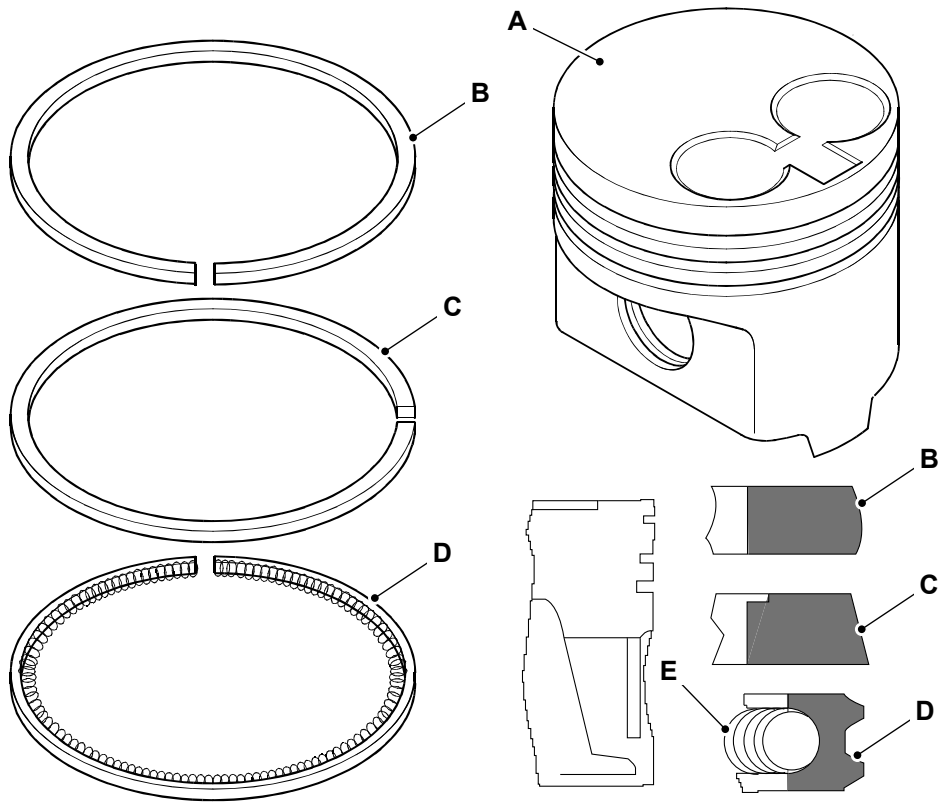
Connecting rods are usually made of high strength steel. They are not rigidly fixed at either end, so that the angle between the connecting rod and the piston can change as the rod moves up and down and rotates around the crankshaft.

The small end of the connecting rod attaches to the piston pin which is a press fit into the connecting rod.

The big end of the connecting rod connects to the bearing journal on the crank throw, they run on replaceable bearing shells that are accessible via the connecting rod bolts which hold the bearing cap on to the big end.

There is a pinhole bored through the bearing and the big end of the connecting rod so that pressurised lubricating engine oil squirts out on to the thrust side of the cylinder wall to lubricate the travel of the pistons and piston rings.

Figure 133.



- A** Piston
- C** Intermediate ring
- E** Spring

- B** Top ring
- D** Oil control ring



39 - Manifold

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03 - Rocker Shaft

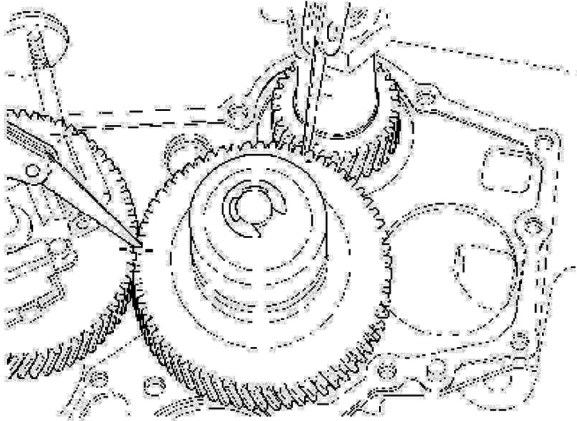
Remove and Install

Refer to Rocker Assembly-Remove and Install and Disassemble-Assemble (PIL 15-42).

Check (Condition)

1. Inspect the gears for wear or damage. If one or more of the gears are worn or damaged, replace them.
2. Measure the backlash of the gears with a feeler gauge. Refer to Figure 156.

Figure 156.



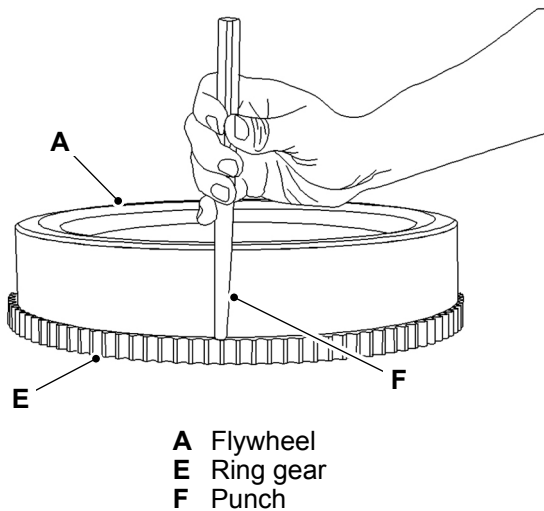
3. Make sure that the backlash is within the specified limits. Refer to Technical data (PIL 15-51).
 - 3.1. If the backlash measurement is greater than the maximum, install new gears. Refer to (PIL 15-51).

Remove and Install

The procedure for the removal and installation of the timing gears is similar to the camshaft removal and installation procedure. Refer to (PIL 15-15).

7. Remove the flywheel.
8. Inspect the ring gear and the flywheel for wear or damage. If the ring gear or the flywheel is worn or damaged, it must be replaced.
9. If necessary, remove the ring gear from the flywheel as follows:
 - 9.1. Keep the flywheel on a suitable support to remove the ring gear from the flywheel.

Figure 172.



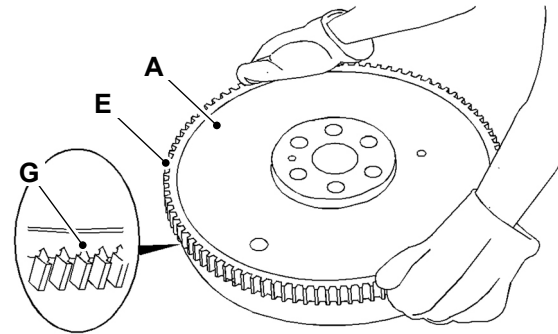
- A** Flywheel
- E** Ring gear
- F** Punch

- 9.2. Remove the ring gear from the flywheel with a hammer and a punch.

Install

1. If removed, install the ring gear to the flywheel as follows:
 - 1.1. Identify the orientation of the new ring gear to install the ring gear correctly onto the flywheel.
 - 1.2. Make sure that the chamfered side of the gear teeth are facing towards the starter motor when the flywheel is installed. This is to make sure that the starter motor engages correctly.

Figure 173.



- A** Flywheel
- E** Ring gear
- G** Chamfered side of the gear teeth

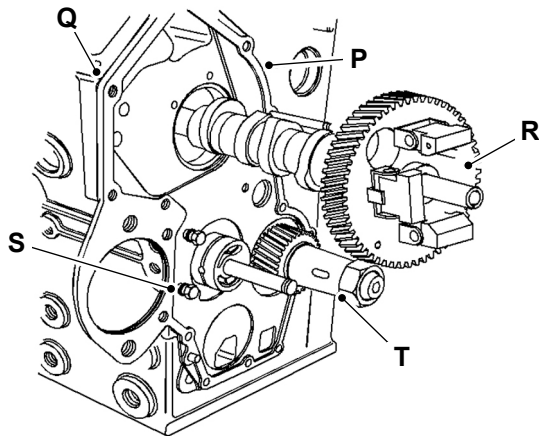
- 1.3. Heat the ring gear in an oven to a maximum specified temperature.
 Temperature: 150°C (301.8°F)
 Special Tool: Static Oven (240V) (Qty.: 1)
- 1.4. Do not use a heat torch to heat the ring gear.
- 1.5. Make sure that the orientation of the ring gear is correct and quickly install the ring gear onto the flywheel.

2. Clean the flywheel housing thoroughly.
3. Inspect the rear oil seal for leaks. If necessary, replace the rear oil seal. Refer to (PIL 15-54).
4. Install the guide stud (M10 x 1.25 mm by 80 mm) at the positions of bolt1 in the crankshaft. Refer to Figure 171.
5. Install the lifting bracket and a suitable lifting device to the flywheel.
6. Position the flywheel onto the guide studs.
7. Install the bolt2 (x4) and finger tighten them.
8. Remove the guide studs and install the bolt1 (x2).
9. Use a suitable tool to prevent the flywheel from rotating.
10. Tighten the bolts to the correct torque value.
11. Remove the lifting bracket and the lifting device from the flywheel.
12. Install the starter motor. Refer to (PIL 15-75).

Table 73. Torque Values

Item	Description	Nm
B	Bolt1	75
C	Bolt2	75

Figure 189.



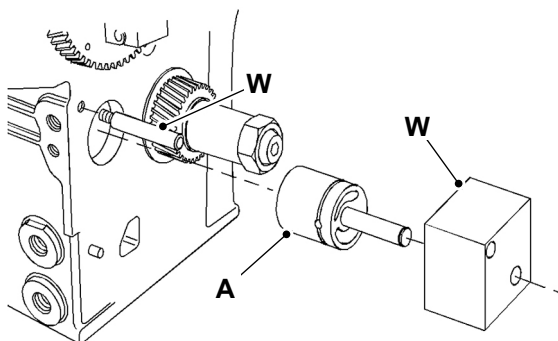
- P** Plate
- Q** Joint
- R** Camshaft
- S** Bolt
- T** Crankshaft

- 5.3. Remove the joint.
- 5.4. Remove the crankshaft. Refer to (PIL 15-12).
- 5.5. Remove the idler hub from the crankcase with a hammer and a suitable drift. Align the drift to the rear face of the hub and drive the hub from the inside of the crankcase outwards. Refer to Figure 190.

Install

1. Install the idler hub as follows. Refer to Figure 190.
 - 1.1. Install the pin of the alignment tool to the crankcase.

Figure 190.



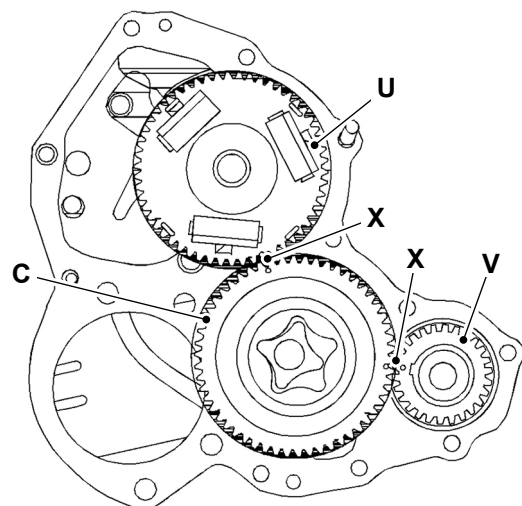
- A** Idler hub
- W** Alignment tool

- 1.2. Install the idler hub into the guide plate of the alignment tool.
- 1.3. Align the guide plate of the alignment tool with a pin of the alignment tool.

- 1.4. Hit the guide plate of the alignment tool with a hammer.
- 1.5. Drive the idler hub into the crankcase until the guide plate contacts the front of the crankcase.
- 1.6. Remove the alignment tool.
- 1.7. Install the crankshaft. Refer to (PIL 15-12).
- 1.8. Position a new joint on the crankcase. Refer to Figure 189.
- 1.9. Align the plate with the dowels in the crankcase.
- 1.10. Install the plate.
- 1.11. Install the bolt and tighten to the correct torque value.
- 1.12. Install the camshaft. Refer to (PIL 15-15).

2. Install the engine oil pump as follows. Refer to Figure 187.
 - 2.1. Install the thrust washer.
 - 2.2. Lubricate the thrust washer with clean engine oil.
 - 2.3. Apply grease to the faces of the inner rotor and to the vanes of the idler gear.
 - 2.4. Align the timing marks on the idler gear with the respective timing marks on gear1 and gear2. Refer to Figure 191.

Figure 191.



- C** Idler gear
- U** Gear1
- V** Gear2
- X** Timing mark

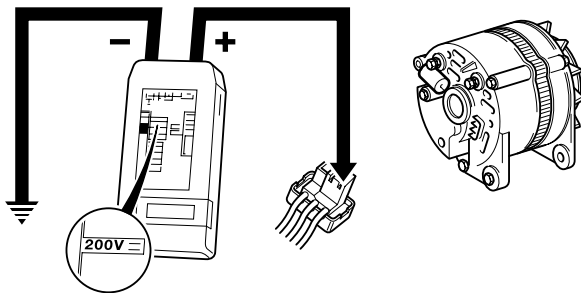
- 2.5. Install the idler gear onto the idler hub.
- 2.6. Install the inner rotor to the idler gear.
- 2.7. Install the collar, spring, shim and the oil pump cover. Refer to Figure 187.

Check 2

The following checks should be made using an analogue (moving pointer) type Multimeter.

1. Stop the engine and turn the ignition switch to OFF.
2. Withdraw the alternator plug and connect the Multimeter between the large terminals and earth. With the Multimeter set to measure, Voltage: 12V

Figure 197.



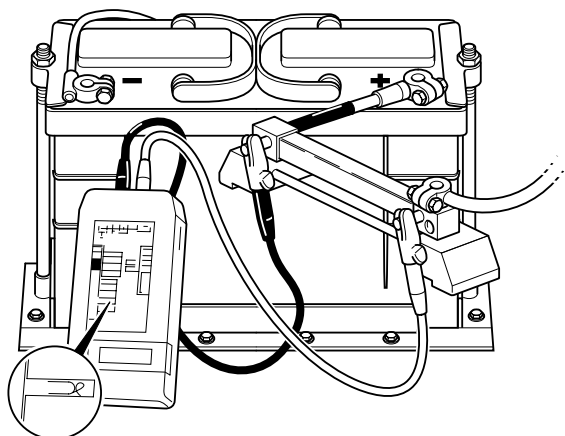
- 2.1. The Multimeter should show battery voltage.

Special Tool: Digital Multimeter (Qty.: 1)

- 2.2. If the reading is zero, check the cables for continuity, particularly at the starter terminals.
3. If the voltage is correct, check the alternator.

Alternator Charging Test

Figure 198.



1. Make sure that all battery and alternator connections are in place, secure and making good metal to metal contact, especially the earth connections to chassis and engine.

2. Make sure that the alternator drive belt tension is correctly adjusted.
3. If the battery is in a fully charged condition, before commencing the test switch on the working lights for
Duration: 3min
4. Alternatively, operate the starter for a few moments with the ESOS (Engine Shut-Off Solenoid) fuse removed.

5. Install an open type shunt between the battery positive lead and the battery positive terminal.
Current: 100A

6. Connect a Multimeter positive lead to machine side of the shunt and negative lead to battery side of the shunt.

7. Connect the leads to the Multimeter and set the Multimeter to the relevant range as follows.

8. AVO 2002

- 8.1. Red lead to volts (middle) socket on Multimeter.

- 8.2. Black lead to negative on Multimeter.

- 8.3. RH slider to DC (Direct Current) voltage.

- 8.4. LH slider, Refer to Figure 198.

9. AVO 2003

Special Tool: AVO Meter (Qty.: 1)

- 9.1. Red lead to amps socket (A) on the Multimeter.

- 9.2. Black lead to negative on Multimeter.

- 9.3. RH slider to DC voltage

- 9.4. LH slider to 200 Shunt

10. FLUKE 85

- 10.1. Red lead to volts socket (V) on Multimeter.

- 10.2. Black lead to COM socket on Multimeter.

- 10.3. Set dial to mV.

11. Start the engine and run at maximum speed (see Technical Data). Multimeter should show maximum alternator output in Amps (see Technical Data). The Multimeter reading should be taken as soon as possible after starting the engine, as the charging current will fall rapidly.

12. A zero reading indicates failure of the alternator and may be caused by one of the following conditions. These are listed in the order of probability.

- 12.1. Defective suppression capacitor.

the digital multimeter between the terminal of the glow plug and a ground.

4. Turn on the ignition switch.
5. Observe the amperage reading of the ammeter and the voltage reading on the multimeter. Refer to Table 83.
6. Make sure that the voltage should not drop more than the specified
Voltage: 0.5V
 - 6.1. If the multimeter reading is below the specified value, replace the glow plug.
 - 6.2. If there is no reading, replace the glow plug.
 - 6.3. If the voltage reading of the multimeter is zero, inspect the ignition switch and the power supply for faulty components and loose connections.
7. Install the connector to the terminal of each of the glow plug and tighten the nut.
8. Connect the cable for the power supply to the glow plugs.

Table 83.

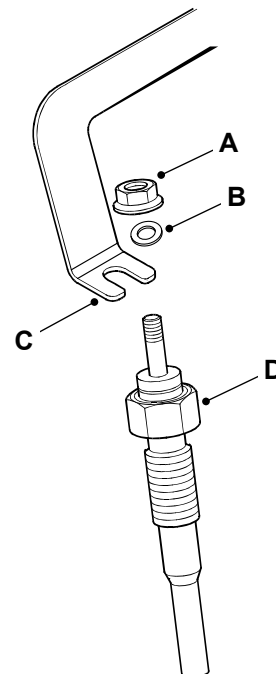
Maximum current through the glow plug	110A
Current through the glow plug after 6s	11.5 ± 1.5A

Remove and Install

Remove

1. Make the machine safe. Refer to (PIL 01-03).
2. Make sure that the engine is safe to work on. If the engine has been running, let it cool before you start the service work.
3. Disconnect the battery. Refer to (PIL 33-03).
4. Remove the nut and the washer from the bus bar.
5. Remove the bus bar from the glow plug.
6. Remove the glow plug from the cylinder head.

Figure 211.



- A** Nut
- B** Washer
- C** Connector
- D** Glow plug

Install

1. Installation is the opposite of the removal procedure. Additionally do the following steps.
2. Make sure that the threads of the glow plugs are clean and free from damage. Replace the damaged glow plugs.
3. Tighten the glow plug and the nut to the correct torque value.

Check (Operation)

Special Tools

Description	Part No.	Qty.
Digital Multimeter	892/00298	1

1. Remove the ESOS (Engine Shut-Off Solenoid) from the engine. Refer to (PIL 15-86).
2. Connect the ESOS to an external power source.

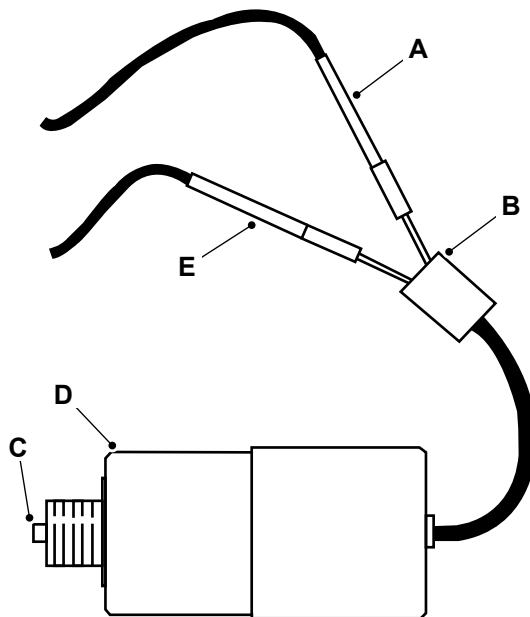
- 3.2. Connect the battery, the ESOS and the leads of the multimeter in series.

- 3.3. Make sure that the current is within the specified limit. If the current is not within this tolerance, replace the ESOS.

Current: $1 \pm 0.1A$

4. Install the ESOS to the engine. Refer to (PIL 15-86).

Figure 214.



- A** Positive lead
- B** Electrical connector
- C** Plunger
- D** ESOS body
- E** Negative terminal

- 2.1. Use a specified battery as a power source.
Voltage: 12V
- 2.2. Connect the lead from the battery positive terminal to one of the pins in the electrical connector on the ESOS.
- 2.3. Connect the lead from the battery negative terminal to the remaining pin in the electrical connector on the ESOS.
- 2.4. The plunger on the ESOS will extend the maximum distance when the leads are connected.
- 2.5. If the plunger does not move or if the plunger does not extend the maximum distance, replace the ESOS.
3. Measure the current through the ESOS.
 - 3.1. Use a suitable digital multimeter.
Special Tool: Digital Multimeter (Qty.: 1)



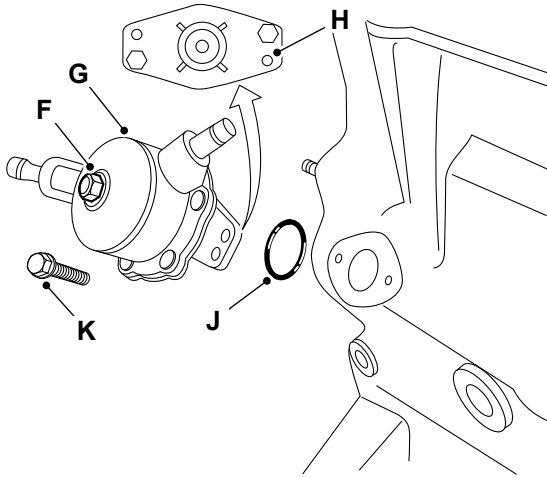
00 - General

Component Identification 15-215
Check (Condition) 15-216

Component Identification

Refer to Fuel System- Exhaust, General, Component Identification (PIL 18-24).

Figure 224.



- F Adjustment screw
- G Fuel priming pump
- H Flange
- J O-ring
- K Bolt2

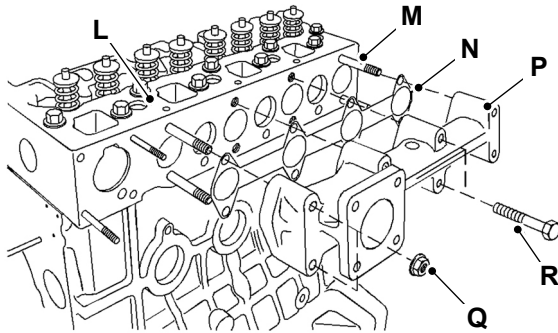
The fuel inlet for the fuel priming can be rotated 360°. The fuel inlet is adjustable in 15° increments. The flange of the fuel priming pump has two sets of locating holes. This allows the fuel priming pump to be mounted in four positions for the outlet connection.

Table 93. Torque Values

Item	Description	Nm
B	Nut1	15
D	Bolt1	15
E	Delivery valve holder	42
F	Adjustment screw	2.5
K	Bolt2	6
Q	Nut2	25
R	Setscrew	25

Exhaust System

Figure 225.



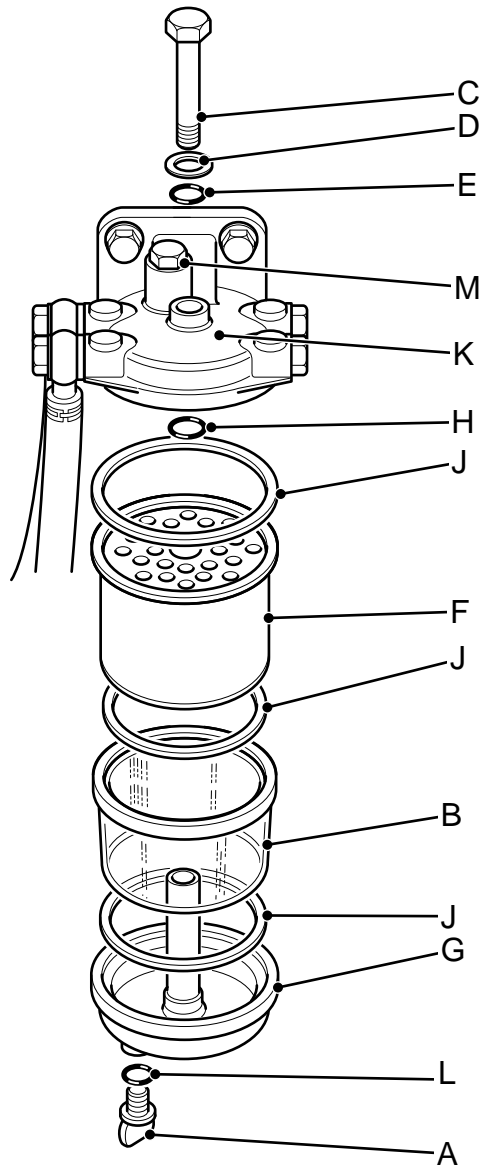
- L Cylinder head
- M Stud
- N Gasket
- P Exhaust manifold
- Q Nut2
- R Setscrew



06 - Level Sender

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Figure 238.



- A Drain plug
- C Bolt
- E O-Ring
- G Base
- J Seals
- L O-Ring

- B Sediment bowl
- D Washer
- F Filter element
- H O-Ring
- K Filter head
- M Screw



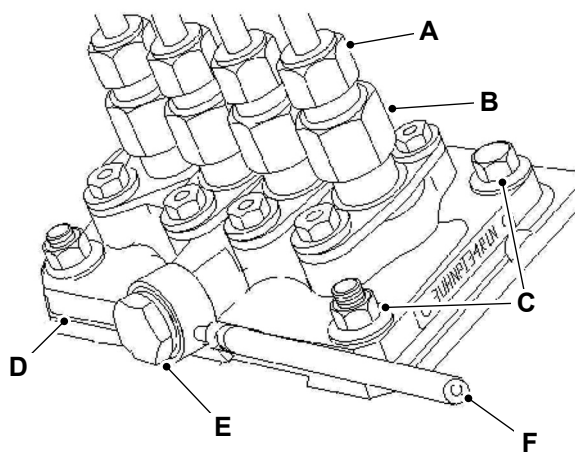
Install

1. Installation is the opposite of the removal procedure. Additionally do the following steps:
2. Make sure that you install the hoses to the correct ports.
3. Bleed the fuel system. Refer to (PIL 18-00).

Operation

The fuel injection pump is a pressurized system that is totally enclosed. The pump sends the correct amount of fuel under high pressure at the correct time through the fuel injectors to the individual cylinders. The fuel injection occurs near the end of the compression stroke. The fuel injection pump regulates the amount of fuel that is delivered to the fuel injectors. This action controls the engine RPM (Revolutions Per Minute) by the governor setting or the position of the throttle control.

Figure 252.



- A** Fuel line to the fuel injectors
- B** Fuel delivery valve
- C** Nuts and setscrews for mounting the fuel injection pump to the crankcase
- D** Shim
- E** Vent screw for the fuel injection pump
- F** Fuel flow from the fuel transfer pump

The camshaft is driven by the idler gear in the timing case. Lobes on the camshaft cause the push-rod for each cylinder to reciprocate. The reciprocating motion first draws the fuel. The reciprocating motion then pressurizes the fuel. The fuel delivery valve for each cylinder acts as a check valve to prevent a loss of pressure to the fuel injector.

The correct operation of the fuel injection pump requires the pump to be completely full of fuel and empty of air. When the vent screw is loosened, air can escape from the fuel injection pump.

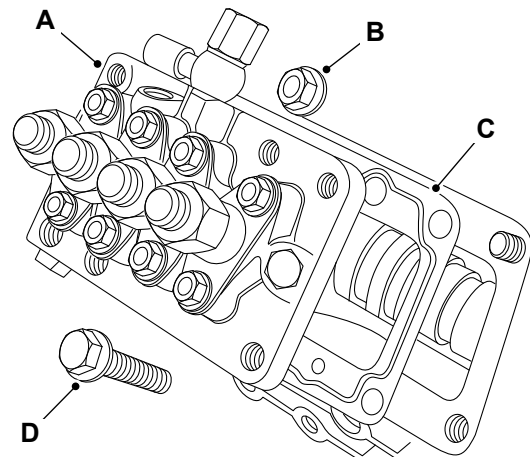
The fuel injection pump will lubricate the components during operation.

Remove and Install

Remove

1. Obey all fuel system health and safety information. Refer to (PIL 18-00).
2. Remove the ESOS (Engine Shut-Off Solenoid). Refer to (PIL 15-86).
3. Remove the fuel pipes. Refer to (PIL 18-96).
4. Gradually loosen the bolt and nut from the fuel injection pump.
5. Carefully raise the fuel injection pump and remove the clip.
6. Remove the fuel injection pump from the crankcase.
7. Remove the shims from the mounting face of the crankcase.
8. Make a note of the thickness and the number of the shims to help installation. The fuel injection timing is determined by the thickness of the shim pack between the fuel injection pump and the mounting face on the crankcase.

Figure 253.



- A** Fuel injection pump
- B** Nut
- C** Shims
- D** Bolt



00 - General

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Remove and Install 18-67

Introduction

The fuel lift pumps function is to raise the level of fuel up through the system into the fuel injection system.



03 - Inlet Manifold

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Introduction

On compression ignition (diesel) engines, the inlet manifold (also called the intake manifold) is the part of the air intake system that distributes air for combustion to the cylinders via each inlet port in the cylinder head. The design of the manifold is important to make sure that air is distributed as evenly as possible under all engine speed and load conditions.

Install

1. Make sure that all the parts are clean and free from contamination.
2. Check the turbocharger for wear or damage. If the turbocharger is worn, replace the complete turbocharger.
3. Check the actuator for correct operation. Refer to (PIL 18-35).
4. If the actuator is damaged or does not operate within the specified limits, replace the complete turbocharger.
5. Clean the mating surfaces of the exhaust manifold.
6. If removed, install the studs to the exhaust manifold.
7. Tighten the studs to the correct torque value.
8. Install the new gasket 2 on the studs.
9. Keep the turbocharger on the exhaust manifold at its correct position.
10. Install the nuts and tighten to the correct torque value.
11. Make sure that the tube assembly 1 and tube assembly 2 are clean and free from damage. If necessary, replace the tube assemblies.
12. If removed, keep the new joint 2 at its correct position on the crankcase with the tube assembly 2.
13. Install the bolt 3 and tighten to the correct torque value.
14. Keep the new joint 1 at its correct position on the tube assembly 2. Align the tube assembly 2 with the bottom of the turbocharger.
15. Install the bolt 2 and tighten to the correct torque value.
16. Lubricate the bearings of the turbocharger with the clean engine oil through the oil inlet port.
17. Rotate the shaft of the turbocharger to distribute the oil.
18. Install the new O-ring on the tube assembly 1.
19. Keep the tube assembly 1 at its correct position on the crankcase.
20. Install the bolt 1 and tighten to the correct torque value.
21. Install the new washer and banjo bolt to the tube assembly 1.
22. Keep the tube assembly 1 at its correct position on the turbocharger.
23. Install the tube clips with the fasteners and spacers.
24. Tighten the banjo bolt to the correct torque value.
25. Make sure that the tube assemblies do not touch any other components.
26. Clean the mating surfaces of the exhaust elbow.
27. Keep the new gasket 1 and exhaust elbow at its correct position on the turbocharger.
28. Install the screw and tighten to the correct torque value.
29. Make sure that the inlet hoses are clean and free from the defects or restrictions.
30. Loosely install the hose clamps on the air inlet hose.
31. Install the inlet hose and then tighten the hose clamps.

Table 105. Torque Values

Item	Description	Nm
C	Screw	32
G	Banjo bolt	18
K	Bolt 1	10
N	Bolt 2	10
S	Bolt 3	10
T	Nut	25
V	Stud	18



21 - Cooling System

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06 - Expansion Tank

Contents

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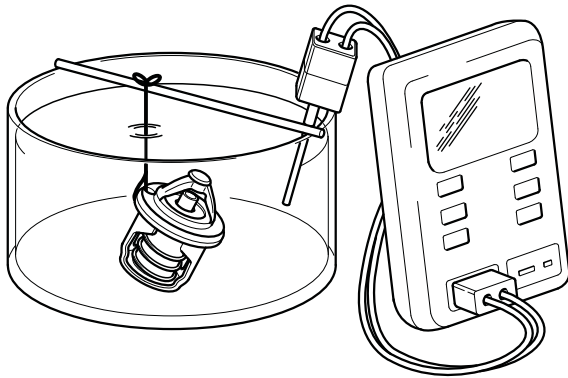
21-06-00 General	21-13
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Check (Operation)

WARNING: Personal injury can result from the escaping fluid under pressure. If a pressure indication is shown on the indicator, push the release valve to relieve pressure before removing any hose from the radiator.

1. Remove the thermostat from the engine. Refer to (PIL 21-12).
2. Heat the water in a pan until the temperature of the water is equal to the fully open temperature of the thermostat.
 - 2.1. Stir the water in the pan. This will distribute the temperature throughout the pan.

Figure 288.



3. Hang the thermostat in the pan of water. The thermostat must be below the surface of the water. The thermostat must be away from the sides and the bottom of the pan.
4. Keep the water at the correct temperature for the specified time.

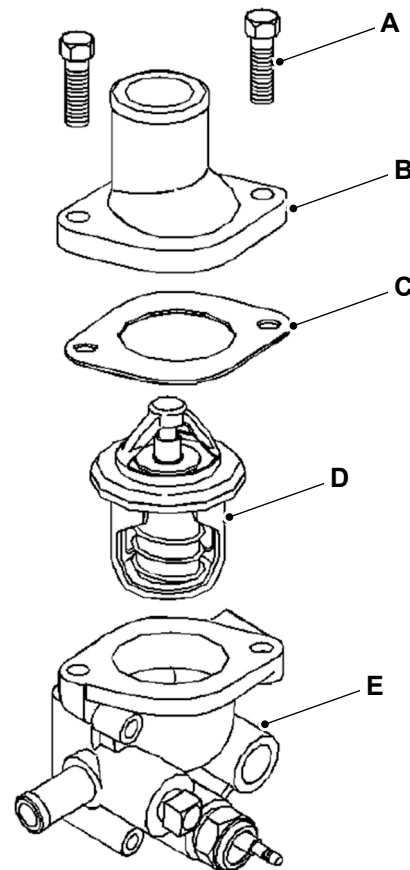
Duration: 10min
5. Remove the thermostat.
6. Immediately measure the opening of the thermostat.
7. Make sure that the opening distance is within the specified limit. If not, replace the thermostat. Refer to (PIL 21-12).

Remove and Install

Remove

1. Drain the cooling system. Refer to (PIL 21-00).
2. Remove the bolts.
3. Remove the outlet connection.
4. Identify the orientation of the outlet connection to help installation.
5. Remove the joint.
6. Remove the thermostat from the thermostat housing.

Figure 289.



- A** Bolt
- B** Outlet connection
- C** Joint
- D** Thermostat
- E** Thermostat housing

Install

1. Inspect the thermostat for wear, damage and correct operation. Refer to (PIL 21-12).

Fault-Finding

Fault

Motor will not start - no oil pressure	Table 113.	Page 27-5
Oil leakage - mating surfaces, case, floating seal and hydraulic motor	Table 114.	Page 27-5
Motor slips down on slope	Table 115.	Page 27-5
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Motor not travel in a straight line at high speed	Table 118.	Page 27-6
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Speed transition problem - from low speed to high speed	Table 121.	Page 27-6
Speed transition problem - from high speed to low speed	Table 122.	Page 27-6

Table 113. Motor will not start - no oil pressure

Cause	Remedy
Low relief valve pressure	Set the correct relief valve pressure.
Pump failure	Check the operation of services other than travel. Repair the pump, if necessary.
Direction switching valve failure	Check the spool for damage. Repair the spool, if necessary.
Brake valve failure	If the spool or valve is thermally seized, repair or replace.
Hydraulic motor failure	Check the hydraulic oil and replace, if necessary.
Gear teeth broken	Disassemble the reduction gear and replace the damaged parts.
Overload	Remove the excess load.

Table 114. Oil leakage - mating surfaces, case, floating seal and hydraulic motor

Cause	Remedy
Mating surface - scratched	Lap the surfaces - use the wet stone or emery paper to lap.
Mating surface - loose bolts	Tighten the bolts and check.
Case - loose plug	Tighten the plug.
Case - cracks due to stone, etc.	Disassemble the reduction gear and replace the damaged parts.
Floating seal - worn sliding surface	Disassemble the reduction gear and replace the damaged parts.
Floating seal - seepage past O-ring	Disassemble the reduction gear and replace damaged parts.
Hydraulic motor - loose mounting bolts	Tighten the bolts.
Hydraulic motor - damaged O-ring	Replace the O-ring.
Hydraulic motor - scratched seal surface	Lap the surfaces - use the wet stone or emery paper to lap.

Table 115. Motor slips down on slope

Cause	Remedy
Poor motor efficiency	Replace the traction motor.
Excessive leakage inside brake valve	Replace the brake valve and/or rear flange.
Broken parking brake spring	Replace the parking brake spring.
Worn parking brake friction plate	Replace the friction plate and/or other plate.

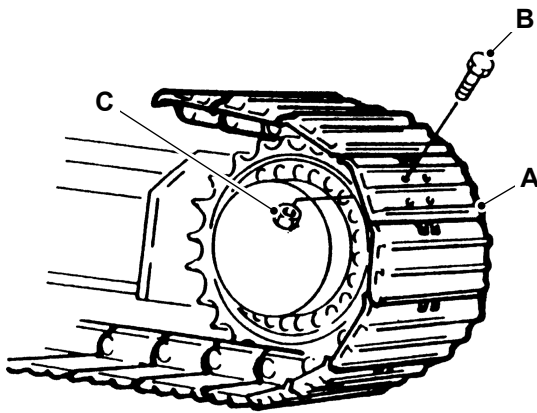
04 - Shoe Plate

Remove and Install

Remove

1. Make the machine safe. Refer to (PIL 01-03).
2. Put the damaged shoe plate over the drive sprocket. Refer to Figure 311.
3. Remove the bolts and nuts that attach the shoe plate to the track link. Refer to Figure 311.

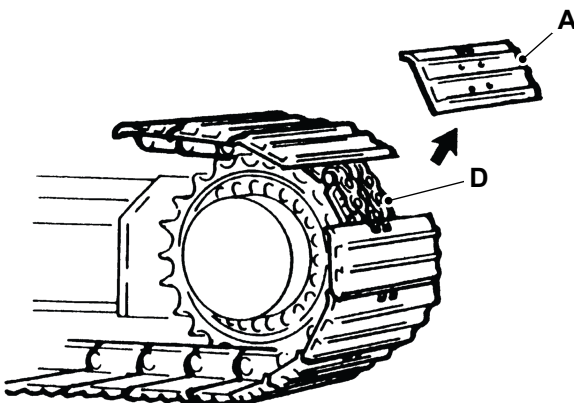
Figure 311.



- A Track shoe
- B Bolts
- C Nuts

4. Remove the damaged shoe plate. Refer to Figure 312.

Figure 312.

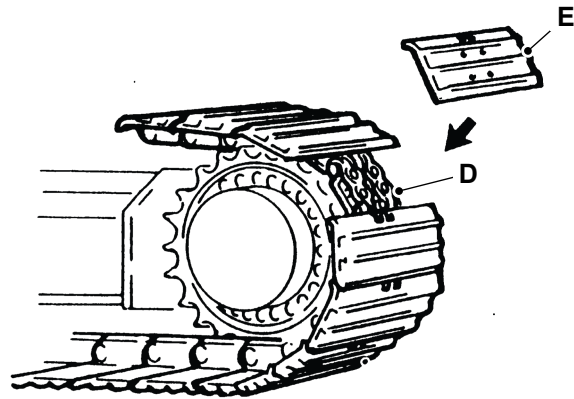


- A Track shoe
- D Track link

Install

1. Put the new shoe plate on the track link. Refer to Figure 313.

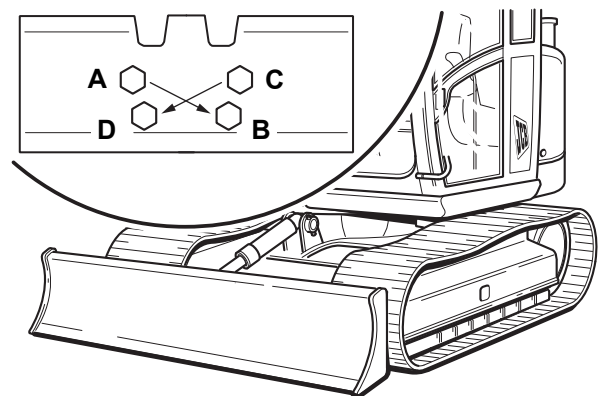
Figure 313.



- D Track link
- E New track shoe

2. Use the bolts and nuts to install the shoe plate to the track link.
3. Tighten the bolts in diagonal sequence. Refer to Figure 314.

Figure 314.



- A Bolt number 1
- B Bolt number 2
- C Bolt number 3
- D Bolt number 4

24 - Bottom Roller

Check (Condition) 27-29
Remove and Install 27-30
Disassemble and Assemble 27-32

Check (Condition)

Consumables

Description	Part No.	Size
JCB Gear Oil HP 90	4000/0301	5L
	4000/0305	20L
	4000/0303	200L

1. Check that the roller diameter at the outer edge are within permitted limits. Renew as necessary.
2. Check that the roller bearing bushes are not marked or worn oval. Renew as necessary.

Metallic Face Seal

Inspection

1. Check the contact area of the metallic face seals.
2. If the contact area of the metallic face seal is undamaged, estimate the remaining wear life as follows:
 - 2.1. New seals - Contact area is a narrow band at outer edge.
 - 2.2. Partly worn seals - Contact area is wider but does not extend full width.
 - 2.3. Scrap seals - Contact area is worn to full width.
3. Renew pair of seals if contact surface is scratched, pitted or corroded.
4. Examine the outer edges, housing ramp and lip. Carefully polish away light damage or corrosion.

Replacement

Note: Do not allow oil to come into contact with the O-rings or housings until assembly is complete.

Thoroughly clean and dry the seals, O-rings and housings before installing seals as follows:

1. Install the O-rings on to the seals. Make sure that they are positioned evenly and are not twisted.
2. Press the O-ring past the lip. Make sure that the dimension is constant around the circumference of the seal.
3. Immediately before final assembly, clean any contamination from the contact surface.
4. Apply a light coat of clean oil.

Consumable: JCB Gear Oil HP 90

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00 - General

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Introduction

The track motor consists of a fixed section, made up of a hydraulic motor and valve unit, and a rotary section which is a simple double-step planetary speed reduction.

When both tracks are selected to operate, the pump section P1 feeds the valve block section for the RH travel motor, and section P2 feeds the valve block section for the LH travel motor. Track feeds from the selected spools flow through the rotary coupling to the respective track motors.

The motor valve plate has two sets of ports.

Port 1 and port 2 are connected to the motor inlet and outlet lines through the counterbalance valve. When pressurised fluid is introduced through the motor valve plate, the pistons, on the port 1 side are forced against the swash plate.

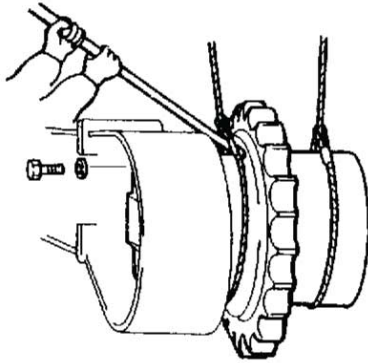
Reaction force from the swash plate generates radial force which causes rotation of the cylinder block. Torque generated at the cylinder block is transmitted to the output shaft, through splines on the cylinder block.

The end of the output shaft has a spline connected gear which drives two sets of planetary gears. These gears reduce output speed in two steps and transmit rotation to the rotary section of the motor through an integral ring gear.

Exhaust fluid is discharged from port 2. When the control valve, on the main valve block, is selected to opposite position, port 2 becomes inlet port, port 1 becomes outlet and rotation is reversed.

For low speed operation (if two speed option is fitted), the 2-speed control valve supplies fluid to all ports on the port 1 side (or port 2 side), producing maximum torque.

Figure 371.



3. Apply the threadlocker and sealer on the mount bolts.

Consumable: JCB Threadlocker and Sealer (Medium Strength)

4. Install the mount bolts and washers to attach the motor to the undercarriage.

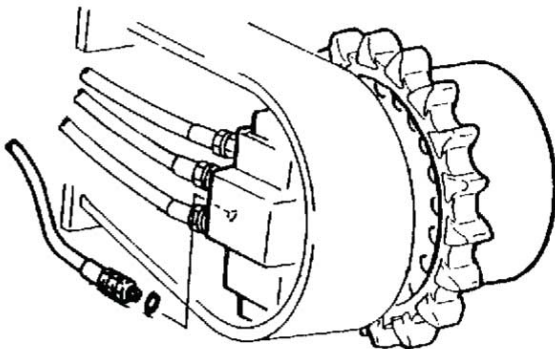
- 4.1. Tighten the bolts to the specified torque value in a diagonal sequence.

Torque: 267–312N·m

5. Remove all the caps and connect all the motor hoses to the motor. Refer to Figure 372.

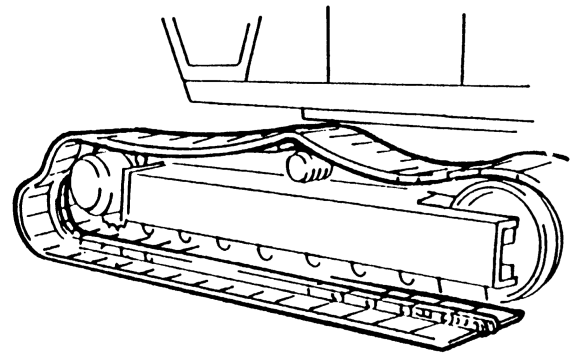
6. Install the covers to the motor. Refer to Figure 372.

Figure 372.



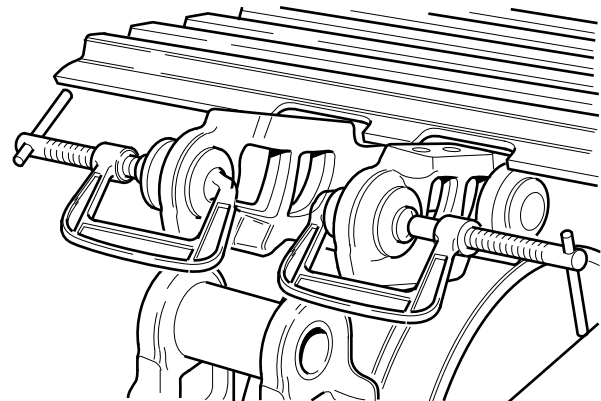
7. Check the gearbox oil level.
8. Bleed the motor. Refer to (PIL 27-38).
9. Install the gearbox sprocket. Refer to (PIL 27-36-12).
10. Remove the wooden blocks and position the lower frame on the track.
11. Move the track link until the master pin hole takes the position over the roller. Refer to Figure 373.

Figure 373.



12. Clean the seal ring housings of the chain link.
13. Insert the seal rings and use the G-clamps to hold the seal rings in position. Refer to Figure 374.

Figure 374.



14. Use a plastic hammer to tap the upper link down to align the holes.
 - 14.1. As the track links overlap, the seal rings must be held in position.
15. Remove the G-clamps.
16. Insert the tapered face guide pin from the inner face and tap through its full length.
17. Put a suitable hydraulic press and align the ram with the guide pin. Refer to Figure 375.

00 - General

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Introduction

The hydraulic system is a power transmission system that uses the force of flowing liquids to transmit power to specific components in a machine.

To help you trace specific hydraulic problems to a faulty unit (valve, actuator, ram etc.), refer to Fault finding (PIL 30-00). Once you have traced the faulty unit, refer to the relevant section for removal, disassembly and checking instructions.

To help identify circuits, valves, rams etc. mentioned in the fault finding procedures, refer to the hydraulic schematic diagrams (PIL 30-00).

- Before you begin fault finding, read the Health and Safety Information (PIL 30-00).
- Make simple checks before you remove or disassemble a major component.
- Make sure that the hydraulic fluid is at the correct working temperature (50 °C, 122 °F).
- Whatever the fault, check the condition of the hydraulic fluid. Drain and replace if necessary. Refer to Hydraulic fluid quality in this procedure.
- Make sure you remove ALL contamination and if possible identify its origin. It may be part of a component from elsewhere in the circuit.

Hydraulic Fluid Quality

This machine uses a large volume of fluid in the hydraulic system for power transmission, equipment lubrication, rust prevention and sealing. According to a survey conducted by a pump manufacturer, seventy per cent of the causes of problems in hydraulic equipment were attributable to inadequate maintenance of the quality of the hydraulic fluid. Therefore, it is obvious that control of the quality of the hydraulic fluid helps prevent hydraulic equipment problems and greatly improves safety and reliability. Furthermore from an economic angle it extends the life of the hydraulic fluid if quality is maintained.

Hydraulic Contamination

Once inside the system, hydraulic circuit contaminants greatly affect the performance and life of hydraulic equipment. For example, contaminants in a hydraulic pump develop internal wear to cause internal leakage and hence lower discharges. Wear particles generated will circulate with the hydraulic fluid to cause further deterioration in the performance of this and other equipment. Contaminants also enter principal sliding sections of the equipment causing temporary malfunction, scuffing, sticking and leakage and can lead to major problems. The main contaminants can be classified as follows:

49 - Schematic Symbols

Introduction	30-15
Diagram	30-16

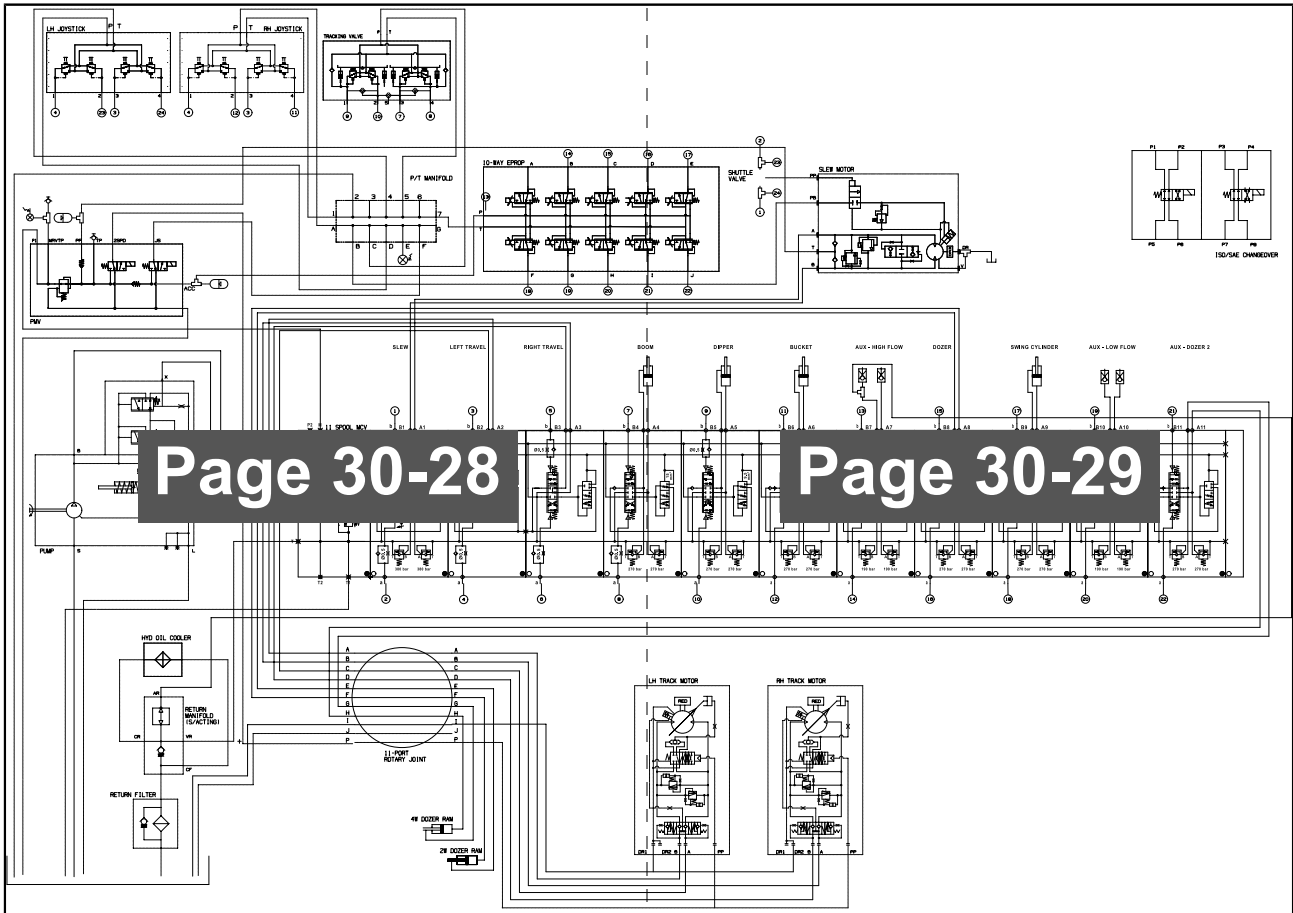
Introduction

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

There are many symbols in use and it would be impossible to include them all here. However it should be noted that most are only variations or refinements on the basic principles explained here. If more detailed information is required you are recommended to obtain a copy of BS2917 or ISO1219.

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

Figure 390. Hydraulic schematic 400/A7000-1 (sheet 3) 11 Spool Valve Block





08 - Gearbox

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- | | |
|---------------------------|--------------------------|
| 1 Snap ring | 2 Cover plate |
| 3 O-ring | 4 Slide ring |
| 5 Carrier assembly | 6 Snap ring |
| 7 Sun gear | 8 Snap ring |
| 9 Thrust washer | 10 Needle bearing |
| 11 Gear | 12 Thrust washer |
| 13 Carrier | 14 Roll pin |
| 15 Shaft | 16 Snap ring |
| 17 Thrust plate | 18 Gear |
| 19 Needle bearing | 20 Sleeve |
| 21 Thrust washer | 22 Snap ring |
| 23 Bearing | 24 Body |
| 25 Seal ring | 26 O-ring |
| 27 Bearing | 28 O-ring |
| 29 Seal ring | 30 Motor |
| 31 Plug | 32 O-ring |
| 33 Shaft | |

Table 152. Torque Values

Item	Nm
31	49

Remove and Install

▲ WARNING Do not work below a raised cab unless the cab is secured in position and safely supported.

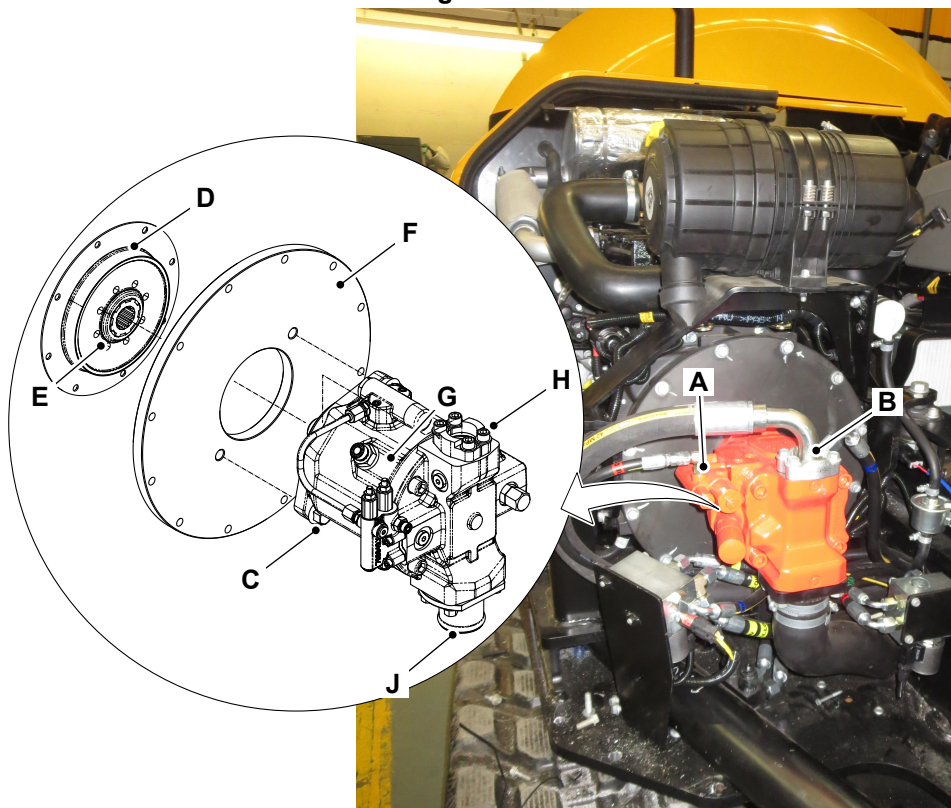
CAUTION This component is heavy. It must only be removed or handled using a suitable lifting method and device.

WARNING Do not work below a raised cab unless the cab is secured in position and safely supported.

Remove

1. Make sure that the exterior of the pump and working area is thoroughly clean and is free of any contamination.
2. Make the machine safe. Refer to (PIL 01-03).
3. Discharge the hydraulic system. Refer to (PIL 30-00).
4. Drain the hydraulic tank into a suitable clean container. Refer to (PIL 30-00).
5. Remove the clips and disconnect the suction hose from the pump inlet manifold.
6. Remove flange bolts (x4) and remove the outlet hose from the pump body.
7. Disconnect the remaining hydraulic hoses.
8. Cap all the open ports to prevent contamination.
9. Secure the pump assembly using a sling around the pump body.
10. Support the pump and remove the mounting bolts (x2).
11. Remove the pump from the machine.

Figure 404.



A Drain hose
C Mounting bolts (x2)
E Splines
G Pump body
J Inlet manifold

B Outlet hose
D Drive plate
F Flywheel cover
H Flanged bolts (x4)

Remove and Install

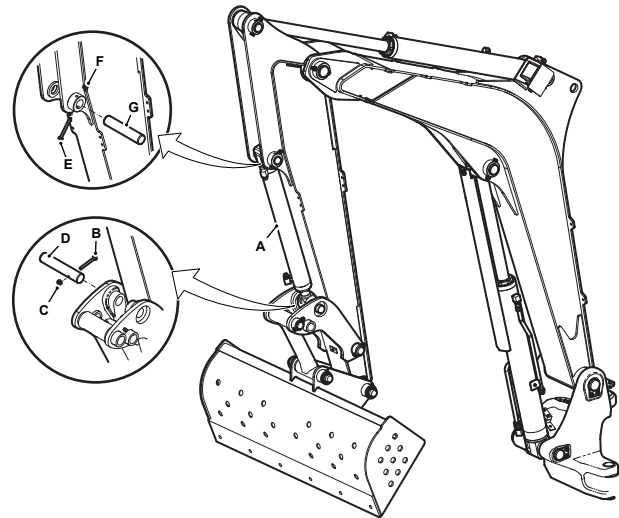
Consumables

Description	Part No.	Size
Special MPL-EP Grease	4003/1501	0.4kg
	4003/1506	12.5kg
	4003/1510	50kg

Remove

1. Make the machine safe. Refer to (PIL 01-03).
2. Discharge the hydraulic pressure. Refer to (PIL 30-00).
3. Position the machine with the bucket on the ground.
4. Engage the supporting structure below the boom/dipper pivot.
5. Remove the hoses from the bucket ram.
 - 5.1. Put labels on the hydraulic hoses to help identification for installation.
 - 5.2. Put caps on all the open ports and hoses to prevent contamination.
6. Remove the locknut and bolt from the pivot pin at the rod end of the bucket ram. Refer to Figure 409.
7. Remove the pivot pin from the rod end of the bucket ram. Refer to Figure 409.
8. Lower the rod end of the bucket ram onto a suitable support.
9. Remove the locknut and bolt from the pivot pin at the cylinder head of the bucket ram. Refer to Figure 409.
10. Remove the pivot pin from the cylinder head of the bucket ram. Refer to Figure 409.
11. Remove the bucket ram from the machine. Refer to Figure 409.
12. Clean the pivot pins.

Figure 409.



- A Bucket ram
- B Bolt
- C Locknut
- D Pivot pin - rod end
- E Bolt
- F Locknut
- G Pivot pin - cylinder head

Install

1. Installation is the opposite of the removal procedure.
2. Apply grease to the bucket ram pivot pins before assembly.
 - 2.1. Apply grease to the pivot points through the grease nipples.

Consumable: Special MPL-EP Grease
3. Connect the hoses to the bucket ram cylinder.
4. Check the hydraulic fluid level is correct in the tank. Refer to (PIL 30-00).
5. Do an operational check of the hydraulic circuit. Refer to (PIL 30-00).

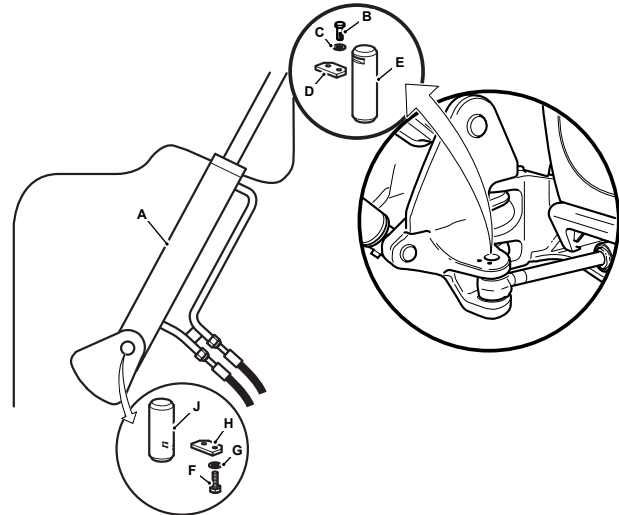
Remove and Install

Consumables

Description	Part No.	Size
EP Hammer Grease	4003/2107	0.4kg
	4003/2106	12.5kg

Remove

1. Make the machine safe. Refer to the (PIL 01-03).
2. Discharge the hydraulic pressure. Refer to (PIL 30-00).
3. Position the machine with the upper structure slewed at an angle to the tracks.
Angle: 90°
4. Remove the hoses from the swing ram.
 - 4.1. Put labels on the hydraulic hoses to help identification for installation.
 - 4.2. Put caps on all the open ports and hoses to prevent contamination.
5. Remove the bolts and washers that attach the plate at the rod end of the swing ram. Refer to Figure 421.
6. Remove the pivot pin from the rod end of the swing ram. Refer to Figure 421.
7. Remove the bolts and washers that attach the plate at the cylinder head of the swing ram. Refer to Figure 421.
 - 7.1. The cylinder head pate of the swing ram is attached below the slew frame of the machine.
8. Remove the pivot pin from the cylinder head of the swing ram. Refer to Figure 421.
9. Remove the rod end of the ram from the kingpost and remove the ram from the front side of the machine. Refer to Figure 421.
10. Clean the pivot pins.

Figure 421.


- A** Swing ram
- B** Bolts
- C** Washers
- D** Plate - rod end
- E** Pin - rod end
- F** Bolts
- G** Washers
- H** Plate - cylinder head
- J** Pin - cylinder head

Install

1. Installation is the opposite of the removal procedure.
2. Apply grease to the swing ram pivot pins before assembly.
 - 2.1. Apply grease to the pivot points through the grease nipples.
Consumable: EP Hammer Grease
3. Connect the hoses to the swing ram cylinder.
4. Check the hydraulic fluid level is correct in the tank.
5. Do an operational check of the hydraulic circuit.

00 - General

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Health and Safety	30-100
Technical Data	30-100
Component Identification	30-101
Discharge and Pressurise	30-101

Introduction

A hydraulic accumulator is a pressure storage reservoir used to store hydraulic fluid, the non-compressible hydraulic fluid is held under pressure by a compressed nitrogen gas. It is designed to increase or relieve pressure in the hydraulic system.

Accumulators enable a hydraulic system to cope with extremes of demand using a less powerful pump, to respond more quickly to a temporary demand, and to smooth out pulsations.

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.

Make sure you have read and understood the Health and Safety implications (PIL 30-18). [Refer to: Hydraulic System > Accumulator > General > Health and Safety \(Page 30-100\).](#)

There are three different types of accumulator installed on JCB machines:

- Diaphragm (sealed for life)-Non Rechargeable
- Diaphragm (with gas valve)-Rechargeable
- Piston Bladder-Rechargeable

Although some accumulators are identical in appearance, the accumulators are charged to different pressures. When renewing an accumulator make sure you know the correct charge pressure, refer to Technical Data (PIL 30-18).

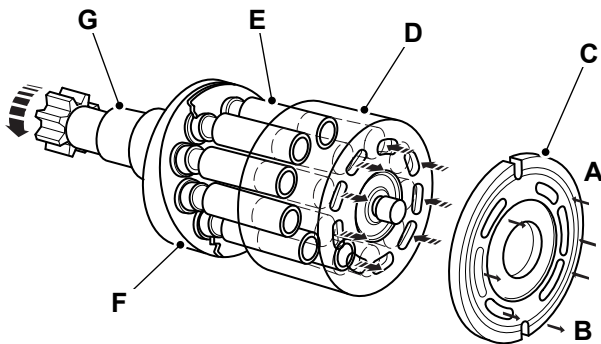
Upon installation of a new accumulator the correct label stating the charge pressure must be attached. The original label which states a zero charge must be removed.



39 - Slew Motor

Contents	Page No.
30-39-00 General	30-113

Figure 454.



- A Port 1
- B Port 2
- C Valve plate
- D Cylinder barrel
- E Piston
- F Swash plate
- G Shaft

Cross Line Relief Valve Section

The shockless relief valve consists of the direct relief valve (poppet) and the piston for changing the spring force in two stages.

When hydraulic pressure is removed from port 1 or port 2 of the hydraulic motor, the motor continues to run due to inertia. This allows the motor to work as a pump and pressure (brake pressure) is generated on the output port.

The shockless relief valve releases this brake pressure with two stages of operation. This makes the shock smooth, and prevents the motor from damage. It also makes the starting of the motor smooth.

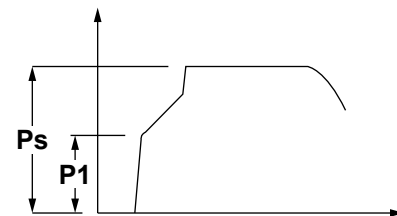
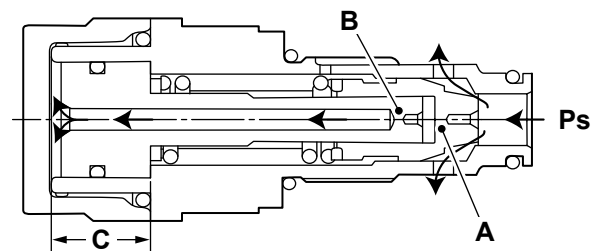
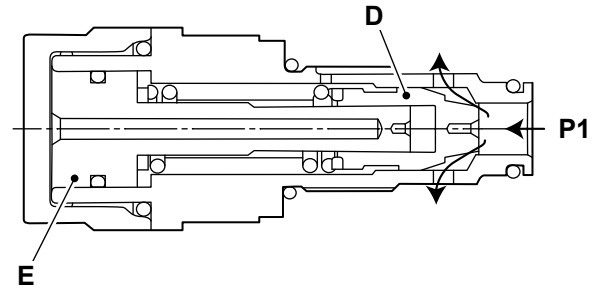
Stage 1

When the pressure 1 goes up, the poppet opens due to the pressure of the spring force.

Stage 2

When pressure 1 enters the second chamber through the orifices 1 and 2, the piston moves to its stroke-end. With this action, the spring is compressed. The spring force becomes stronger, and the pressure 1 is increased to the setting pressure.

Figure 455.



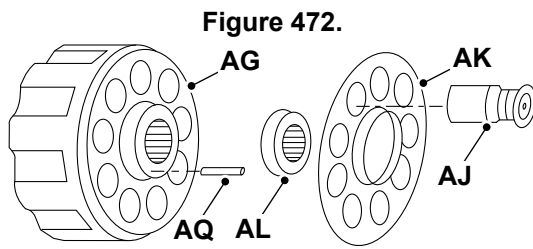
- A Orifice 1
- B Orifice 2
- C Stroke-end
- D Poppet
- E Piston
- P1 Pressure 1
- Ps Setting pressure

Anti-Cavitation Valve Section

When the swing motor is decelerated by operating the control valve, it continues to operate by the inertia of the machine. This allows the motor to work as a pump and the pressure in the chamber tends to become negative.

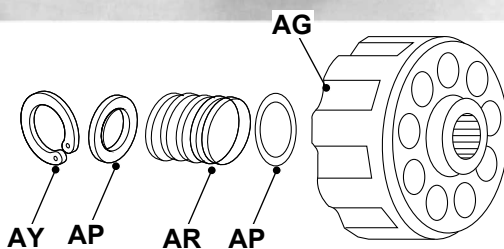
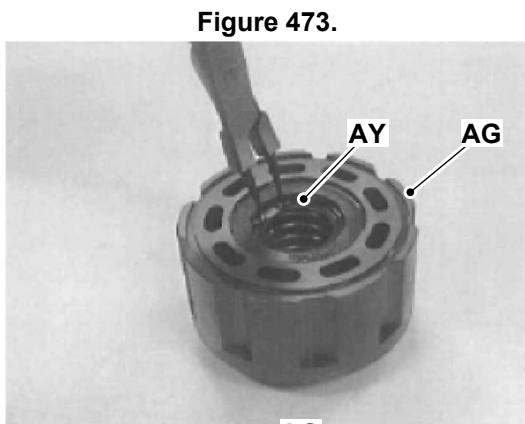
When the pressure in port 2 is below the pressure setting of the relief valve, all flow in port 1 goes out from port 2 through the motor. As a result the chamber only gets the flow from the control valve, which will not be sufficient to prevent the negative pressure. This leads to cavitation in the chamber. The anti-cavitation valve supplies the fluid from port 3 to the chamber, and thus prevents cavitation.

13. Remove the piston assemblies, the shoe holder, the barrel holder and the pin 2. Refer to Figure 472.



- AG** Cylinder barrel
- AJ** Piston assembly
- AK** Shoe holder
- AL** Barrel holder
- AQ** Pin 2

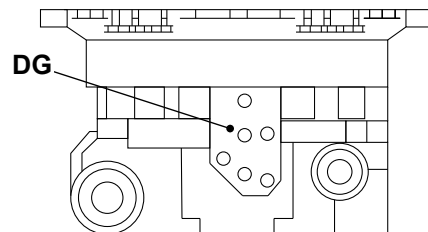
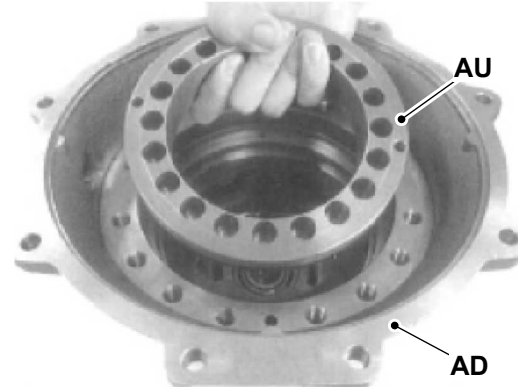
14. Remove the snap ring 3, the retainer 1 and the spring C. Refer to Figure 473.



- AG** Cylinder barrel
- AP** Retainer 1
- AR** Spring C
- AY** Snap ring 3

15. Blow compressed air gently through the port PP to remove the brake piston. Refer to Figure 474.

Figure 474.



- AD** Slew motor body
- AU** Brake piston
- DG** Port PP

16. Remove the O-ring 2 and O-ring 3 from the slew motor body.
17. Remove the disc plate and the steel plate. Refer to Figure 475.

Fault-Finding

Fault

A spool is sticking	Table 176.	Page 30-147
A spool does not move over its full stroke	Table 177.	Page 30-147
The dipper/boom falls under load with the spool in neutral	Table 178.	Page 30-147
System pressure does not rise at all	Table 179.	Page 30-147
Relief pressure is unstable	Table 180.	Page 30-147
Oil leak	Table 181.	Page 30-148

Table 176. A spool is sticking

Cause	Remedy
Oil temperature abnormally high	Check correct oil. Check oil cooler and grille for blockage.
The hydraulic oil is dirty	Clean the tank strainer. If strainer badly clogged, drain and flush hydraulic system.
The service pipe connection is over tightened	Check tightening torque.
The valve housing was twisted during installation	Loosen retaining bolts and tighten to correct torque values.
Pressure too high	Check system pressure.
A spool is bent	Replace the control valve section.
A return spring is broken	Replace as necessary.
A return spring or cap is out of alignment	Remove the cap, check that the spring is in the correct position. Install the cap and tighten bolts to the correct torque value.
Temperature distribution within control valve not uniform	Warm the entire system up before using service.

Table 177. A spool does not move over its full stroke

Cause	Remedy
Dirt is clogging the inside of the valve	Remove the dirt (flush out the valve).

Table 178. The dipper/boom falls under load with the spool in neutral

Cause	Remedy
Oil is leaking past the ram/boom piston seals	Replace the piston seal.
Oil is bypassing dipper/boom spool	Replace control valve section.
Oil is leaking past dipper/boom ARV (Auxiliary Relief Valve)	Remove ARV and clean housing seat and relief valve seat. Install ARV.

Table 179. System pressure does not rise at all

Cause	Remedy
The main poppet, check valve poppet or pilot poppet is sticking open, or dirt is caught in the valve seat	Remove MRV (Main Relief Valve) and dismantle. Inspect and clean all parts. Assemble MRV, ensuring that all parts slide freely. Install the MRV.

Table 180. Relief pressure is unstable

Cause	Remedy
The pilot poppet seat is scratched or the pilot piston is sticking with the main poppet or the parts are worn out	Remove MRV and disassemble. Inspect and clean all parts. Renew damaged parts or remove scratches with very fine emery cloth. Assemble MRV and make sure that all the parts are slide freely. Install the MRV.
The lock nut and adjusting screw are loose	Tighten the lock nut and reset MRV pressure.

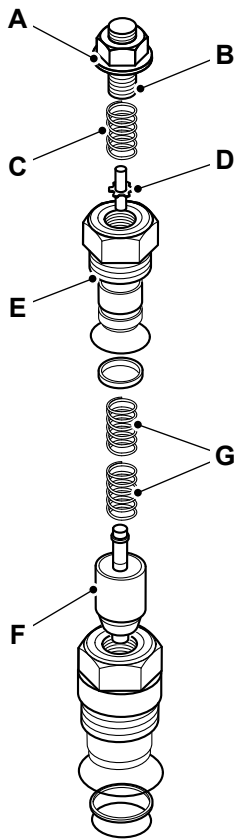
Disassemble and Assemble

Disassemble

1. Remove the plastic locking cap.
2. Release the adjuster locknut and remove the adjuster screw.
3. Remove the spring and relief valve poppet.
4. Remove the upper valve body, the poppet and the springs.
5. Inspect the valve components. Refer to (PIL 30-50-06).

2. Assembly is the opposite of the disassembly sequence.
3. Do a pressure test of the valve. Refer to (PIL 30-00).

Figure 505.



- A** Adjuster locknut
- B** Adjuster screw
- C** Spring
- D** Relief valve poppet
- E** Upper valve body
- F** Poppet
- G** Springs

Assemble

1. Clean the valve body and components in an appropriate solvent.

Diagram

Figure 519.

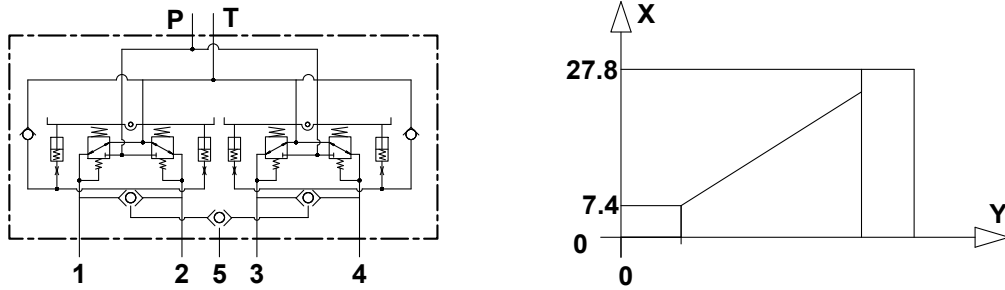


Table 190.

Item	Description
1	To left side travel spool
2	To left side travel spool
3	To right side travel spool
4	To right side travel spool
5	Not used
P	Pilot supply port
T	Tank return port
X	Pressure (bar (psi))
Y	Pedal movement (°)



00 - General

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[Disconnect and Connect](#) 30-184
[Check \(Condition\)](#) 30-185

Introduction

Hydraulic hoses are used to connect different components in the hydraulic circuit. The hoses are graded by pressure, temperature, and fluid compatibility. Hoses are built up with rubber and steel layers. A rubber interior is surrounded by multiple layers of woven wire and rubber. The exterior is designed for abrasion resistance. The bend radius of a hydraulic hose is carefully designed into the machine, since hose failures can be deadly, and violating the hose's minimum bend radius will cause failure. Hydraulic hoses generally have steel fittings swaged on the ends.

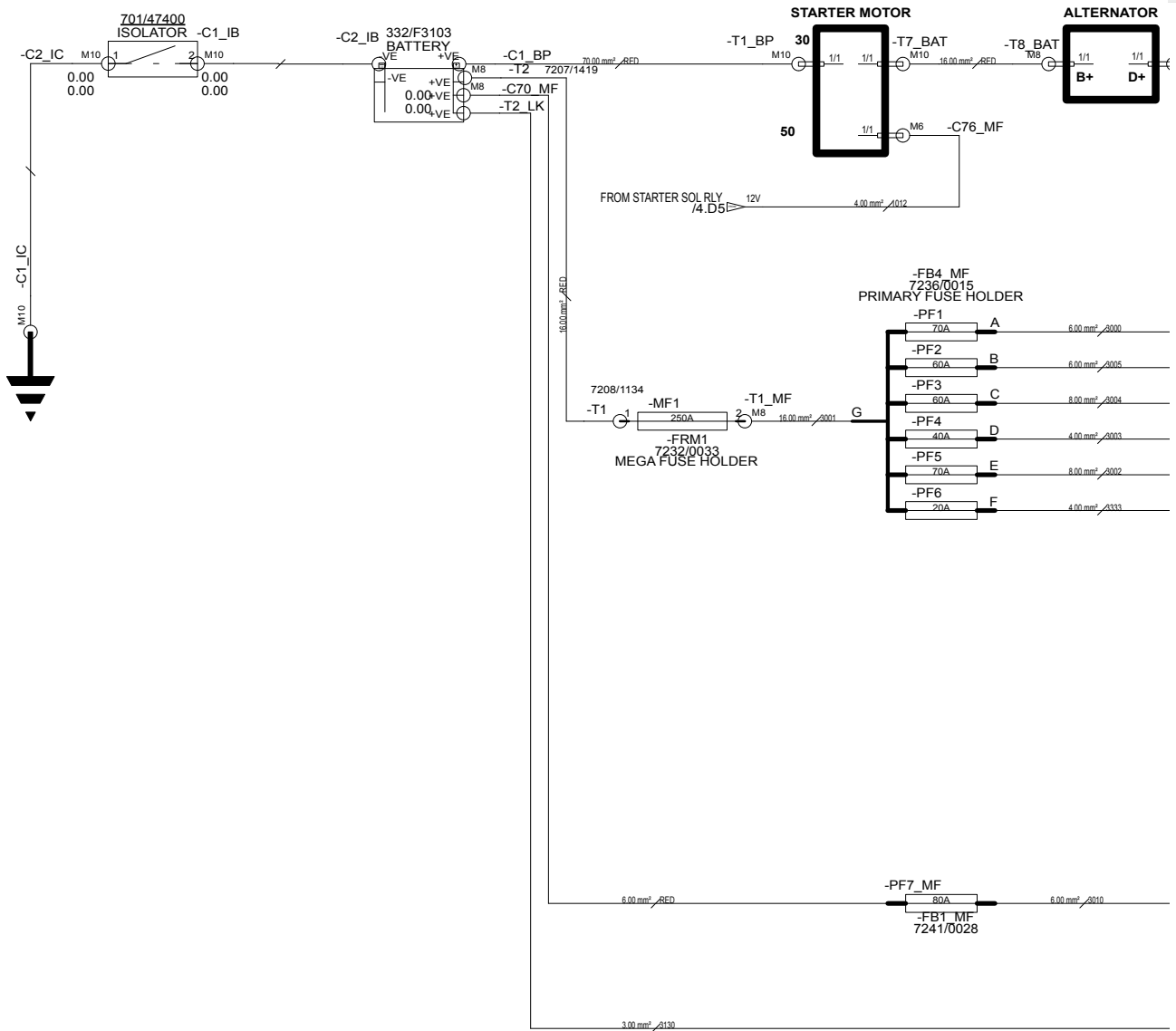


33 - Electrical System

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Figure 542. (Part 1 of 2)

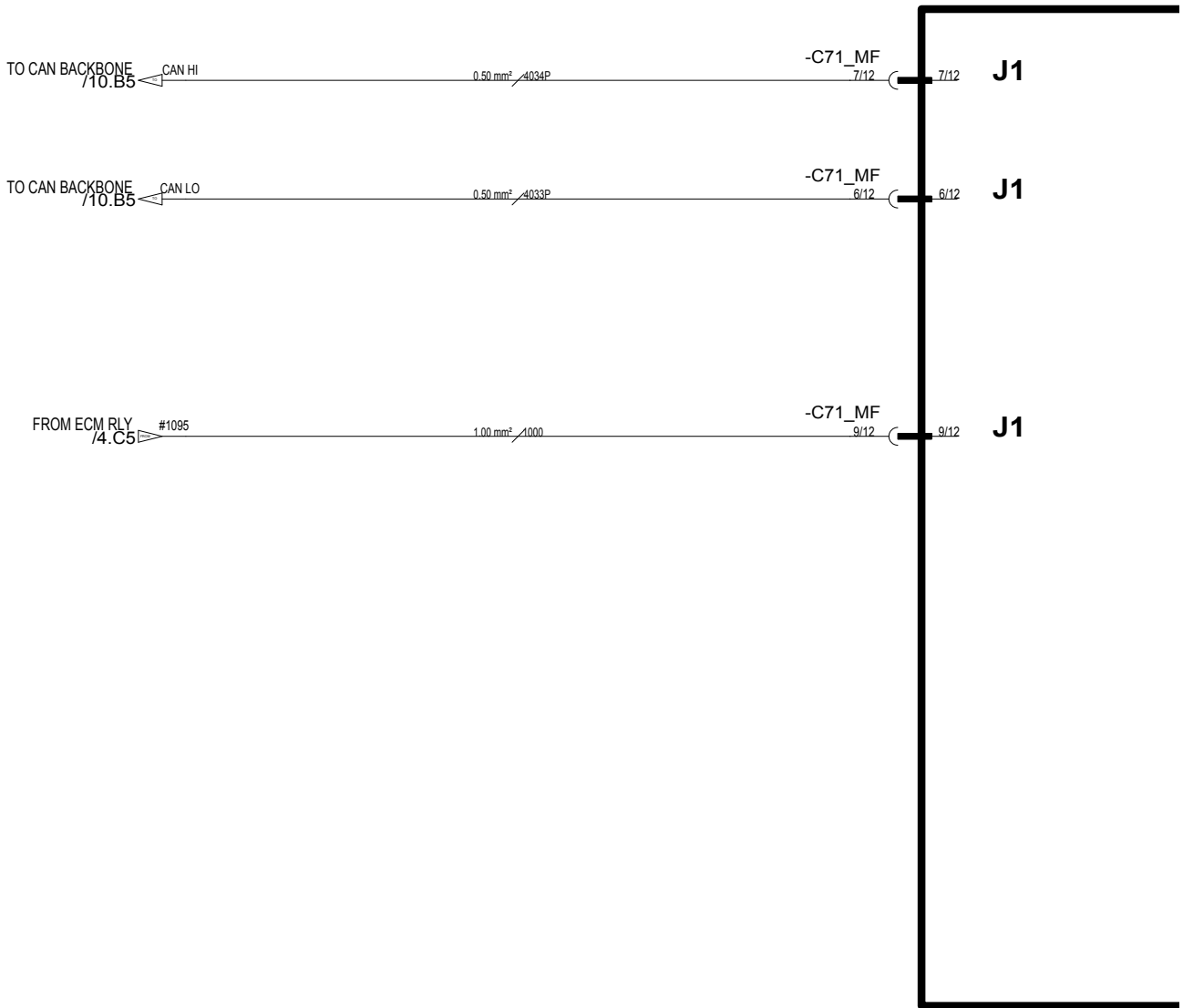


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Figure 546. (Part 1 of 2)

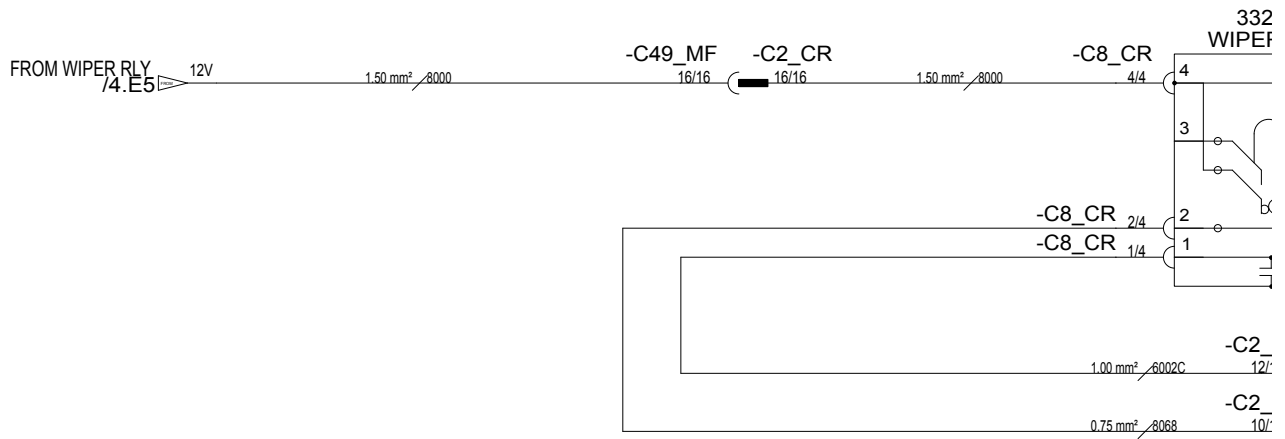
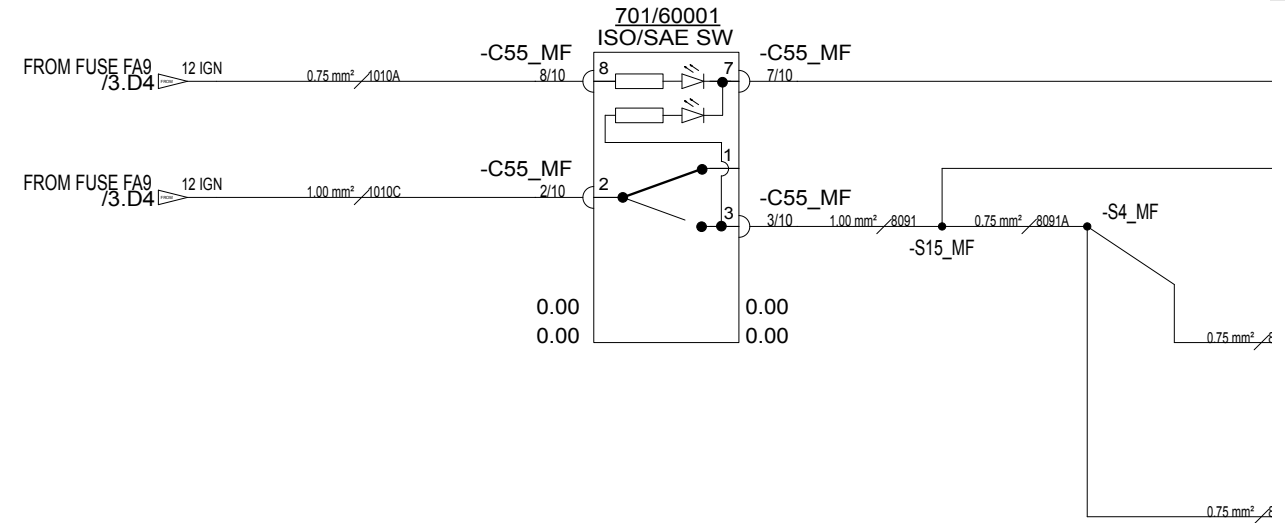
WOODWARD CO



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Figure 554. (Part 1 of 2)



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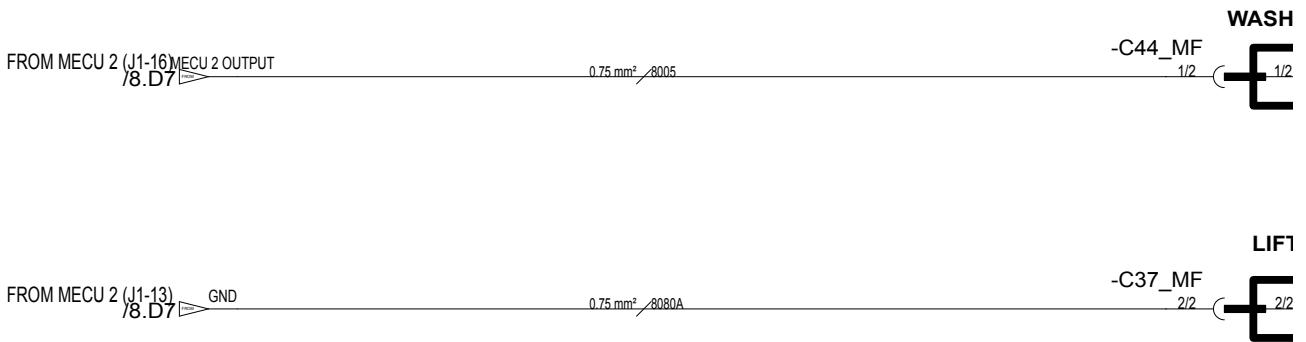
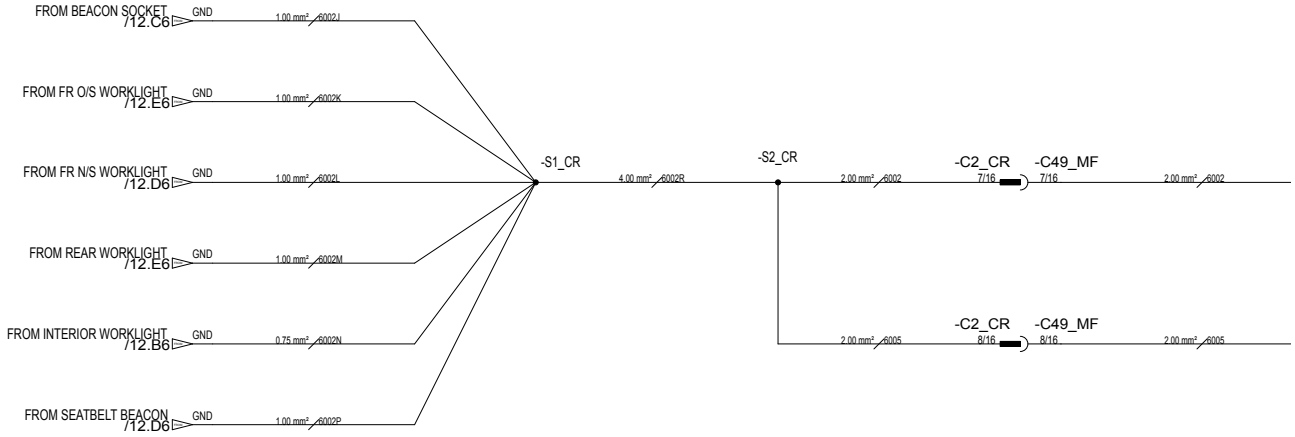




Figure 558. (Part 1 of 2)

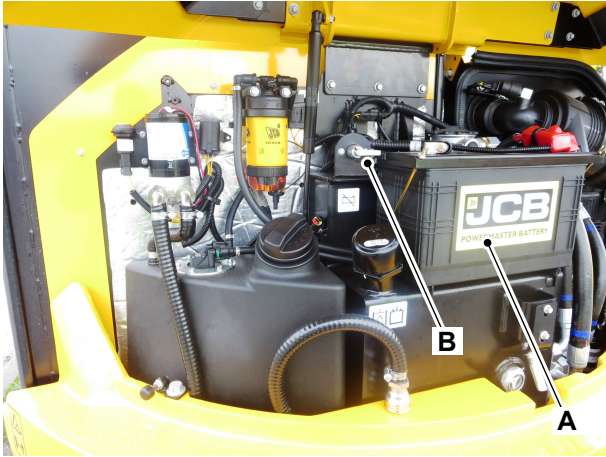


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Component Identification

The battery is located on top of the hydraulic tank. A battery isolator switch is connected to the battery. The battery isolator switch isolates the machine electrical system during maintenance procedures.

Figure 566.



A Battery

B Isolator switch



00 - General

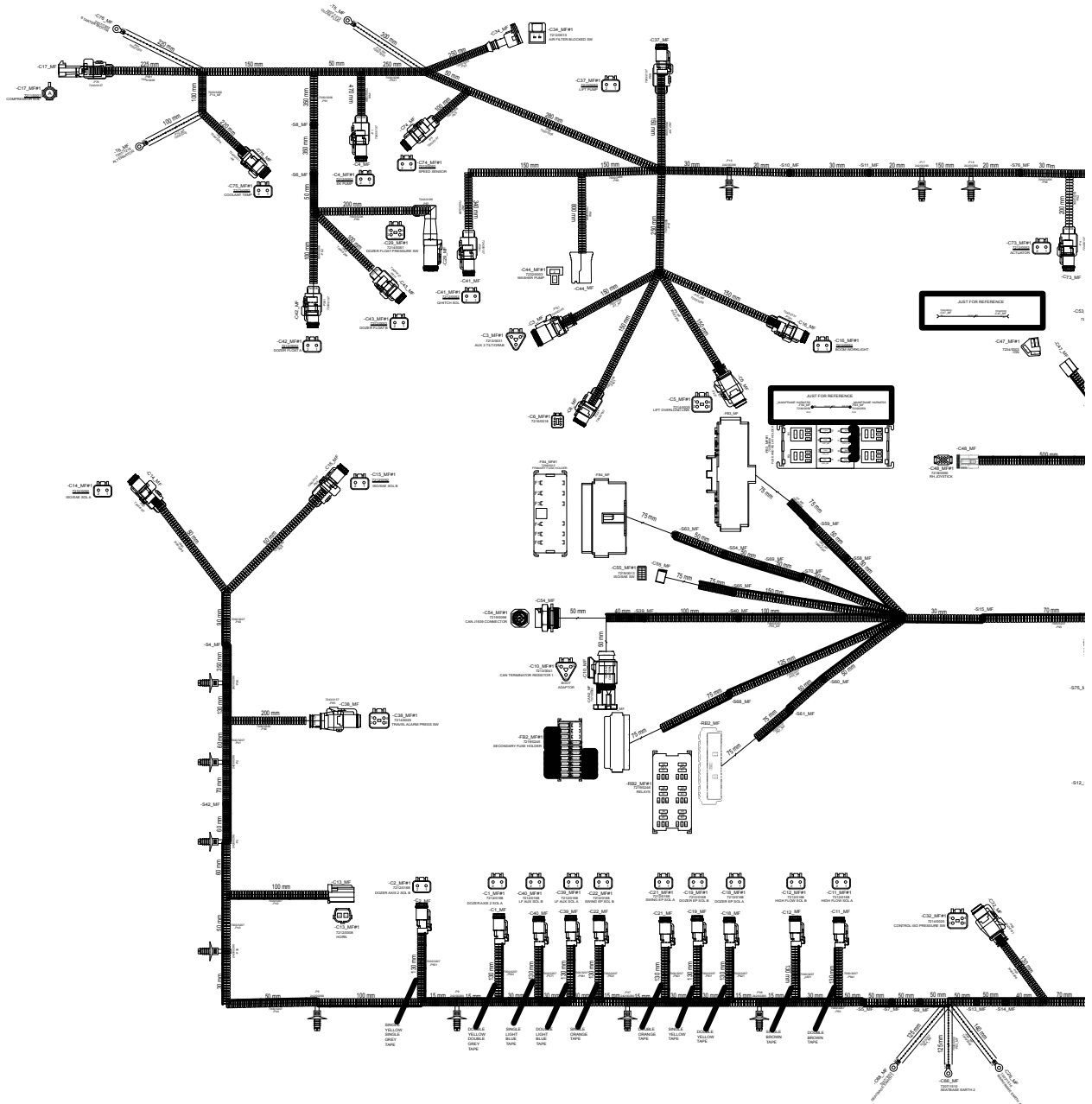
Introduction 33-81
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Introduction

The electrical circuits are protected by fuses. If a fuse blows, find out why and rectify the fault before installing a new one.

A full up to date list of fuses and relays and their locations can be found in the relevant operator manual, maintenance section.

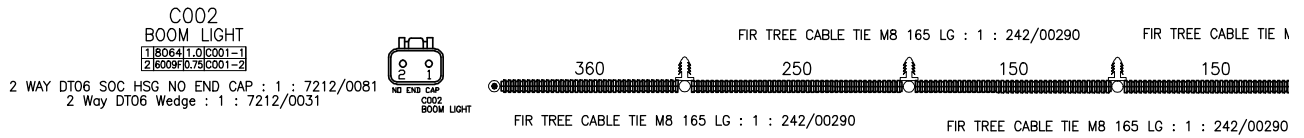
Figure 587. (Part 1 of 2)



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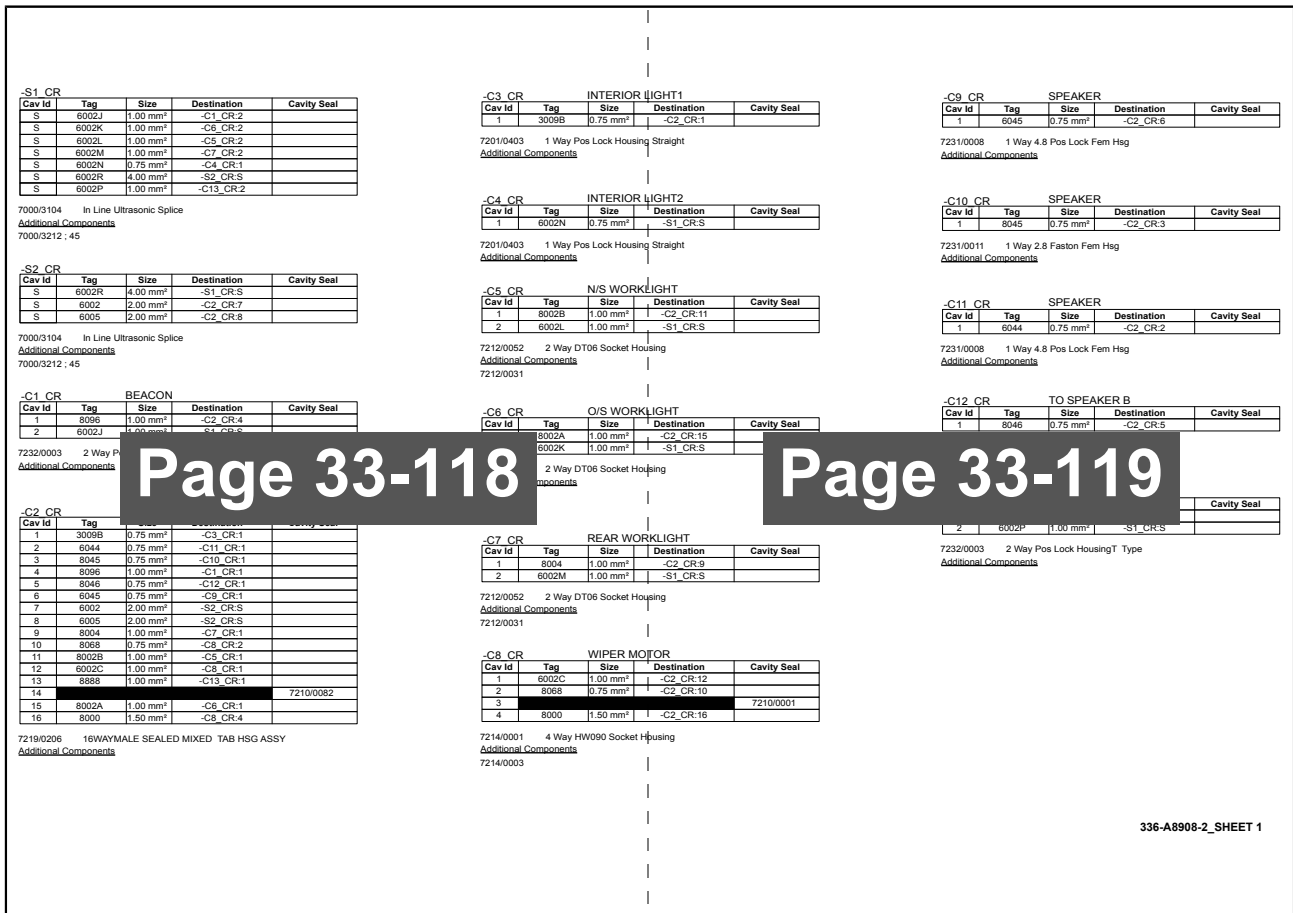
Figure 591. (Part 1 of 2)



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Figure 596. 336-A8908-2 (sheet 2 of 2)



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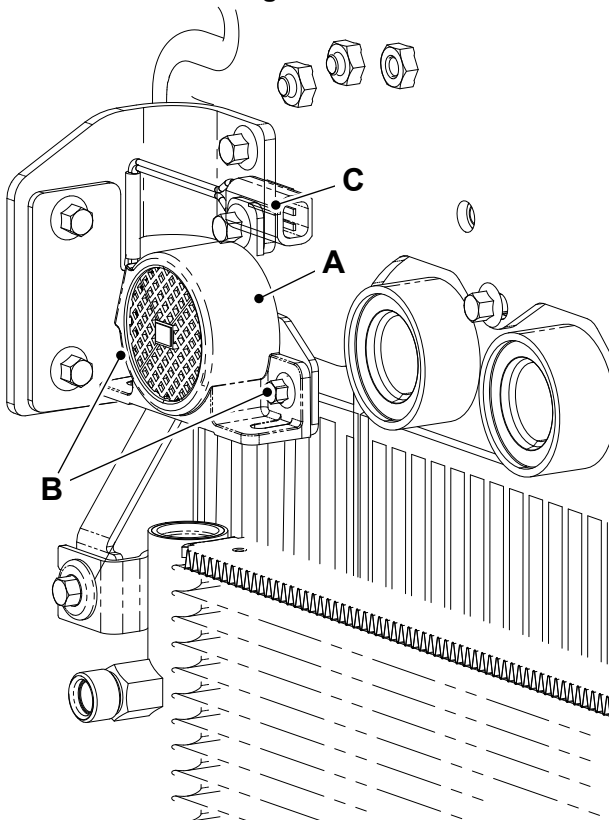
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Remove and Install

Remove

1. Make the machine safe. Refer to (PIL 01-03).
2. Open the hydraulic compartment cover. Refer to (PIL 06-06).
3. Disconnect the electrical connector.

Figure 601.



- A** Travel alarm
- B** Bolts (x2)
- C** Electrical connector

4. Remove the bolts (x2).
5. Remove the travel alarm from the machine.

Install

1. The installation procedure is the opposite of the removal procedure.



Remove and Install

The operator present switch is a non serviceable component. If it is faulty, replace the seat assembly. Refer to (PIL 09-12).



00 - General

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[Remove and Install](#) [33-154](#)

Introduction

The console switches are CAN (Controller Area Network) based switches. They have indicator lights built in to show the current status of the function being operated.



40 - Bulb

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00 - General

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Introduction

Modern machines use ECU (Electronic Control Unit) to control machine systems such as hydraulics, transmission and engine. In much the same way as office computers can be 'networked' to communicate with each other the machine ECU's can be 'networked'. Some advantages of networking are:

- Improved more intelligent control systems
- More comprehensive and reliable in-cab instrumentation
- Service software tools can be used for fault finding and machine control set up

The ECM (Engine Control Module) can communicate with other machine ECU using a CANbus network system.

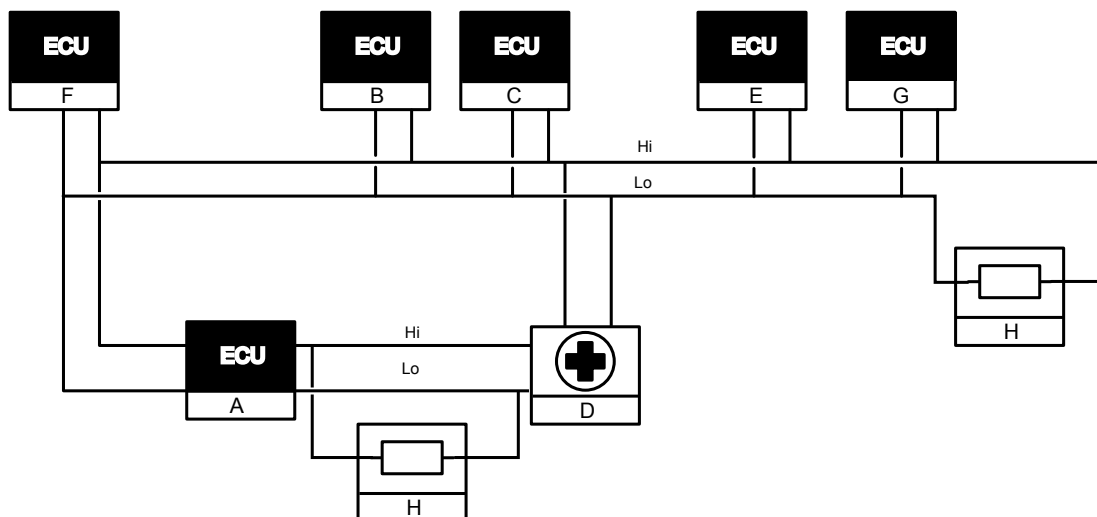
CANbus Communications System

CAN (Controller Area Network) is an electronic communications system that connects all the machine ECU to one pair of data wires, this is called the CANbus. Coded data is sent to and from the ECU on the CANbus. By connecting Servicemaster diagnostic software to the CANbus, data is seen and decoded for use by a service engineer.

CANbus System Schematic

A typical CANbus system architecture is shown for illustration purposes only below: Refer to Figure 623.

Figure 623. Typical CANbus architecture



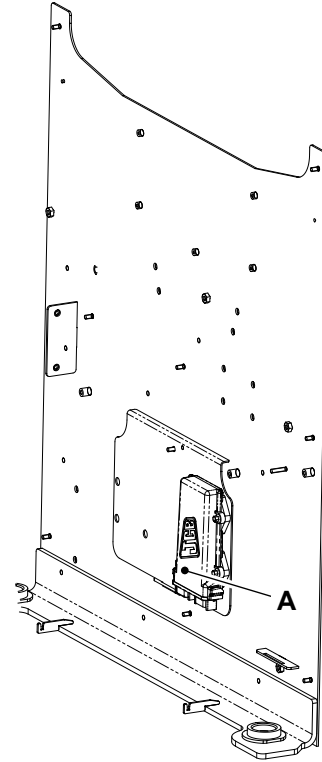
The CAN architecture may differ on your machine. Refer to (PIL 33-00).

30 - LiveLink

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Check (Condition)	33-191
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Introduction

The Livelink ECU (Electronic Control Unit) is located under a cover behind the operator seat in the operator station.

Figure 637.**A** Livelink ECU

00 - General

Introduction

The windscreen wash/wipe system is used to remove rain and debris from a windscreen. The main components of the system are:

- Wiper Arm
- Wiper Blade
- Nozzle (jet)
- Wiper Motor Mechanism
- Tank (reservoir)
- Washer Pump
- Wash/Wipe Switch
- Multifunction Switch (intermittent speed settings)

The wiper assembly consists of an arm, pivoting at one end with a long rubber blade attached to the other. The blade is swung back and forth over the glass, pushing water from its surface. The speed is normally adjustable, with several continuous speeds and often one or more intermittent settings. Some machines may use two wiper arms.

The windscreen wipers operate together with a windscreen washer. The washer pump supplies a mixture of water, alcohol, and detergent (washer fluid) from a tank to the windscreen through a hose. The fluid is dispensed through small nozzles mounted below the screen. It is essential the correct washer fluid is used as an incorrect fluid could freeze in colder climates and damage the pump. Although antifreeze is chemically similar to windscreen wiper fluid, it should not be used because it can damage paint.



57 - Electronic Diagnostic

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Preparation

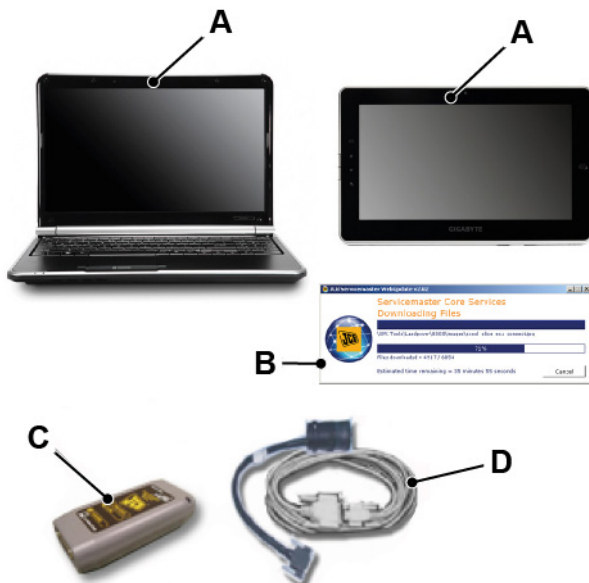
Set-up Servicemaster

The procedures below describe how to set up Servicemaster for USB (Universal Serial Bus) compatible equipment. There are other procedures and options. These are described in detail in the Servicemaster help files contained on the JCB Service Information DVD (Digital Versatile Disc).

Before you start Servicemaster set up procedure make sure that you have following:

- 1 A Microsoft Windows compatible laptop computer with a DVD drive and/or a USB port. Refer to Figure 678.
 - a Make a note that Servicemaster is compatible with Windows 98, 2000, ME, XP, Vista, and 7 operating systems (32 bit and 64bit).
- 2 The latest Servicemaster software (DVD and internet connection for web updates). Refer to Figure 678.
- 3 A JCB compatible DLA (Data Link Adaptor). Refer to Figure 678.
- 4 The correct connection cables. Refer to Figure 678.
 - a Do not connect any cables to the laptop, DLA or machine at this time.

Figure 678.



- A Laptop computer
- B Servicemaster software
- C DLA
- D Connection cables

Servicemaster Setup - First Time

1. Install Servicemaster on your laptop/PC through the DVD.
2. Run the "Servicemaster Web Update".
3. Open Servicemaster on your laptop/PC.
4. Install the "DLA laptop driver software" on your laptop/PC.
5. Configure the DLA type and communications port.
6. Make sure that the DLA flash memory contains the latest firmware file.
7. Connect Servicemaster to the machine through the CAN (Controller Area Network) bus connections.

JCB Servicemaster - New Installation

This topic covers the new installation of JCB Servicemaster on a new laptop/PC (Personal Computer).

1. Insert the CD (Compact Disk) into your computer/laptop.
2. Open the "My Computer" option to select the "SM2_V10-0-3 (D:)" CD drive.
3. Select and open the "SM2_V10-0-3 (D:)" CD drive to explore its contents. Refer to Figure 679.



Fault code	Description	Severity
P0122-16	Accelerator pedal sensor No.1 signal too low	Critical
P0123-17	Accelerator pedal sensor No.1 signal too high	Trivial
P012B-23	Compressor (turbo) in pressure sensor signal below low threshold	Trivial
P012B-24	Compressor (turbo) in pressure sensor sensor signal above high threshold	Trivial
P012B-64	Compressor (turbo) in pressure sensor signal plausibility fault	Trivial
P012C-23	Compressor (turbo) in pressure sensor signal drifted above or below thresholds	Trivial
P012D-24	Compressor (turbo) in pressure sensor signal drifted above or below thresholds	Trivial
P0130-0	Wide Range Air Fuel control (WRAF) fault	Trivial
P0130-0	Wide Range Air Fuel control (WRAF) fault: Range	Trivial
P0130-13	Wide Range Air Fuel control (WRAF) fault: OC	Trivial
P0131-12	Wide Range Air Fuel control (WRAF) fault: SC2VBATT	Trivial
P0132-11	Wide Range Air Fuel control (WRAF) fault: SC2GND	Trivial
P0132-24	Wide Range Air Fuel control (WRAF) level high fault	Trivial
P0133-0	Wide Range Air Fuel control (WRAF) fault: Response	Trivial
P0182-16	Fuel temperature (w/ pump) sensor signal too low	Trivial
P0183-17	Fuel temperature (w/ pump) sensor signal too high	Trivial
P0191-24	PC sensor high offset	Trivial
P0191-25	PC sensor offset diagnosis (drifted high or low)	Trivial
P0191-29	PC sensor offset diagnosis for NOX requirement (drifted high or low)	Trivial
P0191-2A	C/Rail press. Sensor signal keeping the middle range	Trivial
P0192-16	C/Rail pressure sensor signal too low	Trivial
P0193-17	C/Rail pressure sensor signal too high	Trivial
P0195-0	Oil temperature sensor signal external voltage (V-Ref) fault	Service
P0196-27	Oil temperature sensor signal gradient fault	Service
P0196-64	Oil temperature sensor signal plausability fault	Service

Remove and Install

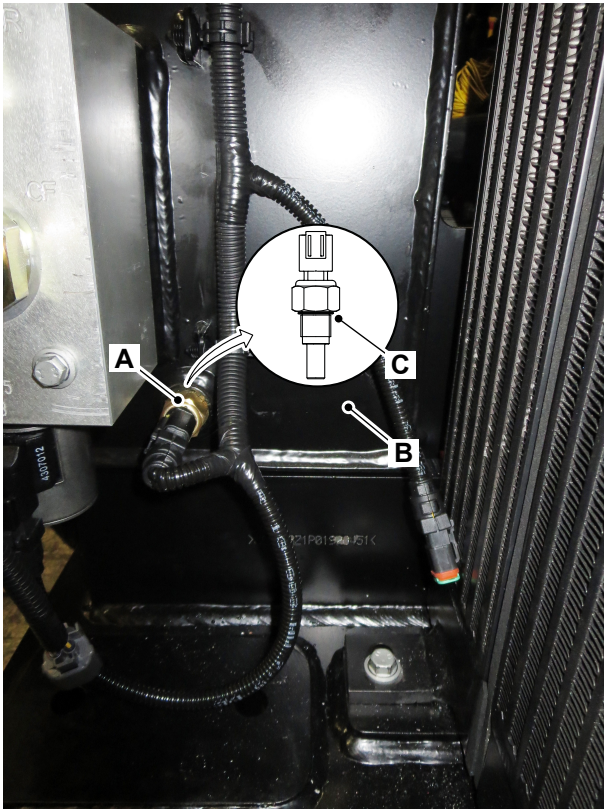
Table 213. Torque Values

Item	Nm
A	16

Remove

1. Make the machine safe. Refer to (PIL 01-03).
2. Discharge the hydraulic pressure. Refer to (PIL 30-00).
3. Drain the hydraulic tank.
4. Disconnect the electrical connector from the hydraulic oil temperature sensor.
5. Remove the hydraulic oil temperature sensor from the hydraulic tank.

Figure 729.



- A Hydraulic oil temperature sensor
- B Hydraulic oil tank
- C Sealing washer

Install

1. The installation procedure is the opposite of the removal procedure. Additionally do the following steps.
2. Make sure that you install the new sealing washer.
3. Tighten the sensor to the correct torque value.

Remove and Install

▲ WARNING It is not possible to vent all residual pressure. Loosen the connection one full turn and allow the pressure to dissipate. Keep all parts of your body well clear of pressurised hydraulic oil and wear protective glasses.

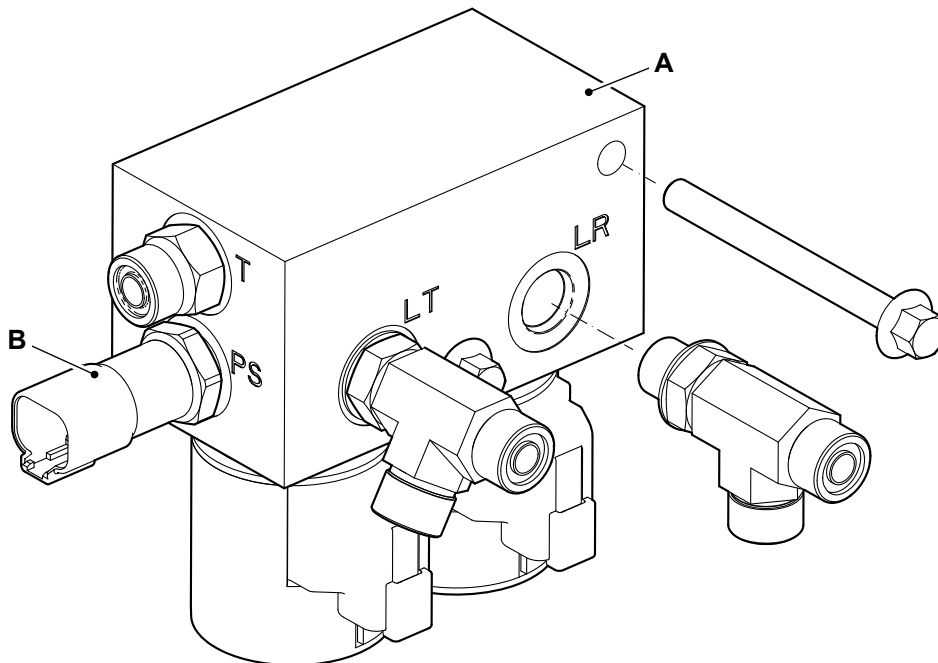
WARNING Do not work below a raised cab unless the cab is secured in position and safely supported.

2. Discharge the hydraulic pressure. Refer to (PIL 30-00).
3. Raise the operator station. Refer to (PIL 09-00).
4. Disconnect the electrical connectors from the dozer float pressure switch.
5. Remove the dozer float pressure switch form the dozer float valve.

Remove

1. Make the machine safe. Refer to (PIL 01-03).

Figure 739.



A Dozer float valve

B Dozer float pressure switch

**Install**

1. The installation procedure is the opposite of the removal procedure. Additionally do the following steps.
2. Tighten the controls isolation pressure switch to the correct torque value.
3. Check the hydraulic oil is at the correct level. Refer to (PIL 30-00).

Table 218. Torque Values

Item	Description	Nm
B	Controls isolation pressure switch	35

00 - General

Introduction

Fastener Types

Some external fasteners on JCB machines are manufactured using an improved type of corrosion resistant finish. This type of finish is called Dacromet and replaces the original Zinc and Yellow Plating used on earlier machines. The two types of fasteners can be readily identified by colour and part number suffix. Refer to Table 1. Fastener Types.

Table 220.

Fastener Type	Colour	Part Number Suffix
Zinc and Yellow	Golden Finish	Z (e.g. 1315/3712Z)
Dacromet	Mottled Silver Finish	D (e.g. 1315/3712D)

Note: As the Dacromet fasteners have a lower torque setting than the Zinc and Yellow fasteners, the torque figures used must be relevant to the type of fastener.

A Dacromet bolt should not be used in conjunction with a Zinc or Yellow plated nut, as this could change the torque characteristics of the torque setting further. For the same reason, a Dacromet nut should not be used with a Zinc or Yellow plated bolt.

All bolts used on JCB machines are high tensile and must not be replaced by bolts of a lesser tensile specification.

Dacromet bolts, due to their high corrosion resistance are used in areas where rust could occur. Dacromet bolts are only used for external applications. They are not used in applications such as gearbox or engine joint seams or internal applications.

Torque and Angle Tightening

Insufficient pre-load of a bolted joint can cause major problems, such as cylinder head warp, leaking gasket joints etc. There are several methods of achieving an accurate pre-load of a bolted joint, the two main methods used on the JCB engine are:

- Torque Control Tightening - Using a torque meter to control the torque is the most popular means of controlling pre-load, and in the majority of instances this method is adequate. It should be noted that with this process, the majority of the torque is used to overcome friction, therefore slight variations

in the frictional conditions can lead to large changes in the bolt pre-load.

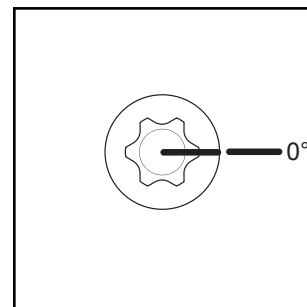
- Angle Control Tightening - Where a more precise pre-load is required, the torque and angle tightening method is used. The bolt is tightened to a predetermined torque (this may be done in stages), and then as a final sequence, the bolt is tightened to a predetermined angle - this method of tightening the bolts results in a smaller variation in the final pre-load. It is critical that the predetermined tightening angle is accurately achieved, failure to tighten accurately to the specified angle could result in the bolt pre-load being incorrect - this will lead to eventual failures. It is good practice to replace all bolts that have been tightened using the torque + angle procedure.

Tightening Method

The following example explains the recommended torque and angle procedure. A torque angle gauge should be used for accuracy, but as a visual check, the bolts can be match marked as described below.

1. Tighten the bolt to the specified torque (specified torque values will be detailed in the relevant PIL sections).
2. Mark a line across the centre of the bolt, and a second line on the part to be clamped - the two lines should be aligned. Refer to Figure 756.

Figure 756.



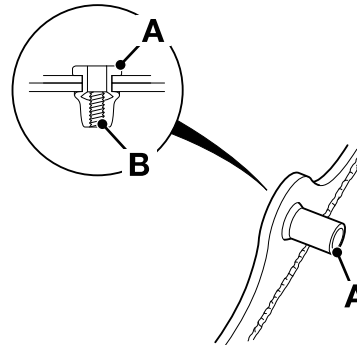
3. Mark a third line at the specified torque angle - in this instance the additional torque angle is 90°. This line must be marked the specified angle in a clockwise direction (to further tighten the bolt). Refer to Figure 757.

00 - General

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Introduction

A threaded insert also known as a rivet nut is a one piece fastener installed blind from one side of the machine body/framework. The threaded insert is compressed so that a section of its shank forms an upset against the machine body/framework, leaving a durable thread.

Figure 760.

- A** Threaded insert
- B** Durable thread

Threaded inserts are installed to various parts of the machine body and framework. They are used in a number of applications, for instance, hose clamp and hydraulic valve retention etc. Various sized threaded inserts are available, refer to technical data to determine the correct size of threaded insert to be used for particular applications.

If for any reason a new threaded insert is required, the correct installation procedure must be followed. Refer to Remove and Install.

00 - General

Introduction

New Oil

There are no special precautions needed for the handling or use of new oil, besides the normal health and safety practices mentioned in the relevant section of this service manual.

Used Oil

Used engine crankcase lubricants contain harmful contaminants. Here are precautions to protect your health when handling used engine oil:

1. Avoid prolonged, excessive or repeated skin contact with used oil.
2. Apply a barrier cream to the skin before handling used oil.
3. Note the following when removing engine oil from skin:
 - 3.1. Wash your skin thoroughly with soap and water.
 - 3.2. Using a nail brush will help.
 - 3.3. Use special hand cleansers to help clean dirty hands.
 - 3.4. Never use petrol, diesel fuel, or paraffin for washing.
4. Avoid skin contact with oil soaked clothing.
5. Don't keep oily rags in pockets.
6. Wash dirty clothing before re-use.
7. Throw away oil-soaked shoes.

First Aid

EYES - In the case of eye contact, flush with water for 15 minutes. If irritation persists, get medical attention.

SWALLOWING - If oil is swallowed do not induce vomiting. Get medical advice.

SKIN - In the case of excessive skin contact, wash with soap and water.

SPILLAGE - Absorb on sand or a locally approved brand of absorbent granules. Scrape up and remove to a chemical disposal area.

FIRES - Extinguish with carbon dioxide, dry chemical or foam. Firefighters should use self-contained breathing apparatus.



00 - General

Introduction 75-19
Technical Data 75-20

Introduction

All locking fluids should be used at all times in line with the manufacturer's recommendations.

Locking fluids are used for the locking of threaded fasteners and for the retention of ball & roller bearings and similar cylindrical items on to shafts and into housings. These fluids consist of an anaerobic resin in a liquid form which hardens when confined between closely fitting metal to metal and many metal to non-metal surfaces.

The fluids available possess a wide span of break-loose strengths, viscosities and gap filling properties and are marketed for a variety of locking and retaining purposes requiring different strength grades. Some of the sealants in use in JCB are also of anaerobic resin type and only differ from the locking fluids in respect of viscosity and other technical details.

Strength grades

Various strength grades of fluid are available, the highest strength type for permanent locking where disassembly is unlikely, medium strength for permanent locking but allowing disassembly with ordinary tools and low strength for locking of components where frequent adjustment or easy dismantling is required.

It is recommended that trials be carried out before scheduling locking fluids for any new type of application that has not been already proved as satisfactory in production or when use at elevated temperatures is intended.

Additional technical information is normally available from the product manufacturers.

Approved locking fluids

The table shown in Technical Data shows the approved locking fluids available to use on JCB machines. The table also provides basic details to help with selection of locking fluids. More up to date information can be found on the manufacturer's website.



75 - Consumable Products

15 - Adhesive
00 - General

Subsec-tion	Commer-cial name	Product Number	Colour	Shelf life	Technical data	Comments
Direct glazing	Terostat 8900 LV	4103/4200	Black	365d in car-tridges 180d in sausage pack. 180d in hob-bocks and drums	80bar (1,159.4psi) tensile strength	One component, pumpable adhesive/sealant based on polyurethane, which cures by reaction with moisture to an elastic rubber. The skin formation and curing time are dependent on humidity, temperature and depth of joint. High temperature and high moisture reduces curing time. Sag resistant, temperature range of -40°C (103.9°F) to 90°C (193.9°F) short exposure (up to 1h) of 130°C (265.8°F).
Direct glazing	Sika 295 UV	4103/4300	Black, white	365d	-	Direct glazing adhesive for plastic glazing panels. One component polyurethane adhesive of paste like consistency. 60min tack free time, 1d cure time (4mm at 23°C (73.4°F)). Good UV, fresh water and sea-water resistance. Do not apply below temperatures of 10°C (50.0°F) or above 35°C (95.0°F).



24 - Maintenance Schedules

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30 - Hydraulic System

Part No.	Description	Qty.	Comments
892/00167	Ram Protection Sleeve (90mm rod diameter)	1	
892/00239	Pressure Gauge Kit	1	
892/00280	Pressure Gauge (0-600 Bar)	1	
892/00334	Ram Seal Installation Tool	1	
892/00346	Pressure Gauge (0-70 Bar)	1	
892/01016	Ram Protection Sleeve (25mm rod diameter)	1	
892/01017	Ram Protection Sleeve (30mm rod diameter)	1	
892/01018	Ram Protection Sleeve (40mm rod diameter)	1	
892/01019	Ram Protection Sleeve (50mm rod diameter)	1	
892/01020	Ram Protection Sleeve - Slew (50mm rod diameter)	1	
892/01021	Ram Protection Sleeve (60mm rod diameter)	1	
892/01022	Ram Protection Sleeve - Slew (60mm rod diameter)	1	
892/01023	Ram Protection Sleeve (65mm rod diameter)	1	
892/01024	Ram Protection Sleeve (70mm rod diameter)	1	
892/01025	Ram Protection Sleeve (75mm rod diameter)	1	
892/01026	Ram Protection Sleeve (80mm rod diameter)	1	
892/01027	Ram Seal Assembly Tool	1	
892/01255	Hydraulic Flushing Rig	1	
993/99513	Ram Piston Nut Removal Installation Spanner 60mm A/F	1	
993/99514	Ram Piston Nut Removal Installation Spanner 65mm A/F	1	
993/99515	Ram Piston Nut Removal Installation Spanner 70mm A/F	1	
993/99518	Ram Piston Nut Removal Installation Spanner 90mm A/F	1	
993/99519	Ram Piston Nut Removal Installation Spanner 100mm A/F	1	
993/99520	Ram Piston Nut Removal Installation Spanner 110mm A/F	1	
SSP0046	Ram Piston Nut Removal Installation Spanner 80mm A/F	1	

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