





Workshop manual

A Foreword
B Safety
C Preventive maintenance
0 Complete machine
1 Engine
2 Transmission
3 Driveline/axle
4 Brakes
5 Steering
6 Suspension
7 Load handling
8 Control system
9 Frame, body, cab and accessories
10 Common hydraulics
11 Common electrics
12 Common pneumatics
D Error codes
E Schematics
F Technical data
G Terminologi och Index

Table of Contents A Foreword

Foreword	3
About the Workshop Manual	3
General	3
Conditions	3
Storage	3
About the machine version	3
Copyright	3
Reading instructions	4
Warning information	4
Important information	4
Read the Operator's Manual	4
Read the Maintenance Manual	4
Workshop manual contents	5
Function group structure	6
References between different information types	7
Product alternatives and optional equipment	8
Machine card	8
Function descriptions	9
About the documentation	12
Documentation sections	12
Ordering of documentation	12
Feedback	13
Form for copying	13

Foreword

About the Workshop Manual

General

Thank you for choosing Cargotec as your machine supplier. We hope that we will meet your expectations.

Conditions

The instructions are based on the use of generally available standard tools. All lifting devices, such as slings, straps and ratchet blocks, must meet governing national standards and regulations for lifting devices.

Cargotec will not accept any responsibility for modifications performed without permission from Cargotec, or in the event of the use of lifting devices, tools or work methods other than those described in this manual.

Storage

NOTE

The workshop manual should be accessible to service personnel.

About the machine version

The information in this publication corresponds to the machine's design and appearance at the time of delivery from Cargotec. Due to customisations, there may be variations and/or deviations.

Cargotec reserves the right to modify specifications and equipment without prior notice. All information and data in this manual are valid at the time of publication.



DANGER

External equipment must only be used if it is approved by Cargotec.

Danger to life and property!

Only use equipment approved by Cargotec.

Copyright

Cargotec Sweden AB

Duplication of the content in this manual, in whole or in part, is strictly prohibited without written permission from Cargotec Sweden AB.

Duplication by any means such as copying, printing, etc., is prohibited.

Reading instructions

Warning information

Warnings inform on potential dangers which can, if the warnings are not heeded, result in personal injury or product damage.

DANGER

Situation that may result in serious personal injury, possible death, if the instruction is not followed.

WARNING

Situation that may result in serious personal injury if the instruction is not followed.

CAUTION

Situation that may result in damage to the product if the instruction is not followed.

Important information

Important information marked with NOTE facilitates the work process, operation/handling or increases understanding of the information.

NOTE

Information that is important without being safety related.

Read the Operator's Manual

The symbol to the left is used in certain cases on the machine and refers to important information in the operator's manual.



Read the Operator's Manual

000262

Read the Maintenance Manual

The symbol to the left is sometimes found on the machine. It refers to important information in the Maintenance Manual.



Read the Maintenance Manual

001128

Workshop manual contents

The Workshop Manual contains information to facilitate maintenance (part replacement) and is a supplement to the Maintenance Manual. Accompanying the Workshop Manual is supplier documentation for engine, transmission and drive axle. If possible, the Workshop Manual provides reference to supplier documentation instead of printing the same information twice. Methods for preventive maintenance and certain checks are found in the Maintenance Manual, no references are given. Use the function groups to locate the information in the Maintenance Manual.

The workshop manual is divided into the following sections.

A	Foreword	General information about the workshop manual's purpose, contents and reading instructions as well as survey for feedback of views and any inaccuracies.
B	Safety	Keep in mind for your safety.
C	Preventive maintenance	Reference to maintenance manual: Preventive maintenance.
0	Complete machine	<p>Technical description, comprehensive function descriptions and a description of the function of components included in the machine, divided into function groups.</p> <p>The components used for each function are described under each subfunction. Consequently, common components are described in several places, but in general under the first function to use the component.</p> <p>Together with the general description is a detailed description of what is unique about the specific subfunction. The next subfunction to use the same component only has a description what is unique for the new function.</p> <p>Work instructions for corrective maintenance (replacement of components).</p>
1	Engine	
2	Transmission	
3	Driveline/axle	
4	Brakes	
5	Steering	
6	Suspension	
7	Load handling	
8	Control system	
9	Frame, body, cab and accessories	
10	Common hydraulics	
11	Common electrics	
12	Common pneumatics	
D	Error codes	Error code information and instructions for reading error code information.
E	Schematics	Wiring diagrams, hydraulic diagrams and list of electrical components.
F	Technical data	Technical data, conversion tables, information for conversion of units.
G	Terminology and index	General terminology and abbreviations, explanation of terms and abbreviations that can appear in the sections, index for headings in the manual.

Function group structure

The information in the manual is divided into a structure of functions at different levels based on machine structure and usage. The categories are known as function groups.

The highest level (called main group) indicates area, such as group 7 Load handling. The second level (called two-position) indicates function, such as 7.2 Lifting/lowering. The third and fourth levels are used to break down functions into smaller parts (components).

The main group and two-position group level structure for the function groups is used for all Cargotec machines, e.g. 4.3 Power-assisted brake system. Machine-specific function group adaptations are done at the third and fourth group level, e.g. 4.3.9 Wheel brake and 4.3.9.1 Disc assembly. Function groups (headings) are only included in the documentation of a machine if the machine has that function or component. Thus, there may be gaps in function group numbering, e.g. the three-position heading 4.8.7 Oil cooler is included for some machines but not for others.

The function groups are intended as a search term to be able to find various types of information between different sections and manuals. The information of a function group is divided into smaller segments based on type of content, such as description or replacement.

The Maintenance Manual and Workshop Manual contain different information. The Maintenance Manual only contains information required for preventive maintenance and minor troubleshooting. The Workshop Manual contains more in-depth information and repair instructions.

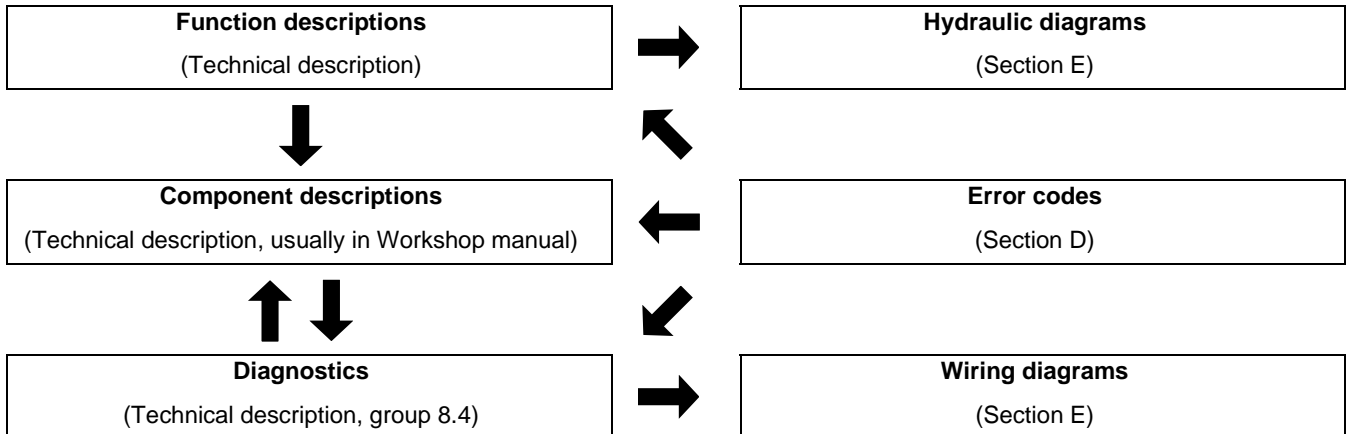
References between sections in the same manual are indicated using section and group number, e.g., "see section 4 *Brakes*, group 4.3.9 *Wheel brake*". Reference within a section are indicated with page number, e.g., "see *Sensor fuel level, description page 24*".

There are no references between the Maintenance Manual and Workshop Manual. If more information on a function group is required, search under the same function group in the other manual. For more in-depth information on where different types of information are located and what references are made, see *References between different information types page 7*.

References between different information types

The maintenance manual and workshop manual are mainly divided into function groups, see *Workshop manual contents page 5*. Certain parts are broken out as separate parts to increase usability, e.g., "Technical data".

The basic rule of searching for information is to use function groups to find different types of information regarding the function or component in question. As a complement to this, there are references according to the below.



- From Function description to Component description, to enable fast finding of more information about the different components that create a function.
- From Function description to Hydraulic diagram, to enable fast finding of the right hydraulic diagram for the function in question.
- From Component description or Function description to Diagnostics, to enable fast finding of the right diagnostic menu that can be used to check the component (only applies to electrical components).
- From Diagnostics to Wiring diagrams. to enable fast finding of the right circuit diagram for further troubleshooting.
- From Diagnostics to Component description or Function description. To enable fast finding of more information about the component's appearance and position when troubleshooting.
- From Error codes to Diagnostics, to enable fast finding of the right diagnostic menu to troubleshoot component or function in question.
- From Error codes to Function description or Component description, to enable fast finding of more information about components or function.

Product alternatives and optional equipment

The information in the manual is divided into modules. If a product alternative or optional equipment is fitted, handling may differ from that indicated in the modules depending on what is being described. See below.

Special equipment is not described in the manual. If uncertain as to what equipment is fitted to the machine, use the machine card to determine which information is relevant. See *Machine card page 8*.

Product alternative

Product alternative describes options that are fitted instead of a specific piece of standard equipment (e.g. engine alternative).

Equivalent information for different product alternatives are described consecutively in separate segments within the same function group. To indicate that there are different alternatives, "Product alternative" is added to the heading together with a simple description of the alternative, e.g. "(Product alternative Climate control system ECC)". In addition, the alternative that is an option is marked with the symbol for optional equipment.

Optional equipment

Optional equipment refers to options that can be added to standard equipment for more or improved functions.

Information on auxiliary equipment is described in separate segments together with the standard equipment. The optional equipment description covers how the equipment affects standard function and what components are added.

Machine card

NOTE

If the machine has been modified after delivery, information on the machine card may be incomplete or incorrect.

The machine card indicates of which drawings the machine consists, in many cases these can be associated options and product alternatives. For more information about handling of product alternatives and optional equipment, see *Product alternatives and optional equipment page 8*. The machine card is delivered with the parts catalogue.

The machine card is divided into the same function groups as the spare parts catalogue, maintenance manual and workshop manual. For reasons of practicality, the machine card only uses the first and second level of the function group register. The function groups are written in groups of four characters, e.g. group 0107 refers to group 1.7 Cooling system in the manual.

For more information on how the machine card is used to order spare parts, see the foreword of the spare parts catalogue.

If the information on the card machine does not help, contact Cargotec.



Symbol for optional equipment

000264

NOTE

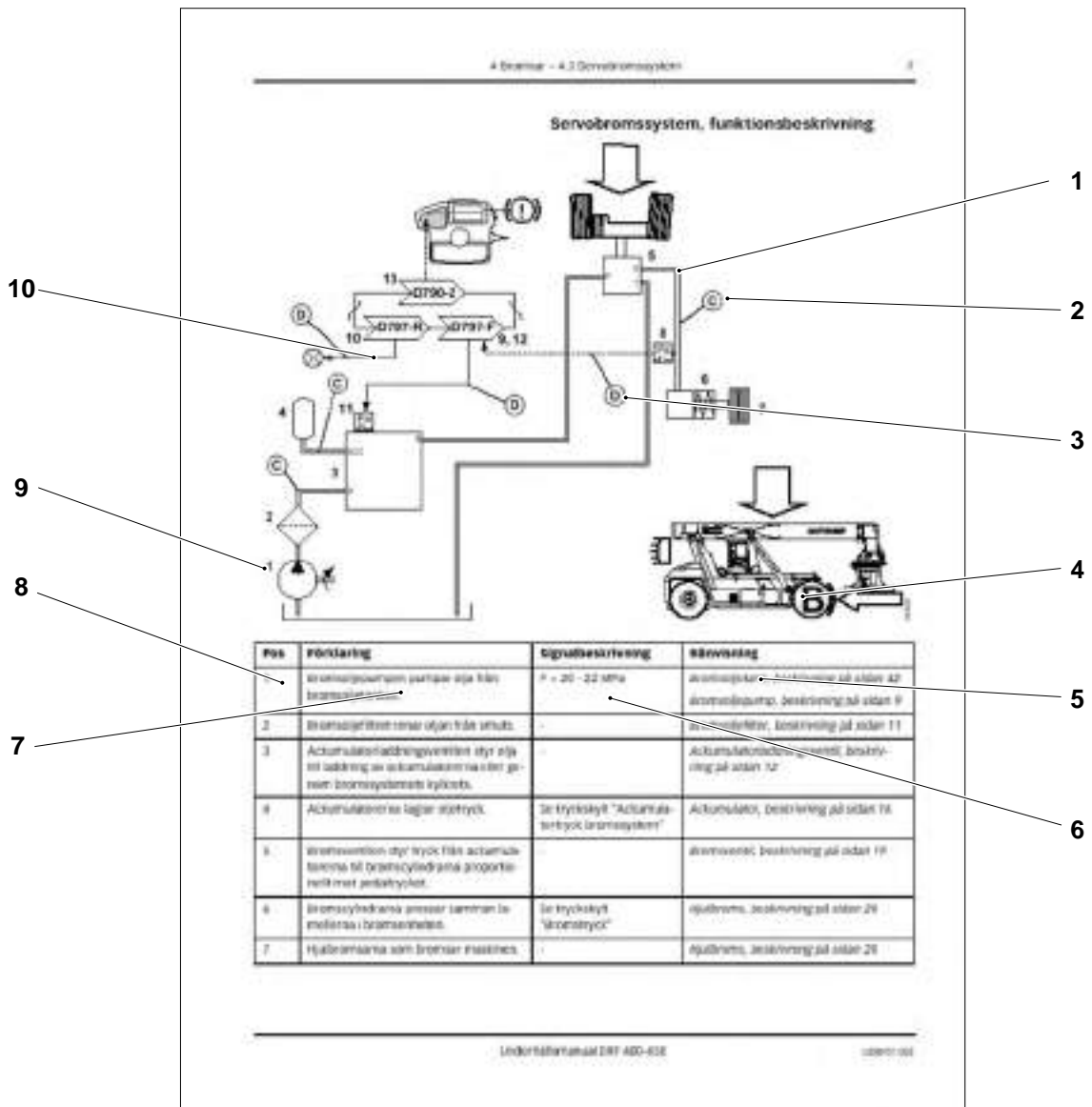
All documents that accompany the machine are non-registered documents. No notification is made regarding changes.

Function descriptions

Function descriptions are schematic overviews that describe how a function works as well as which components and signals work together.

Function descriptions describe the function in a logical flow from input signal to desired output signal. Most functions require that preset conditions are fulfilled for the function to be activated. In these cases, the conditions are listed above the illustration.

Function descriptions use symbols to illustrate components such as valves, sensors, etc.

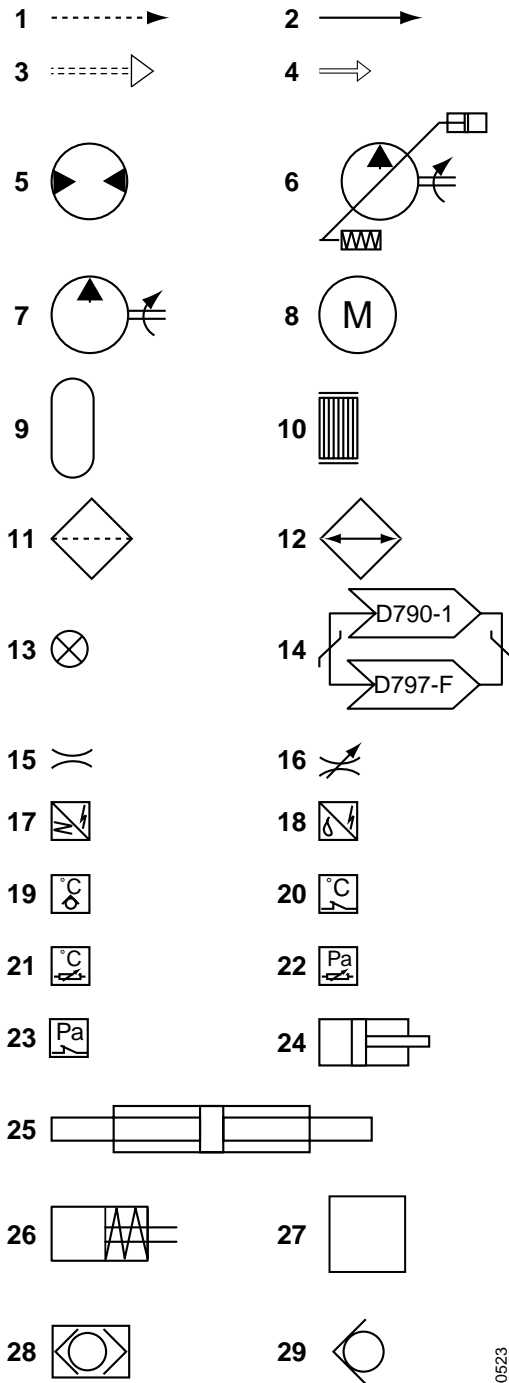


Example of function description

1. Hydraulic force (solid double line)
2. Flag pressure check connection (Check point), indicates that there is pressure check connection for checking pressure signal
3. Flag diagnostic test, indicates that the signal can be checked with diagnostic test, see section *8 Control system*, group *8.4 Diagnostics*
4. Illustration of function, (apply brake)
5. Reference to description of component
6. Signal description, reference value for signal out from component
7. Description of component's function
8. Position number, reference to position in illustration
9. Position number in illustration, reference to row in table
10. Electric power (solid single line)

Symbol explanation function descriptions

The following symbols are used in function descriptions, the symbols are based on standard symbols used in wiring and hydraulic diagrams.



1. Electric control signal
2. Electric force
3. Hydraulic control signal
4. Hydraulic force
5. Hydraulic motor
6. Hydraulic oil pump with variable displacement
7. Hydraulic oil pump with fixed displacement
8. Electric motor
9. Accumulator
10. Disc brake
11. Filter
12. Radiator
13. Bulb
14. Control system, two control units with CAN-bus
15. Restriction
16. Adjustable restriction
17. Inductive position sensor
18. Electrically controlled servo valve
19. Thermal bypass valve
20. Temperature-controlled switch
21. Temperature sensor
22. Pressure sensor
23. Pressure-controlled switch
24. Hydraulic cylinder
25. Double-acting hydraulic cylinder
26. Spring brake cylinder
27. Valve block
28. Shuttle valve
29. Non-return valve

000523

About the documentation

Documentation sections

The documentation to the machine comprises the following sections:

Operator's manual

The operator's manual is supplied with the machine in the cab.

Documentation kit

Maintenance manual and spare parts catalogue with machine card are supplied with the machine as a separate documentation kit.

Supplementary documentation

Supplementary documentation can be ordered for the machine.

- Workshop manual.
- Supplier documentation for engine, transmission and drive axle.

Ordering of documentation

Documentation is ordered from your Cargotec dealer.

Always specify the publication number when ordering.

See the machine card for publication number.

Feedback

Form for copying

Cargotec's ambition is that you who work with maintenance of a Kalmar machine shall have access to correct information.

Your feedback is important to be able to improve the information.

Copy this form, write down your views and send it to us. Thank you for your participation!

To:	<p>Cargotec Sweden AB Technical Documentation Torggatan 3 SE-340 10 Lidhult SWEDEN Fax: +46 372 263 93</p>
From:	<p>Company / Sender:</p> <p>Telephone: </p> <p>E-mail: </p> <p>Date: - -</p>
Manual information	<p>Name / Publication number:</p> <p>Section / page number:</p>
Sug- ges- tions, views, remarks, etc.	<p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p>

Table of Contents B Safety

Safety	3
General safety information	3
Safety concerns everyone!	3
A near accident is a warning!	3
Safety instructions	4
General	4
Service position	4
Hydraulic and brake systems, depressurising	5
Oils	6
Fuel system	7
Clothing, etc.	8
Several mechanics on the same machine	9
Working under machine	9
Lifting heavy components	10
Vibrations	10
Noise	11
Solvents	11
Fire and explosion risks	12
Fluid or gas under pressure	13
Coolant	14
Refrigerant	14
Air pollution	15
Tensioned springs	16
Electric motors	16
Rotating components and tools	17
Tyres and rims	18
Lifting equipment	18
Spare parts	19
Non-ionised radiation	20
Environment	21
General	21

Safety

General safety information

Safety concerns everyone!

The safety information concerns everyone who works with the machine! Persons who do not follow the safety instructions given in this manual must make absolutely sure that the work is performed without risks of personal injury and without risk of damage to machine or machine property!

Remember to:

- follow the instructions in this manual
- be trained for the work in question
- follow local laws, safety rules and regulations
- use the correct equipment and tools for the job
- wear the correct clothes
- use common sense and work carefully. Do not take any risks!

Cargotec has in this publication documented and warned for situations and risks that may occur in connection with using as well as service or repairs of the machine during normal circumstances.

That is why it is important that all who work with the machine, or repair or service the machine, read and follow the information in the Workshop Manual and Operator's Manual.

A near accident is a warning!

A near-accident is an unexpected event where neither persons, machine or property are injured or damaged. However, a near-accident indicates that there is an injury risk and actions must be taken to avoid the risk of injuries.

Safety instructions

General

Read, consider and follow the safety instructions below before starting to work in the machine:

- *Service position page 4*
- *Hydraulic and brake systems, depressurising page 5*
- *Oils page 6*
- *Fuel system page 7*
- *Clothing, etc. page 8*
- *Several mechanics on the same machine page 9*
- *Working under machine page 9*
- *Lifting heavy components page 10*
- *Vibrations page 10*
- *Noise page 11*
- *Solvents page 11*
- *Fire and explosion risks page 12*
- *Fluid or gas under pressure page 13*
- *Coolant page 14*
- *Refrigerant page 14*
- *Air pollution page 15*
- *Tensioned springs page 16*
- *Electric motors page 16*
- *Rotating components and tools page 17*
- *Tyres and rims page 18*
- *Lifting equipment page 18*
- *Spare parts page 19*
- *Non-ionised radiation page 20*

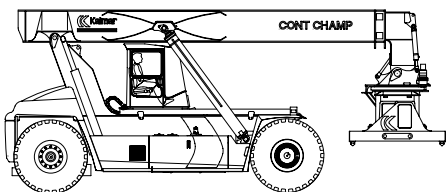
Service position

General

Service position is used for service, maintenance and other situations when the machine needs to be secured.

Service position means:

- Machine parked, that is, parking brake applied.
- Boom fully retracted and lowered to horizontal position.
- Engine off.
- Main electric power off (with battery disconnecter).



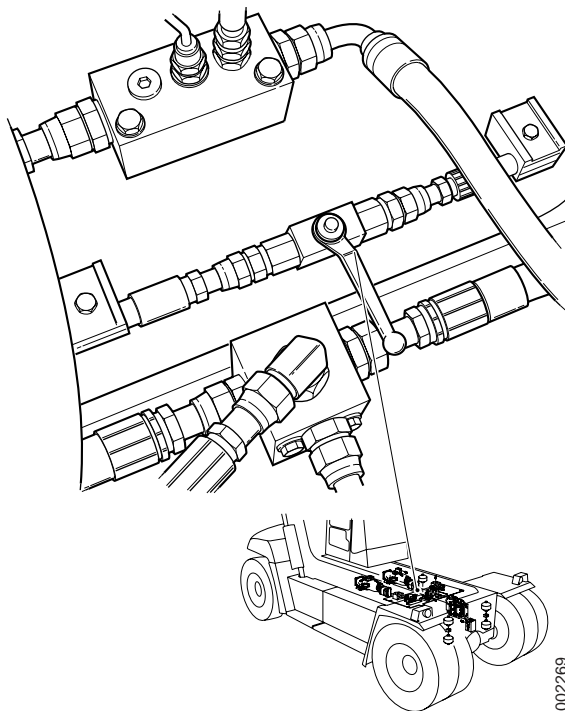
003603

Machine with a fully retracted and lowered boom

Hydraulic and brake systems, depressurising



- 1 Machine in service position.
- 2 Depressurise the hydraulic system.
Turn the start key to position I and activate extension out, a strong hissing sound is heard if there is pressure in the hydraulic system. Activate lift, extension and side shift several times.
- 3 Turn the start key to position 0 and turn off the main electric power.



- 4 Depressurise the attachment.
Open the relief valve for top lift.

CAUTION

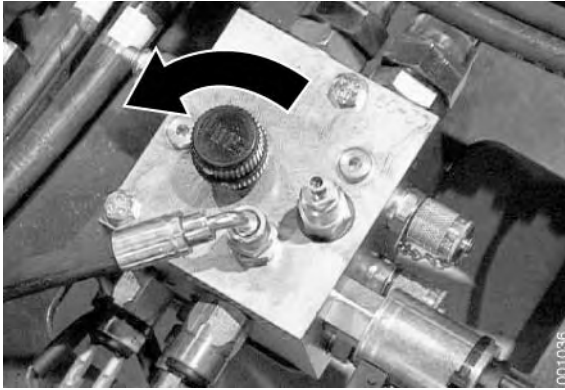
Hydraulic oil may be directed the wrong way.

Risk of damage to the fine filter for hydraulic oil.

Check that the relief valve top lift is closed before the engine is started after the completion of work.

The illustration above shows closed valve.

002269



- 5 Depressurise the brake system by opening the drain valve on the accumulator charging valve.

NOTE

Keep the drain valve open as long as work is in progress.

NOTE

After work is finished, close drain valve and tighten the lock ring.

Oils

The following safety instructions shall be followed for work when handling oils.



WARNING

Warm and pressurised oil.

Always depressurise hydraulic and brake systems completely before starting to work in the systems. Hydraulic and brake systems are pressurised and the oil may cause personal injuries.

Avoid skin contact with the oil, use protective gloves. Warm oil can cause burn injuries, rashes and irritation! The oil may also be corrosive to mucous membranes in, e.g., the eyes, skin and throat.

IMPORTANT

Always clean the area around components and connections before they are loosened. Dirt in oil systems causes increased wear, resulting in subsequent material damages.

Always take action to avoid spills. In places where drain containers cannot be used, use a pump or hose for safe handling.

Always check that plugs seal tight before collection containers are moved.

Handle all oil as environmentally hazardous waste. Oils freely released cause damage to the environment and may also cause fires. Waste oils/fluids shall always be handled by an authorised company.

Fuel system

The following safety instructions shall be followed for work when handling fuel.



DANGER

Pay attention to the risk of fire when working on the fuel system.

Work on the fuel system shall be avoided when the engine is warm since fuel can spill on hot surfaces and may ignite.

Ensure that naked flames, sparks or glowing objects have been removed before work begins on or near the fuel system.

Do not smoke in the vicinity of the machine when working on the fuel system.



WARNING

Use protective gloves and protective goggles. If a component is to be disconnected, hold a rag over the connection as protection and to collect fuel. The engine's fuel system operates at very high pressure. The pressure is so high that the jet can injure the skin, resulting in severe injuries. Risk of personal injuries.

Avoid skin contact with fuel, use protective gloves. Fuel is corrosive to mucous membranes in, e.g., eyes, skin and throat.



CAUTION

Always clean the area around components and connections before they are loosened. Dirt in the fuel may cause malfunctions and engine stop in undesirable situations as well as increase wear, resulting in subsequent material damages.

IMPORTANT

Always take action to avoid spills. In places where drain containers cannot be used, use a pump or hose for safe handling.

Always check that plugs and connections seal tight before moving collection containers.

Handle the fuel as environmentally hazardous waste. Fuel freely released causes damage to the environment and may also cause fires. Fuel shall always be handled by an authorised company.

Clothing, etc.

Clothes should be in good condition. Remove loosely hanging clothing (tie, scarf, etc.). Do not wear clothes with wide sleeves, wide trouser legs, etc.

Remove jewellery as it may conduct electricity and get caught in moving parts.

Long hair should be adequately gathered since it can easily get caught in moving parts. Be careful when working with welding or an open flame since hair easily catches on fire.

Several mechanics on the same machine



WARNING

If several mechanics are working on the same vehicle, take extra care so that unintentional movements do not injure another person. Communicate so that everyone knows where all are and what they are doing.

Risks

Work with wheels or axle suspension, mountings, etc. may result in components on the other side moving and causing damage/injury.

Movements performed from the operator's station, e.g., movement of lifting equipment, may cause severe personal injuries.

Safety precautions

- Make sure that the machine's lifting equipment is completely lowered or secured in another way.
- Move battery disconnecter to position zero, remove the key.
- Be aware of the risks when several persons work around the vehicle.
- Make your co-workers aware of what you're working with.
- Do not work with drive wheels on the machine's both sides at the same time.

Working under machine

Working under cab

On machines with liftable cab, the cab must be secured in the raised position with the locks designed for this purpose.

Working under the frame

A raised vehicle may not, for any reason, be supported or lifted in parts that belong to the wheel suspension or steering. Always support under the frame or wheel axle.

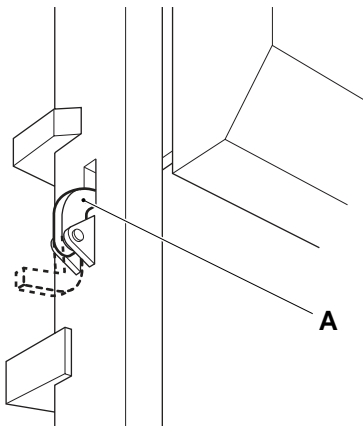
Risks

Mechanical or hydraulic tools and lifting devices can fall over or accidentally be lowered due to malfunctions or incorrect use.

Safety precautions

Use axle stands and supports that stand securely.

Lifting tools should be inspected and type approved for use.



001977

Locks on lift mast for securing the liftable cab in the raised position.

Lifting heavy components



WARNING

Careless handling of heavy components can lead to serious personal injury and material damage.

Use type approved lifting tools or other devices to move heavy components. Make sure that the device is stable and intact.

Risks

Unsuitable lift slings, straps, etc. may break or slip.

The centre of gravity (balance point) of the component can change during the course of the work, and the component may then make unexpected movements which may cause severe personal injuries and material damage.

A component lifted with lifting equipment can start to turn if the equilibrium is upset.

A component lifted using an overhead crane may start to swing back and forth, which can cause severe crushing injuries or material damage.

Safety precautions

Lifting with lifting device. Use lifting tools or other tools, especially when there are such adapted for certain work. See workshop manual for methods.

If lifting must be performed without lifting device:

- Lift near the body.
- Keep your back vertical. Raise and lower with legs and arms, do not bend your back. Do not rotate your body while lifting. Ask for assistance in advance.
- Wear gloves. They're good protection against minor crushing injuries and cuts to fingers.
- Always use protective shoes.

Vibrations

In case of long-term use of vibrating tools, for example, impact nut runners or grinders, injuries may be sustained as vibrations can be transmitted from tools to hands. Especially when fingers are cold.

Safety precautions

Use heavy gloves to protect against cold and somewhat against vibrations.

Switch between work duties to give the body time to rest.

Vary work position and grip so that the body is not stressed in only one position by the vibrations.

Noise

Noise louder than 85 dB (A) that lasts for longer than 8 hours is considered harmful to hearing. (Limit values may vary between different countries.) High tones (high frequencies) are more damaging than low tones at the same sound level. Impact noise can also be hazardous, e.g. hammer blows.

Risks

At noise levels higher than the limits hearing damage can occur. In more severe cases, hearing damage can become permanent.

Safety precautions

Use hearing protection. Make sure that it is tested and protects against the noise level in question.

Limit noise with noise-absorbing dividers, for example, noise-absorbing materials in roof and on walls.

Solvents

Fluids that (as opposed to water) dissolve grease, paint, lacquer, wax, oil, adhesive, rubber, etc. are called organic solvents. Examples: White (petroleum) spirits, gasoline, thinner, alcohols, diesel, xylene, trichloroethylene, toluene. Many solvents are flammable and constitute a fire hazard.

Risks

Products containing solvents produce vapours that can cause dizziness, headaches and nausea. They may also irritate mucous membranes in the throat and respiratory tracts.

If the solvent ends up directly on the skin it may dry out and crack. Risk of skin allergies increases. Solvents may also cause injury if they penetrate through the skin and are absorbed by the blood.

If the body is continuously exposed to solvents, the nervous system may be damaged. Symptoms include sleep disorders, depressions, nervousness, poor memory or general tiredness and fatigue. Continuous inhalation of gasoline and diesel fumes is suspected to cause cancer.

Safety precautions

Avoid inhaling solvent fumes by providing good ventilation, or wearing a fresh-air mask or respiratory device with a suitable filter for the toxic gases.

Never leave a solvent container without tight-sealing lid.

Use solvents with a low content of aromatic substances. It reduces the risk of injury.

Avoid skin contact.

Use protective gloves.

Make sure that work clothes are solvent-resistant.

Fire and explosion risks

Examples of flammable and explosive substances are oils, gasoline, diesel fuel oil, organic solvents (lacquer, plastics, cleaning agents), rustproofing agents, welding gas, gas for heating (acetylene), high concentration of dust particles consisting of combustible materials. Rubber tyres are flammable and cause explosive fires.

Risks

Examples of cause of ignition is welding, cutting, smoking, sparks when working with grinders, contact between hot machine parts and flammable materials, heat development in rag drenched with oil or paint (linseed oil) and oxygen. Oxygen cylinders, lines and valves shall be kept free from oil and grease.

Fumes from, e.g., gasoline are heavier than air and may "run" down into a sloping plane, or down in a grease pit, where welding flames, grinding sparks or cigarette embers may cause an explosion. Evaporated gasoline explodes very forcefully.

Special cases

Diesel fuel oil with added gasoline has a lower ignition point. Risk of explosion already at room temperature. The explosion risk for warmed diesel fuel oil is higher than for gasoline.

When changing oil in the engine, hydraulic system and transmission, keep in mind that the oil may be hot and can cause burn injuries.

Welding on or near machine. If diesel and or other oils have leaked out and been absorbed by rags, absorbent agents, paper or other porous material, hot welding sparks can cause ignition and explosive fires.

When a battery is charged, the battery fluid is divided into oxygen and hydrogen gas. This mixture is very explosive. The risk of explosion is especially high when using a booster battery or quick-charger, as this increases the risk of sparks.

Today's machines contain a lot of electronic equipment. When welding, the control units must be disconnected and the electric power must be turned off with the battery disconnecter. Powerful welding currents may otherwise short-circuit the electronics, destroy expensive equipment or cause an explosion or fire.

Never weld on painted surfaces (remove paint, by blasting at least 10 cm around the welding or cutting point). Use gloves, breathing protection and protective glasses. Also, welding work may not be done near plastic or rubber materials without first protecting them from the heat. Paints, plastics, and rubber develop a number of substances that may be hazardous to health when heated. Be careful with machines that have been exposed to intense heat or fire.

Safety precautions

Store hazardous substance in approved and sealed container.

Make sure that there is no ignition source near flammable or explosive substances.

Make sure that ventilation is adequate or there is an air extraction unit when handling flammable substances.

Fluid or gas under pressure

High-pressure lines can be damaged during work, and fluid or gas can stream out.

There may be high pressure in a line even if the pump has stopped. Therefore, gas or fluid can leak out when the connection to the hose is loosened.

A gas cylinder subjected to careless handling can explode, for example, if it falls onto a hard surface. Gas can stream out through damaged valves.

Risks

Risk of damage/injuries in connection with work on:

- Hydraulic systems (e.g., working hydraulics and brake system).
- Fuel system.
- Tyre repairs.
- Air conditioning.

Safety precautions

- Use safety glasses and protective gloves.
- Never work on a pressurised system.
- Never adjust a pressure limiting valve to a higher pressure than recommended by the manufacturer.
- A hydraulic hose that swells, for example, at a connection, is about to rupture. Replace it as soon as possible! Check connections thoroughly.
- Use fluid when checking for leaks.
- Never blow clothes clean with compressed air.
- Discarded pressure accumulator shall first be depressurised and then punctured before it is discarded (to avoid risk of explosion). Carefully, drill a hole with 3 mm diameter after depressurising.
- Never use your hands directly to detect a leak. A fine high-pressure stream from a hydraulic hose can easily penetrate a hand and causes very severe injuries.

Coolant

The coolant in the machine's cooling system consists of water, anti-corrosion compound and (when needed) anti-freeze fluid, for example, ethylene glycol.

Coolant must not be drained into the sewer system or directly onto the ground.

Risks

The cooling system operates at high pressure when the engine is warm. Hot coolant can jet out and cause scalding in case of a leak or when the expansion tank cap (filler cap) is opened.

Ingesting ethylene glycol and anti-corrosion compound is dangerous and hazardous to health.

Safety precautions

- Use protective gloves and safety glasses if there is a risk of splashing or spraying.
- Open the filler cap first, to release the excess pressure. Open carefully. Hot steam and coolant can stream out.
- If possible, avoid working on the cooling system when the coolant is hot.

Refrigerant

Refrigerant is used in the machine's air conditioning system.

Work on the air conditioning system must be performed by accredited/authorised and trained personnel according to national legislation and local regulations.

Risks

The air conditioning operates at high pressure. Escaping refrigerant can cause frostbite.

Refrigerant that is heated (e.g., when repairing leaking climate/AC system), generates gases that are very dangerous to inhale.

Safety precautions

- Use special instructions and equipment for refrigerant according to the manual when working on the air conditioning system. Special certification and authorisation is often required of the person who may do the work. (Note national legislation and local regulations!)
- Use protective gloves and safety glasses if there's a risk of leaks.
- Make sure that heat-producing sources or objects are not close by (cigarette glow, welding flame).

Air pollution

Air pollution is the impurities in the air around us and which are regarded as hazardous to health. Certain pollution is more prominent in certain environments.

The following health-hazardous air pollution is especially prominent in workshops:

- **Carbon monoxide (fumes)** is present in exhaust fumes. Odourless and therefore especially dangerous.
- **Nitrogen oxides (nitrous gases)** are present in exhaust fumes.
- **Welding smoke** especially hazardous to health when welding on oily surfaces, galvanised or lacquered materials.
- **Oil mist** for example, when applying anti-corrosion agent.
- **Grinding dust and gases** generated when grinding and heating plastics, lacquer, anti-corrosion agents, lubricants, paint, etc.
- **Isocyanates** are present in certain paints, fillers, adhesives and foam plastics used on machines.

Risks

Sulphuric acid mist is corrosive and injures the respiratory tracts. (Generated when heating certain plastics and paints.)

Isocyanates can be released in the form of steam, dust (or may be present in aerosols) when cutting, grinding or welding. Can irritate mucous membranes producing symptoms similar to asthma and impairing lung function. Even brief exposure to high concentrations can give problems with persistent high sensitivity.

Safety precautions

- Make sure of adequate ventilation with fresh air when welding, battery charging and other work when hazardous gases are generated.
- Use suitable protective gloves and breathing protection when there is a risk of oil mist. Make sure that the protection is oil-proof.
- Apply oil-resistant protective lotion to unprotected skin.
- Make sure that an eye-wash station is in the immediate vicinity when working with corrosive substances.
- Avoid unnecessary operation of the machine inside the workshop. Connect an air extractor to the exhaust pipe so that the exhaust fumes are removed from the workshop.

Tensioned springs

Examples of tensioned springs:

1. Torque springs in pedals for example
2. Return spring (cup springs) in parking brake cylinder.
3. Lock rings
4. Gas springs

Risks

If a tensioned spring releases, it is shot out by the spring force and can also take adjoining parts with it.

Small springs can cause eye injuries.

Parking brake springs are tensioned with high force and can cause very severe accidents if they are accidentally released in an uncontrolled manner.

Gas springs and gas-charged shock absorbers are tensioned with high force and can cause very severe accidents if they are accidentally released in an uncontrolled manner.

Safety precautions

- Use safety glasses.
- Lock rings should be of a suitable type and in good condition.
- Follow the instructions in this and other manual when performing maintenance and changing parts and components.
- Always use recommended tools.

Electric motors

Safety precautions

Always turn off the battery disconnecter when working on electric motors.

Always block the machine's wheels and make sure that the parking brake is activated and that the gear selector is in neutral position before starting any work on the machine.

Rotating components and tools

Examples of rotating components and tools:

- Cooling fan
- Drive belts
- Propeller shafts
- Drills
- Grinders

Risks

Rotating components, for example, fans or shafts, can cause severe injuries if touched.

Drills, lathes, grinders or other machines with rotating parts can cause severe accidents if clothes or hair get caught and are wound up in the machine.

Safety precautions

- Do not use gloves when working with a drill.
- Remove loose, hanging clothing, scarf or tie.
- Never use clothing with wide sleeves or trouser legs.
- Make sure that clothing is intact and in good condition.
- Long hair should be gathered up in a hair-net or similar.
- Remove large or loose hanging jewellery from hands, arms and neck.

Tyres and rims



DANGER

Tires shall be regarded as pressure reservoirs. If handled incorrectly, they constitute a fatal danger

Parts can be thrown with explosive force and may cause severe injuries.

Never repair damaged tyres, rims or lock rings. Tyre changes shall be performed by authorised personnel.

Risks

Dismantling wheels: Tyres, rims or lock rings can be thrown.

Inflating of wheels: Tires, rims or lock rings may be ejected.

Safety precautions

- Always deflate the tyre before starting to work on the wheel.
- Check that tyres, rims and lock rings aren't damaged. Never repair damaged rims or lock rings.
- Wheels shall be inflated on the machine or in a protective device, designed and dimensioned so that it can handle or dissipate a shock wave from a tyre explosion as well as catch the ejected parts.
- Use protective screen and safety glasses.

Lifting equipment

When working on the machine in general, and with the machine's lifting equipment in particular, the greatest caution must be exercised with respect to securing the boom and attachment.

For this reason, always be in the habit of having the boom fully lowered and fully retracted during work on the machine.

Risks

Risk of crushing if the machine's lifting equipment is not lowered or secured.

Risk of crushing is extra high when depressurising the hydraulic system, see *Hydraulic and brake systems, depressurising page 5*.

Safety precautions

- Do not start work until the boom is lowered and fully retracted if possible.

Spare parts



WARNING

The following parts must, for safety reasons, only be replaced with original spare parts:

- Brake valve
- Drive axle
- Valve for mini-wheel/lever steering
- Steering valve (Orbitrol)
- Steering valve incl. priority valve
- Steering axle
- Steering cylinder
- Rims
- Lift boom
- Boom nose extension
- Lift cylinder
- Valve block lift
- Extension cylinder
- Valve block extension
- Rotation motor unit
- Tilt cylinder
- Twistlocks, lifting shoe
- Safety switch (for hydraulic function)
- Emergency switch
- Frame
- Accumulator
- Main valve load handling
- Accumulator charging valve
- All control units

Non-ionised radiation



WARNING

Extra equipment such as communication radio, RMI, phone, etc. can emit non-ionised radiation.

Danger of disruption to active or inactive medical products.

Use communication radio, RMI, phone, etc. when there are no people with active or inactive medical products in the vicinity.

NOTE

When there are no people with active or inactive products in the vicinity the phone and communication radio in the cab may be used.

Equipment should not be used during operation or load handling as your concentration as operator is reduced.

Cargotec accepts no responsibility for equipment not installed by Cargotec or with Cargotec approved installation.

Environment

General

Ever-increasing industrialisation of our world is having a significant impact on our global environment. Nature, animals and man are subjected daily to risks in connection with various forms of chemical handling.

There are still no environmentally safe chemicals, such as oils and coolants, available on the market. Therefore, all who handle, perform service on or repair machines must use the tools, assisting devices and methods necessary to protect the environment in an environmentally sound manner.

By following the simple rules below, you will contribute to protecting our environment.

Recycling

Well-thought out recycling of the machine is the cornerstone of ending its life cycle and being able to re-use materials in new products. According to calculations by Cargotec, the machine can be recycled to more than 90% by weight.

Environmentally hazardous waste

Components such as batteries, plastics, and other materials that may be considered as environmentally hazardous waste must be handled in an environmentally correct manner.

Discarded batteries contain substances hazardous to personal health and the environment. Therefore, handle batteries in an environmentally safe manner and according to national regulations.

Oils and fluids

Oils freely discharged cause environmental damage and can also be a fire hazard. Therefore, when emptying and draining oils or fuel, take appropriate action to prevent unnecessary spills.

Waste oils and fluids must always be taken care of by an authorised disposal company.

Pay close attention to oil leaks and other fluid leaks! Take immediate action to seal the leaks.

Air conditioning unit

The refrigerant in the air conditioning unit for the cab contributes to the greenhouse effect and may not be intentionally released into the open air. Special training is required for all service work on the air conditioning unit. Many countries demand certification by a governing authority for such work.

Working in a contaminated area

The machine shall be equipped for work within a contaminated area (environmental contamination or health-hazardous area) before work is started. Also, special local regulations apply to such handling and to service work on such a machine.

Declarations

The machine does not contain asbestos.

The machines contains lead in batteries and in electric cabling. In certain models, there are lead castings as counterweight.

If the machine is equipped with air conditioning, then refrigerant of the type R134a is used, in an amount between 1-3 kg.

C Preventive maintenance

The information is found in the Maintenance Manual

The information is found in the Maintenance Manual.

For information on how to order the Maintenance Manual, see the section *A Foreword*.

Table of Contents 0 Complete machine

Complete machine	3
Complete machine, description	3
Troubleshooting, general work instructions	4
Troubleshooting without an error code, example	5
Troubleshooting with error code, example	5
Troubleshooting cable harness	7
Troubleshooting hydraulic hoses	8

Complete machine

Complete machine, description

The Kalmar DRF 400–450 is a "Reachstacker" for container handling. The machine has a lifting capacity of 40–45 tonnes depending on version.

The drive source is a six-cylinder, four-stroke diesel engine with direct injection.

The transmission is hydromechanical, with constant mesh gears. It has four speeds forwards and four speeds in reverse. Engine power is transmitted by a torque converter.

The driveline/axle comprises a propeller shaft and a rigid drive axle with hub reduction. Drive is via the front wheels.

The service brake is of wet disc type, built together with drive wheel hubs. The parking brake is a disc brake and acts on the drive axle input shaft.

Steering is via the rear wheels and a double acting hydraulic cylinder. The steering axle is pendulum-suspended in the frame.

The wheels are mounted on the hubs with clamps. Twin wheels are mounted on the drive axle, while the steering axle has single wheels.

Load handling comprises components and functions for managing loads. Loads are lifted with an attachment that is fitted on a liftable telescopic boom. Load handling is divided into lifting/lowering, extension, side shift, spreading, rotation, tilt, levelling and load carrier functions.

- Lifting/lowering is the function used to raise and lower the boom.
- Extension is the function to extend the boom in and out.
- Side shift is used to move the lift attachment laterally in relation to the machine.
- Spreading is used to adjust the width between the attachment's lifting points.
- Rotation is rotating the load in relation to the machine.
- Tilt is angling the load in the longitudinal direction of the truck.
- Levelling is angling the load in the lateral direction of the truck.
- The load carriers are designed to hold a fixed load.

The control system is functions for warning the operator of dangerous situations and machine faults. The control system has diagnostic resources that simplify troubleshooting.

The frame supports the machine. Mounted in the frame are the engine, transmission, drive axle and steering. The side of the frame houses tanks for fuel, hydraulic oil and oil for the brake system. The cab is centrally located and can be tilted longitudinally. As an option the cab is available in a side-mounted version that can be raised and lowered.

Troubleshooting, general work instructions

When troubleshooting, it is important that the work is structured and logical. The point of the troubleshooting described in the maintenance manual is to exclude components as error source so that the real error source can be pin-pointed. A suggested structured work method is described below.

When troubleshooting, it is important to understand how the machine functions. Certain malfunctions can be pin-pointed directly using function descriptions. Sections 0–12 contain descriptions of the various functions of the machine.

Troubleshooting procedure

- 1 Check that there is battery voltage available.
 - Battery disconnecter, must be in position 1.
 - Battery voltage, should be 22–30 V.
 - Fuses, check that they are intact.
- 2 Check that all oil and fluid levels are normal.
 - Fuel
 - Engine oil
 - Transmission oil
 - Brake system fluid
 - Hydraulic oil
 - Coolant
 - Washer fluid
- 3 Check if there are error codes.
- 4 If there are error codes, use the error code lists as a guide. See *Troubleshooting with error code, example page 5*.

In the error code lists there are recommended actions for every error code. Error code lists are found in section *D Error codes*.
- 5 If there is no error code or the problem persists, use the function description for the function in question in section 0–12.

The function description contains information on which components are involved in the function and how these components work together. In some cases, there is information on what conditions are required in order for it to be possible to activate the function. Measurement points are marked with flags (C for measuring outlet, D for diagnostic menu).

Troubleshooting without an error code, example

- 1 Choose suitable section 0–12 to find the function and sub-function that have caused the symptom.
- 2 Read the function description for the function in question to get an overall understanding of which components are affected and how these interact.
- 3 Use the function description and check the signals for the function in question to find where in the function chain that signal or reaction is incorrect.
- 4 The fault is probably between the two units where the signal is failing. Start by checking the component that should send the signal.
- 5 If the component that is to send the signal seems to be correct, check transmission of the signal (electric wiring or hydraulic hoses).

For electric cabling, see *Troubleshooting cable harness page 7*.

For hydraulic hoses, see *Troubleshooting hydraulic hoses page 8*.

- 6 If the leads or hoses between the components seem in order, then check the component that receives the signal.

Troubleshooting with error code, example

Error codes are strong indicators of malfunctions detected by the control system. Many error codes are connected to electrical malfunctions but there are also error codes that interpret associations between one or several signals that indicate a non-electrical malfunction. It's important to not draw conclusions too fast based on an error code.

- 1 Read out error codes from the display, e.g., error code 34.
- 2 Use the error code lists and search information about the error code, see "Example of error code information in error code list" below.

Error code lists are found in section *D Error codes*.

For detailed instruction on reading out error code, see section *D Error codes*.

- 3 Follow the instructions in the field "Action".
- 4 Use diagnostic menus and circuit diagrams to determine if the input signal to the control unit is correct; see section *8 Control system*, group *8.4 Diagnostics* as well as section *E Schematics*.
- 5 Use the function group to find more information if needed.

In section 0–12 there is function description, the function's included components and their position as well as, in certain cases, work instructions for how components are checked, cleaned or adjusted.

- 6 If possible, eliminate component fault by testing the component individually.

Electric components can sometimes be checked with resistance measurements using a multimeter.

Hydraulic components are often checked by measuring pressure (then described in the function group and indicated in the section *C Preventive maintenance*). Sometimes valves can be activated mechanically to determine if the malfunction is electric or hydraulic.

- 7 If the component's measurement values are correct, continue by troubleshooting electric cables and hydraulic hoses.

For electric cabling, see *Troubleshooting cable harness page 7*.

For hydraulic hoses, see *Troubleshooting hydraulic hoses page 8*.

- 8 If the cable is not defective, then connect the lead to the control unit.

NOTE

The main electric power shall be turned off with the battery disconnecter!

- 9 Disconnect the cable from the component in question.
 10 Turn on the main electric power with the battery disconnecter.
 11 Turn the ignition key to the operating position.
 12 Check that voltage reaches the component.

Table 1. Example of error code information in error code list

Code	Description	Limitation	Action	Connections and components	Diagnostic menu	Function group
34	Signal error from parking brake switch, indicates released and applied at same time or nothing at all.	Parking brake cannot be released.	Check cabling between the control unit and the component with diagnostic menu. Check component.	D791-1/K8:5 - S107, K8:13 - S107	HYD, menu 5	4.1.2 Parking brake control

Troubleshooting cable harness

NOTE

Perform troubleshooting for all cables in the same way to avoid damage to control units, components or measuring equipment.

- 1 Study the circuit diagram in question, check where the suspected cable is connected and if, and if so where, it is spliced.
- 2 Turn off the main electric power with the battery disconnecter.
- 3 Unplug the connector at the control unit or component in question.



CAUTION

Wipe and re-grease the connectors.

Risk of corrosion on contact surfaces.

Clean all connectors loosened during troubleshooting using electronic cleaner 923836.0826 and re-grease them with connector grease 923836.0552.

- 4 Check if there is open circuit.

NOTE

Some components cannot be checked without power supply to the component. In such an event, proceed to point 5.

- a. Measure resistance between connections for the component in the connector at the control unit or component.
 - b. The resistance must correspond with the component. Otherwise there may be an open circuit or short circuit in cable harness and/or component.
- 5 Check if there is short circuit to frame:
 - a. Unplug the connector at both the control unit and the component in question.
 - b. Measure the resistance of one lead at a time. Measure between the lead and a frame-connected part of the machine.
 - c. The multimeter should show endless resistance.

Troubleshooting hydraulic hoses



WARNING

Oil under high pressure!

Personal injury!

Always depressurise hydraulic and brake systems before starting to work on the systems.

- 1 Depressurise the hydraulic and brake systems; see section *B Safety*.
- 2 Study the relevant hydraulic diagram, check between whichever components the suspect hose is connected and correspondingly where it is spliced.
- 3 Locate the hose on the machine.
Start at one component and follow the hose to the next component.
- 4 Inspect the entire hose and splicing points with respect to chafing damage, pinching damage and leaks.
Change damaged hoses. When removing a hydraulic hose, change of O-ring is always recommended on the hoses that have these (ORFS).

Table of Contents1 Engine

1	Engine	3
1.1	Controls and instruments	23
1.1.1	Ignition switch	23
1.1.2	Accelerator pedal	24
1.2	Fuel system	25
1.2.1	Fuel tank	25
1.2.2	Sensor, fuel level	25
1.6	Air intake and exhaust outlet	26
1.6.1	Air cleaning system	26
1.6.3	Exhaust system	26
1.6.4	Intercooler	27
1.7	Cooling system	28
1.7.4	Radiator and expansion tank	29
1.7.5	Cooling fan	30
1.7.7	Coolant	32
1.7.10	Engine heater	35
1.9	Engine control system	36
1.9.1	Control unit, engine	36
1.11	Start/stop	37
1.11.1	Starter motor	37
1.11.2	Stopping device	37

1 Engine

Engine, general

Engine alternative

The machine can be equipped with one of the following engine alternatives:

- Volvo TWD1240VE stage II as per Directive 97/68/EC
- Volvo TAD1250VE (stage III as per Directive 97/68/EC)
- Cummins QSM11 (stage III as per Directive 97/68/EC)

If there are differences between engine alternatives, this is written in brackets after headings or under figures to clarify that which is shown.

Volvo engines have many similarities. Descriptions and instructions that are the same for both engine alternatives are denominated "(engine alternative Volvo)". If a description or set of instructions only applies to one engine alternative then the whole engine designation is written out, for instance "(engine alternative Volvo TAD1250VE)".

Component supplier documentation


The Workshop manual only describes components and work descriptions that concern installation in the machine. For descriptions and instructions for the engine's components and systems, refer to supplier documentation.

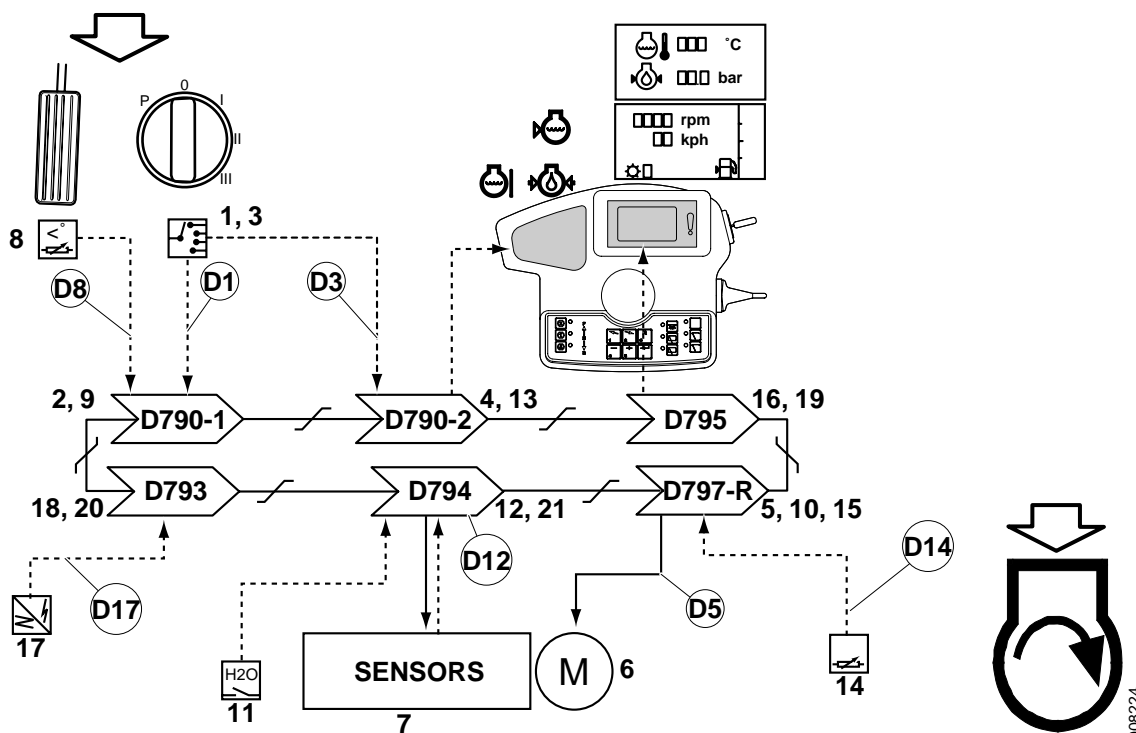
References to component supplier documentation are only provided in exceptional cases. If information about a component is not found, the component supplier documentation should be used.

Pos	Explanation	Signal description	Reference
5	The ignition key lock sends a voltage signal to the Control unit KIT (D790-2) when the start key is turned to the start position.	U = 24 V	<i>Ignition switch, description page 23</i> D5: Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.6.4 <i>ENGINE</i> , menu 4
6	Control unit KIT (D790-2) transmits a start signal on the CAN bus.	Checked by control system, error shown with error code.	Section 11 <i>Common electrics</i> , group 11.5.3.11 <i>Control unit KIT</i>
7	The engine control unit (D794) supplies power to the starter motor.	U = 24 V	<i>Starter motor, description (engine alternative Volvo) page 37</i> D7: Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.6.5 <i>ENGINE</i> , menu 5
8	The starter motor cranks the engine.	-	<i>Starter motor, description (engine alternative Volvo) page 37</i> D7: Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.6.5 <i>ENGINE</i> , menu 5
9	The engine's sensors send signals to the engine control unit (D794), which regulates the injectors so that the engine starts.	Checked by control system, error shown with error code.	Section 11 <i>Common electrics</i> , group 11.5.3.10 <i>Engine control unit</i>
10	The accelerator pedal sends the cab control unit (D790-1) a voltage signal proportional to the downward press of the pedal.	U = 0.5–4.5 V Lower voltage than 0.5 V and higher voltage than 4.5 V used to detect malfunction in cable harnesses and controls.	Section 9 <i>Frame, body, cab and accessories</i> , group 9.1 <i>Controls and instruments</i> D10: Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.6.1 <i>ENGINE</i> , menu 1
11	The cab control unit (D790-1) transmits a message with the rpm request on the CAN bus	Checked by control system, error shown with error code.	Section 11 <i>Common electrics</i> , group 11.5.3.1 <i>Cab control unit</i>
12	The engine control unit (D794) increases engine speed.	-	Section 11 <i>Common electrics</i> , group 11.5.3.10 <i>Engine control unit</i>
13	The NO switch for coolant level sends a voltage signal to Control unit, engine (D794) if the coolant level in the expansion tank is low.	U = 24 V	<i>Cooling system, description page 28</i>
14	The engine control unit (D794) transmits engine data and warning messages on the CAN bus.	Checked by control system, error shown with error code.	Section 11 <i>Common electrics</i> , group 11.5.3.10 <i>Engine control unit</i> D14: Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.6.6 <i>ENGINE</i> , menu 6 and 8.4.6.7 <i>ENGINE</i> , menu 7
15	The KID control unit (D795) shows engine data via display figures.	-	Section 11 <i>Common electrics</i> , group 11.5.3.12 <i>KID control unit</i>

Pos	Explanation	Signal description	Reference
16	The fuel level sensor (B757) sends a voltage signal to Control unit, frame rear (D797-R) proportional to the fuel level in the tank.	U = 0.5–4.5 V Lower voltage than 0.5 V and higher voltage than 4.5 V used to detect malfunction in cable harnesses and controls.	<i>Sensor, fuel level, description page 25</i> D16: Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.3.7 <i>CAB</i> , menu 7
17	Control unit, frame rear (D797-R) transmits fuel level on the CAN bus.	Checked by control system, error shown with error code.	Section 11 <i>Common electrics</i> , group 11.5.3.3 <i>Control unit, frame rear</i>
18	The KID control unit (D795) displays the fuel level in the operating menu for engine.	-	Section 11 <i>Common electrics</i> , group 11.5.3.12 <i>KID control unit</i>
19	The output shaft sensor (B758) sends the transmission control unit (D793) pulses with frequency proportional to output shaft rpm.	-	D19: Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.7.6 <i>TRANSM</i> , menu 6
20	The transmission control unit (D793) transmits speed on the CAN bus.	Checked by control system, error shown with error code.	Section 11 <i>Common electrics</i> , group 11.5.3.9 <i>Control unit, transmission</i>
21	The KID control unit (D795) shows the machine's speed.	-	Section 11 <i>Common electrics</i> , group 11.5.3.12 <i>KID control unit</i>
22	If output shaft rpm is so high that it reaches the limit for the machine's speed limitation, the cab control unit (D790-1) transmits a reduce engine rpm request on the CAN bus.	Checked by control system, error shown with error code.	Section 11 <i>Common electrics</i> , group 11.5.3.1 <i>Cab control unit</i>
23	Control unit engine (D794) restricts engine rpm.	-	Section 11 <i>Common electrics</i> , group 11.5.3.10 <i>Engine control unit</i>

Engine alternative Cummins QSM11, function description (model year-2008)

Condition	Reference value	Reference
Engine heater 	Disconnected (when cable is in start lock-out is activated)	<i>Engine heater, description page 35</i>



Pos	Explanation	Signal description	Reference
1	The ignition switch sends a voltage signal to the cab control unit (D790-1) when the ignition key is turned to position 1.	U = 24 V	<i>Ignition switch, description page 23</i> D1: Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.1.4 <i>CAN/POWER</i> , menu 4 and 8.4.6.4 <i>ENGINE</i> , menu 4
2	The cab control unit (D790-1) transmits Ignition on as a start message on the CAN bus.	Checked by control system, error shown with error code.	Section 11 <i>Common electrics</i> , group 11.5.3.1 <i>Cab control unit</i>
3	The ignition switch sends a voltage signal to Control unit KIT (D790-2) when the start key is turned to the start position.	U = 24 V	<i>Ignition switch, description page 23</i> D2: Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.6.4 <i>ENGINE</i> , menu 4
4	The KIT control unit (D790-2) transmits a start signal on the CAN bus.	Checked by control system, error shown with error code.	Section 11 <i>Common electrics</i> , group 11.5.3.11 <i>Control unit KIT</i>

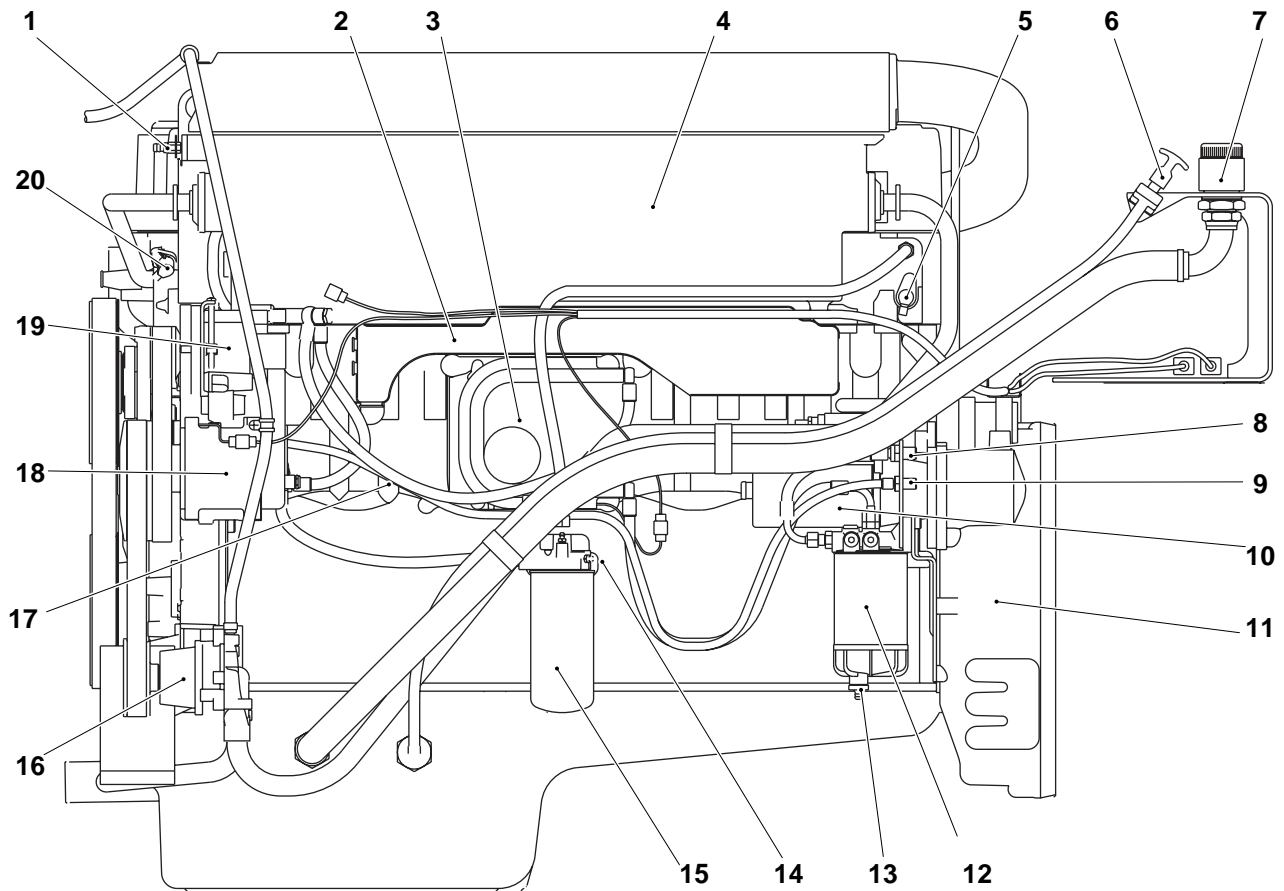
Pos	Explanation	Signal description	Reference
5	Control unit, frame rear (D797-R) supplies power to the starter motor.	U = 24 V	<i>Starter motor, description (engine alternative Cummins) page 37</i> D5: Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.6.5 <i>ENGINE</i> , menu 5
6	The starter motor cranks the engine.	-	<i>Starter motor, description (engine alternative Cummins) page 37</i>
7	The engine's sensors send signals to the engine control unit (D794), which regulates the injectors so that the engine starts.	-	Section 11 <i>Common electrics</i> , group 11.5.3.10 <i>Engine control unit</i>
8	The accelerator pedal sends the cab control unit (D790-1) a voltage signal proportional to the downward press of the pedal.	U = 0.5–4.5 V Lower voltage than 0.5 V and higher voltage than 4.5 V used to detect malfunction in cable harnesses and controls.	Section 9 <i>Frame, body, cab and accessories</i> , group 9.1 <i>Controls and instruments</i> D8: Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.6.1 <i>ENGINE</i> , menu 1
9	The cab control unit (D790-1) transmits a message with the rpm request on the CAN bus	Checked by control system, error shown with error code.	Section 11 <i>Common electrics</i> , group 11.5.3.1 <i>Cab control unit</i>
10	The engine control unit (D794) controls engine speed.	-	Section 11 <i>Common electrics</i> , group 11.5.3.10 <i>Engine control unit</i>
11	The NO switch for coolant level sends a voltage signal to Control unit, engine (D794) if the coolant level in the expansion tank is low.	U = 24 V	<i>Cooling system, description page 28</i>
12	The engine control unit (D794) transmits engine data and warning messages on the CAN bus.	Checked by control system, error shown with error code.	Section 11 <i>Common electrics</i> , group 11.5.3.10 <i>Engine control unit</i> D12: Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.6.6 <i>ENGINE</i> , menu 6 and 8.4.6.7 <i>ENGINE</i> , menu 7
13	The KID control unit (D795) shows engine data via display figures.	-	Section 11 <i>Common electrics</i> , group 11.5.3.12 <i>KID control unit</i>
14	The fuel level sensor (B757) sends a voltage signal to Control unit, frame rear (D797-R) proportional to the fuel level in the tank.	U = 0.5–4.5 V Lower voltage than 0.5 V and higher voltage than 4.5 V used to detect malfunction in cable harnesses and controls.	<i>Sensor, fuel level, description page 25</i> D14: Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.3.7 <i>CAB</i> , menu 7
15	Control unit, frame rear (D797-R) transmits fuel level on the CAN bus.	Checked by control system, error shown with error code.	Section 11 <i>Common electrics</i> , group 11.5.3.3 <i>Control unit, frame rear</i>
16	The KID control unit (D795) displays the fuel level in the operating menu for engine.	-	Section 11 <i>Common electrics</i> , group 11.5.3.12 <i>KID control unit</i>

Pos	Explanation	Signal description	Reference
17	The output shaft sensor (B758) sends the transmission control unit (D793) pulses with frequency proportional to output shaft rpm.	-	D17: Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.7.6 <i>TRANSM</i> , menu 6
18	The transmission control unit (D793) transmits speed information on the CAN bus.	Checked by control system, error shown with error code.	Section 11 <i>Common electrics</i> , group 11.5.3.9 <i>Control unit, transmission</i>
19	The KID control unit (D795) shows the machine's speed.	-	Section 11 <i>Common electrics</i> , group 11.5.3.12 <i>KID control unit</i>
20	If the speed is at the machine's speed limitation limit, the cab control unit (D790-1) transmits an engine speed reduction request on the CAN bus.	Checked by control system, error shown with error code.	Section 11 <i>Common electrics</i> , group 11.5.3.1 <i>Cab control unit</i>
21	Control unit engine (D794) restricts engine rpm.	-	Section 11 <i>Common electrics</i> , group 11.5.3.10 <i>Engine control unit</i>

Pos	Explanation	Signal description	Reference
5	Control unit, frame rear (D797-R) supplies power to the starter motor.	U = 24 V	<i>Starter motor, description (engine alternative Cummins) page 37</i> D5: Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.6.5 <i>ENGINE</i> , menu 5
6	The starter motor cranks the engine.	-	<i>Starter motor, description (engine alternative Cummins) page 37</i>
7	The engine's sensors send signals to the engine control unit (D794), which regulates the injectors so that the engine starts.	-	Section 11 <i>Common electrics</i> , group 11.5.3.10 <i>Engine control unit</i>
8	The accelerator pedal sends the cab control unit (D790-1) a voltage signal proportional to the downward press of the pedal.	U = 0.5–4.5 V Lower voltage than 0.5 V and higher voltage than 4.5 V used to detect malfunction in cable harnesses and controls.	Section 9 <i>Frame, body, cab and accessories</i> , group 9.1 <i>Controls and instruments</i> D8: Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.6.1 <i>ENGINE</i> , menu 1
9	The cab control unit (D790-1) transmits a message with the rpm request on the CAN bus	Checked by control system, error shown with error code.	Section 11 <i>Common electrics</i> , group 11.5.3.1 <i>Cab control unit</i>
10	The engine control unit (D794) controls engine speed.	-	Section 11 <i>Common electrics</i> , group 11.5.3.10 <i>Engine control unit</i>
11	The NO switch for coolant level grounds the control terminal of the coolant level relay (K322) if the coolant level is low in the expansion tank.	Low coolant level: U _{K322:85} = 0 V	<i>Cooling system, description page 28</i>
12	Coolant level relay (K322) breaks the circuit to Control unit, engine (D794) if the coolant level is low in the expansion tank.	-	<i>Cooling system, description page 28</i>
13	The engine control unit (D794) transmits engine data and warning messages on the CAN bus.	Checked by control system, error shown with error code.	Section 11 <i>Common electrics</i> , group 11.5.3.10 <i>Engine control unit</i> D13: Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.6.6 <i>ENGINE</i> , menu 6 and 8.4.6.7 <i>ENGINE</i> , menu 7
14	The KID control unit (D795) shows engine data via display figures.	-	Section 11 <i>Common electrics</i> , group 11.5.3.12 <i>KID control unit</i>
15	The fuel level sensor (B757) sends a voltage signal to Control unit, frame rear (D797-R) proportional to the fuel level in the tank.	U = 0.5–4.5 V Lower voltage than 0.5 V and higher voltage than 4.5 V used to detect malfunction in cable harnesses and controls.	<i>Sensor, fuel level, description page 25</i> D15: Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.3.7 <i>CAB</i> , menu 7

Pos	Explanation	Signal description	Reference
16	Control unit, frame rear (D797-R) transmits fuel level on the CAN bus.	Checked by control system, error shown with error code.	Section 11 <i>Common electrics</i> , group 11.5.3.3 <i>Control unit, frame rear</i>
17	The KID control unit (D795) displays the fuel level in the operating menu for engine.	-	Section 11 <i>Common electrics</i> , group 11.5.3.12 <i>KID control unit</i>
18	The output shaft sensor (B758) sends the transmission control unit (D793) pulses with frequency proportional to output shaft rpm.	-	D18: Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.7.6 <i>TRANSM</i> , menu 6
19	The transmission control unit (D793) transmits speed information on the CAN bus.	Checked by control system, error shown with error code.	Section 11 <i>Common electrics</i> , group 11.5.3.9 <i>Control unit, transmission</i>
20	The KID control unit (D795) shows the machine's speed.	-	Section 11 <i>Common electrics</i> , group 11.5.3.12 <i>KID control unit</i>
21	If the speed is at the machine's speed limitation limit, the cab control unit (D790-1) transmits an engine speed reduction request on the CAN bus.	Checked by control system, error shown with error code.	Section 11 <i>Common electrics</i> , group 11.5.3.1 <i>Cab control unit</i>
22	Control unit engine (D794) restricts engine rpm.	-	Section 11 <i>Common electrics</i> , group 11.5.3.10 <i>Engine control unit</i>

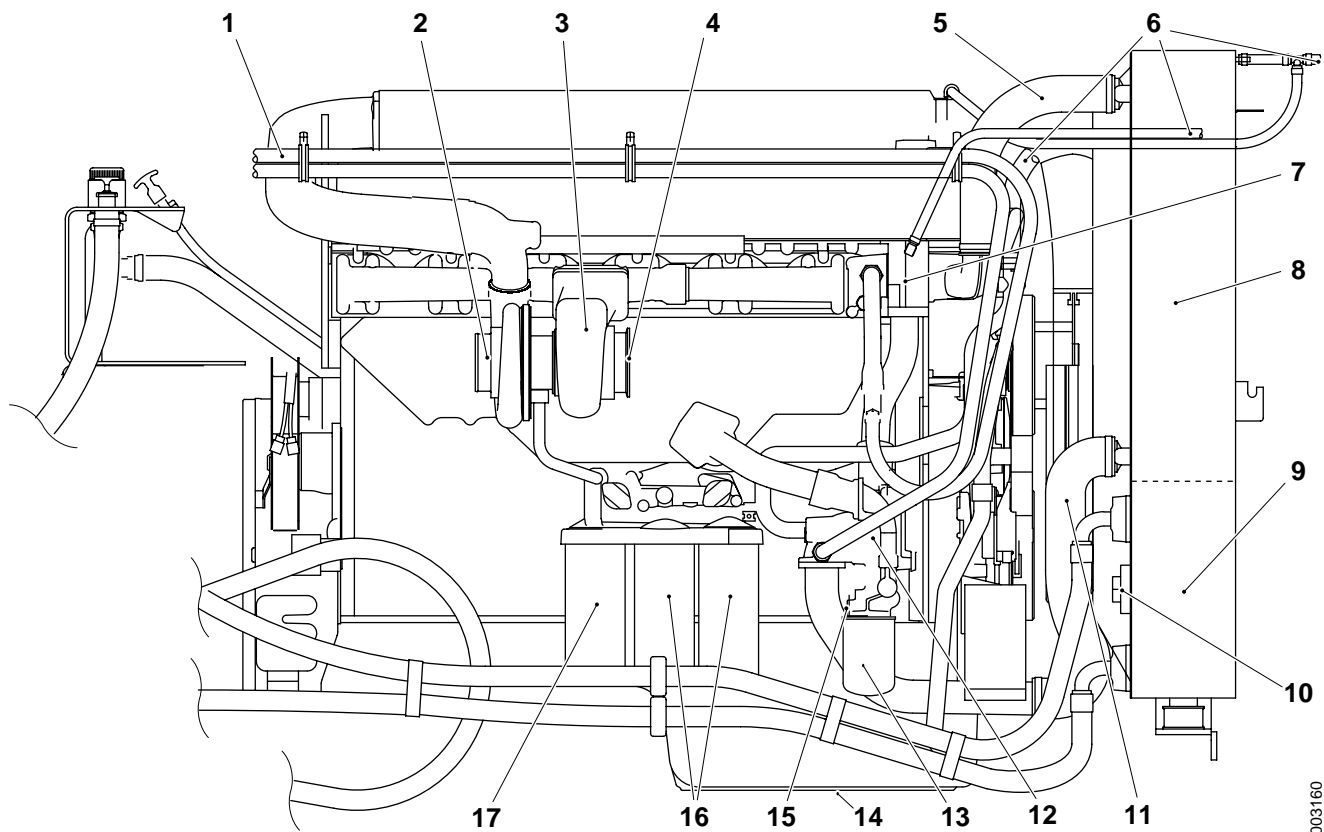
Engine alternative Volvo TWD1240VE, component location



Engine alternative, Volvo TWD1240VE, right side (in machine's direction of travel)

001641

- | | |
|--|--|
| 1. Air nipple, cooling system | 11. Sensor, engine speed |
| 2. Charge air pressure and charge air temperature sensor | 12. Fuel pre-filter |
| 3. Engine control unit (D794) | 13. Draining of condensation from fuel filter and water-in-fuel sensor |
| 4. Intercooler | 14. NO switch, fuel pressure |
| 5. Coolant temperature sensor | 15. Fuel filter |
| 6. Dipstick | 16. Extra coolant pump |
| 7. Engine oil filling point | 17. Oil pressure and oil temperature sensor |
| 8. Fuel connection (intake) | 18. Compressor, air conditioning |
| 9. Fuel connection (return) | 19. Alternator |
| 10. Starter motor | 20. Sensor camshaft rpm |

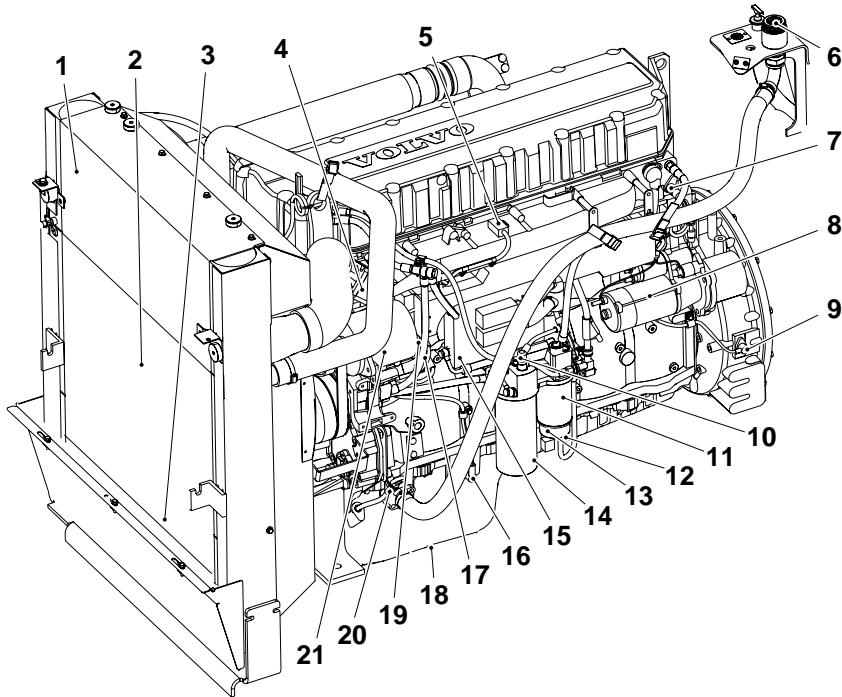


Engine alternative, Volvo TWD1240VE, left side (in machine's direction of travel)

- | | |
|-------------------------------|---|
| 1. Connection cab heat | 9. Transmission oil cooler |
| 2. Air cleaner connection | 10. Thermostat, transmission oil cooler |
| 3. Turbocharger | 11. Radiator connection intake |
| 4. Exhaust system connection | 12. Coolant pump |
| 5. Radiator connection outlet | 13. Coolant filter |
| 6. Expansion tank connection | 14. Engine oil drain plug |
| 7. Thermostat | 15. Coolant shut-off cock |
| 8. Water cooler | 16. Oil filter (full flow) |
| | 17. Oil filter (bypass) |

003160

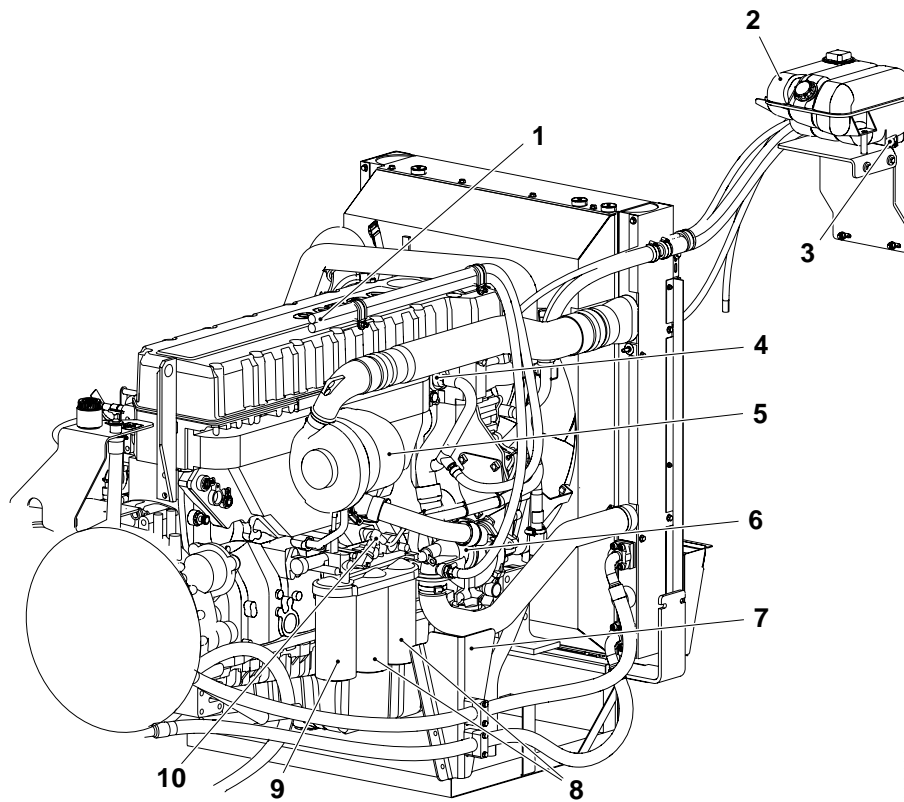
Engine alternative Volvo TAD1250VE, component location



006446

Volvo TAD1250VE engine right side (in machine's direction of travel)

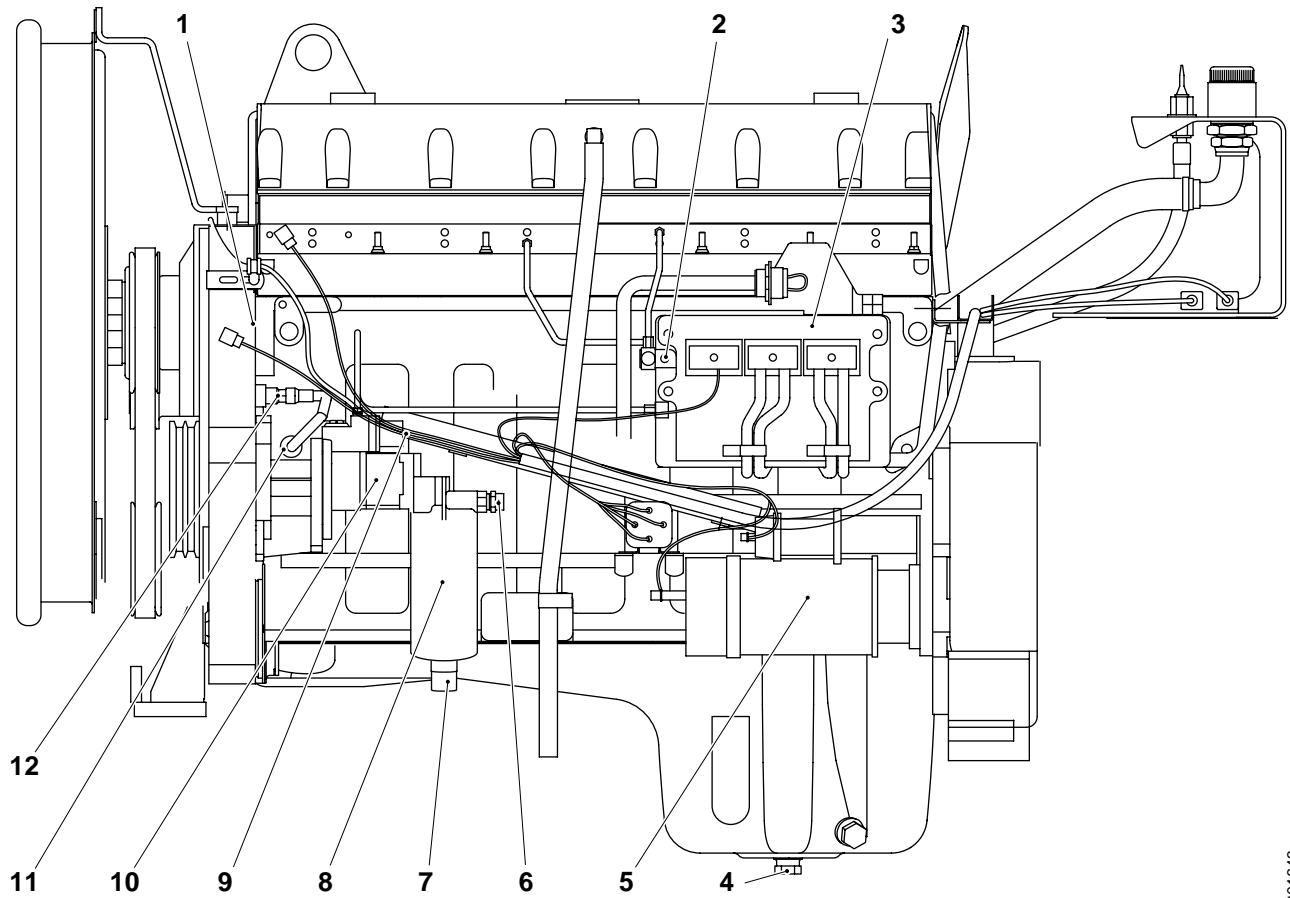
- | | | | |
|-----|---|-----|-------------------------------------|
| 1. | Intercooler | 12. | Water separator |
| 2. | Water cooler | 13. | Sensor, water-in-fuel |
| 3. | Transmission oil cooler | 14. | Fuel filter |
| 4. | Preheating element | 15. | Engine control unit (D794) |
| 5. | Charge air pressure and charge air temperature sensor | 16. | Oil level sensor |
| 6. | Engine oil filling point | 17. | Crankcase pressure sensor |
| 7. | Coolant temperature sensor | 18. | Engine oil drain plug |
| 8. | Starter motor | 19. | Oil pressure and temperature sensor |
| 9. | Sensor, engine speed | 20. | Dipstick |
| 10. | NO switch, fuel pressure | 21. | Alternator |
| 11. | Fuel pre-filter | | |



Volvo TAD1250VE engine, left side (in machine's direction of travel)

- | | | | |
|----|-----------------------|-----|-------------------------------------|
| 1. | Connection cab heat | 6. | Coolant pump |
| 2. | Expansion tank | 7. | Coolant filter (behind console) |
| 3. | Sensor, coolant level | 8. | Oil filter (full flow) |
| 4. | Thermostat | 9. | Oil filter (bypass) |
| 5. | Turbocharger | 10. | Oil pressure sensor, piston cooling |

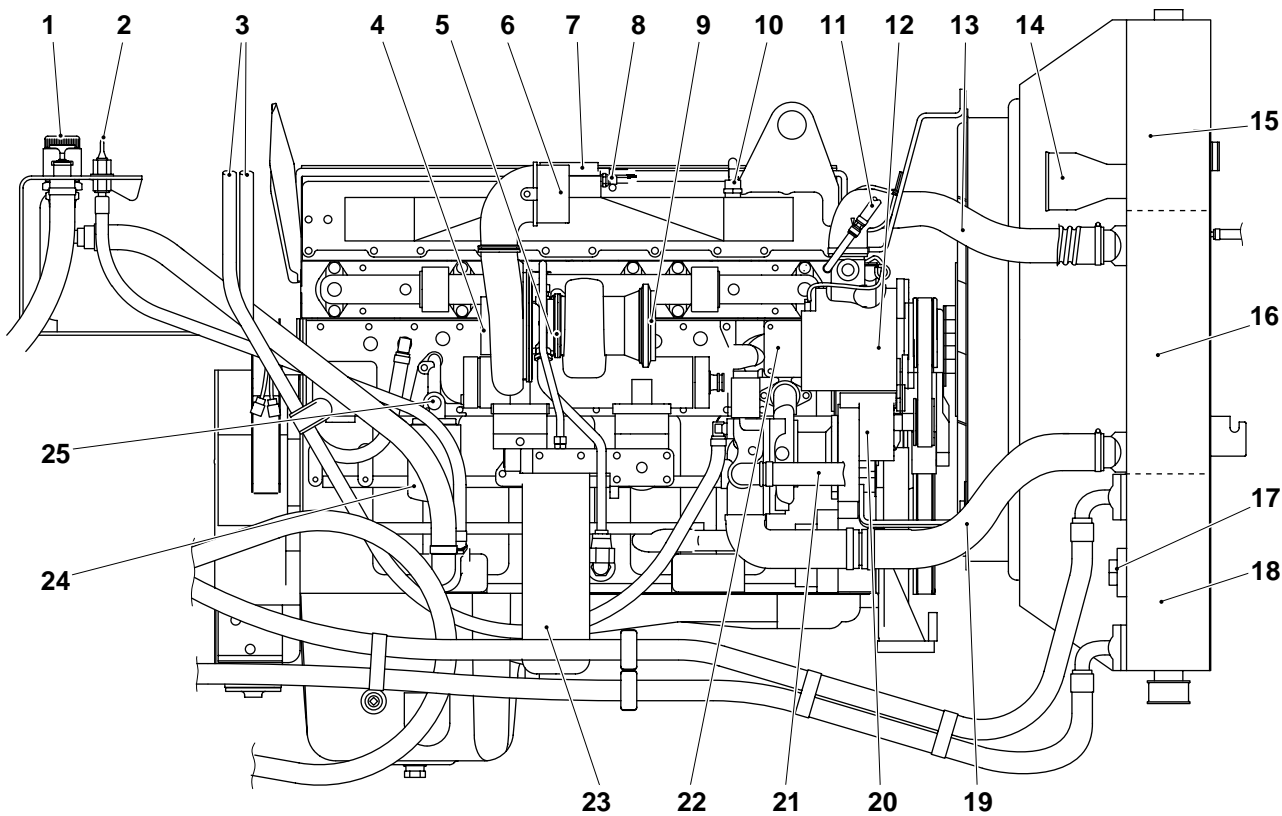
Engine alternative Cummins QSM11, component location



Engine alternative, Cummins, right side (in machine's direction of travel)

- | | |
|---|---|
| 1. Location for air conditioning compressor | 7. Draining of condensation from fuel filter and water-in-fuel sensor |
| 2. Fuel connection (outlet) | 8. Fuel filter |
| 3. Engine control unit (D794) | 9. Sensor fuel pressure |
| 4. Engine oil drain plug | 10. Fuel pump |
| 5. Starter motor | 11. Oil pressure and oil temperature sensor |
| 6. Fuel connection (intake) | 12. Crankshaft position sensor |

001643



Engine alternative, Cummins, left side (in machine's direction of travel)

- | | |
|---|----------------------------------|
| 1. Engine oil filling point | 13. Radiator connection (outlet) |
| 2. Dipstick | 14. Intake, intercooler |
| 3. Connection cab heat | 15. Intercooler |
| 4. Air cleaner connection | 16. Water cooler |
| 5. Turbocharger | 17. Thermostat |
| 6. Intercooler connection (outlet) | 18. Transmission oil cooler |
| 7. Intercooler connection (intake) | 19. Radiator connection (intake) |
| 8. Intake temperature sensor | 20. Coolant pump |
| 9. Exhaust system connection | 21. Expansion tank connection |
| 10. Boost pressure sensor | 22. Thermostat housing |
| 11. Expansion tank connection | 23. Oil filter |
| 12. Alternator (coolant temperature sensor behind alternator) | 24. Coolant filter |
| | 25. Coolant shut-off cock |

Engine and transmission, separation (engine alternative Volvo)

Separation

- 1 Machine in service position, see section *B Safety*.
- 2 Disconnect the requisite hoses and cables before separating engine and transmission.

NOTE

Drain and collect liquids before detaching hoses.

- 3 Attach hoisting equipment to the engine.



- 4 Use a jack to secure the transmission.



- 5 Remove the plugs in front of the flywheel.

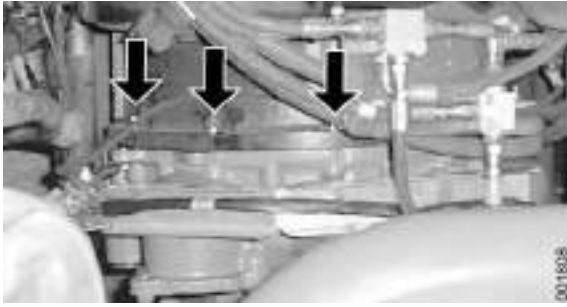
Use the outer hole to turn the engine round.

- 6 Remove the flex plate's attaching bolt. Turn the engine until flex plate's attaching bolts are visible in the inner hole. The flex plate has eight attachment points to be loosened.
- 7 Take up the slack in the hoisting equipment.

NOTE

Do not lift the engine or transmission.





- 8 Remove the bolts between the engine and the transmission.
- 9 Loosen the engine or transmission attachment brackets and separate the engine and transmission.

Assembly

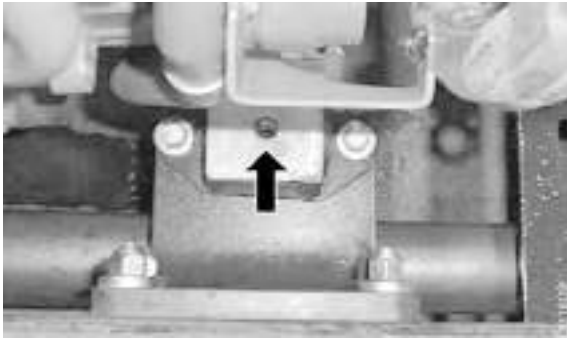
- 10 Check that the holes for the flex plate's mounting in the flywheel are just in front of the flex plate's retaining nuts.

The flex plate has eight attachment points to be connected with the flywheel on the engine.

- 11 Fit the engine or transmission brackets.

Tighten to a torque of **168 Nm**.

- 12 Connect the engine to the transmission.

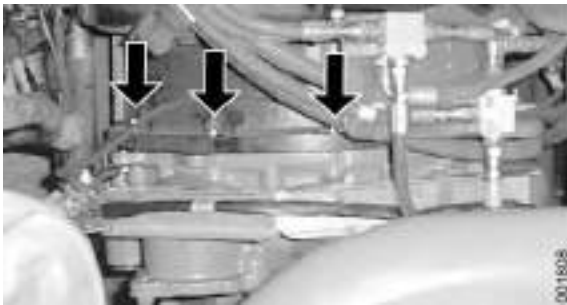


- 13 Fit the bolts between the engine and transmission. Tighten to a torque of **40 Nm**.

- 14 Fit the flex plate's attaching bolts. Tighten to a torque of **40 Nm**.

NOTE

The engine must be loosened from the engine mounts and separated from the transmission to remove a dropped bolt. Secure the bolt in the socket when installing.



- 15 Fit the plugs in front of the flywheel.
- 16 Remove the hoisting equipment from the engine.
- 17 Remove the jack from underneath the transmission.
- 18 Connect the requisite hoses and cables for the engine and transmission. Check and fill fluids as needed.
- 19 Bleed air from the engine's fuel system before start.



Engine and transmission, separation (engine alternative Cummins QSM11)

Separation

- 1 Machine in service position, see section *B Safety*.
- 2 Attach hoisting equipment to the engine.
- 3 Disconnect the requisite hoses and cables before separating engine and transmission.

NOTE

Drain and collect liquids before detaching hoses.

- 4 Use a jack to secure the transmission.



- 5 Remove the cover washer.





- 6 Rotate the engine for each bolt in the flex plate that has to be removed.
- 7 Remove the screws of the flex plate through the hole under the cover washer.
- 8 Take up the slack in the hoisting equipment.

NOTE

Do not lift the engine.

- 9 Remove the bolts between engine and transmission.
- 10 Loosen the engine and transmission brackets.
- 11 Withdraw the engine rearwards to separate it from the transmission.

Assembly

- 12 Rotate the engine so that the holes in the flywheel are just in front of the attachment points on the flex plate.

The flex plate has eight attachment points to be connected with the flywheel on the engine.

- 13 Fit the bolts to the engine and transmission brackets. Tighten to a torque of **168 Nm**.
- 14 Connect the engine to the transmission.
- 15 Fit the bolts between engine and transmission. Tighten to a torque of **52 Nm**.
- 16 Fit the flex plate's attaching bolts. Tighten to a torque of **40 Nm**.

NOTE

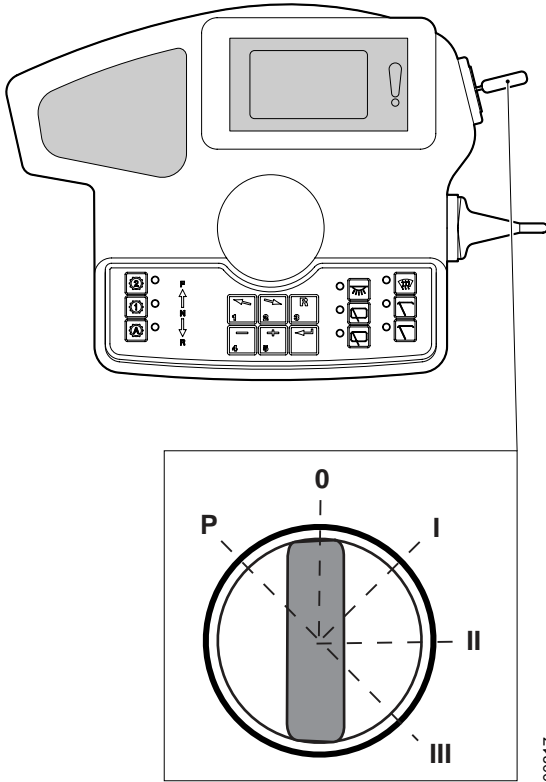
The engine must be loosened from the engine mounts and separated from the transmission to remove a dropped bolt. Secure the bolt in the socket when installing.

- 17 Fit the plug in front of the flywheel.
- 18 Remove the hoisting equipment from the engine.
- 19 Remove the jack from underneath the transmission.
- 20 Connect the requisite hoses and cables for the engine and transmission. Check and fill fluids as needed.

1.1 Controls and instruments

1.1.1 Ignition switch

Ignition switch, description



P No function.

0 Stop position. Everything switched off; key can be removed.

I Operating position.

Voltage to all electrical functions. Engine and transmission control units are now ready for start.

The signal can be checked from the diagnostic menu, see section 8 Control system , group 8.4.1.4 CAN/POWER, menu 4.

II Preheating position.

In the preheating position the engine's intake air is heated by the electric heater to a suitable temperature. The preheating lamp illuminates during preheating.

The signal can be checked from the diagnostic menu, see section 8 Control system , group 8.4.6.4 ENGINE, menu 4.

III Start position.

Engagement of starter motor for engine start.

NOTE

The machine is equipped with an electric restart interlock, which prevents engagement of the starter motor when the engine is rotating.

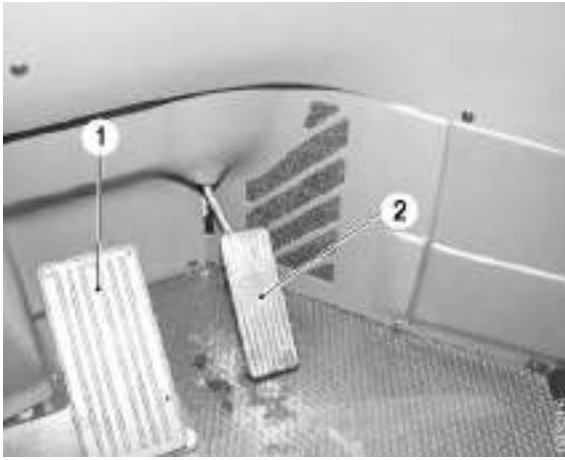
Conditions for starter motor engagement are that transmission is in neutral position and the engine is not already running.

The signal can be checked from the diagnostic menu, see section 8 Control system , group 8.4.6.4 ENGINE, menu 4.

000317

1.1.2 Accelerator pedal

Accelerator pedal, replacement



1. Brake pedal
2. Accelerator pedal

- 1 Machine in service position, see section *B Safety*.
- 2 Pull one edge of the cover away to facilitate access to the accelerator pedal.
- 3 Unplug the cable from the connector.
- 4 Unscrew the connector from the accelerator pedal.
- 5 Replace the accelerator pedal.
- 6 Fit in the reverse order.
- 7 Calibrate the gas pedal, see the section *8 Control system*, group *8.5.2.3 Calibrate DRIVE-TRAIN*.

Accelerator pedal, calibration

See section *8 Control system*, group *8.5.2.3 Calibrate DRIVE-TRAIN*.

1.2 Fuel system

Fuel system, description

The fuel system distributes fuel between the cylinders and thereby controls the engine output power and rpm.

When the engine is started, the fuel pump sucks fuel from the tank through the fuel filter and forces it to the unit injections. The unit injectors spray in the fuel and atomises the fuel to the engine's combustion chamber.

1.2.1 Fuel tank

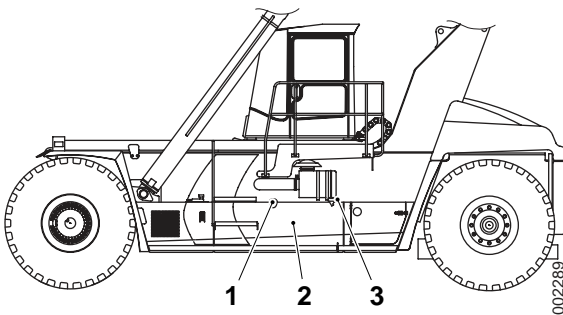
Fuel tank, description

The fuel tank is located on the left-hand side of the machine behind the brake fluid reservoir.

1.2.2 Sensor, fuel level

Sensor, fuel level, description

The signal can be checked from the diagnostic menu, see section 8 *Control system* , group 8.4.3.7 *CAB, menu 7*.



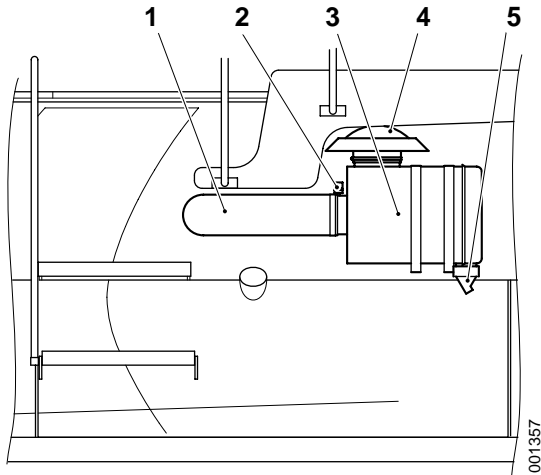
1. Fuel filler orifice
2. Fuel tank
3. Sensor, fuel level (behind air filter)

1.6 Air intake and exhaust outlet

1.6.1 Air cleaning system

Air cleaning system, description

Combustion in the engine requires air. Free unobstructed flow for fresh air and exhausts is essential for effective engine operation.



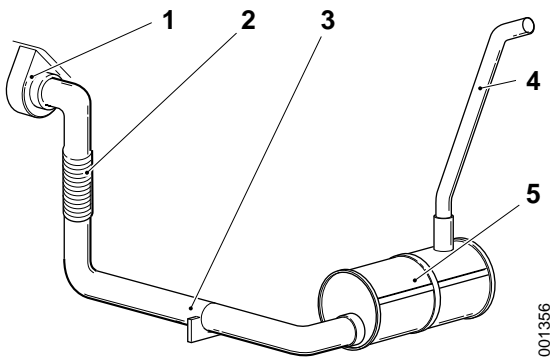
Air cleaning system, overview

1. Intake hose
2. Filter indicator
3. Air cleaner
4. Intake
5. Dust reservoir

1.6.3 Exhaust system

Exhaust system, description

The exhaust system is installed in the chassis. A heat shield is installed between the engine and the exhaust system to protect wiring, etc. A flex-pipe between the turbo and silencer absorbs the engine's movements. On the outside of the machine, there is a heat shield fitted over the exhaust system.



Exhaust system overview

1. Turbocharger
2. Flex pipe
3. Exhaust pipe
4. Tail pipe
5. Silencer



WARNING

Hot exhaust system!

Risk of burn injuries!

Never touch the turbo or muffler when the machine is running or just after it has been turned off!

1.6.4 Intercooler

Intercooler, description

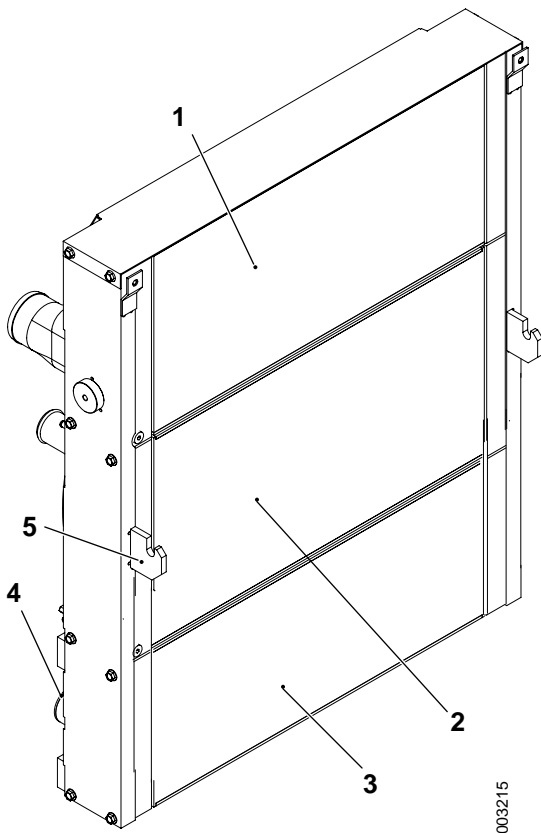
Engine alternative Volvo TAD1250VE and Cummins QSM11

The charge air is cooled by an air-air intercooler in the upper part of the cooling unit.

Engine alternative Volvo TWD1240VE

The charge air is cooled by a water-air intercooler on the engine, see engine supplier documentation.

Also refer to *Cooling system, description page 28*.



Cooling unit, engine alternative Volvo TAD1250VE and Cummins QSM11

1. Intercooler
2. Engine cooler
3. Transmission oil cooler
4. Transmission oil thermostat
5. Condenser mounting (to AC)

1.7 Cooling system

Cooling system, description

The engine is water-cooled and has passages through which the coolant from the radiator flows round a closed system.

Main parts of the cooling system:

- Coolant pump
- Expansion tank
- Thermostat
- Cooling fan
- Radiator
- Engine oil cooler
- Intercooler
- Coolant filter

How the engine cooling system works:

1. The coolant pump pumps coolant through the cylinder head, engine block and oil cooler. On the engine alternative Volvo TWD1240VE a separate coolant pump pumps coolant through the intercooler.
2. The thermostat directs the heated coolant back to the coolant pump or through the radiator.
3. When the coolant is colder than the thermostat opening temperature it is pumped back to the engine.
When the coolant is warmer than the thermostat opening temperature it is pumped through the radiator and then back to the coolant pump.
4. The expansion tank allows the coolant to expand without escaping from the engine.

1.7.4 Radiator and expansion tank

Radiator and expansion tank, description

Radiator for the engine is located in the cooling unit which is fitted behind the engine.

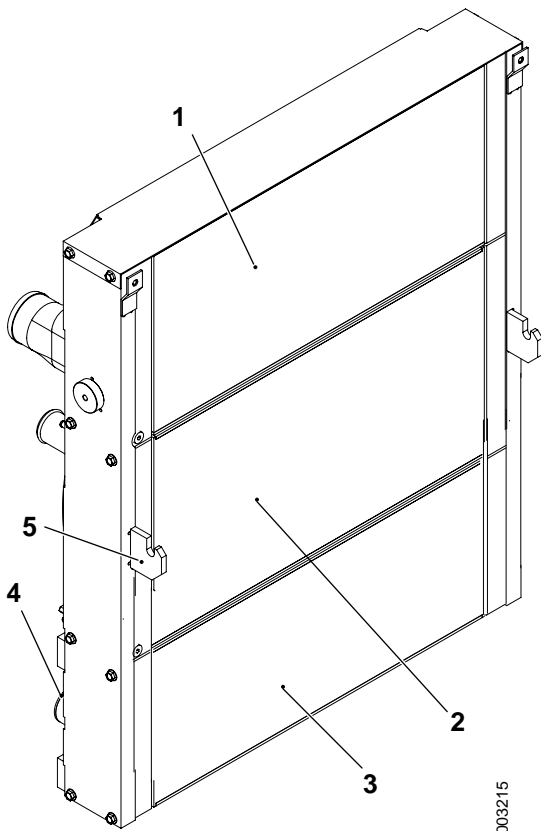
The purpose of the cooler assembly is to cool:

- Engine coolant
- Transmission oil (cooled in the lower part of the cooling unit), see also section 2 *Transmission*, group 2.6.3 *Oil cooler*.
- The charge air (engine alternative Volvo TAD1250VE and Cummins QSM11) is cooled in the upper cooling unit), see also *Intercooler, description page 27*.

Engine alternative Volvo TWD1240VE has water-air intercooler mounted directly on the engine.

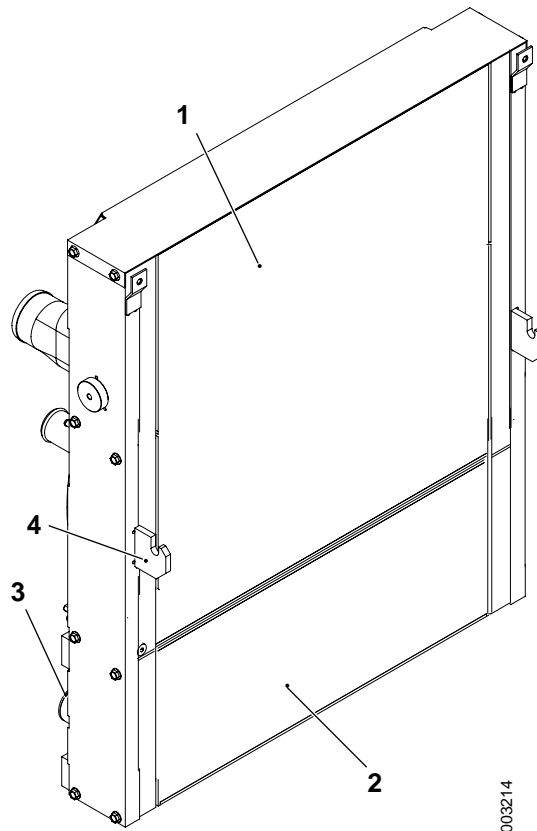
Also refer to *Cooling system, description page 28*.

For more information, see *supplier documentation, engine*.



Cooling unit, engine alternative Volvo TAD1250VE and Cummins QSM11

1. Intercooler
2. Engine cooler
3. Transmission oil cooler
4. Transmission oil thermostat
5. Condenser mounting (to AC)



Cooling unit, engine alternative Volvo TWD1240VE

1. Engine cooler
2. Transmission oil cooler
3. Transmission oil thermostat
4. Condenser mounting (to AC)

1.7.5 Cooling fan

Fan belt, replacement (engine alternative Volvo)

- 1 Position the cab in the front position.
- 2 Machine in service position, see section *B Safety*.
- 3 Remove the cover plates over the engine and radiator.
- 4 Release the tension on the fan belt and release the fan belt from belt pulley on the belt tensioner.
- 5 Remove the fan belt.



The figure shows engine without cooling fan.

- 6 Fit the new fan belt as illustrated.

Drive belt, extra water pump, replacement (engine alternative Volvo TWD1240VE)

- 1 Position the cab in the front position.
- 2 Machine in service position, see section *B Safety*.
- 3 Remove the cover plates over the engine and radiator.
- 4 Release the tension on the fan belt.
- 5 Remove the drive belt.



The figure shows engine without cooling fan.

- 6 Fit the new drive belt as illustrated.



Fan belt, replacement (engine alternative Cummins)

- 1 Position the cab in the front position.
- 2 Machine in service position, see section *B Safety*.
- 3 Remove the cover plates over the engine and radiator.
- 4 Loosen the belt tensioner.
- 5 Remove the fan belt.
- 6 Fit a new fan belt.
- 7 Tension the fan belt with the belt tensioner.

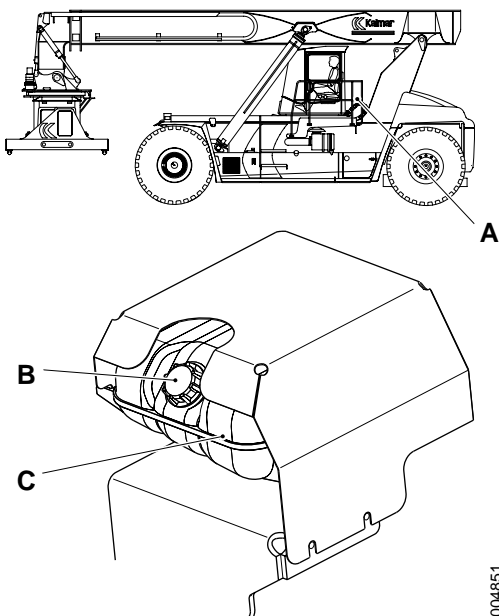
1.7.7 Coolant

Coolant, changing (engine alternative Volvo)

NOTE

Read the safety instructions for coolant before starting work, see section B Safety.

- 1 Machine in service position, see section *B Safety*.
- 2 Remove the cap on the expansion tank.
- 3 Place a receptacle under the radiator and engine. (The cooling system holds about 40 l.)



- A. Location, expansion tank
 B. Filling point
 C. Level marking



- 4 Drain the cooling system.

Open the drain cock on the bottom of the radiator. Collect the coolant in the receptacle.



- 5 Open the drain cock on the engine.

- 6 Once all the coolant has drained out, close drain cocks.

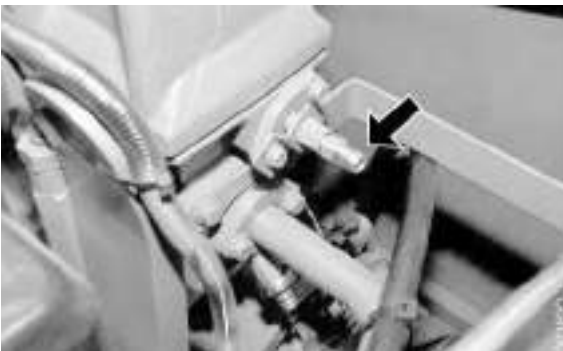
- 7 Fill the new premixed coolant of the correct type in the expansion tank. For volume and quality, see section *F Technical data*.

CAUTION

Different types of coolant cannot be mixed.

Risk of engine damage and damage to the cooling system if different coolant types are mixed.

When changing and refilling the coolant the coolant must be of the same type as was previously used.



- 8 Open the bleed nipple to release the air and speed up the filling. Close the bleed nipple when clean coolant without air bubbles is flowing out.

- 9 Turn on the main electric power and start the engine.

- 10 Turn on max. heat in the cab.

- 11 Run the engine to operating temperature so the thermostat opens and coolant is pumped around the whole system.

- 12 Check the level in the expansion tank, fill if required.

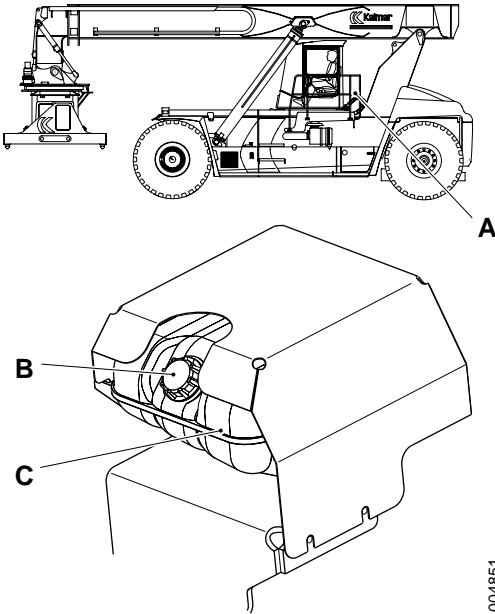
- 13 Check the coolant level again after 10 operating hours.

Coolant, changing (engine alternative Cummins QSM11)

NOTE

Read the safety instructions for coolant before starting work, see section B Safety

- 1 Machine in service position, see section B Safety.
- 2 Remove the cap on the expansion tank.
- 3 Place a receptacle under the radiator and engine. (The cooling system holds about 40 l.)



- A. Location, expansion tank
 B. Filling point
 C. Level marking

004851



- 4 Drain the cooling system.
 Open the drain cock on the bottom of the radiator. Collect the coolant in the receptacle.



1. Coolant shut-off cock
2. Coolant filter
3. Oil filter

- 5 Open the drain cock on the engine.
- 6 Once all the coolant has drained out, close drain cocks.
- 7 Fill the new premixed coolant of the correct type in the expansion tank. For volume and quality, see section *F Technical data*.

CAUTION

Different types of coolant cannot be mixed.

Risk of engine damage and damage to the cooling system if different coolant types are mixed.

When changing and refilling the coolant the coolant must be of the same type as was previously used.

- 8 Turn on the main electric power and start the engine.
- 9 Turn on max. heat in the cab.
- 10 Run the engine to operating temperature so the thermostat opens and coolant is pumped around the whole system.
- 11 Check the level in the expansion tank, fill if required.
- 12 Check the coolant level again after 10 operating hours.

1.7.10 Engine heater

Engine heater, description



See *supplier documentation, engine*.

A start-inhibitor function is available as an option coupled with the engine heater. The function is activated when the heater is running.

1.9 Engine control system

1.9.1 Control unit, engine

Engine control unit, general

See section *11 Common electrics*, group *11.5.3.10 Engine control unit* and *supplier documentation, engine*.

1.11 Start/stop

1.11.1 Starter motor

Starter motor, description (engine alternative Volvo)

The starter motor cranks the engine until fuel combustion begins and the engine starts.

The starter motor is supplied with voltage directly from the start batteries. A relay on the starter motor (solenoid) is activated by the engine control unit (D794).

For more information, see *supplier documentation, engine*.

Starter motor, description (engine alternative Cummins)

The starter motor cranks the engine until fuel combustion begins and the engine starts.

The starter motor is supplied with voltage directly from the start batteries. A relay on the starter motor (solenoid) is activated by Control unit, frame rear (D797-R).

The signal can be checked from the diagnostic menu, see section 8 *Control system*, group 8.4.6.5 *ENGINE, menu 5*.

For more information, see *supplier documentation, engine*.

1.11.2 Stopping device

Stopping device, description

The engines have electrically regulated injectors that stop delivering fuel when the voltage is cut off, which means that the engine stops.

The engine can only be stopped by turning off the ignition via the ignition switch.

NOTE

The battery disconnect switch must not be used for emergency stop!

For more information, see *supplier documentation, engine*.


 Automatic engine shutdown is available as an option. This means that the engine shuts off automatically after 3-30 minutes (depending on customer setting) if the machine is stationary and idling.

Table of Contents 2 Transmission

2	Transmission.....	3
2.1	Controls and instruments	21
2.1.1	Gear selector and multi-function lever	21
2.2	Torque converter/Clutch system	22
2.2.1	Flex plates	22
2.6	Lubrication system	26
2.6.3	Oil cooler	29
2.7	Cooling system	31
2.7.3	Oil cooler	31
2.8	Transmission control system	32
2.8.1	Control unit transmission	32
2.8.2	Normally closed (NC) switch, disengagement	32
2.8.3	Transmission cable harness	32

2 Transmission

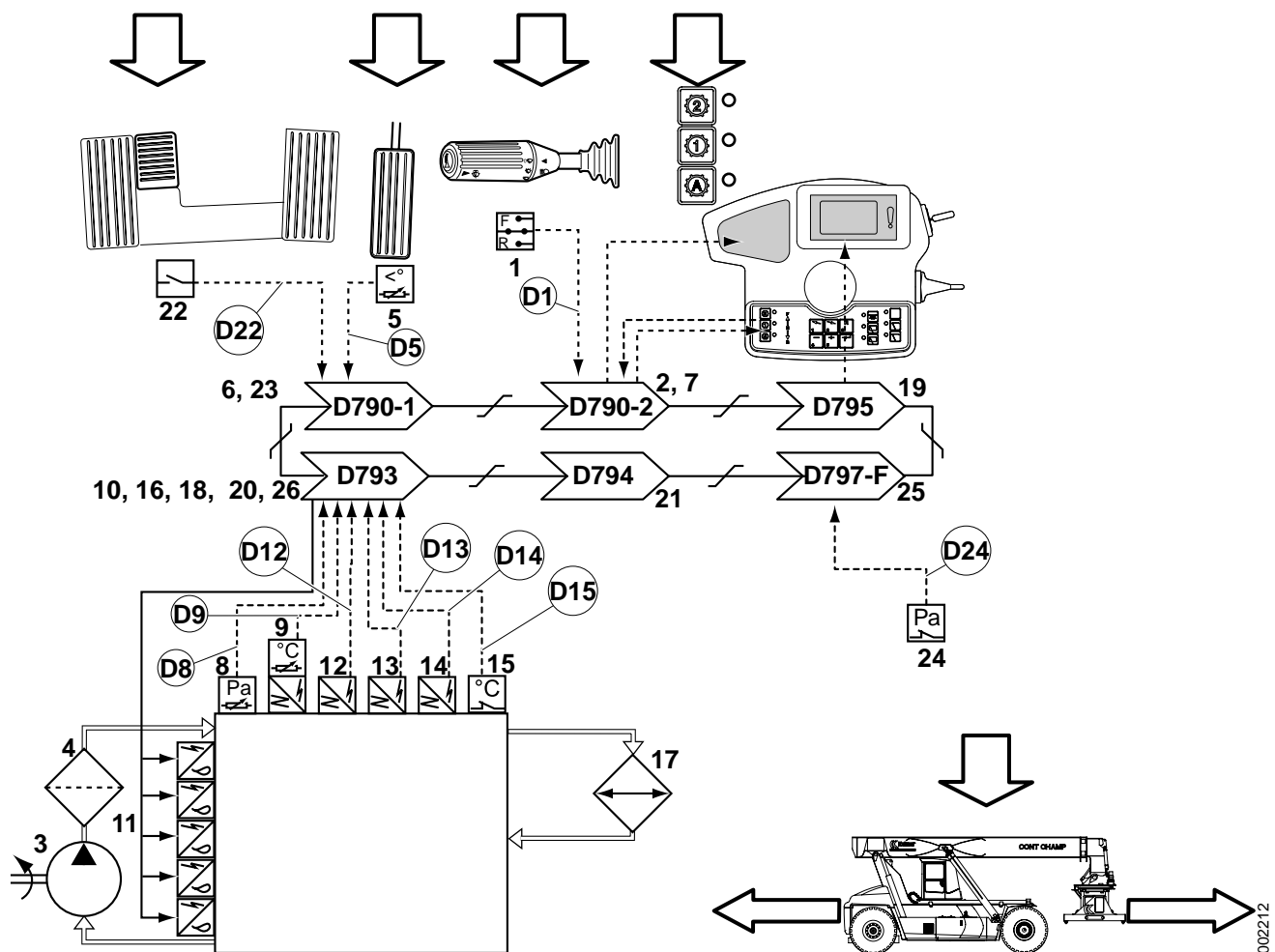
Transmission, general

Component supplier documentation

The workshop manual only describes components and work descriptions that concern installation in the machine. For descriptions of and instructions for the transmission's components and systems, refer to the supplier documentation.

References to component supplier documentation are only provided in exceptional cases. If information about a component is not found, the component supplier documentation should be used.

Transmission, function description (transmission alternative Dana)

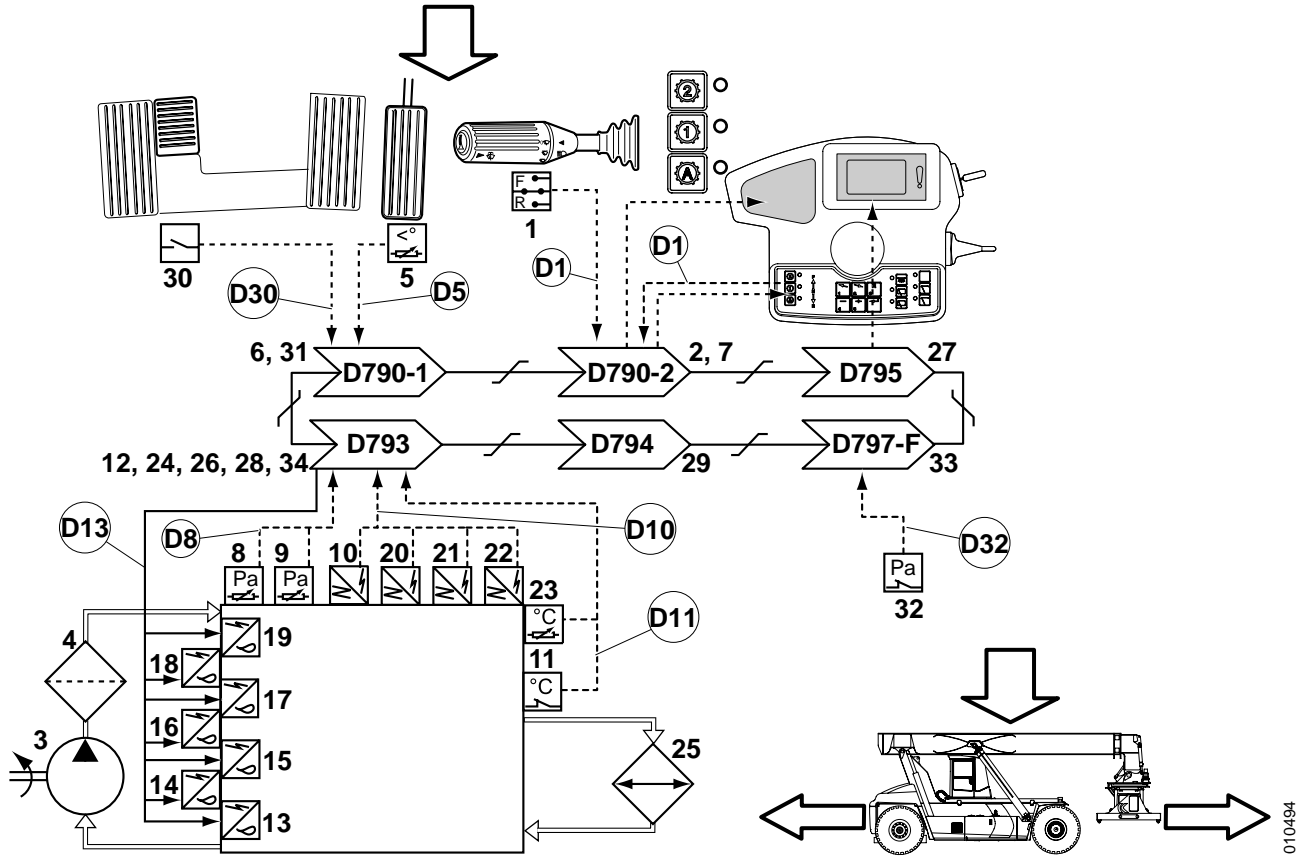


Pos	Explanation	Signal description	Reference
1	The gear selector sends a voltage signal to the KIT control unit (D790-2).	Forward, Conn. F: U = 24 V Reverse, Conn. R: U = 24 V	Section 9 <i>Frame, body, cab and accessories</i> , group 9.1 <i>Controls and instruments</i> D1: Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.7.2 <i>TRANSM</i> , menu 2
2	The KIT control unit (D790-2) transmits the selected direction of travel (forward or reverse) on the CAN bus.	Checked by control system, error shown with error code.	Section 11 <i>Common electrics</i> , group 11.5.3.11 <i>KIT control unit</i>
3	The transmission's oil pump pumps oil when the engine is running.	-	-
4	The transmission's oil filter cleans the oil from impurities.	-	-
5	The accelerator pedal transmits a signal to the cab control unit (D790-1).	U = 0.5-4.5 V	Section 1 <i>Engine</i> , group 1.1.2 <i>Accelerator pedal</i> D5: Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.6.1 <i>ENGINE</i> , menu 1

Pos	Explanation	Signal description	Reference
6	The cab control unit (D790-1) transmits the desired throttle application on the CAN bus.	Checked by control system, error shown with error code.	Section 11 <i>Common electrics</i> , group 11.5.3.1 <i>Cab control unit</i>
7	The KIT control unit (D790-2) transmits the selected shifting program on the CAN bus.	Checked by control system, error shown with error code.	Section 11 <i>Common electrics</i> , group 11.5.3.11 <i>KIT control unit</i>
8	The oil pressure sensor sends the transmission control unit (D793) a voltage signal proportional to oil pressure.	Checked by Control unit transmission, error shown with error code.	D8: Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.7.10 <i>TRANSM</i> , menu 10
9	The engine speed and oil temperature sensor (B758/766) sends the transmission control unit (D793) a pulse signal with frequency proportional to engine speed and a voltage signal proportional to the transmission oil temperature.	Checked by Control unit transmission, error shown with error code.	D9: Diagnostic menu, See Section 8 <i>Control system</i> , group 8.4.7.6 <i>TRANSM</i> , menu 6 and 8.4.7.10 <i>TRANSM</i> , menu 10
10	The transmission control unit (D793) supplies voltage to valve block transmission control to obtain desired function.	Checked by Control unit transmission, error shown with error code.	Section 11 <i>Common electrics</i> , group 11.5.3.9 <i>Transmission control unit</i>
11	Solenoid valves for travel direction and gear position in valve block transmission control activate gears in the transmission and the engine's power is transmitted to the transmission's output shaft.	Checked by Control unit transmission, error shown with error code.	-
12	The turbine speed sensor (B751) sends the transmission control unit (D793) a pulse signal with frequency proportional to turbine speed.	Checked by Control unit transmission, error shown with error code.	D12: Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.7.6 <i>TRANS</i> , menu 6
13	The drum sensor (B752) sends the transmission control unit (D793) a pulse signal with frequency proportional to drum speed.	Checked by Control unit transmission, error shown with error code.	D13: Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.7.6 <i>TRANSM</i> , menu 6
14	The output shaft speed sensor (B758) sends the transmission control unit (D793) a pulse signal with frequency proportional to output shaft speed.	Checked by Control unit transmission, error shown with error code.	D14: Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.7.6 <i>TRANSM</i> , menu 6
15	The torque converter temperature switch (S221) sends the transmission control unit (D793) a voltage signal if oil temperature in the torque converter becomes too high.	Checked by Control unit transmission, error shown with error code.	D15: Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.7.10 <i>TRANSM</i> , menu 10

Pos	Explanation	Signal description	Reference
16	The transmission control unit (D793) controls gear shifting according to selected shifting program.	Checked by Control unit transmission, error shown with error code.	Section 11 Common electrics, group 11.5.3.9 <i>Transmission control unit</i>
17	The oil cooler cools the transmission oil. A thermostat senses the oil's temperature and directs the oil back to the transmission if the oil is cold.	-	<i>Oil cooler, description page 31</i>
18	The transmission control unit (D793) transmits temperature and speed data on the CAN bus.	Checked by control system, error shown with error code.	Section 11 Common electrics, group 11.5.3.9 <i>Transmission control unit</i>
19	The KID control unit (D795) shows transmission information in operating menus.	Checked by control system, error shown with error code.	Section 11 Common electrics, group 11.5.3.12 <i>KID control unit</i>
20	If the signal from the output shaft speed sensor (B758) indicates that machine speed exceeds the speed limitation, the transmission control unit (D793) transmits a engine speed reduction request on the CAN bus.	-	D15: Diagnostic menu, see section 8 Control system , group 8.4.7.6 TRANSM, menu 6
21	The engine control unit (D794) reduces engine speed.	-	Section 11 Common electrics, group 11.5.3.10 <i>Engine control unit</i>
22	If the clutch pedal (S220-1) is depressed, it sends a voltage signal to the cab control unit (D790-1).	U = 24 V	Section 9 Frame, body, cab and accessories, group 9.1 Controls and instruments D22: Diagnostic menu, see section 8 Control system , group 8.4.7.1 TRANSM, menu 1
23	The cab control unit (D790-1) transmits disengage drive on CAN bus.	Checked by control system, error shown with error code.	Section 11 Common electrics, group 11.5.3.1 <i>Cab control unit</i>
24	Normally closed (NC) switch, disengagement (S220-2) sends the Control unit, frame front (D797-F) a voltage signal if brake pressure is high enough to allow drive disengagement.	Brake pressure above 0.2 MPa: Conn 1, U = 24 V Conn 2, U = 24 V Brake pressure below 0.2 MPa: Conn 1, U = 24 V Conn 2, U = 0 V	<i>Normally closed (NC) switch, disengagement, description page 32</i> D24: Diagnostic menu, see section 8 Control system , group 8.4.7.1 TRANSM, menu 1
25	Control unit, frame front (D797-F) transmits disengagement approved on the CAN bus.	Checked by control system, error shown with error code.	Section 11 Common electrics, group 11.5.3.2 <i>Control unit, frame front</i>
26	The transmission control unit (D793) supplies voltage to valve block transmission control so that drive is disengaged.	Checked by Control unit transmission, error shown with error code.	Section 11 Common electrics, group 11.5.3.9 <i>Transmission control unit</i>

Transmission, function description (transmission alternative Dana full flow)



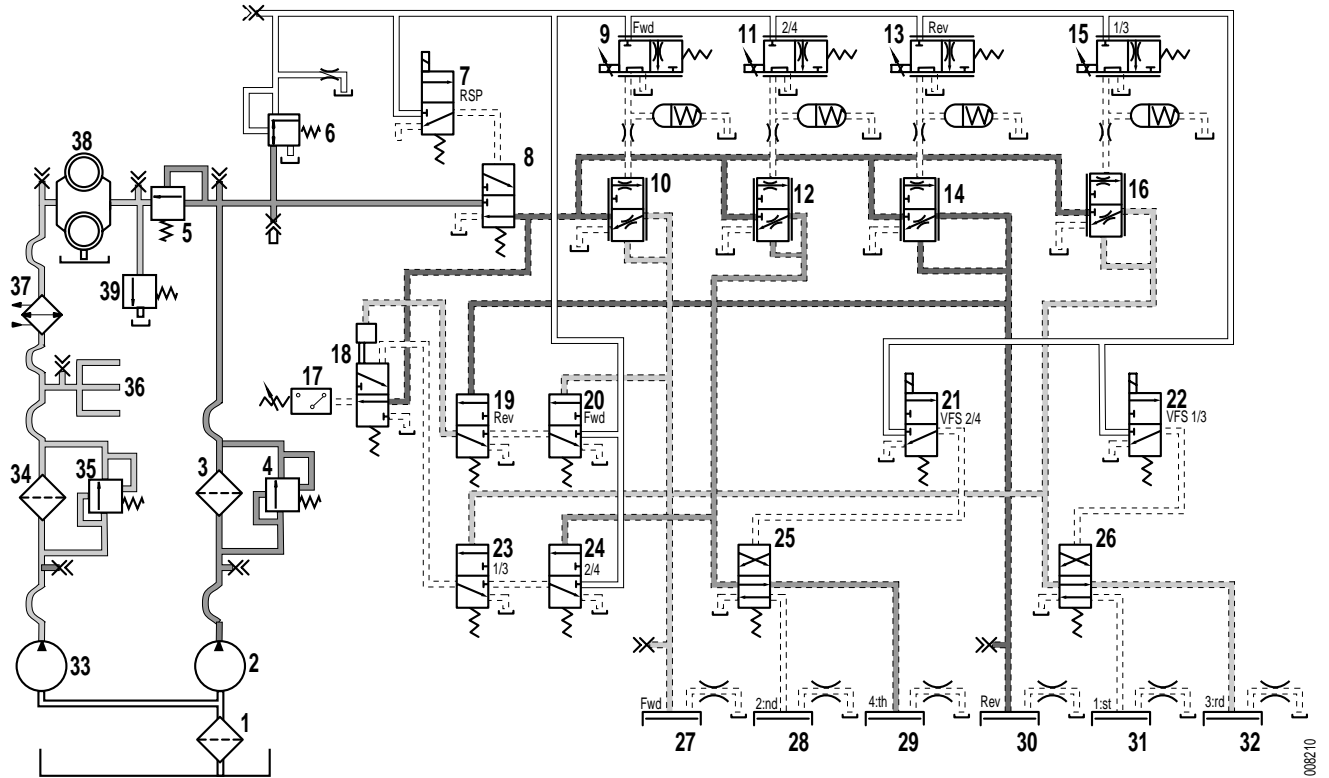
Pos	Explanation	Signal description	Reference
1	The gear selector sends a voltage signal to the KIT control unit (D790-2).	Forward, Conn. F: U = 24 V Reverse, Conn. R: U = 24 V	Section 9 Frame, body, cab and accessories, group 9.1 Controls and instruments D1: Diagnostic menu, see section 8 Control system, group 8.4.7.2 TRANSM, menu 2
2	The KIT control unit (D790-2) transmits the selected direction of travel (forward or reverse) on the CAN bus.	Checked by control system, error shown with error code.	Section 11 Common electrics, group 11.5.3.11 KIT control unit D1: Diagnostic menu, see section 8 Control system, group 8.4.7.2 TRANSM, menu 2
3	The transmission's oil pump pumps oil when the engine is running.	-	-
4	The transmission's oil filter cleans the oil from impurities.	-	-
5	The accelerator pedal transmits a signal to the cab control unit (D790-1).	U = 0.5-4.5 V	Section 1 Engine, group 1.1.2 Accelerator pedal D5: Diagnostic menu, see section 8 Control system, group 8.4.6.1 ENGINE, menu 1

Pos	Explanation	Signal description	Reference
6	The cab control unit (D790-1) transmits the desired throttle application on the CAN bus.	Checked by control system, error shown with error code.	Section 11 <i>Common electrics</i> , group 11.5.3.1 <i>Cab control unit</i>
7	The KIT control unit (D790-2) transmits the selected shifting program on the CAN bus.	Checked by control system, error shown with error code.	Section 11 <i>Common electrics</i> , group 11.5.3.11 <i>KIT control unit</i>
8	Pressure sensor gear 1/3 (B6067) sends the transmission control unit (D793) a voltage signal proportional to oil pressure.	Checked by Control unit transmission, error shown with error code.	D8: Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.7.10 <i>TRANSM</i> , menu 10
9	Pressure sensor gear 2/4 (B6069) sends the transmission control unit (D793) a voltage signal proportional to oil pressure.	Checked by Control unit transmission, error shown with error code.	D8: Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.7.10 <i>TRANSM</i> , menu 10
10	Sensor, engine speed (B7530) sends a pulse signal with frequency proportional to the engine speed to Control unit, transmission (D793).	Checked by Control unit transmission, error shown with error code.	D10: Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.7.6 <i>TRANSM</i> , menu 6
11	The oil temperature sensor (B7660) sends the transmission control unit (D793) a voltage signal proportional to transmission oil temperature.	Checked by Control unit transmission, error shown with error code.	D11: Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.7.10 <i>TRANSM</i> , menu 10
12	The transmission control unit (D793) supplies voltage to the solenoid and servo valves to obtain the desired function.	Checked by Control unit transmission, error shown with error code.	Section 11 <i>Common electrics</i> , group 11.5.3.9 <i>Transmission control unit</i>
13 14 15 16 17 18 19	Solenoid valve drive forward (Y6066F) or Solenoid valve drive reverse (Y6066R) and Servo valve gear forward/reverse (Y6300) are activated to select the direction of travel. Solenoid valve gear selection 1/3 (Y6075) and Servo valve gear 1/3 (Y6067) or Solenoid valve gear selection 2/4 (Y6074) and Servo valve gear 2/4 (Y6069) are activated to select gear position. The engine's power is transferred to the transmission's output shaft.	Checked by Control unit transmission, error shown with error code.	D13: Diagnostic menu, See Section 8 <i>Control system</i> , group 8.4.7.7 <i>TRANSM</i> , menu 7, 8.4.7.8 <i>TRANSM</i> , menu 8 and 8.4.7.9 <i>TRANSM</i> , menu 9
20	The turbine speed sensor (B7510) sends the transmission control unit (D793) a pulse signal with frequency proportional to turbine speed.	Checked by Control unit transmission, error shown with error code.	D10: Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.7.6 <i>TRANSM</i> , menu 6

Pos	Explanation	Signal description	Reference
21	The drum sensor (B7520) sends the transmission control unit (D793) a pulse signal with frequency proportional to drum speed.	Checked by Control unit transmission, error shown with error code.	D10: Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.7.6 <i>TRANSM</i> , menu 6
22	The output shaft speed sensor (B7580) sends the transmission control unit (D793) a pulse signal with frequency proportional to output shaft speed.	Checked by Control unit transmission, error shown with error code.	D10: Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.7.6 <i>TRANSM</i> , menu 6
23	The torque converter temperature switch (S2210) sends the transmission control unit (D793) a voltage signal if oil temperature in the torque converter becomes too high.	Checked by Control unit transmission, error shown with error code.	D11: Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.7.10 <i>TRANSM</i> , menu 10
24	The transmission control unit (D793) controls gear shifting according to selected shifting program.	Checked by Control unit transmission, error shown with error code.	Section 11 <i>Common electrics</i> , group 11.5.3.9 <i>Transmission control unit</i>
25	The oil cooler cools the transmission oil. A thermostat senses the oil's temperature and directs the oil back to the transmission if the oil is cold.	-	<i>Oil cooler, description page 31</i>
26	The transmission control unit (D793) transmits temperature and speed data on the CAN bus.	Checked by control system, error shown with error code.	Section 11 <i>Common electrics</i> , group 11.5.3.9 <i>Transmission control unit</i>
27	The KID control unit (D795) shows transmission information in operating menus.	Checked by control system, error shown with error code.	Section 11 <i>Common electrics</i> , group 11.5.3.12 <i>KID control unit</i>
28	If the signal from the output shaft speed sensor (B7580) indicates that machine speed exceeds the speed limitation, the transmission control unit (D793) transmits a engine speed reduction request on the CAN bus.	-	D10: Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.7.6 <i>TRANSM</i> , menu 6
29	The engine control unit (D794) reduces engine speed.	-	Section 11 <i>Common electrics</i> , group 11.5.3.10 <i>Engine control unit</i>
30	If the clutch pedal (S220-1) is depressed, it sends a voltage signal to the cab control unit (D790-1).	U = 24 V	Section 9 <i>Frame, body, cab and accessories</i> , group 9.1 <i>Controls and instruments</i> D30: Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.7.1 <i>TRANSM</i> , menu 1
31	The cab control unit (D790-1) transmits disengage drive on CAN bus.	Checked by control system, error shown with error code.	Section 11 <i>Common electrics</i> , group 11.5.3.1 <i>Cab control unit</i>

Pos	Explanation	Signal description	Reference
32	Normally closed (NC) switch, disengagement (S220-2) sends the Control unit, frame front (D797-F) a voltage signal if brake pressure is high enough to allow drive disengagement.	Brake pressure above 0.2 MPa: Conn 1, U = 24 V Conn 2, U = 24 V Brake pressure below 0.2 MPa: Conn 1, U = 24 V Conn 2, U = 0 V	<i>Normally closed (NC) switch, disengagement, description page 32</i> D32: Diagnostic menu, see section 8 Control system , group 8.4.7.1 TRANSM, menu 1
33	Control unit, frame front (D797-F) transmits disengagement approved on the CAN bus.	Checked by control system, error shown with error code.	Section 11 Common electrics, group 11.5.3.2 Control unit, frame front
34	The transmission control unit (D793) supplies voltage to valve block transmission control so that drive is disengaged.	Checked by Control unit transmission, error shown with error code.	Section 11 Common electrics, group 11.5.3.9 Transmission control unit

Transmission shifting, function description (transmission alternative Dana)

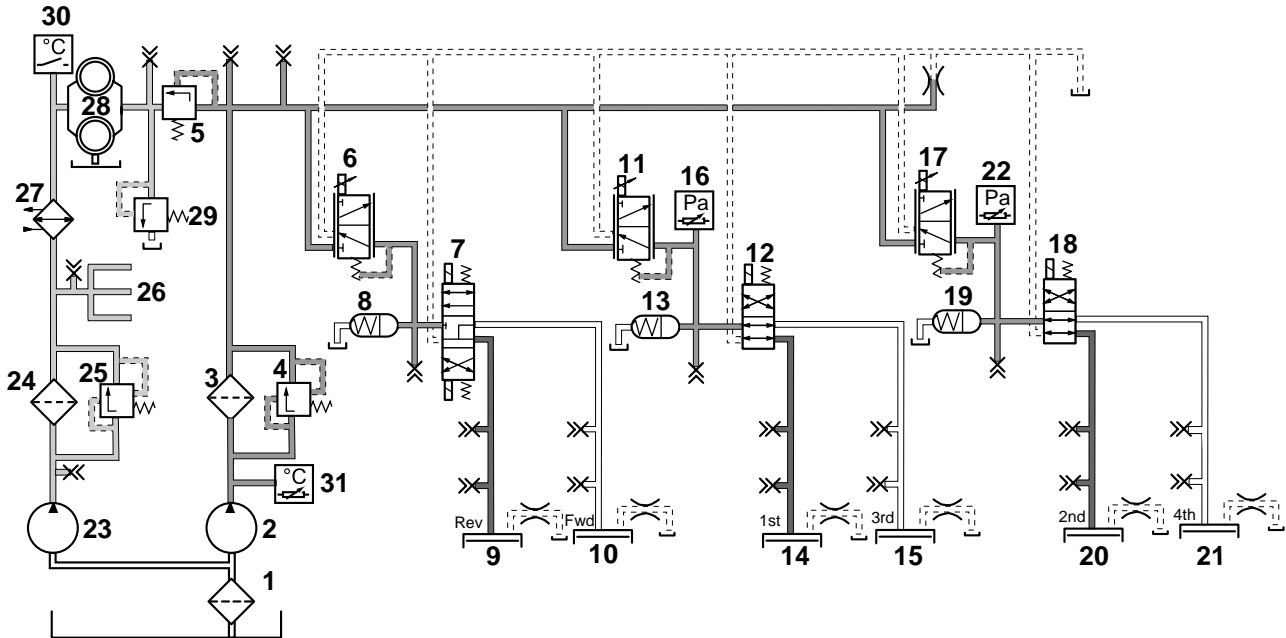


Pos	Explanation	Signal description	Reference
1.	Bottom strainer oil sump, separates particles from the oil before the pumps.	-	-
2.	The transmission's oil pump 1 feeds the transmission with control pressure for control of the transmission.	100.5 l/min at 1973 rpm	-
3.	The oil filter cleans the oil.	-	-
4.	The bypass valve in the filter bracket leads the oil past the filter if the resistance through the filter becomes too high.	Opening pressure: 410-450 kPa	-
5.	The pressure governor releases pressure to the torque converter if the pressure becomes too high.	Opening pressure: 2200 kPa	-
6.	The pressure reducer reduces the feed pressure to servo pressure.	1200 kPa	-
7.	Solenoid valve neutral position (RSP) (Y6066) controls Valve spool neutral position.	-	Diagnostic menu, see section 8 Control system , group 8.4.7.7 TRANSM, menu 7

Pos	Explanation	Signal description	Reference
8.	Valve spool neutral position opens or closes to allow control pressure to the transmission.	-	-
9.	Solenoid valve drive forward (Y630) controls Pressure booster drive forward.	0-600 kPa	Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.7.8 <i>TRANSM</i> , menu 8 and 8.4.7.9 <i>TRANSM</i> , menu 9
10.	Pressure booster forward increases the pressure and pressurises Drive clutch forward.	0-2000 kPa	-
11.	Solenoid valve gear 2/4 (Y6069) controls Pressure booster gear 2/4.	0-600 kPa	Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.7.8 <i>TRANSM</i> , menu 8 and 8.4.7.9 <i>TRANSM</i> , menu 9
12.	Pressure booster gear 2/4 increases the pressure and feeds Valve slide gear selection 2/4 as well as Valve slide gear 2/4 control.	0-2000 kPa	-
13.	Solenoid valve drive reverse controls Pressure booster drive reverse.	0-600 kPa	Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.7.8 <i>TRANSM</i> , menu 8 and 8.4.7.9 <i>TRANSM</i> , menu 9
14.	Pressure booster reverse increases the pressure and pressurises Drive clutch reverse.	0-2000 kPa	-
15.	Solenoid valve 1/3 (Y6067) controls Pressure booster gear 1/3.	0-600 kPa	Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.7.8 <i>TRANSM</i> , menu 8 and 8.4.7.9 <i>TRANSM</i> , menu 9
16.	Pressure booster gear 1/3 increases the pressure and feeds Valve slide gear selection 1/3 as well as Valve slide gear 1/3 control.	0-2000 kPa	-
17.	Contact drive sends signal to the control unit to verify that drive clutches for travel direction and gear selection are activated when solenoid valve neutral position (RSP) (Y6066) is activated.	-	
18.	The drive control valve compares pressure signals from drive clutches for direction of travel and gear selection and sends the pressure signal on to the drive contact.	-	-
19.	The valve spool for reverse drive control opens when the reverse drive clutch is pressurised and leads a pressure signal to the drive control valve.	0-2000 kPa	
20.	The valve spool for forward drive control opens when the forward drive clutch is pressurised and leads a pressure signal to the drive control valve.	0-2000 kPa	-
21.	Solenoid valve VFS 2/4 (Y6074) controls servo pressure to Valve slide gear selection 2/4.	1200 kPa	Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.7.7 <i>TRANSM</i> , menu 7

Pos	Explanation	Signal description	Reference
22.	Solenoid valve VFS 1/3 (Y6075) controls servo pressure to Valve spool gear selection 1/3.	1200 kPa	Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.7.7 <i>TRANSM</i> , menu 7
23.	The valve slide for gear 1/3 control opens when valve slide gear selection 1/3 is pressurised and leads a pressure signal to the drive control valve.	0-2000 kPa	-
24.	The valve slide for gear 2/4 control opens when valve slide gear selection 2/4 is pressurised and leads a pressure signal to the drive control valve.	0-2000 kPa	-
25.	Valve slide gear selection 2/4 pressurises drive clutch gear 2 or drive clutch gear 4.	0-2000 kPa	-
26.	Valve spool gear selection 1/3 pressurises Drive clutch gear 1 or Drive clutch gear 3.	0-2000 kPa	-
27.	Drive clutch forward locks the transmission in forward drive when the clutch is pressurised.	-	-
28.	Drive clutch gear 2 locks the transmission in gear position 2 when the clutch is pressurised.	-	-
29.	Drive clutch gear 4 locks the transmission in gear position 4 when the clutch is pressurised.	-	-
30.	Drive clutch reverse locks the transmission in reverse drive when the clutch is pressurised..	-	-
31.	Drive clutch gear 1 locks the transmission in gear position 1 when the clutch is pressurised.	-	-
32.	Drive clutch gear 3 locks the transmission in gear position 3 when the clutch is pressurised.	-	-
33.	The transmission oil pump pumps oil through the cooler and supplies the torque converter with oil pressure to run the machine.	85.1 l/min at 1973 rpm	-
34.	The oil filter cleans the oil.	-	-
35.	The bypass valve in the filter bracket leads the oil past the filter if the resistance through the filter becomes too high.	-	-
36.	The oil is distributed to different lubrication points in the transmission.	-	-
37.	The transmission oil cooler cools the oil.	-	-
38.	The torque converter transmits the engine's power to the transmission.	-	-
39.	The safety valve leads the oil back to the sump if the pressure in the torque converter becomes too high.	Opening pressure: 900 kPa	-

Transmission shifting, function description (transmission alternative Dana full flow)



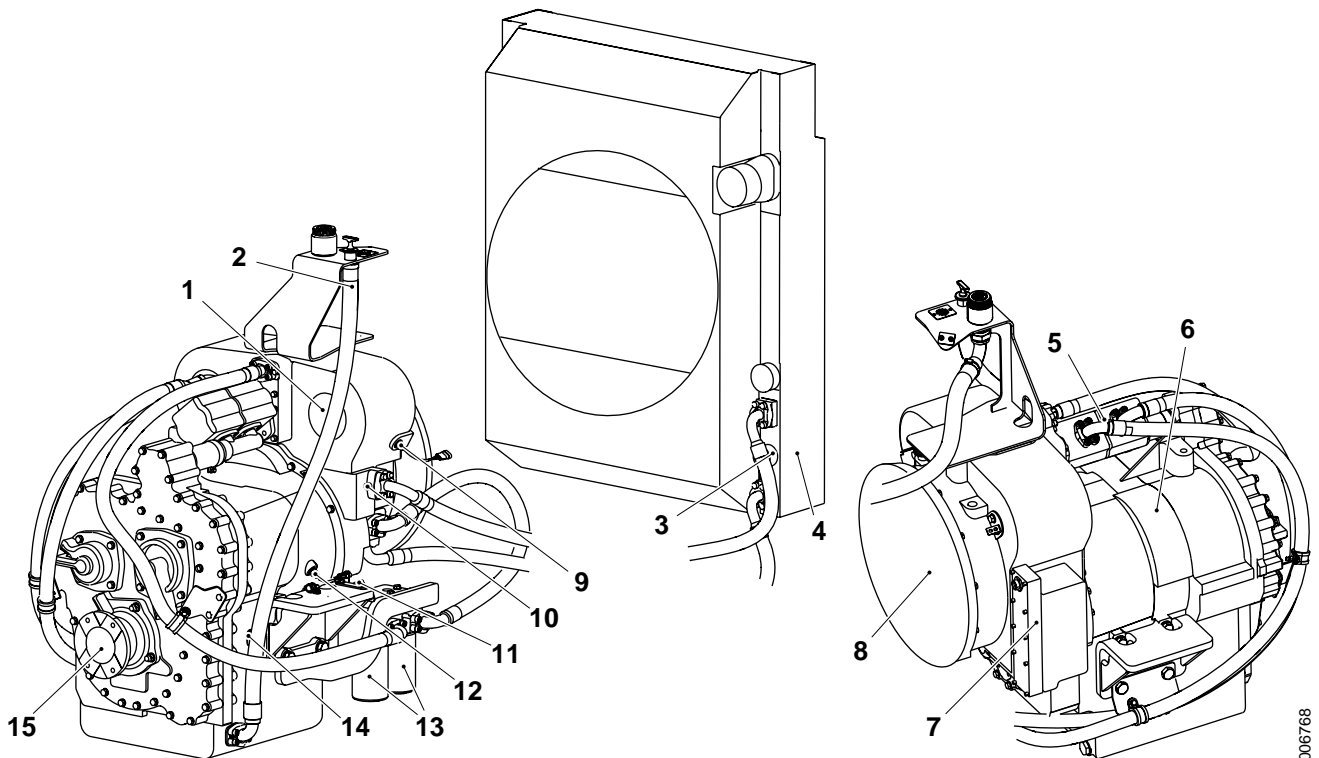
013040

Pos	Explanation	Signal description	Reference
1	Bottom strainer oil sump, separates particles from the oil before the pumps.	-	-
2	The transmission's oil pump 1 feeds the transmission with control pressure for control of the transmission.	30.4 l/min at 685 rpm	-
3	The oil filter cleans the oil.	-	-
4	The bypass valve in the filter bracket leads the oil past the filter if the resistance through the filter becomes too high.	Opening pressure: 410-450 kPa	-
5	The pressure governor releases pressure to the torque converter if the pressure becomes too high.	Opening pressure: 2200 kPa	-
6	Servo valve front/rear (Y6300) controls pressure to Valve travel direction, proportional to the desired traction.	-	Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.7.7 <i>TRANSM</i> , menu 7
7	Solenoid valve drive forward (Y6066F) or Solenoid valve drive reverse (Y6066R) controls Valve travel direction for drive forward or reverse. Depending on the solenoid valve activated, Valve travel direction controls pressure to drive clutch forward or drive clutch reverse.	-	Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.7.8 <i>TRANSM</i> , menu 8 and 8.4.7.9 <i>TRANSM</i> , menu 9

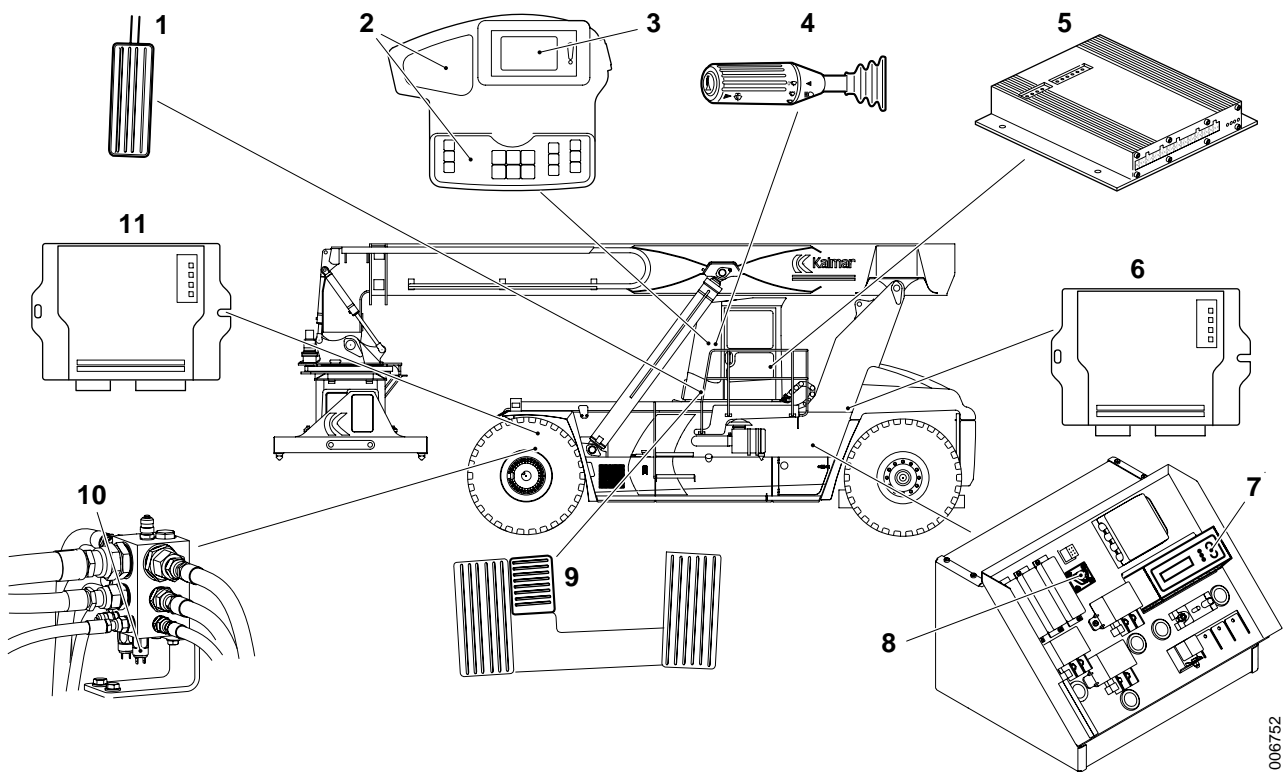
Pos	Explanation	Signal description	Reference
8	The accumulator evens out the pressure.	-	-
9	Drive clutch reverse locks the transmission in reverse drive when the clutch is pressurised..	Drive reverse: 2200-2600 kPa	-
10	Drive clutch forward locks the transmission in forward drive when the clutch is pressurised.	Drive forward: 2200-2600 kPa	-
11	Servo Valve 1/3 (Y6067) controls pressure to Solenoid valve gear selection gear 1/3 (Y6075) proportional to the desired engagement force.	-	Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.7.8 <i>TRANSM, menu 8</i> and 8.4.7.9 <i>TRANSM, menu 9</i>
12	Solenoid valve gear selection gear 1/3 (Y6075) pressurises Drive clutch gear 1 or Drive clutch gear 3.	-	Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.7.7 <i>TRANSM, menu 7</i>
13	The accumulator evens out the pressure.	-	-
14	Drive clutch gear 1 locks the transmission in gear position 1 when the clutch is pressurised.	Gear selected: 2200-2600 kPa	-
15	Drive clutch gear 3 locks the transmission in gear position 3 when the clutch is pressurised.	Gear selected: 2200-2600 kPa	-
16	Pressure sensor gear 1/3 (B6067) sends the transmission control unit (D793) a voltage signal proportional to engagement pressure.	-	Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.7.10 <i>TRANSM, menu 10</i>
17	Servo Valve 2/4 (Y6069) controls pressure to Solenoid valve gear selection gear 1/3 (Y6075) proportional to the desired engagement force.	-	Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.7.8 <i>TRANSM, menu 8</i> and 8.4.7.9 <i>TRANSM, menu 9</i>
18	Solenoid valve gear selection gear 2/4 (Y6074) pressurises Drive clutch gear 1 or Drive clutch gear 3.	-	Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.7.7 <i>TRANSM, menu 7</i>
19	The accumulator evens out the pressure.	-	-
20	Drive clutch gear 2 locks the transmission in gear position 2 when the clutch is pressurised.	Gear selected: 2200-2600 kPa	-
21	Drive clutch gear 4 locks the transmission in gear position 4 when the clutch is pressurised.	Gear selected: 2200-2600 kPa	-
22	Pressure sensor gear 2/4 (B6069) sends the transmission control unit (D793) a voltage signal proportional to engagement pressure.	-	Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.7.10 <i>TRANSM, menu 10</i>
23	The transmission oil pump pumps oil through the cooler and supplies the torque converter with oil pressure to run the machine.	15.8 l/min at 685 rpm	-
24	The oil filter cleans the oil.	-	-
25	The bypass valve in the filter bracket leads the oil past the filter if the resistance through the filter becomes too high.	-	-

Pos	Explanation	Signal description	Reference
26	The oil is distributed to different lubrication points in the transmission.	-	-
27	The transmission oil cooler cools the oil.	-	-
28	The torque converter transmits the engine's power to the transmission.	-	-
29	The safety valve leads the oil back to the sump if the pressure in the torque converter becomes too high.	Opening pressure: 900 kPa	-
30	The torque converter temperature switch (S2210) sends the transmission control unit (D793) a voltage signal if oil temperature in the torque converter becomes too high.	-	Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.7.10 <i>TRANSM</i> , menu 10
31	The oil temperature sensor (B7660) sends the transmission control unit (D793) a voltage signal proportional to oil temperature.	-	Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.7.10 <i>TRANSM</i> , menu 10

Transmission, component location (transmission alternative Dana)



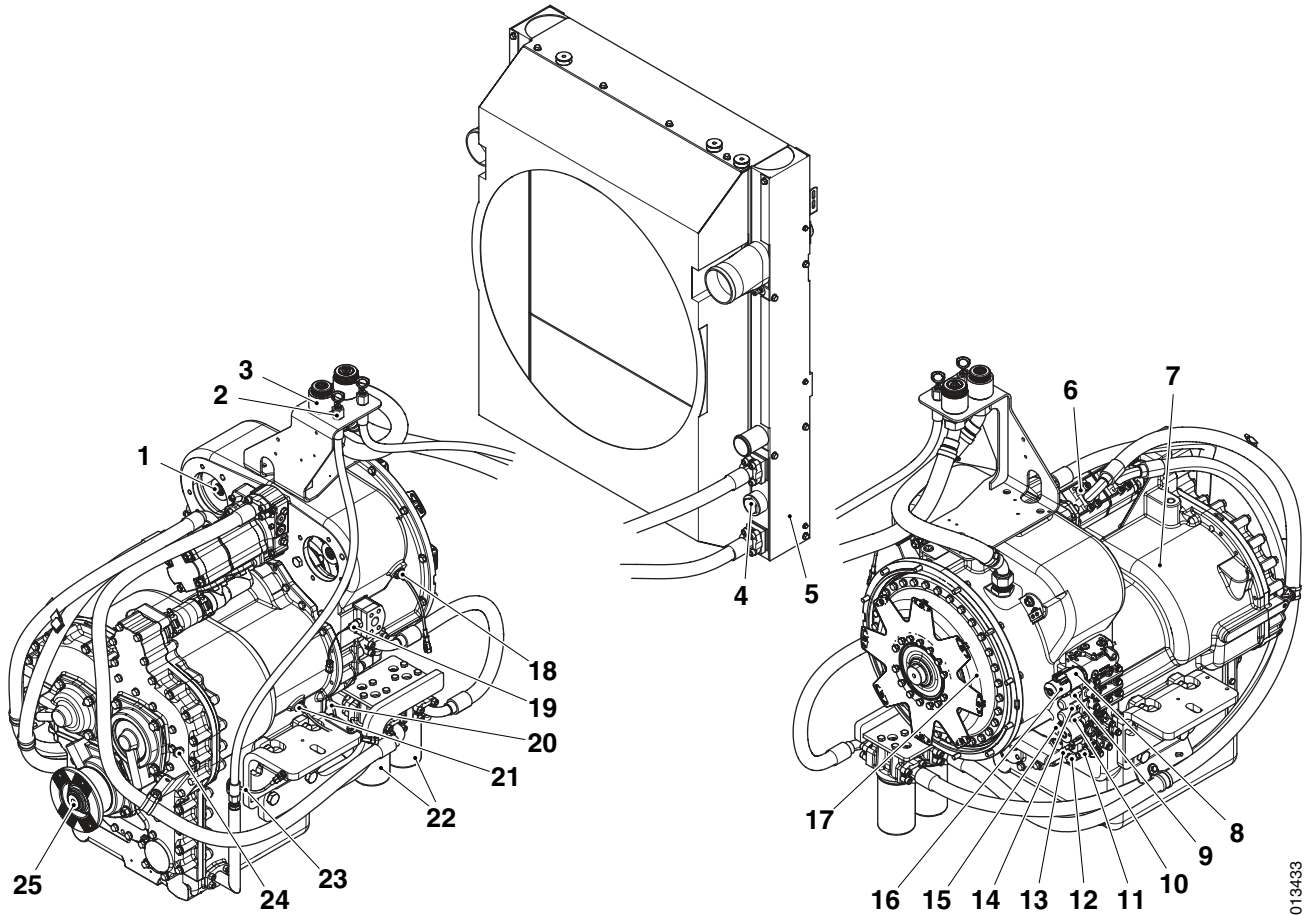
- | | |
|---|--|
| 1. Power take-off | 9. Engine rpm and oil temperature sensor (B758/766)
(from radiator to sump) |
| 2. Transmission oil dipstick and filler orifice | 10. Temperature switch, torque converter (S221) |
| 3. Thermostat | 11. Turbine speed sensor (B751) |
| 4. Transmission oil cooler | 12. Sensor, drum rpm (B752) |
| 5. Oil pump transmission | 13. Oil filter transmission |
| 6. Gearbox | 14. Sensor rpm output shaft (B758) |
| 7. Valve block transmission control | 15. Output shaft |
| 8. Torque converter | |



- | | | | |
|----|----------------------------------|-----|-----------------------------------|
| 1. | Accelerator pedal (B690) | 7. | Transmission control unit (D793) |
| 2. | Control unit KIT (D790-2) | 8. | Diagnostic socket, transmission |
| 3. | Control unit KID (D795) | 9. | Declutch pedal (S220-1) |
| 4. | Multi-function lever (S162) | 10. | NO switch, declutch (S220-2) |
| 5. | Control unit cab (D790-1) | 11. | Control unit frame front (D797-F) |
| 6. | Control unit frame rear (D797-R) | | |

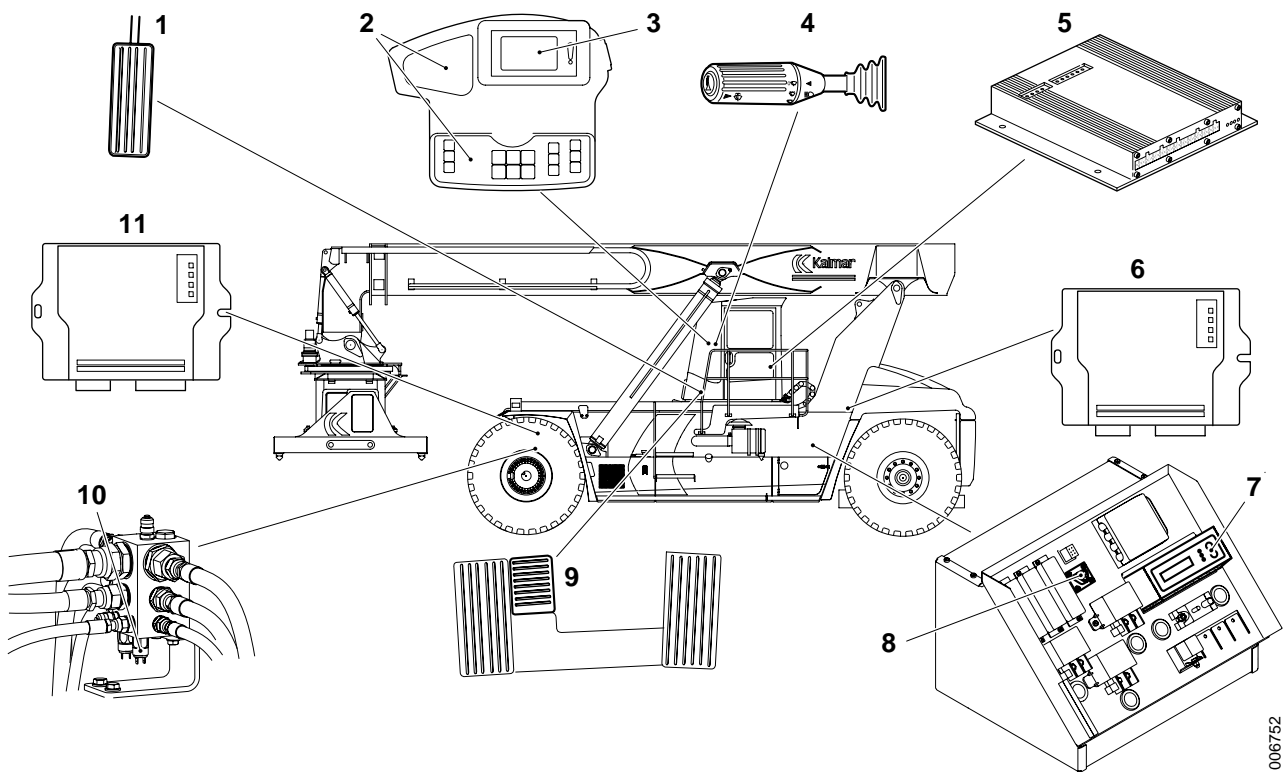
006752

Transmission, component location (transmission alternative Dana full flow)



013433

- | | |
|---|--|
| 1. Power take-off | 14. Servo valve gear 2/4 (Y6069) |
| 2. Dipstick | 15. Solenoid valve gear selection 2/4 (Y6074) |
| 3. Filling of transmission oil | 16. Solenoid valve drive reverse (Y6066R) |
| 4. Thermostat | 17. Torque converter |
| 5. Transmission oil cooler | 18. Sensor engine speed (B7530) |
| 6. Oil pump transmission | 19. Temperature switch, torque converter (S2210) |
| 7. Gearbox | 20. Turbine speed sensor (B7510) |
| 8. Solenoid valve drive forward (Y6066F) | 21. Sensor, drum rpm (B7520) |
| 9. Servo valve gear forward/reverse (Y6300) | 22. Oil filter transmission |
| 10. Servo valve gear 1/3 (Y6067) | 23. Sensor rpm output shaft (B7580) |
| 11. Solenoid valve gear selection 1/3 (Y6075) | 24. Sensor oil temperature (B7660) (from radiator to sump) |
| 12. Pressure sensor gear 1/3 (B6067) | 25. Output shaft |
| 13. Pressure sensor gear 2/4 (B6069) | |



006762

- | | | | |
|----|----------------------------------|-----|-----------------------------------|
| 1. | Accelerator pedal (B690) | 7. | Transmission control unit (D793) |
| 2. | Control unit KIT (D790-2) | 8. | Diagnostic socket, transmission |
| 3. | Control unit KID (D795) | 9. | Declutch pedal (S220-1) |
| 4. | Multi-function lever (S162) | 10. | NO switch, declutch (S220-2) |
| 5. | Control unit cab (D790-1) | 11. | Control unit frame front (D797-F) |
| 6. | Control unit frame rear (D797-R) | | |

Engine and transmission, separation

Engine alternative Volvo: see section 1 Engine , group 1 Engine and transmission separation (Engine alternative Volvo).

Engine alternative Cummins: see section 1 Engine , group 1 Engine and transmission separation (Engine alternative Cummins).

2.1 Controls and instruments

2.1.1 Gear selector and multi-function lever

Gear and multi-function lever, description

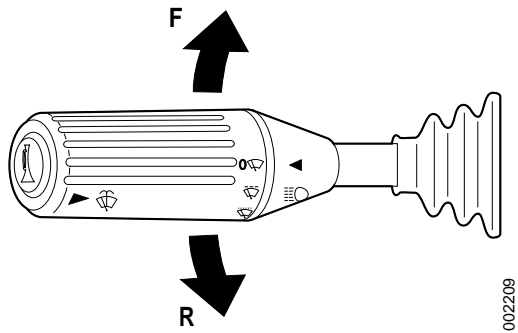
Travel direction is selected with the gear and multi-function lever.

Selection of travel direction:

- F – Forward
- N – Neutral
- R – Reverse

The switch is supplied voltage by and sends signals to the KIT control unit (D790-2).

The signal can be checked from the diagnostic menu, see section 8 *Control system* , group 8.4.7.2 *TRANSM*, menu 2.



2.2 Torque converter/Clutch system

2.2.1 Flex plates

Flex plates, replacement (engine alternative Volvo)

- 1 Machine in service position, see section *B Safety*.
- 2 Remove the cover plate for the flywheel.



- 3 Remove the bolts for the flex plate.





- 4 Turn the engine for each bolt to be removed from the flex plate.
- 5 Attach the transmission to an overhead crane.
- 6 Remove the bolts holding together the transmission and engine.



- 7 Carefully separate the transmission and engine.



Flex plate attachment.

- 8 Remove the bolts holding the flex plate to the transmission.
- 9 Replace the flex plate.
- 10 Fit in the reverse order. Fit the attaching bolts with **40 Nm**.
- 11 Before the machine is put into operation, the transmission must be calibrated; see *Transmission, calibration page 32*.

Flex plates, replacement (engine alternative Cummins QSM11)

- 1 Machine in service position, see section *B Safety*.
- 2 Remove the cover plate.
- 3 Remove the bolts for the flex plate.



- 4 Turn the engine for each bolt to be removed from the flex plate.
- 5 Attach the transmission to an overhead crane.
- 6 Remove the bolts holding together the transmission and engine.



7 Carefully separate the transmission and engine.



- 8 Remove the bolts holding the flex plate to the transmission.
- 9 Replace the flex plate.
- 10 Fit in the reverse order. Fit the attaching bolts with **40 Nm**.
- 11 Before the machine is put into operation, the transmission must be calibrated; see *Transmission, calibration page 32*.

Flex plate attachment.

2.6 Lubrication system

Lubrication system, description

The transmission lubricating system has the following function:

- Lubricate gear wheel and bearings
- Apply the clutches in the transmission
- Cool down the torque converter and the transmission
- Clean the oil of any impurities with two oil filters.

During operation of the engine, the oil pump draws oil from the transmission's oil sump through a strainer, and it then pumps it through two oil filters to a control valve.

The control valve supplies oil at the correct pressure to the transmission's valve housing to activate the clutch plates for FORWARD or REVERSE and gear 1, 2, 3 or 4. The clutch plates require just a small amount of the oil flow supplied by the pump. The remainder of the oil is pumped through the torque converter circuit to the oil cooler and returns to the transmission for lubrication.

See also *supplier documentation, transmission*.

Oil and oil filter, changing

NOTE

Read the safety instructions for oil before working, see section B Safety.

NOTE

The transmission must not be over filled!

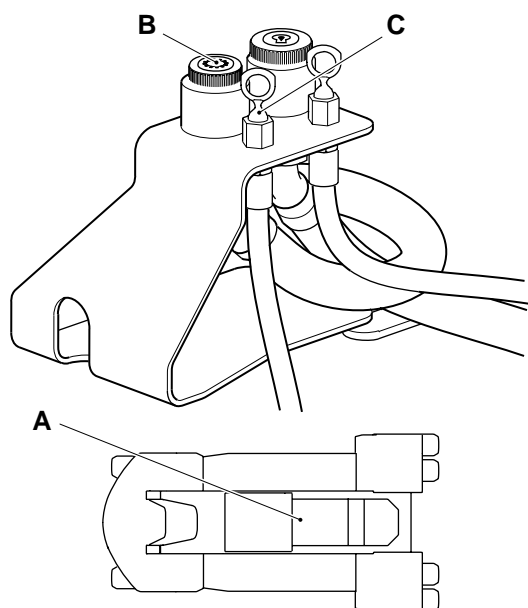
- 1 Operate and warm up the transmission oil.
- 2 Machine in service position, see section *B Safety*.
- 3 Remove the drain plug for transmission oil and let the oil drain into the receptacle.



Draining transmission oil

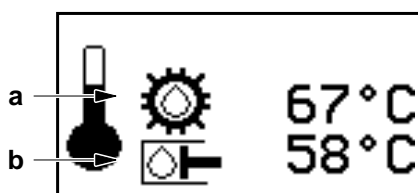


Oil filter transmission



013334

- A. Location of filler orifice and level control
 B. Filling
 C. Dipstick



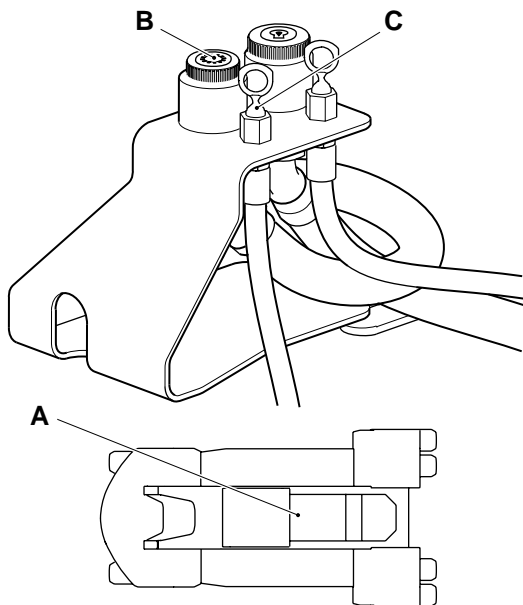
000356

- Operating menu, oil temperature
 a. Transmission oil temperature
 b. Hydraulic oil temperature

- 4 Change oil filter.
 Moisten the O-ring of the new oil filters with transmission oil. Tighten until it makes contact and then another two-thirds of a turn.
- 5 When the transmission oil has drained, fit the drain plug.
 Make sure that the washer for the oil plug is included.

- 6 Fill with new transmission oil through the filler orifice (position B).
 For volume and grade, see section *F Technical data*.
- 7 Start the engine and allow it to idle for at least two minutes.
- 8 Check that the transmission oil drain plug is airtight.
- 9 Check the transmission oil level with the engine running at idle and top up to the marking for low level.

- 10 Warm up the transmission so that the display shows an oil temperature between 60-65 °C. Use the oil temperature operating menu to check transmission oil temperature.
- 11 Check the oil level. Fill to the MAX mark.



- A. Location of filler orifice and level control
 B. Filling
 C. Dipstick

Oil level, check

NOTE

Read the safety instructions for oil before working, see section B Safety.

The transmission's oil filler pipe and dipstick (position B) are located under the service hatch in front of the cab.

- 1 Check the oil level with the engine at idle, transmission in neutral position and at operating temperature (approx. 60-65 °C in the display). The dipstick has two markings, MAX and MIN. The oil level should be at MAX.

Wipe off the dipstick before checking.

NOTE

The oil dipstick is long. Wear gloves.

- 2 Fill transmission oil (position B) if required (for volume and grade, see section F Technical data).

Fill – wait a moment – check the dipstick.

NOTE

Work carefully when filling transmission oil to prevent other fluids or particles from contaminating the oil, which means risk of transmission damage.

013334

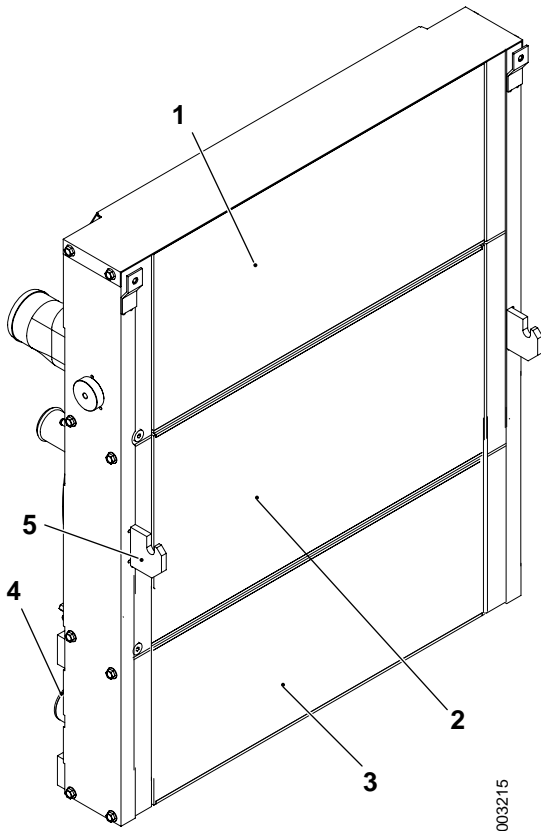
2.6.3 Oil cooler

Oil cooler, description

The transmission oil is cooled in the lower section of the cooling unit.

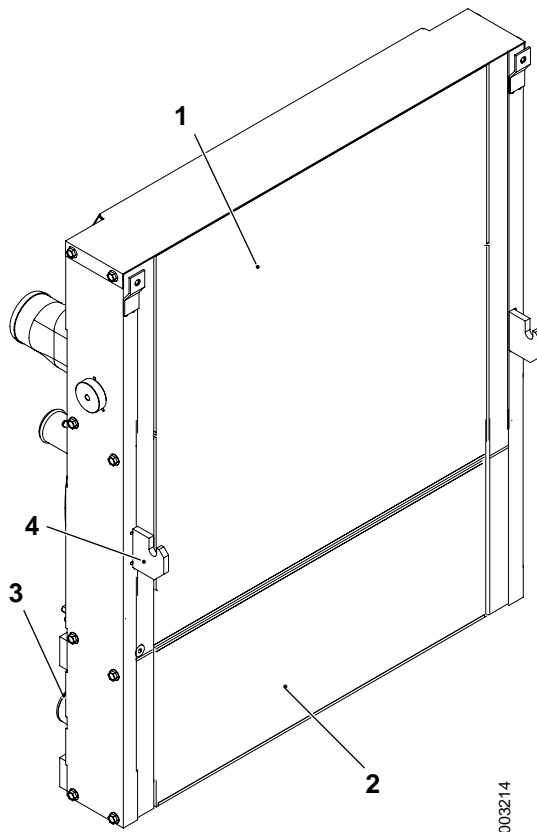
A temperature-controlled bypass valve, which only acts on the transmission oil cooling circuit, is located in a pipe on the underside of the cooler (engine side). The valve closes when the oil starts to reach working temperature. This means that the oil reaches normal working temperature more quickly.

For more detailed information, see *supplier documentation, transmission*.



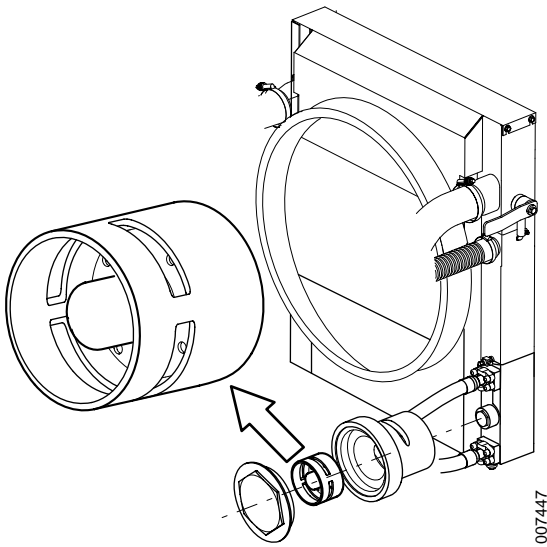
Cooling unit, engine alternative Cummins QSM11 and Volvo TAD1250VE

1. Intercooler
2. Radiator, engine
3. Transmission oil cooler
4. Transmission oil thermostat
5. Condenser mounting (to AC)



Cooling unit, engine alternative Volvo TWD1240VE

1. Radiator, engine
2. Transmission oil cooler
3. Transmission oil thermostat
4. Condenser mounting (to AC)



Thermostat transmission oil cooler, changing

NOTE

Read the safety instructions for oil before working, see section B Safety.

- 1 Machine in service position, see section B Safety.
- 2 Drain the oil from the transmission, see *Oil and oil filter, changing page 26*.
- 3 Loosen the cover plug and remove the thermostat.
- 4 Check the O-ring and the spring in the bottom, change as needed.
- 5 Install the new thermostat, and the cover plug.

IMPORTANT

It is very important that the thermostat is used with the temperature bulb facing out as shown.

- 6 Fill with transmission oil; see *Oil and oil filter, changing page 26*.
- 7 Start the engine and check for leaks.
- 8 Check the transmission oil level; see *Oil level, check page 28*.

2.7 Cooling system

2.7.3 Oil cooler

Oil cooler, description

See Oil cooler, description page 29.

2.8 Transmission control system

Transmission, calibration

See section 8 *Control system*, group 8.5.2.3 *Calibrate DRIVE-TRAIN*.

2.8.1 Control unit transmission

Transmission control unit, general

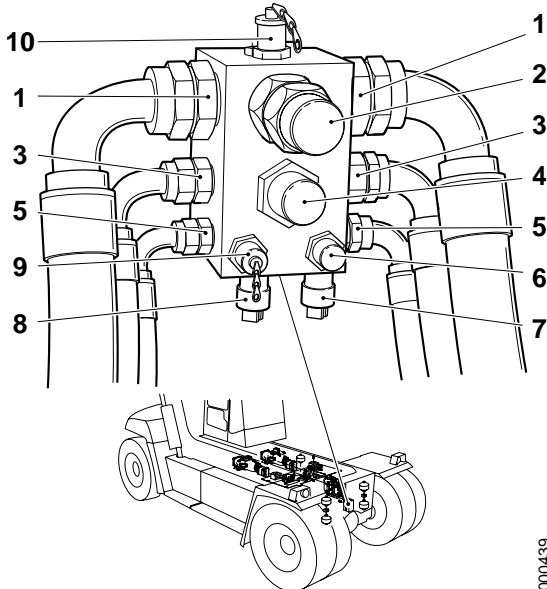
See section 11 *Common electrics*, group 11.5.3.9 *Transmission control unit* and *Supplier documentation*.

2.8.2 Normally closed (NC) switch, disengagement

Normally closed (NC) switch, disengagement, description

The NC switch for disengagement detects if the wheel brakes are pressurised. The NC switch is located on the distribution block for the brake system, above the drive axle's differential.

The sensor can be checked from the diagnostic menu, see section 8 *Control system*, group 8.4.7.1 *TRANSM, menu 1*.



1. Brake cooling connection, return from wheel brake
2. Brake cooling connection, return to cooler and tank
3. Brake cooling connection, to wheel brake
4. Brake cooling connection from accumulator charging valve
5. Brake cylinder connection, to wheel brake
6. Brake pressure connection, from brake valve
7. NO switch, declutch (S220)
8. NO switch, brake lights (S216)
9. Measuring outlet, brake pressure
10. Measuring outlet, brake cooling back pressure

2.8.3 Transmission cable harness

Transmission cable harness, description

See section E *Schematics*.

Table of Contents 3 Driveline/Axle

3	Driveline/axle	3
3.2	Propeller shaft	3
3.3	Drive axle	4

3 Driveline/axle

3.2 Propeller shaft

Propeller shaft, description

The propeller shaft transfers engine power from the transmission to the drive axle. The propeller shaft has two joints, which means that the engine and drive axle can move in relation to each other.

Propeller shaft, replacement

- 1 Machine in service position, see section *B Safety*.
- 2 Clean the contact surfaces (cross-toothed) on the drive axle and transmission.



- 3 Fit the propeller shaft in position with the coupling upward.
- 4 Fit the propeller shaft attaching bolts.
Tightening torque **156 Nm**. Retighten the attaching bolts after 50 hours of operation.

3.3 Drive axle

Drive axle, general

Component supplier documentation

The workshop manual only describes components and work descriptions related to installation in the machine. Please refer to the component supplier documentation for descriptions and instructions of drive axle components and systems.

References to supplier documentation are only used in exceptional cases. If information about a component is missing, use the supplier documentation.

Drive axle, replacement

DANGER

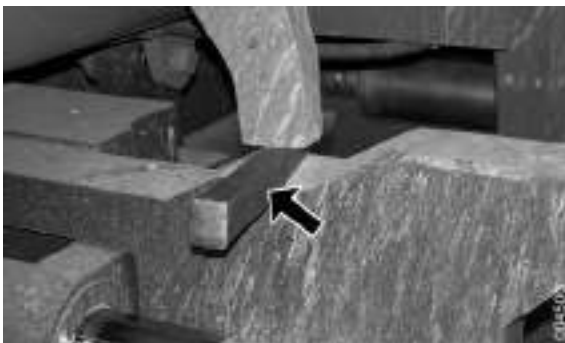
Drive axle and machine are very heavy.

Risk of pinch injury!

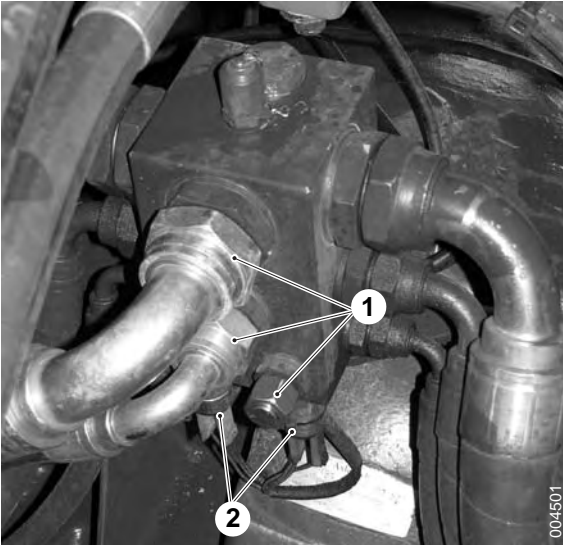
Do not go under a machine which has been lifted by a jack etc under any circumstances. For machine weights, please refer to section *F Technical data*



- 1 Park the machine with blocks behind the steering wheels.
- 2 Depressurise the brake and hydraulic systems, see section *B Safety*.
- 3 Turn the start key to position 0 and turn off the main electric power.



- 4 Install wedges between the steering axle and frame.



1. Hydraulic hoses
2. Cables

- 5 Disconnect hydraulic hoses (position 1) and cabling (position 2) from the distribution block.

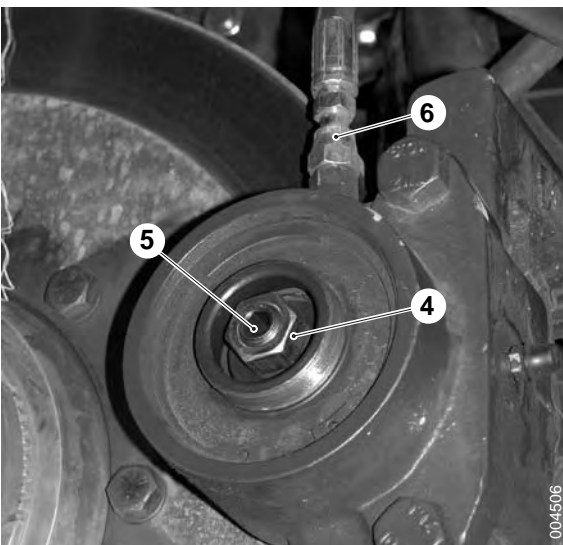
NOTE

Plug all unions at once to protect the hydraulic system from contamination.



3. Casing parking brake

- 6 Remove the casing (position 3) on the parking brake.



4. Lock nut
5. Release screw
6. Hydraulic hose, parking brake

- 7 Loosen the lock nut (position 4) and screw in the screw (position 5), this compresses the brake spring. Screw until the brake pads release from the brake disc. Reinstall the casing on the parking brake (position 3).
- 8 Disconnect the hydraulic hose (position 6) from the parking brake.

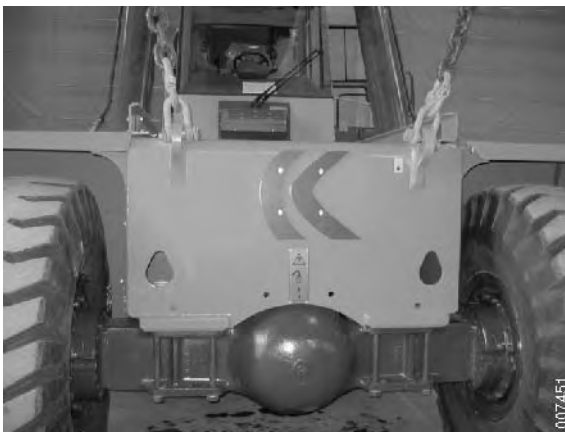
NOTE

Plug all unions at once to protect the hydraulic system from contamination.



Securing propeller shaft.

- 9 Disconnect the propeller shaft from the drive axle. Secure the propeller shaft, otherwise there is a risk that it will be pulled apart.



Lifting the machine

- 10 Lift the machine so that the wheels are off the ground.
- 11 Remove the drive wheels from the drive axle.
- 12 Block up the drive axle under the hubs.

CAUTION

The drive axle may start to roll.

Crushing injury!

Make sure that the drive axle does not roll away when not under control.

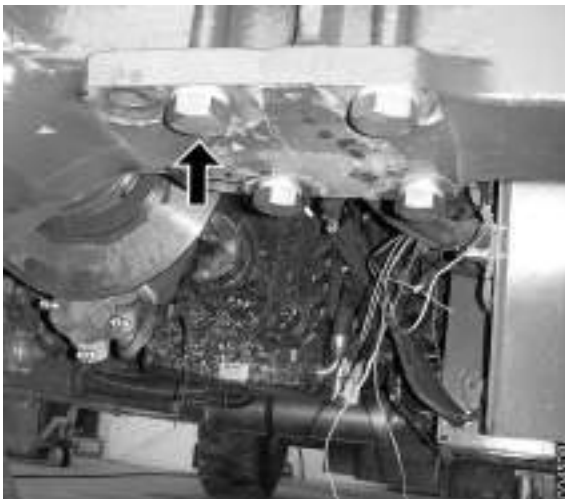
- 13 Remove the bolts that secure the drive axle in the frame.
- 14 Lift away the drive axle.

CAUTION

The drive axle may start to roll.

Crushing injury!

Make sure that the drive axle does not roll away when not under control.



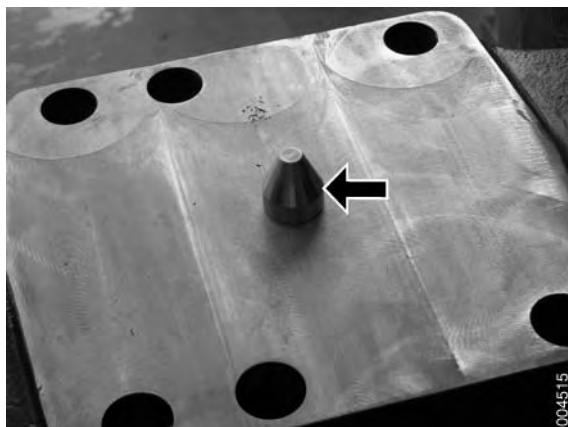
Attaching bolts, drive axle

- 15 Transfer parts from the old drive axle to the new one.

NOTE

Plug all unions at once to protect the hydraulic system from contamination.

- 16 Clean the contact surfaces on the drive axle and frame. Also clean the bolts' contact surface on the underside of the drive axle.



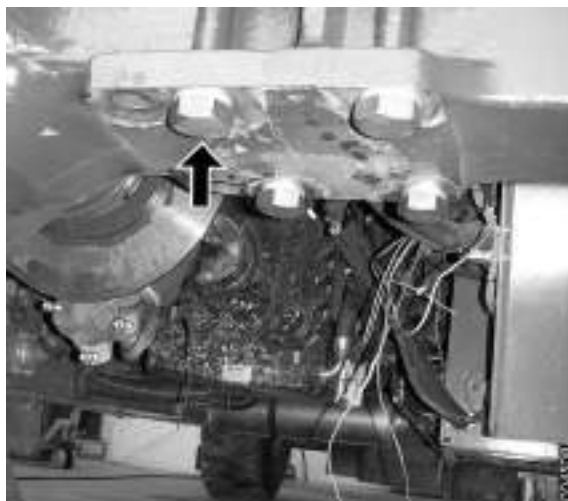
- 17 Remove the nuts for attaching the drive axle, blow clean and re-install the nuts.
- 18 Transfer the guide pins from the old axle to the new axle.
- 19 Lift the drive axle into place under the frame.

CAUTION

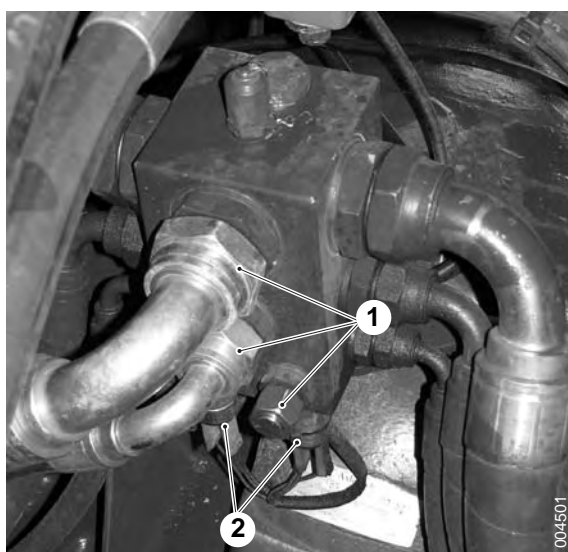
The drive axle may start to roll.

Crushing injury!

Make sure that the drive axle does not roll away when not under control.



- 20 Lower the frame toward the drive axle. Check that the guide pins fit in the frame.
- 21 Fit the new bolts that secure the drive axle in the frame. Tighten the bolts to a torque of **2820 Nm**.
- 22 Install the drive wheels on the new axle.
- 23 Rustproof the bolts with suitable paint.



- 24 Connect hydraulic hoses (position 1) and cabling (position 2) to the distribution block on the drive axle.
- 25 Connect the hydraulic hose to the parking brake, adjust the parking brake.
- 26 Connect the drive shaft to the drive axle, tighten the bolts to a torque of **156 Nm**. (Retighten the attaching bolts after 50 hr operating time).
- 27 Check the oil level in the drive axle.
- 28 Start the machine and bleed the brakes; see section *4 Brakes*, group *4.3.9 Wheel brake*.
- 29 Check for leaks.

Table of Contents 4 Brakes

4	Brakes	3
4.1	Controls and instruments	3
4.1.1	Brake pedal	3
4.3	Power-assisted brake system	5
4.3.1	Brake fluid pump	7
4.3.2	Brake fluid filter	12
4.3.3	Accumulator charging valve	13
4.3.4	Accumulator	16
4.3.5	Brake valve	20
4.3.6	Drive axle block	24
4.3.7	NC switch, brake fluid pressure	25
4.3.8	NO (normally open) switch, brake lights	26
4.3.9	Wheel brake	28
4.3.10	Pipes and hoses	30
4.5	Parking brake system	31
4.5.1	Brake fluid pump	32
4.5.2	Brake fluid filter	32
4.5.3	M-valve parking brake	33
4.5.4	Parking brake unit	34
4.5.5	Parking brake NC switch	37
4.5.6	Pipes and hoses	37
4.8	Temperature control, cleaning and brake oil	38
4.8.1	Brake fluid tank	39
4.8.2	Tank heater	40
4.8.3	Brake fluid pump	40
4.8.4	Accumulator charging valve	40
4.8.5	Drive axle block	40
4.8.6	Wheel brake	40
4.8.7	Oil cooler	41
4.8.8	Cooling fan	42
4.8.9	Thermal bypass valve	42
4.8.10	Sensor brake oil temperature	43
4.8.11	Breather filter	44
4.8.12	Brake fluid filter	45
4.8.13	Pipes and hoses	46
4.8.14	Brake system fluid	46

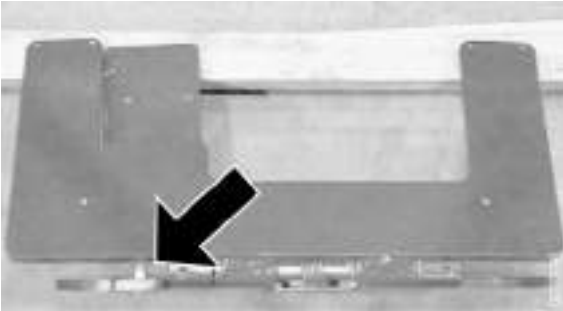
4 Brakes

4.1 Controls and instruments

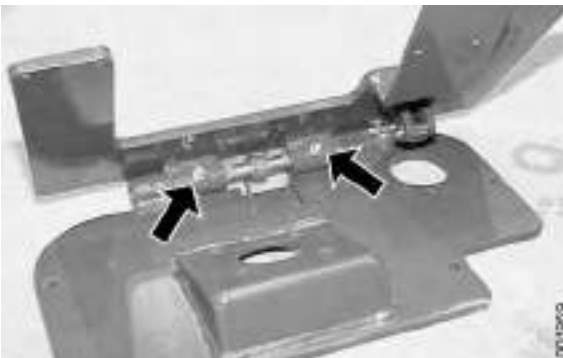
4.1.1 Brake pedal

Brake pedal, checking and adjusting

- 1 Clean the floor round the brake pedal and check that nothing is obstructing the movement of the brake pedal.
- 2 Check that the brake pedal springs back adequately and that the clearance between brake pedal and brake valve is 1–1.5 mm. If needed, adjust the brake pedal's stop bolt to correct clearance.
- 3 Check that the pedal moves easily.



Stop screw for adjusting clearance between brake pedal and brake valve. (The illustration shows a loose brake pedal.)



Lubrication points, brake pedal. (The illustration shows a loose brake pedal.)

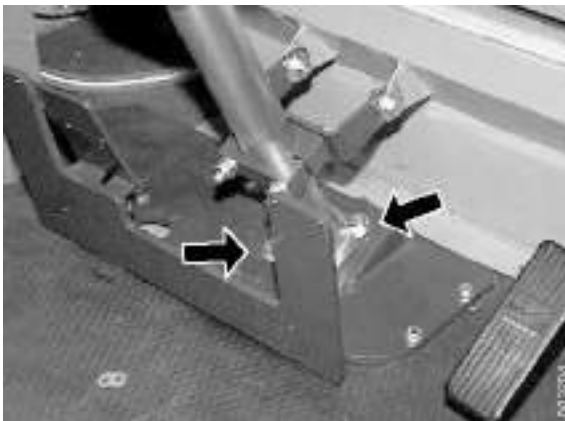
- 4 Lubricate the pedal hinge with "EP2" universal grease.
- 5 Check that the rubber pad on the brake pedal is intact and that the pattern is not worn away. Replace as necessary.
- 6 Check the brake valve; see *Brake valve, checking page 20*.

Brake pedal, replacement

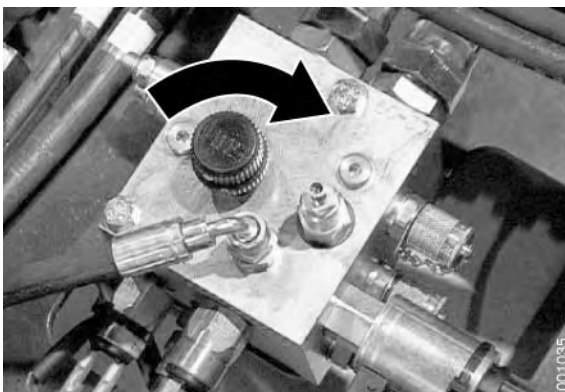
NOTE

Read the safety instructions for oil before working, see section B Safety.

- 1 Turn off the engine and the main electrical power.
- 2 Depressurise the brake and hydraulic systems, see section *B Safety*.
- 3 Detach the brake valve from the brake pedal.
Secure the brake valve on the cab's underside and remove the brake valve attaching bolt.



Mounting of steering wheel shaft and steering valve in pedal bracket.



- 4 Remove the panel around the steering wheel shaft.

NOTE

There is a variant available with adjustable steering wheel shaft.

- 5 Detach the steering valve from the pedal bracket.
Secure the steering valve on the cab's underside. Remove the steering valve's attaching bolts. Pull down the valve slightly so that the steering axle releases from the steering valve.
- 6 Detach the steering wheel shaft from the brake pedal.
Undo the bolts and pull the steering wheel shaft up slightly so that the brake pedal can be removed.
- 7 Detach the clutch-release pedal from the brake pedal.
- 8 Remove the brake pedal.
Remove the brake pedal's attaching bolt and lift away the brake pedal.
- 9 Transfer the pedal rubber to the new pedal.
- 10 Fit the new brake pedal.
Fit the pedal and fit the pedal's attaching bolts.
- 11 Connect the steering valve to the brake pedal.
- 12 Connect the brake valve to the brake pedal.
- 13 Fit the clutch pedal to the brake pedal.
- 14 Close the drain valve on the accumulator charging valve.

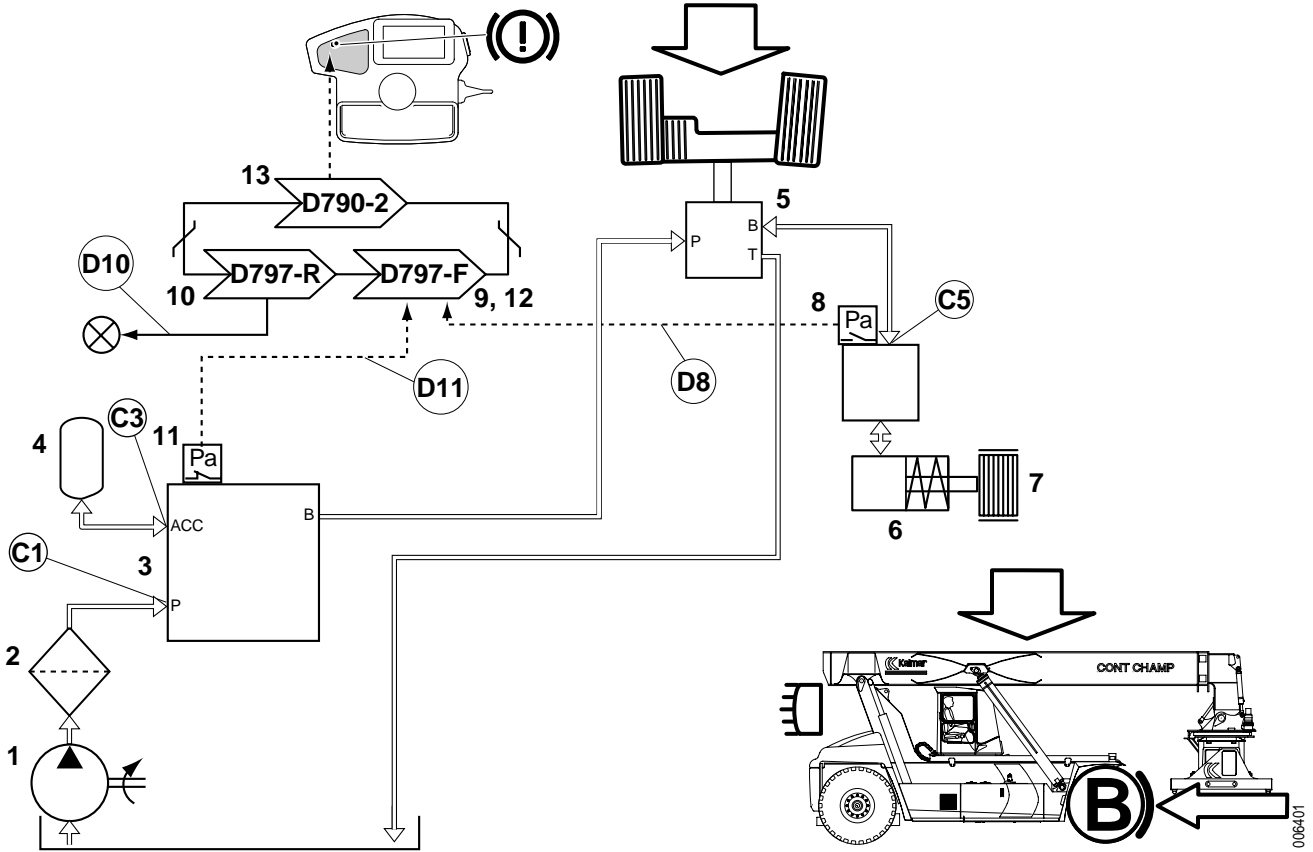
NOTE

Check that the accumulator drain valve is fully closed and tighten the lock ring.

- 15 Grease and adjust the brake pedal, see *Brake pedal, checking and adjusting* page 3.

4.3 Power-assisted brake system

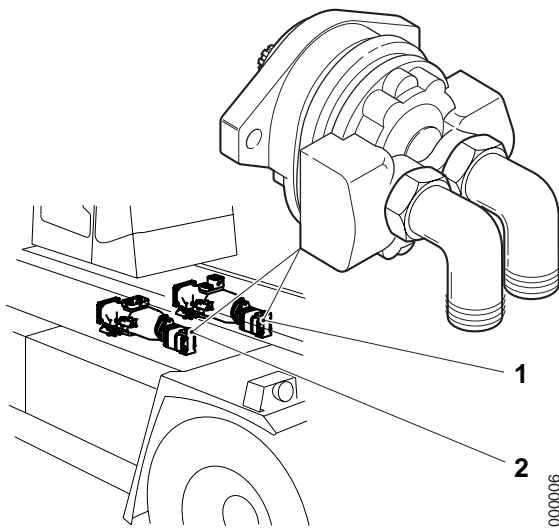
Power assisted brake system, function description



Pos	Explanation	Signal description	Reference
1	The brake fluid pump pumps fluid from the brake fluid tank.	$P = 20.5 \pm 1.0 \text{ MPa}$	<i>Brake fluid tank, description page 39</i> <i>Brake fluid pump, description page 7</i>
2	The brake oil filter cleans the oil.	-	<i>Brake fluid filter, description page 45</i>
3	The accumulator charging valve directs oil to charging of accumulators or through the brake system's cooling circuit.	-	<i>Accumulator charging valve, description page 13</i>
4	The accumulators store oil pressure.	See the pressure plate, Accumulator pressure brake system, on the left-hand frame member.	<i>Accumulator, description page 16</i>
5	The brake valve directs pressure from the accumulators to the brake cylinders proportional to pressing of the pedal.	-	<i>Brake valve, description page 20</i>

Pos	Explanation	Signal description	Reference
6	The brake cylinders compress the discs in the brake unit.	See the pressure plate, Brake pressure, on left-hand frame member.	<i>Wheel brake, description page 28</i>
7	The wheel brakes brake the machine.	-	<i>Wheel brake, description page 28</i>
8	The brake light NO switch (S216) closes the circuit when the brake cylinders are pressurised.	Brake pressure above 0.2 MPa: Conn 1, U = 24 V Conn 2, U = 24 V Brake pressure below 0.2 MPa: Conn 1, U = 24 V Conn 2, U = 0 V	<i>Switch normally open (NO), brake lights, description page 26</i> D8: Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.5.4 <i>HYD</i> , menu 4
9	Control unit, frame front (D797-F) transmits the brake light request on the CAN bus.	Checked by control system, error shown with error code.	Section 11 <i>Common electrics</i> , group 11.5.3.2 <i>Control unit, frame front</i>
10	The brake lights are activated by Control unit, frame rear (D797-R).	U = 24 V	Section 9 <i>Frame, body, cab and accessories</i> , group 9.6.4 <i>Brake lights</i> D10: Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.2.11 <i>LIGHTS</i> , menu 11
11	NC switch, brake oil pressure (S204) opens the circuit if the pressure in the accumulators is low.	Brake pressure above 11.5 MPa: Conn 1, U = 24 V Conn 2, U = 24 V Brake pressure below 11.5 MPa: Conn 1, U = 24 V Conn 2, U = 0 V	<i>NC switch, brake oil pressure, description page 25</i> D11: Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.5.4 <i>HYD</i> , menu 4
12	Control unit, frame front (D797-F) transmits a warning about low brake pressure on the CAN bus.	Checked by control system, error shown with error code.	Section 11 <i>Common electrics</i> , group 11.5.3.2 <i>Control unit, frame front</i>
13	Control unit KIT (D790-2) activates Warning light brake pressure.	Checked by control system, error shown with error code.	Section 11 <i>Common electrics</i> , group 11.5.3.11 <i>Control unit KIT</i>

Hydraulic diagram, basic machine



1. Brake fluid pump
2. Pump cooling and filtering, working hydraulics

000006

4.3.1 Brake fluid pump

Brake fluid pump, description

The brake system has a gear pump with fixed displacement. The brake oil pump is fitted at the front of the left-hand main pump. The pump generates hydraulic power, which is stored in the accumulators for brake force to the power-assisted brake and parking brake. It also generates the oil flow used for cleaning and cooling. The switchover between power generation and flow is regulated by the accumulator charging valve, see *Accumulator charging valve, description page 13*.

The brake oil pump is driven by the main pump's shaft from gearbox power take-off. The brake oil pump's speed is directly dependent on engine speed. The pump flow rate increases with engine speed and varies with the speed of the input shaft.

NOTE

It is very important that the clearance between the gears and between the gear and the housing is correct. Clearance that is too small creates wear damage. Clearance that is too large reduces the pump's power output.

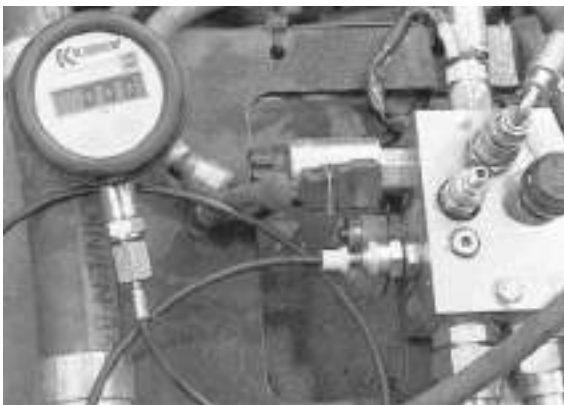
Brake fluid pump, check

NOTE

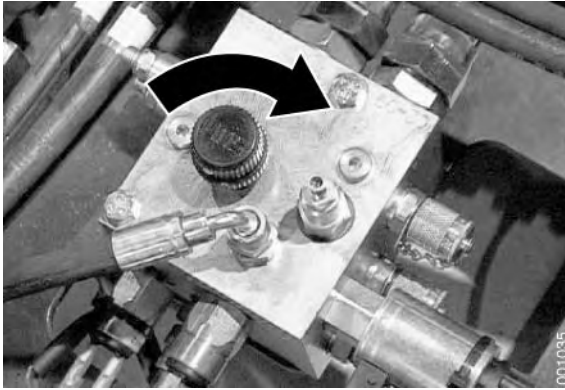
Read the safety instructions for oil before working, see section B Safety.

Checking pump pressure

- 1 Operate and warm up the machine so that the oil in the brake system reaches operating temperature, at least 50 °C.
- 2 Machine in service position, see section *B Safety*
- 3 Depressurise the brake and hydraulic systems, see section *B Safety*.
- 4 Connect a pressure gauge (0–25 MPa) to the pump pressure measuring outlet on the accumulator charging valve.
- 5 Start the engine and run it at idling speed.



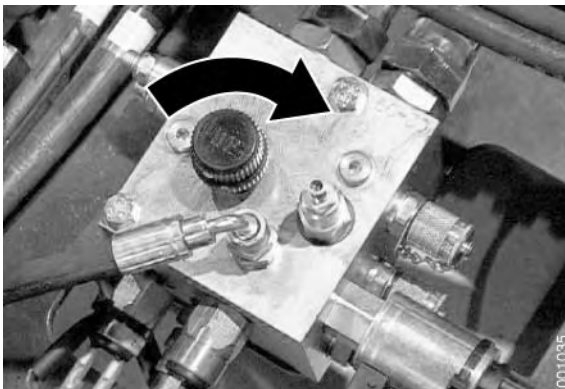
Measuring outlet, pump pressure



Close the accumulator charging valve



Measuring outlet, accumulator pressure



- 6 Close the drain valve on the accumulator charging valve and check the pump pressure during charging.

During charging the pressure should increase to **20.5 ±1.0 MPa** before the accumulator charging valve switches to cooling. When the accumulator charging valve switches to cooling, the pressure drops.

- 7 Check the pressure during cooling.

During cooling the pressure should be **max. 1.0–1.5 MPa** at max. engine rpm.

- 8 Stop the engine

- 9 Depressurise the brake and hydraulic systems, see section *B Safety*.

- 10 Remove the pressure gauge and fit the protective cap on the measuring outlet.

- 11 Close the drain valve on the accumulator charging valve.

Checking accumulator charging

- 12 Depressurise the brake and hydraulic systems, see section *B Safety*.

- 13 Connect a pressure gauge (0–25 MPa) to the measuring outlet for accumulator pressure on the accumulator charging valve.

- 14 Start the engine and run it at idling speed.

- 15 Close the drain valve on the accumulator charging valve.

- 16 Check that the pressure increases slowly to **20.5 ±1.0 MPa**.

- 17 Brake repeatedly and check at which pressure the accumulator charging valve switches to charging.

The valve must switch to cooling at **15.5 ±0.5 MPa**.

- 18 Depressurise the brake and hydraulic systems, see section *B Safety*.

- 19 Remove the pressure gauge and fit the protective cap on the measuring outlet.

- 20 Close the drain valve on the accumulator charging valve.

NOTE

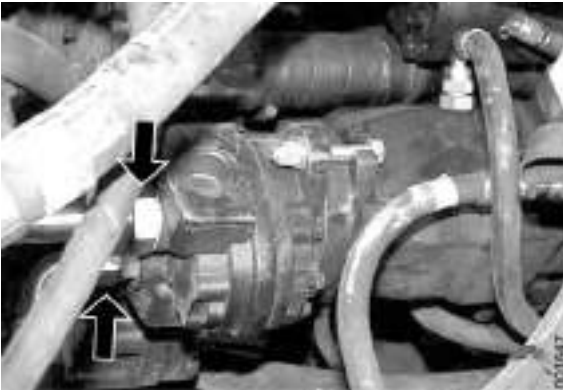
Check that the accumulator drain valve is fully closed and tighten the lock ring.

Brake oil pump, replacement (hydraulic oil pump alternative Rexroth)

NOTE

Read the safety instructions for oil before working, see section B Safety.

- 1 Machine in service position, see section B Safety.
- 2 Depressurise the brake and hydraulic systems, see section B Safety.
- 3 Mark up and detach the hydraulic hoses from the pump.



NOTE

Plug all connections immediately to protect the brake system from impurities.



- 4 Remove the attaching bolts, pull the pump out backwards and lift it away.
- 5 Transfer the connection adapters and the contact to the new pump.



- 6 Remove the spacer ring from the brake pump or hydraulic oil pump.
Clean the O-rings' contact surfaces on the spacer ring.
- 7 Check the O-rings and replace as required. Install the O-rings on the spacer ring. Brush sealing silicone on the sealing face against the brake pump, see section F Technical data.

NOTE

Only use silicone on the side facing the brake pump.



8 Fit the spacer ring on the main pump.

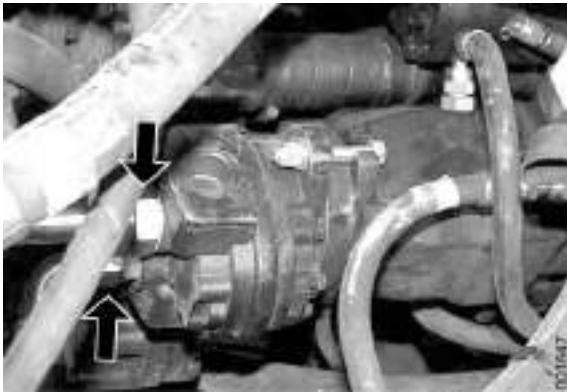


9 Brush sealing silicone on the brake pump's sealing face against the spacer ring; see section *F Technical data*.

10 Fit the brake pump on the main pump.

Fit the pump and check that the gear engages in the shaft and that the spacer ring is directly against the brake pump.

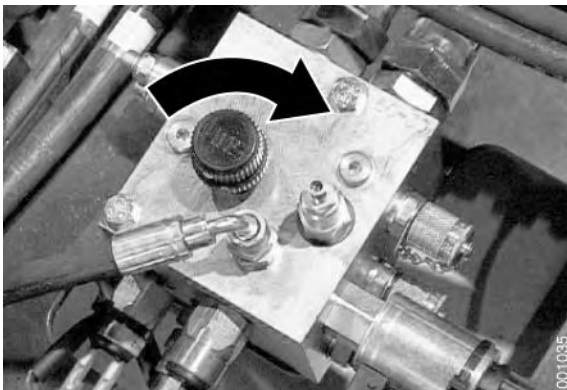
Fit the pump's attaching bolts.



11 Connect the hydraulic hoses to the brake pump.

NOTE

Check that the O-rings are intact and are fitted correctly.



12 Close the drain valve on the accumulator charging valve.

NOTE

Check that the accumulator drain valve is fully closed and tighten the lock ring.

13 Turn on the main electric power and start the engine.

- 14 Check that the hose connections and seal between the hydraulic oil pump and brake pump are fully sealed.

Check the feed pressure from the brake pump, see *Brake fluid pump, check page 7*.

- 15 Check the oil level in the brake system, fill as necessary.

NOTE

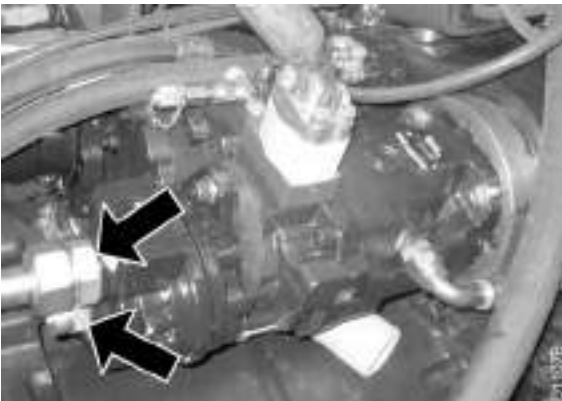
If the pump is replaced due to malfunction, change the oil and filter in the brake system as well.

Brake oil pump, replacement (hydraulic oil pump alternative Sauer-Danfoss)

NOTE

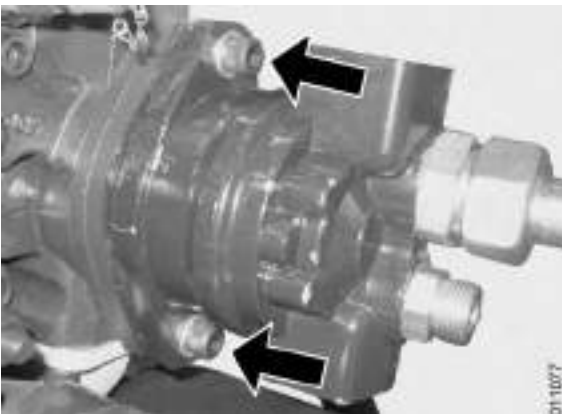
Read the safety instructions for oil before working, see section B Safety.

- 1 Machine in service position, section B Safety.
- 2 Depressurise the brake and hydraulic systems, see section B Safety.
- 3 Mark up and detach the hydraulic hoses from the pump.



NOTE

Plug all connections immediately to protect the brake system from impurities.



- 4 Remove the attaching bolts, pull the pump out backwards and lift it away.
- 5 Transfer the connection adapters and the contact to the new pump.

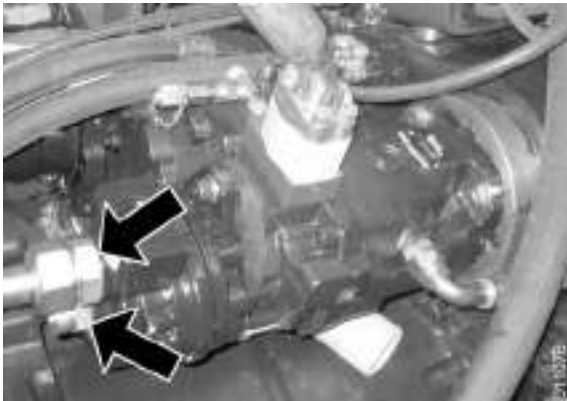


6 Brush sealing silicone on the brake pump's sealing face; see section *F Technical data*.

7 Fit the brake pump on the main pump.

Position the pump and check that the pump's splines engage in the shaft in the main pump.

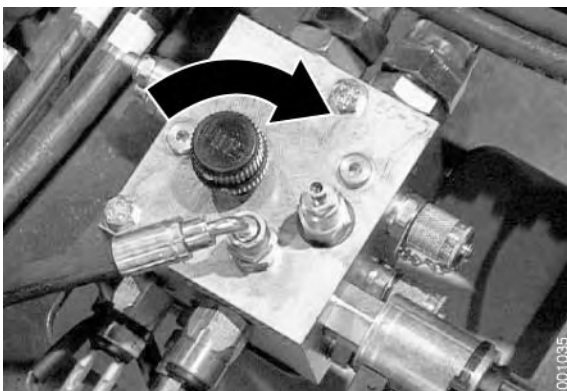
Fit the pump's attaching bolts.



8 Connect the hydraulic hoses to the brake pump.

NOTE

Check that the O-rings are intact and are fitted correctly.



9 Close the drain valve on the accumulator charging valve.

NOTE

Check that the accumulator drain valve is fully closed and tighten the lock ring.

10 Turn on the main electric power and start the engine.

11 Check that the hose connections and seal between the hydraulic oil pump and brake pump are fully sealed.

Check the feed pressure from the brake pump, see *Brake fluid pump, check page 7*.

12 Check the oil level in the brake system, fill as necessary.

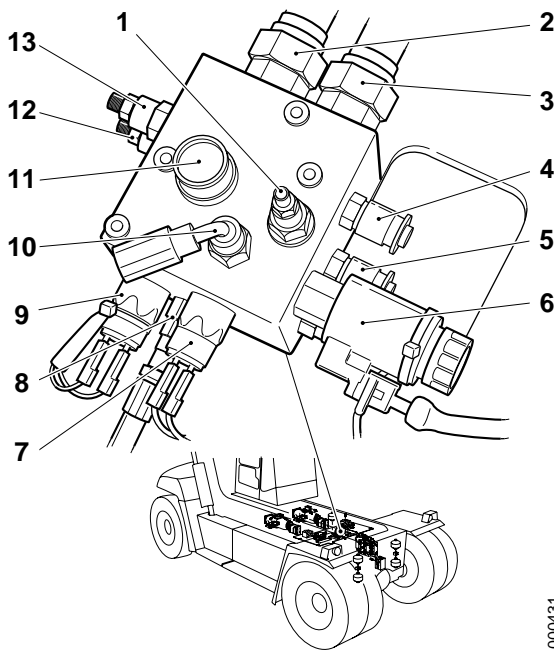
NOTE

If the pump is replaced due to malfunction, change the oil and filter in the brake system as well.

4.3.2 Brake fluid filter

Brake fluid filter, general

See *Brake fluid filter, description page 45*.



1. Safety valve
2. Connection from pump (P)
3. Wheel brake connection (T)
4. Measuring outlet, pump pressure (P)
5. Measuring outlet, accumulator pressure (M)
6. Solenoid valve parking brake (Y642)
7. NC switch, parking brake (GHB) (S200)
8. Connection, accumulators (ACC)
9. NC switch, brake fluid pressure (LB) (S204)
10. Connection, parking brake caliper (HB)
11. Drain valve
12. Main valve, charging
13. Pressure limiting valve

4.3.3 Accumulator charging valve

Accumulator charging valve, description

The accumulator charging valve distributes oil from the hydraulic oil pump between pressure storage and cooling of the wheel brakes. The accumulator charging valve is fitted on the beam in front of the gear-box in the engine compartment.

The accumulator charging valve stores pressure by guiding the oil to the accumulators. The wheel brakes are cooled by oil being guided to the drive axle cooling circuit and then on to the brake system cooler.

The accumulator charging valve prioritises charging of the accumulators above cooling. A restriction of the charging means that a small quantity of oil also flows to cooling during accumulator charging. At idling speed the flow from the pump is so small that all oil flows to pressure storage.

The drain valve (position 11) is used to relieve the pressure in the accumulators to the tank. The valve opens a connection between the accumulators and the wheel brake's cooling circuit. The oil is drained through the wheel brake to the tank.

There is a measuring outlet for measuring the accumulator pressure (position 5) and pump pressure (position 4) on the accumulator charging valve. The pressures are individual to each machine and each are specified on the pressure plate on the left-hand frame member, see section 10 *Common hydraulics*. The accumulator charging valve also houses the parking brake solenoid valve (position 6), brake fluid pressure NC switch (position 9) and parking brake NC switch (position 7).

- *Solenoid valve parking brake, description page 33*
- *NC switch, brake oil pressure, description page 25*
- *Parking brake NC switch, description page 37*

Accumulator charging, checking and adjustment

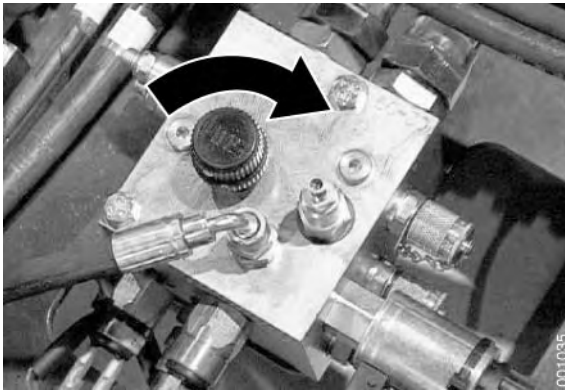
NOTE

Read the safety instructions for oil before working, see section B Safety.

- 1 Machine in service position, see section *B Safety*.
- 2 Check accumulator charging; see *Brake fluid pump, check page 7*.



Adjusting screw accumulator charging pressure



- 3 If necessary, adjust the accumulator charging pressure on the pressure limiting slide.
Undo the lock nut and adjust the pressure by turning the adjusting screw.
Clockwise: reduce pressure.
Counter-clockwise: increase pressure.
- 4 Open the drain valve on the accumulator charging valve so that the accumulators are drained and the valve switches to charging. Close the valves and check the max. pressure again.
- 5 Repeat steps 3 and 4 until the pressure is correct.
- 6 Close the drain valve on the accumulator charging valve.

NOTE

Check that the accumulator drain valve is fully closed and tighten the lock ring.

Accumulator charging valve, replacement**NOTE**

Read the safety instructions for oil before working, see section B Safety.

- 1 Machine in service position, see section B Safety.
- 2 Depressurise the brake and hydraulic systems, see section B Safety.
- 3 Mark up hydraulic hoses and electric cables.
- 4 Detach the wiring from the accumulator charging valve.
- 5 Detach and plug all hydraulic hoses from the accumulator charging valve.
Remove the parking brake valve (C) for easier access.

NOTE

Plug all connections immediately to protect the brake system from impurities.





- 6 Remove the accumulator charging valve.
- 7 Transfer the connection adapters and sensors to the new accumulator charging valve.
- 8 Fit the new valve.

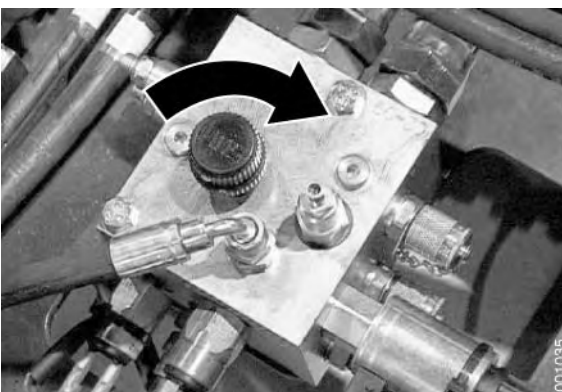


- 9 Connect the hoses to the accumulator charging valve in accordance with the marking.

NOTE

Check that the O-rings are intact and are fitted correctly.

- 10 Fit the parking brake valve and NC switch parking brake.
- 11 Connect the wiring to the accumulator charging valve.



- 12 Close the drain valve on the accumulator charging valve.

NOTE

Check that the accumulator drain valve is fully closed and tighten the lock ring.

- 13 Turn on the main electric power and start the engine.
Check that the hydraulic connections are sealed tightly.
- 14 Check the charging and changing function, see *Accumulator charging, checking and adjustment* page 13.

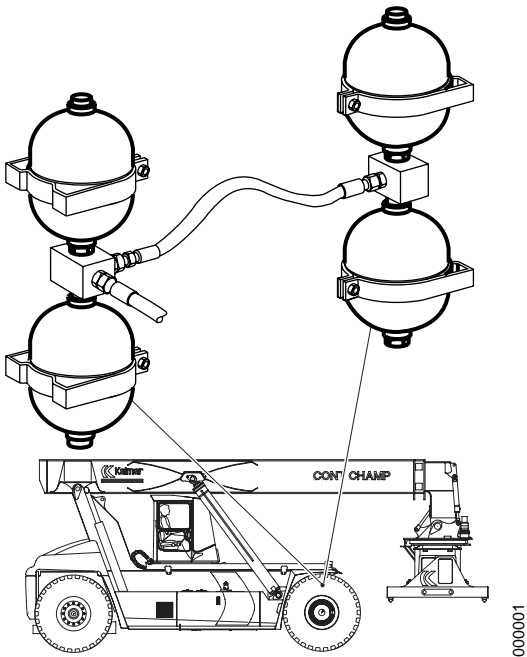
4.3.4 Accumulator

Accumulator, description

The accumulators store pressure so that there is a pressure reserve in the event of engine or brake system malfunction. The brake system has four accumulators connected in parallel. These are fitted at the front in the engine compartment, above the drive axle.

The accumulators are of the diaphragm type. Each accumulator is divided into two spaces by a diaphragm. One side of the diaphragm is pressurised by nitrogen gas. The other side is pressurised by the hydraulic oil, which compresses the nitrogen gas.

The accumulator has test outlets for checking the gas pressure on the opposite side to the pressure connection.



Accumulator, checking

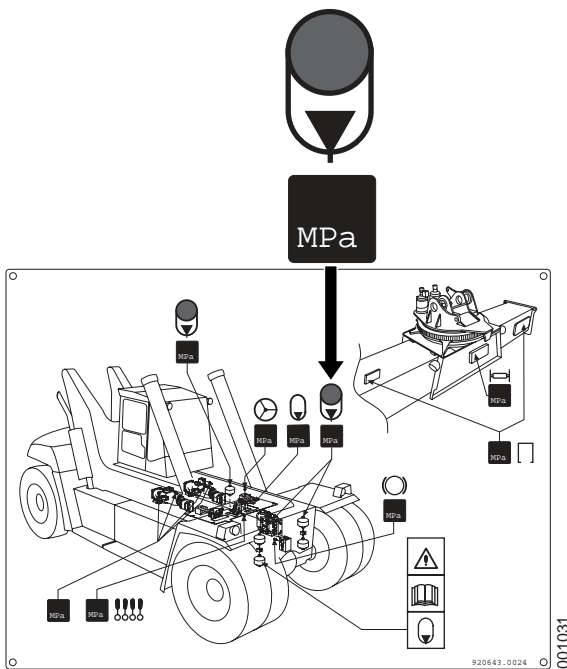
NOTE

Read the safety instructions for oil before working, see section B Safety.

- 1 Machine in service position, see section B Safety.
- 2 Depressurise the brake and hydraulic systems, see section B Safety.
- 3 The accumulators can be tested with separate test equipment or in the machine. Primarily, separate test equipment should be used since it is faster and more accurate.

Test equipment can be ordered from Cargotec.

- **Check with test equipment:** continue with step 4.
- **Check in machine:** continue with step 6.



Pressure plate, gas pressure brake accumulators



Checking with test equipment

- 4 Remove the accumulators and test them with the intended test equipment.
The accumulators' gas pressure should match with the pressure plate.
- 5 Continue with step 17.

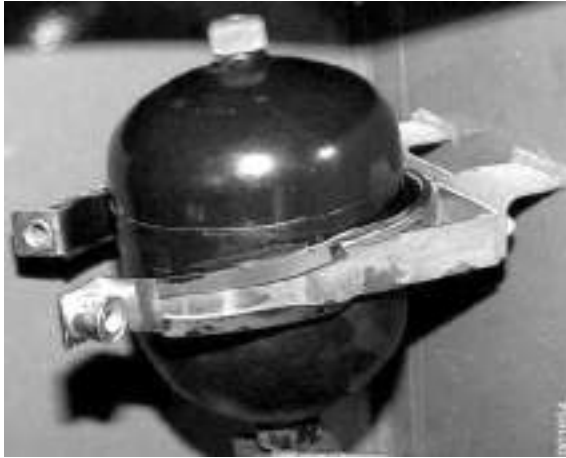
Checking in machine

- 6 Detach three of the accumulators from the distribution block. Plug the distribution block connections with plugs that can withstand high pressure. Plug the connections on the accumulators to protect against contamination.
- 7 Connect a pressure gauge (0–25 MPa) to the measuring outlet for accumulator pressure on the accumulator charging valve.
- 8 Turn on the main electric power and start the engine.
- 9 Close the drain valve on the accumulator charging valve and charge the accumulator until the accumulator charging valve changes to cooling.
- 10 Check that the plugs seal properly.
- 11 Stop the engine
- 12 Lower the pressure by means of braking carefully several times while checking the pressure on the pressure gauge.

When the pressure reaches **approx. 10 MPa** the pressure must decrease immediately to 0 MPa.

If the pressure drops immediately when the engine is shut off, then the accumulator does not have any pre-charge pressure. This indicates internal leakage and the accumulator must be changed.

If the pressure can be reduced slowly to a pressure below **10 MPa** then the precharge pressure is too low and the accumulator must be replaced or given to authorised personnel for maintenance.



- 13 Depressurise the brake and hydraulic systems, see section *B Safety*.
- 14 Mark up and disconnect the tested accumulator. Plug the connections. Connect one of the other accumulators to the distribution block.
- 15 Repeat steps 8 - 14 until all accumulators have been checked.
- 16 Depressurise the brake and hydraulic systems, see section *B Safety*.

Installing and final checking

- 17 Connect all accumulators to the distribution blocks. If needed, replace or fill defective accumulators.

NOTE

Check that the seals are intact and are fitted correctly.

- 18 Turn on the main electric power and start the engine.
- 19 Close the drain valve on the accumulator charging valve.

NOTE

Check that the accumulator drain valve is fully closed and tighten the lock ring.

- 20 Check that the accumulators' connections are sealed tightly.
- 21 When the accumulators are fully charged, shut off the engine and turn the start key to position I.
- 22 Check that at least **8** brake applications (pedal depressions) can be performed before the pressure drops to **10 MPa**.

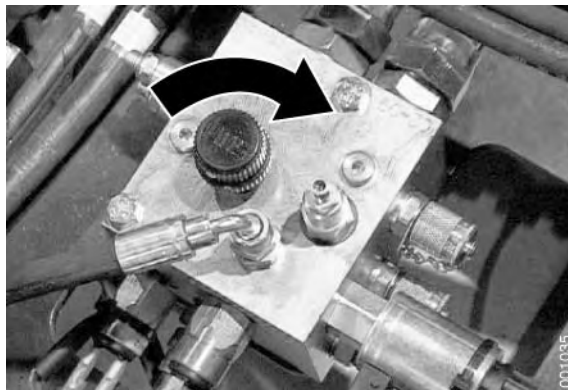
At **11.5 MPa** the warning lamp for low brake pressure must come on.

Accumulator, replacement

NOTE

*Read the safety instructions for oil before working, see section *B Safety*.*

- 1 Machine in service position, see section *B Safety*.
- 2 Turn off the engine and the main electrical power.
- 3 Depressurise the brake and hydraulic systems, see section *B Safety*.

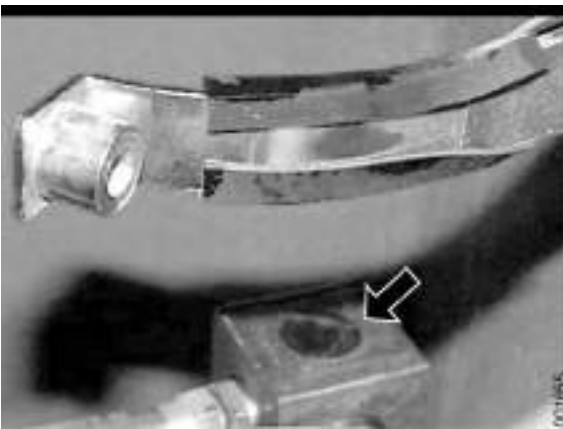




- 4 Detach the accumulator's clamp and remove the bolt.
- 5 Detach the accumulator from the distribution block.

NOTE

Hold the block firmly so that the other accumulator does not work loose.



- 6 Bend the clamp away and remove the accumulator.

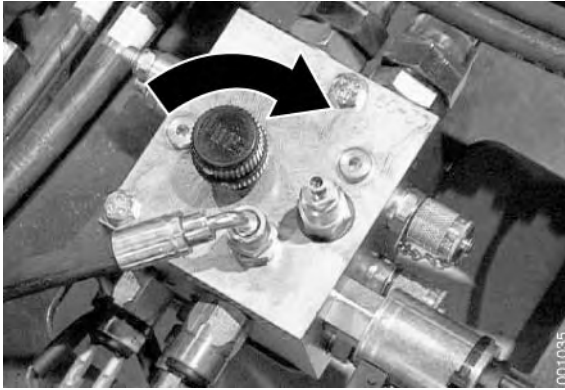


- 7 Fit the new accumulator.

NOTE

Check that the seal is intact and is fitted correctly.

- 8 Secure the accumulator's clamp and tighten the bolt.



- 9 Close the drain valve on the accumulator charging valve.

NOTE

Check that the accumulator drain valve is fully closed and tighten the lock ring.

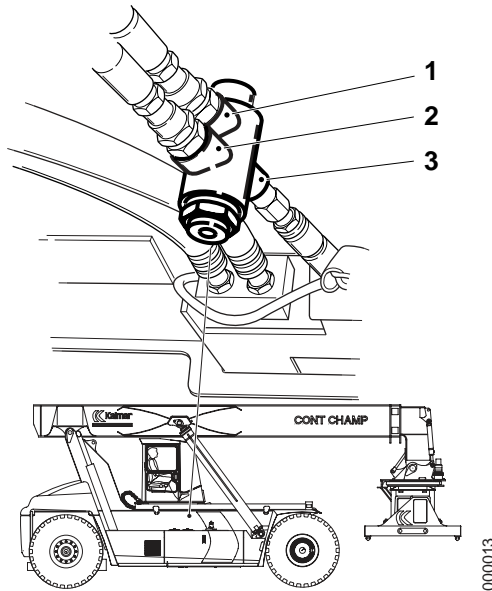
- 10 Turn on the main electric power and start the engine.
- 11 Check that the accumulator's connection is sealed tightly.
- 12 Check precharging and function, see *Accumulator, checking* page 16 steps 18-19.

4.3.5 Brake valve

Brake valve, description

The brake valve, which is located on the underside of the cab underneath the brake pedal, controls the hydraulic pressure to the brakes. A lever transfers pedal force to the valve.

The brake valve is a mechanically activated proportional valve. This means that the resistance in the brake valve increases in proportion to brake pressure. This provides optimum pedal responsiveness and increased safety as the operator senses if no brake pressure is being built up (no resistance in the pedal).



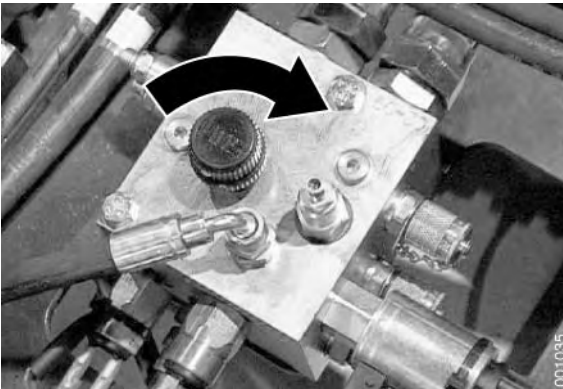
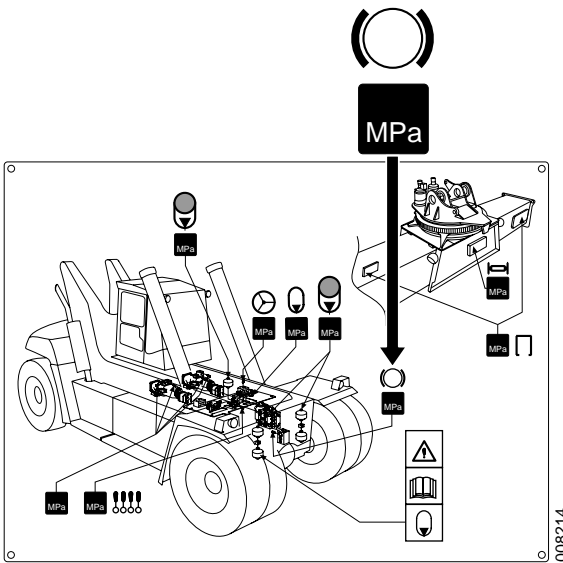
1. Inlet from accumulator [P]
2. Return connection [T]
3. Outlet to brake cylinders [B]

Brake valve, checking

NOTE

Read the safety instructions for oil before working, see section B Safety.

- 1 Operate and warm up the machine so that the brake fluid reaches operating temperature, at least 50 °C.
- 2 Machine in service position, see section *B Safety*.
- 3 Depressurise the brake and hydraulic systems, see section *B Safety*.



- 4 Connect a pressure gauge (0-25 MPa) to the measuring outlet for brake pressure on the distribution block on the front axle.
- 5 Close the drain valve on the accumulator charging valve.
- 6 Start the machine and run it at idling speed until the accumulators are charged and the accumulator charging valve changes to cooling.
- 7 Press down the pedal completely and read off the pressure. Compare to the pressure plate on the left frame member.
- 8 Stop the engine

- 9 Depress the pedal fully and keep it pressed down, check the pressure.
The brake pressure must correspond with the value specified on the pressure plate and must not decrease from this value for 15 seconds.
- 10 Release the pedal, the brake pressure must decrease to 0 MPa immediately. Otherwise the brake valve is not sealed and can cause the brakes to remain applied and then overheat during operation.
Replace the brake valve if it is not sealed.
- 11 Depressurise the brake and hydraulic systems, see section *B Safety*.
- 12 Remove the pressure gauge and fit the protective cap on the measuring outlet.
- 13 Close the drain valve on the accumulator charging valve.

NOTE

Check that the accumulator drain valve is fully closed and tighten the lock ring.

Brake valve, replacement

NOTE

Read the safety instructions for oil before working, see section B Safety.

- 1 Slide the cab forward slightly so that the brake valve is accessible under the cab.
- 2 Machine in service position, see section B Safety.
- 3 Depressurise the brake and hydraulic systems, see section B Safety.
- 4 Mark up and detach the hydraulic hoses from the brake valve.



NOTE

Plug the connections immediately to protect the brake system from impurities.

- 5 Secure the brake valve under the cab.



- 6 Remove the brake valve attaching bolt.
- 7 Remove the brake valve.
- 8 Transfer the connection adapters to the new brake valve.
- 9 Install the new brake valve.

NOTE

Remember the spacer ring.

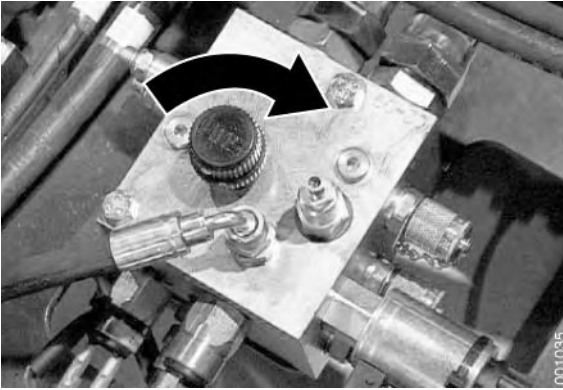
- 10 Connect the hydraulic hoses to the brake valve in accordance with the marking.

NOTE

Check that the O-rings are intact and are fitted correctly.

- 11 Grease and adjust the brake pedal, see *Brake pedal, checking and adjusting* page 3.

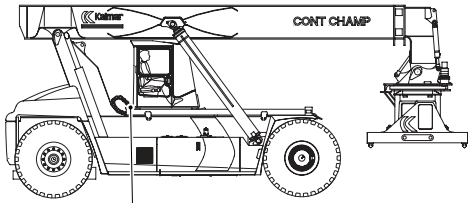




- 12 Close the drain valve on the accumulator charging valve.

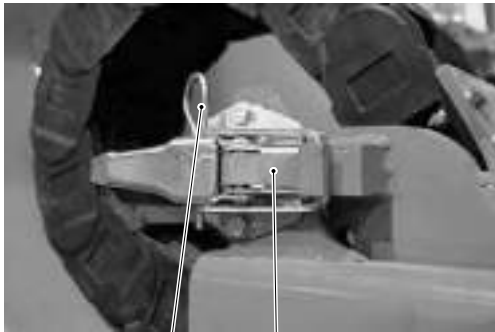
NOTE

Check that the accumulator drain valve is fully closed and tighten the lock ring.



A

- 13 On machines with manual sliding cab. Secure the cab in the rear-most position with the cab locks.
- 14 Turn on the main electric power and start the engine. Run the engine at idling speed.
- 15 Test the brakes a couple of times.
- 16 Check that the brake valve's connections are sealed tightly.
- 17 Bleed the wheel brakes' brake cylinders, see *Wheel brakes, bleeding* page 29.



B

C

000270

- A. Location, lock handle
 B. Lock pin
 C. Lock handle for securing cab

4.3.6 Drive axle block

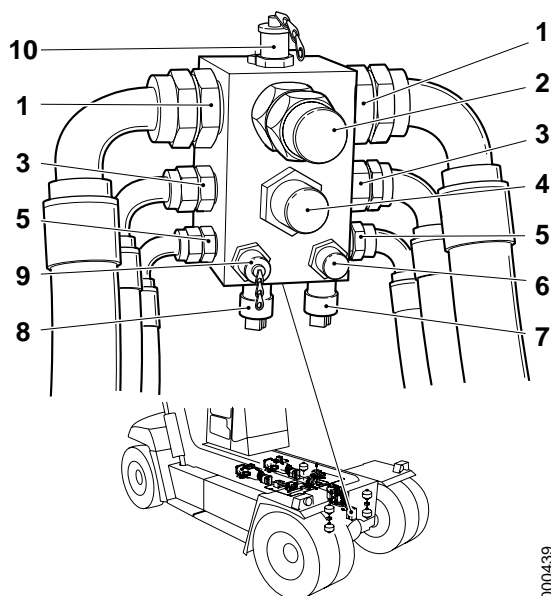
Drive axle block, description

The drive axle block distributes oil flow and brake pressure to the right and left-hand wheel brakes. The drive axle block is located on a bracket above the drive axle differential.

The drive axle block has a measuring outlet for brake pressure and for measuring back pressure in the disc brake's cooling circuit.

The drive axle block has a bypass valve which guides oil directly from the cooling circuit intake to the cooling circuit return if the resistance in the axle becomes too great. This protects the wheel brake seals, e.g. when the oil is cold.

The drive axle block houses two switches: brake light NO (normally open) switch (S216), see *Switch normally open (NO), brake lights, description page 26*, and declutch NO switch (S220-2), see section 2 *Transmission, group 2.8.2 Normally open (NO) switch, declutch*.



000439

1. Brake cooling connection, return from wheel brake
2. Brake cooling connection, return to cooler
3. Brake cooling connection, to wheel brake
4. Brake cooling connection from accumulator charging valve
5. Brake cylinder connection, to wheel brake
6. Brake pressure connection, from brake valve
7. NO switch, declutch (S220-2)
8. NO switch, brake lights (S216)
9. Measuring outlet, brake pressure
10. Measuring outlet, brake cooling back pressure

4.3.7 NC switch, brake fluid pressure

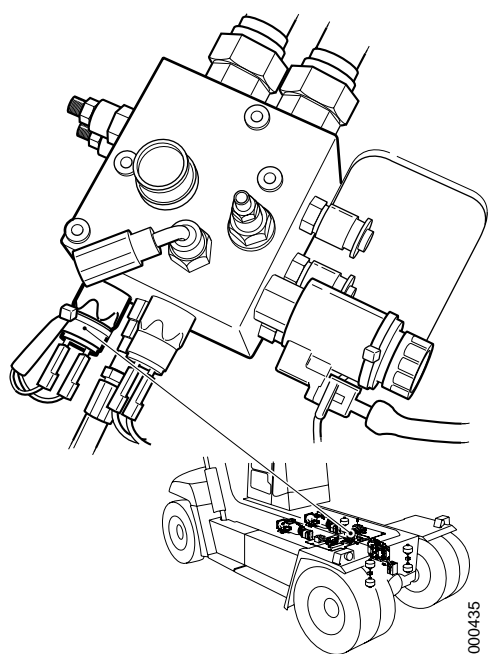
NC switch, brake oil pressure, description

The brake oil pressure NC switch (S204) detects the pressure in the accumulators. The NC switch is located on the accumulator charging valve on the lifting beam in front of the gearbox in the engine compartment.

When the pressure in the feed circuit is high enough to ensure braking of the machine, the sensor closes an electric circuit. This is used to warn for pressure-drop in the brake system. The sensor's opening pressure is chosen so that there is pressure for another eight brake applications without additional feed from the pump after the light has gone off.

The brake oil pressure NC switch (S204) is supplied voltage by Control unit, frame front (D797-F). When the pressure increases above the cut-off pressure, the voltage signal to Control unit, frame front (D797-F) is cut off.

The signal can be checked from the diagnostic menu, see tab 8 *Control system*, group 8.4.5.4 *HYD, menu 4*.



000435

Brake oil pressure NC switch, adjustment

NOTE

Read the safety instructions for oil before working, see section B Safety.

- 1 Operate and warm up the machine until the oil reaches operating temperature, at least 50 °C.
- 2 Machine in service position, see section *B Safety*.
- 3 Depressurise the brake and hydraulic systems, see section *B Safety*.
- 4 Connect a pressure gauge (0-25 MPa) to the measuring outlet for accumulator pressure on the accumulator charging valve.
- 5 Close the drain valve on the accumulator charging valve.
- 6 Start the engine and fully charge the accumulators (the accumulator charging valve changes to cooling).
- 7 Stop the engine and turn the starter key to position I.
- 8 Brake several times, stop when the warning lamp for low brake pressure comes on.
- 9 Read off the accumulator pressure. The pressure should be **approx. 11.5 MPa**.
- 10 If necessary, adjust the warning level by turning the adjusting screw in the rear edge of the sensor, between the contact pins.



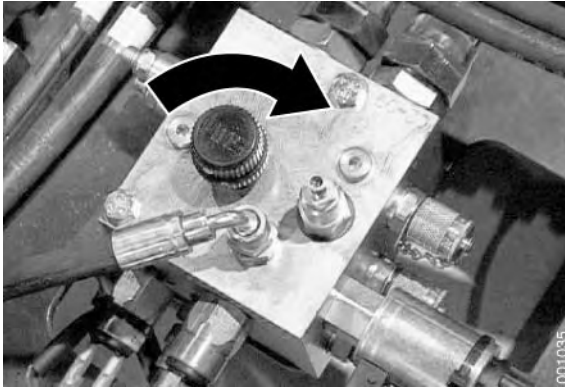
NOTE

The setting is very sensitive, turn max. 1/4 turn at a time.

- 11 Repeat steps 6-10 until the warning lamp comes on at 11.5 MPa.
- 12 Seal the adjusting screw with locking fluid.
- 13 Depressurise the brake and hydraulic systems, see section *B Safety*.
- 14 Remove the pressure gauge and fit the protective cap on the measuring outlet.
- 15 Close the drain valve on the accumulator charging valve.

NOTE

Check that the accumulator drain valve is fully closed and tighten the lock ring.



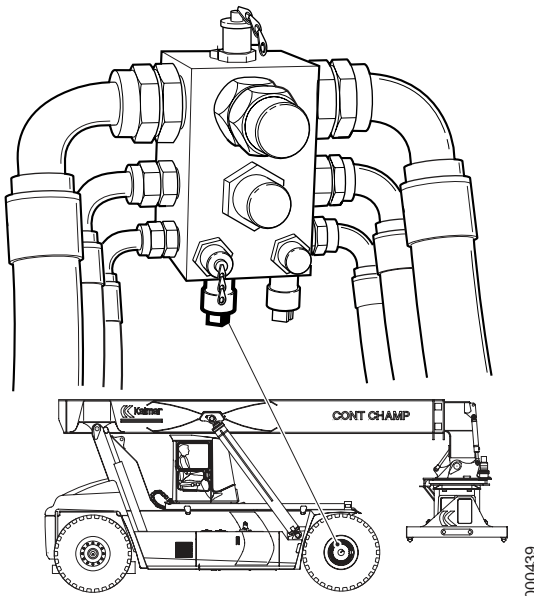
4.3.8 NO (normally open) switch, brake lights

Switch normally open (NO), brake lights, description

The brake light NO switch controls brake light activation when the machine brakes. The switch is located on the drive axle block which sits on a bracket above the drive axle differential.

The brake light NO switch (S216) is supplied voltage by and sends a voltage signal to Control unit, frame front (D797-F). When the pressure increases above the closing pressure, a voltage signal is sent to Control unit, frame front (D797-F).

The signal can be checked from the diagnostic menu, see tab 8 *Control system*, group 8.4.5.4 *HYD*, menu 4.

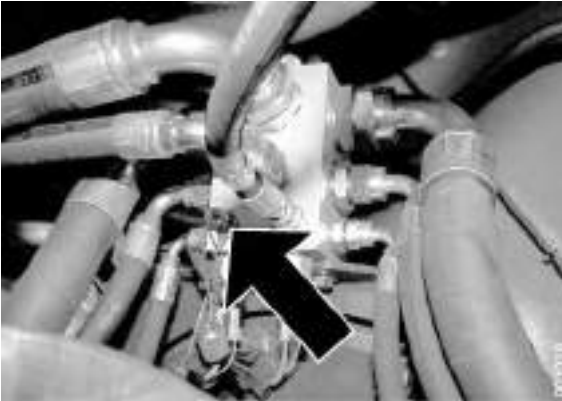


Brake light NO switch, checking

NOTE

Read the safety instructions for oil before working, see section B Safety.

- 1 Operate and warm up the machine until the brake fluid reaches operating temperature, at least 50 °C.
- 2 Stop the engine and turn the starter key to position I.
- 3 Brake and check that the brake light comes on.



DIAG HYD	4 (6)
PRESSURE SWITCHES	
BRAKE PRESSURE	X
BRAKE LIGHT PRESS.	X
DECLUTCH PRESSURE	X

000144

- 4 Depressurise the brake and hydraulic systems, see section *B Safety*.
- 5 Connect a pressure gauge (0-25 MPa) to the measuring outlet for brake pressure on the distribution block.
- 6 Close the drain valve on the accumulator charging valve.
- 7 Start the engine.

- 8 Use the display, go to the diagnostic menu, see section *8 Control system*, group *8.4.5.4 HYD, menu 4*.

BRAKE LIGHT PRESS. indicates status for the brake light contact. 1 = Activated contact (brakes applied).

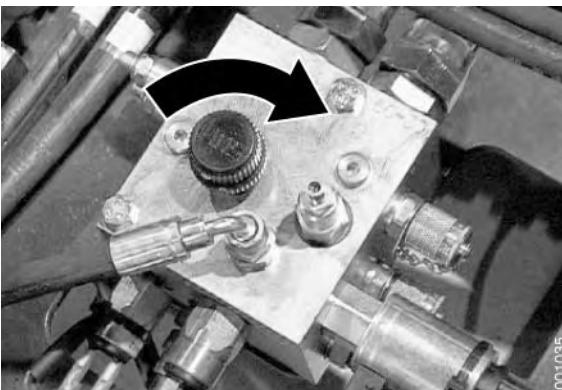
- 9 Press down the brake pedal slowly until the brake light is activated or the status of the input signal changes. Keep the pedal in this position and check the pressure on the pressure gauge.

The status can be changed and the brake light should come on when the pressure is **approx. 0.2 MPa**.

- 10 Stop the engine
- 11 Depressurise the brake and hydraulic systems, see section *B Safety*.
- 12 Remove the pressure gauge and fit the protective cap on the measuring outlet.
- 13 Close the drain valve on the accumulator charging valve.

NOTE

Check that the accumulator drain valve is fully closed and tighten the lock ring.

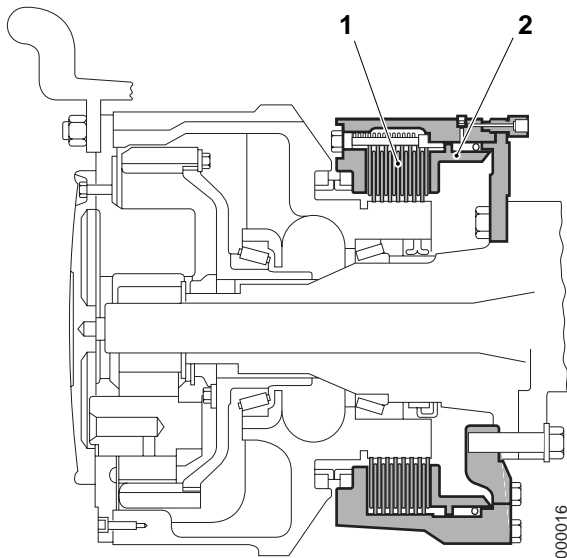
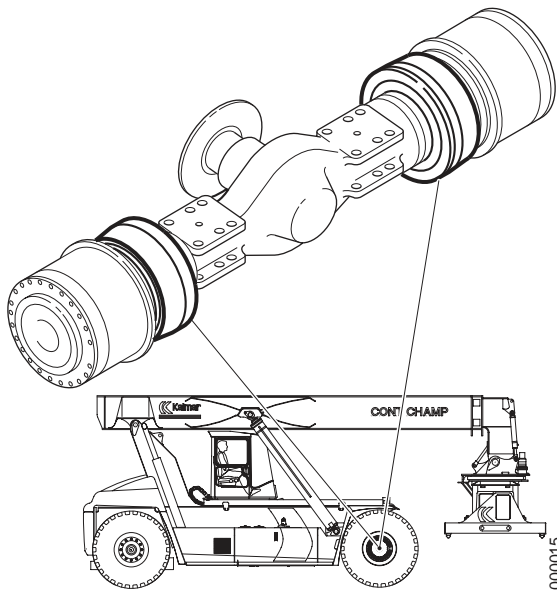


4.3.9 Wheel brake

Wheel brake, description

The wheel brakes brake the machine during operation and are located on the drive axle between the drive axle housing and hub reduction.

The wheel brake uses so-called wet disc brakes (WDB). Wet disc brakes require minimal maintenance and have a long service life due to effective cooling. Maintenance requirements are minimised since oil circulates in the brake system and prevents corrosion.



Wheel hub and brake, cross-section

1. Disc assembly
2. Brake cylinder

The wheel brakes have two main sections - disc assembly and brake cylinder. The disc assembly performs the braking. The brake cylinder presses the discs in the disc assembly together during braking.

Wheel brakes, bleeding

NOTE

Read the safety instructions for oil before working, see section B Safety.

IMPORTANT

Both the brake cylinder and disc brake must be bled after work where the brake system is opened or after work on the wheel brake.

Brake cylinder

- 1 Machine in service position, see section B Safety.
- 2 Place a ring spanner on the bleed nipple and connect a transparent hose to the bleed nipple.
Lead the other end of the hose down into a collection container.
- 3 Start the machine and depress the brake pedal, keep the pedal depressed.
- 4 Open the bleed nipple and allow oil to run out of it until the oil is free of air bubbles.

NOTE

The hydraulic hose between the brake pedal and brake is approx. 7 metres long. Therefore, allow at least two litres of oil to pass through the air bleeder nipple when bleeding to ensure that no air pockets remain in the system.

- 5 Close the bleed nipple.
- 6 Move the spanner and hose and repeat steps 1–4 on the other side.



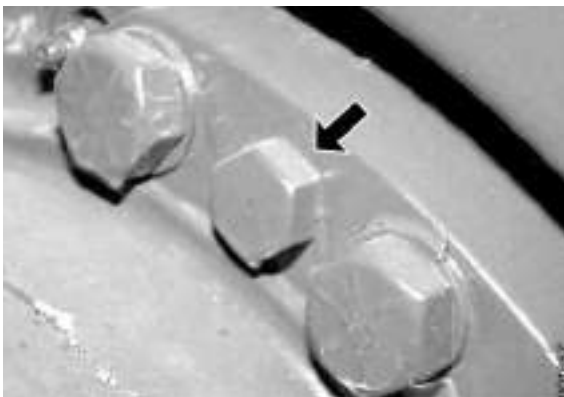
Bleed nipple, brake cylinder, on top of the drive axle at the wheel hub's inner short side (left-hand side).

Disc brake

NOTE

Disc brake ventilation is vital to correct cooling of the discs.

- 1 Start the engine and allow it to idle. Wait until the brake accumulators are fully loaded and the accumulating charging valve has switched to brake cooling.
- 2 Remove the bleed screw of the disc brake and let oil flow out of the hole until it is free of air bubbles. Refit the bleed screw.
- 3 Repeat steps 1-3 on the other wheel.
- 4 Check the oil level in the brake system, fill as necessary.



Bleed nipple, disc brake, on top of the drive axle at the wheel hub's inner short side (left-hand side).

Wheel brake, replacement

See *supplier documentation, drive axle*.

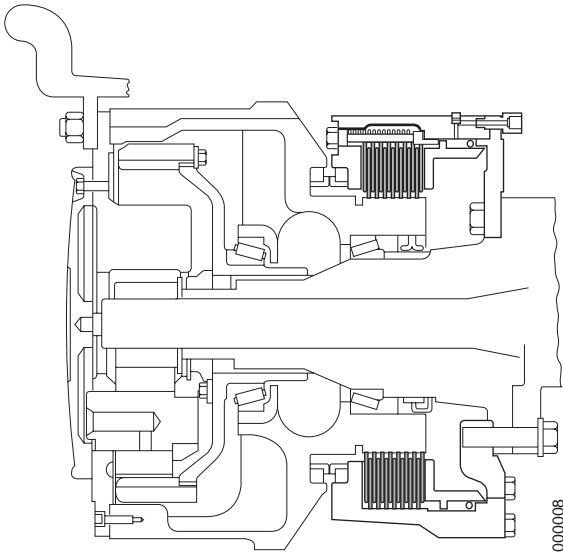
4.3.9.1 Disc assembly

Disc assembly, description

The disc assembly consists of several thin metal discs fixed alternately to the wheel brake housing and to the hub reduction housing. The discs are mounted on splines, which allows them to move laterally.

Oil circulates between the discs cooling them, thus the name wet disc brake. The oil is the same as in other parts of the brake system.

Braking is effected by the brake cylinder pressing together the discs. This creates friction between the discs that are fixed to the axle and those fixed to the hub reduction.



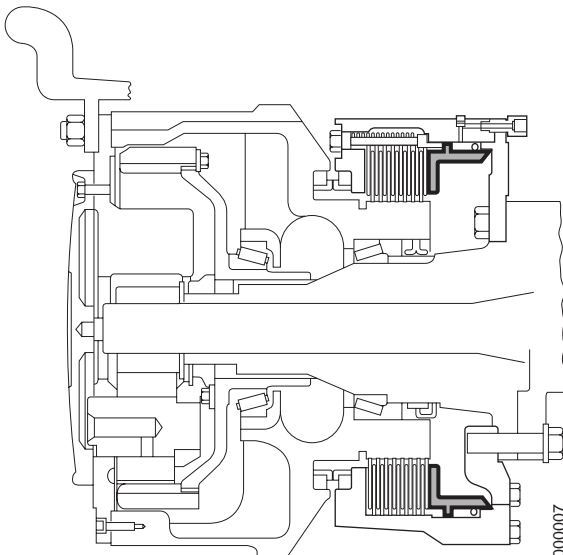
Disc assembly

4.3.9.2 Brake cylinder

Brake cylinder, description

The brake cylinder is integrated in the wheel brake and consists of a metal ring (cylinder) with two seal rings. The seals have lateral support from a bevel on the cylinder and a bevel on the wheel brake housing.

The space between the seal rings is pressurised through a channel in the wheel brake housing. The pressure moves the metal ring sideways and compresses the disc assembly.



Brake cylinder

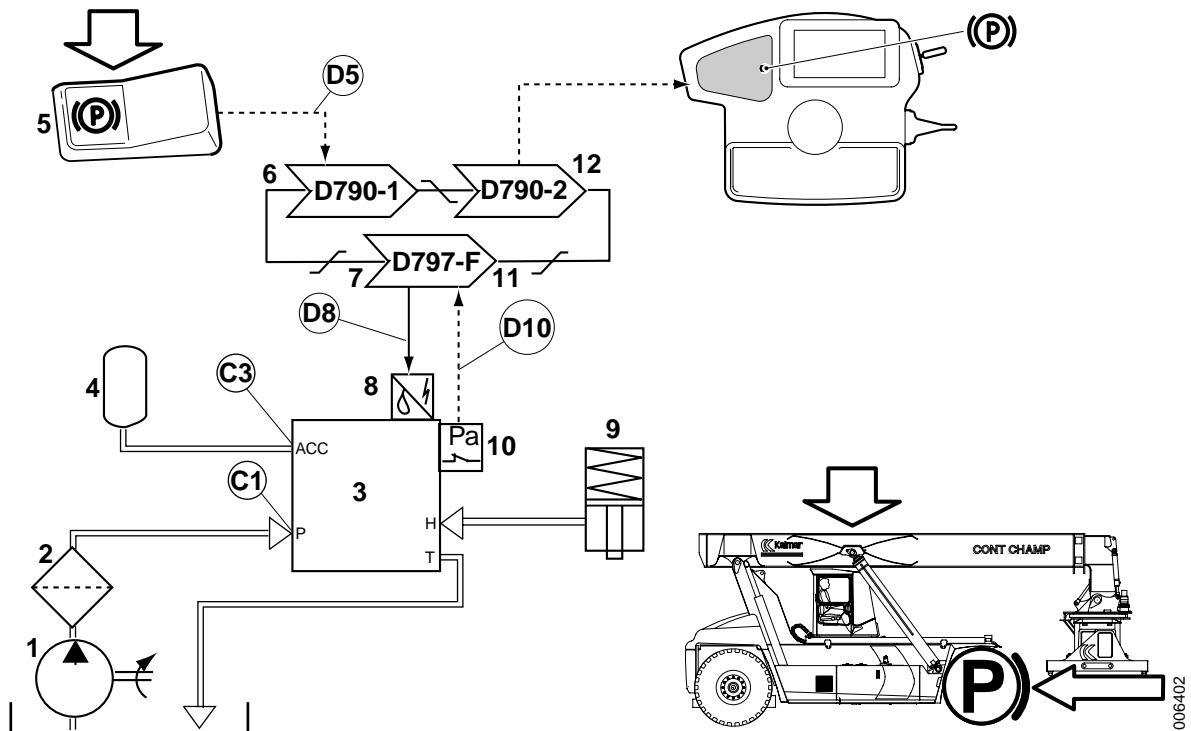
4.3.10 Pipes and hoses

Piped and hoses, description

See section *10 Common hydraulics*, group *10.5.1 Pipes and hoses*.

4.5 Parking brake system

Parking brake system, function description



Pos	Explanation	Signal description	Reference
1	The brake fluid pump pumps fluid from the brake fluid tank.	P = 19 ±0.5 MPa	Brake fluid tank, description page 39 Brake fluid pump, description page 7
2	The brake fluid filter cleans dirt from the oil.	-	Brake fluid filter, description page 45
3	The accumulator charging valve directs oil to charging of accumulators or through the brake system's cooling circuit.		Accumulator charging valve, description page 13
4	The accumulators store oil pressure.	See pressure plate on left frame beam.	Accumulator, description page 16
5	Switch parking brake (S107) activates parking brake. The switch uses two signals - one for applied and one for released parking brake. Both signals must be correct to enable release of the parking brake.	Switch activated: Conn 1, U = 22–28 V Conn 7, U = 0 V Switch in home position: Conn 1, U = 0 V Conn 7, U = 22–28 V	Section 9 Frame, body, cab and accessories, group 9.1 Controls and instruments D5: Diagnostic menu, see section 8 Control system, group 8.4.5.5 HYD, menu 5
6	The cab control unit (D790-1) transmits release or apply parking brake on the CAN bus.	Checked by control system, error shown with error code.	Section 11 Common electrics, group 11.5.3.1 Cab control unit

Pos	Explanation	Signal description	Reference
7	Control unit, frame front (D797-F) activates the parking brake solenoid valve (Y642).	U = 24 V	Section 11 <i>Common electrics</i> , group 11.5.3.2 <i>Control unit, frame front</i> D8: Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.5.5 <i>HYD</i> , menu 5
8	Solenoid valve parking brake (Y642) affects the valve slide which drains pressure in the parking brake calliper to tank.	Pump pressure.	<i>Solenoid valve parking brake, description page 33</i> D8: Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.5.5 <i>HYD</i> , menu 5
9	The brake calliper is drained of pressure and the spring applies the parking brake.	0 MPa	<i>Parking brake unit, description page 34</i>
10	The parking brake NC switch (S200) closes the circuit when the pressure decreases.	Applied parking brake: Conn 1: U = 24 V Conn 2: U = 0 V Released parking brake: Conn 1: U = 24 V Conn 2: U = 24 V	<i>Parking brake NC switch, description page 37</i> D10: Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.5.5 <i>HYD</i> , menu 5
11	Control unit, frame front (D797-F) transmits parking brake applied on the CAN bus.	Checked by control system, error shown with error code.	Section 11 <i>Common electrics</i> , group 11.5.3.2 <i>Control unit, frame front</i>
12	The KIT control unit (D790-2) activates the parking brake indicator light (508).	Checked by control system, error shown with error code.	Section 11 <i>Common electrics</i> , group 11.5.3.11 <i>Control unit KIT</i>

Hydraulic diagram, basic machine

4.5.1 Brake fluid pump

Brake fluid pump, general

See group 4.3.1 *Brake fluid pump*.

4.5.2 Brake fluid filter

Brake fluid filter, general

See *Brake fluid filter, description page 45*.

4.5.3 M-valve parking brake

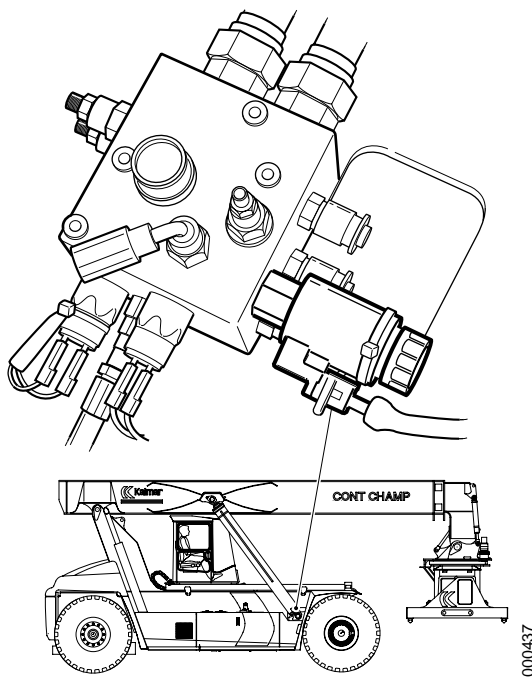
Solenoid valve parking brake, description

The parking brake solenoid valve (Y642) activates the parking brake. The solenoid valve is fitted on the accumulator charging valve, which is fitted on the lifting beam in front of the gearbox in the engine compartment, see *Accumulator charging valve, description page 13*.

The solenoid valve opens a connection between the accumulators and the parking brake calliper at activation. This means that the parking brake calliper is pressurised and the parking brake is disengaged. When the voltage feed to the solenoid valve is cut off, the connection between the accumulators and parking brake calliper is terminated. Instead, a connection between the parking brake calliper and tank is opened and the parking brake applied. This means that the parking brake is applied if the machine loses electrical power or if the brake system becomes depressurised.

The solenoid valve is supplied with voltage by Control unit, frame front (D797-F) on activation.

The signal can be checked from the diagnostic menu, see section *8 Control system*, group *8.4.5.5 HYD, menu 5*.



Solenoid valve parking brake, checking



DANGER

The machine may start to roll. Risk of crushing.

Block the wheels so that the machine cannot start to roll when the parking brake is released.

- 1 Start the engine and run the engine at idling speed until the warning lamp for brake pressure goes out and the accumulator charging valve changes to cooling.
- 2 Turn off the engine and turn the start key to position I.
- 3 Release the parking brake with switch parking brake and check that the parking brake's brake caliper releases. The brake caliper should be able to move.
- 4 Activate the parking brake with the parking brake switch and check that the parking brake's brake caliper is applied.

4.5.4 Parking brake unit

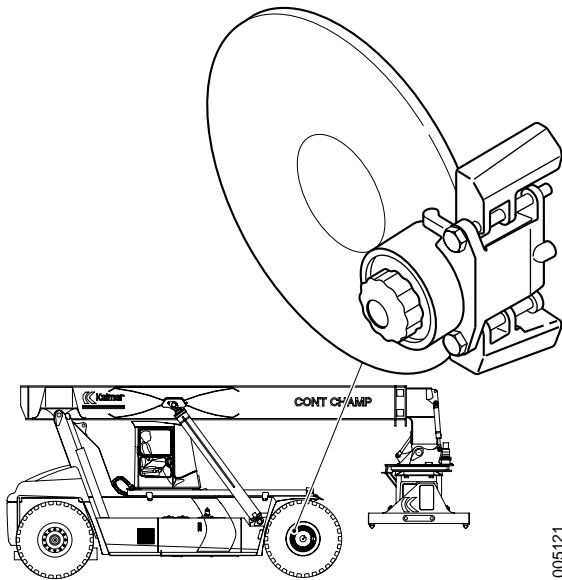
Parking brake unit, description

The parking brake unit keeps the machine stationary when parked. The parking brake unit is located on the drive axle input shaft between the propeller shaft and drive axle.

The parking brake acts on the propeller shaft via a disc mounted on the drive axle input shaft and a brake calliper with dry brake pads mounted in a bracket on the drive axle.

NOTE

If the hydraulic pressure in the feed circuit drops, a warning is activated before the pressure drops so low that the parking brake is applied. If the parking brake is applied while the machine is in motion, the brake disc and brake pads must be replaced.



Parking brake unit, checking and adjustment (drive axle alternative Kessler)



DANGER

The machine may start to roll.

Risk of crushing.

Block the wheels so that the machine cannot start to roll when the parking brake is released.

- 1 Start the engine and run up hydraulic pressure until the accumulators are fully charged and the accumulator charging valve switches to cooling.
- 2 Turn off the engine and turn the start key to position I.
- 3 Release the parking brake.
- 4 Check that the parking brake caliper can move on the bracket.
- 5 Check that the brake disc is free from oil and dirt.



6 Remove the cover from the brake caliper.



7 Undo the lock nut.

8 Adjust the adjustment screw so that the brakes are applied.

9 Turn back the adjusting screw so that the clearance between pad and disc is 0.5 ± 0.1 mm.

10 Tighten lock nut.

NOTE

To avoid turning the adjustment screw as well it must be held still when tightening the lock nut.

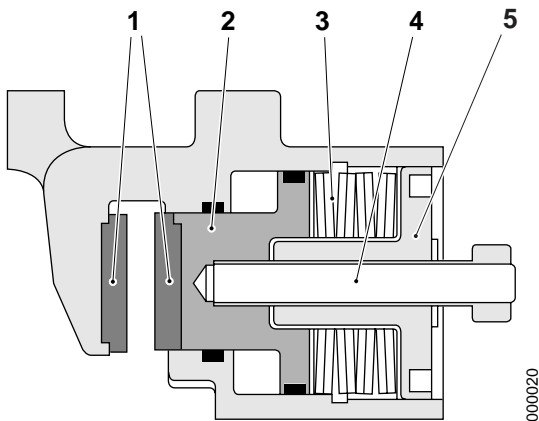
11 Refit the cover to the caliper.

12 Test the operation of the parking brake.

4.5.4.1 Parking brake caliper

Brake calliper, description

The brake calliper has a spring section and a hydraulic section. The spring section applies the brake while the hydraulic section is used to release the brake. This means that the parking brake is applied if the brake system loses pressure. This, in turn, means that the machine is braked if a serious fault arises.



000020

1. Brake pads
2. Release cylinder
3. Return spring
4. Slackening screw
5. Adjusting washer

4.5.4.2 Parking brake pads

Brake pads, description

The brake pads consist of a metal plate with friction material (lining).

Brake pads, replacement

DANGER

The machine may start to roll.

Risk of crushing.

Block the wheels so that the machine cannot start to roll when the parking brake is released.

- 1 Machine in service position and wheels blocked, see section *B Safety*.
- 2 Remove the cover from the brake caliper.



- 3 Undo the lock nut.
- 4 Slacken the adjusting screw to release the brake pads.
- 5 Remove the split pin and undo the nut on one of the attaching bolts holding the parking brake calliper in place.





- 6 Pull the attaching bolt out so that the brake pads can be angled out and removed.

NOTE

The bolt does not need to be removed.

- 7 Remove the parking brake pads.
- 8 Clean the brake disc with methylated spirit.
- 9 Install new parking brake pads.
- 10 Press the attaching bolt back.
- 11 Fit the nut and a new split pin.
- 12 Adjust the parking brake, see *Parking brake unit, checking and adjustment (drive axle alternative Kessler) page 34.*

4.5.4.3 Parking brake disc

Brake disc, description

The brake disc is mounted on the drive axle input shaft. The drive axle's gear ratio amplifies the braking force.

4.5.5 Parking brake NC switch

Parking brake NC switch, description

The parking brake NC switch (S200) detects whether the parking brake is applied or released. The NC switch is fitted on the accumulator charging valve, which is fitted on the lifting beam in front of the gearbox in the engine compartment, see *Accumulator charging valve, description page 13.*

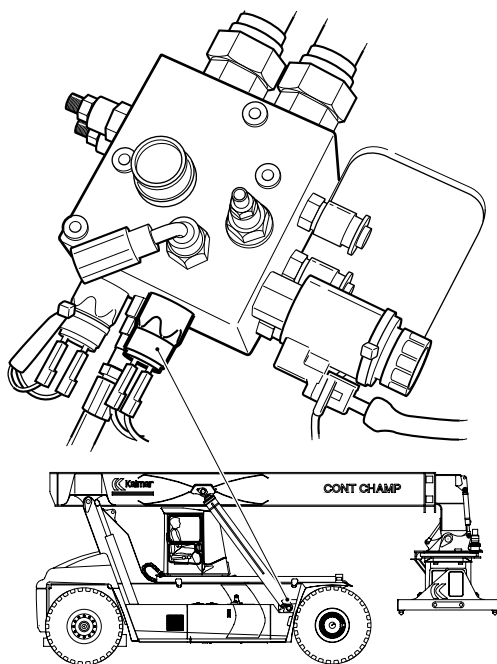
Break-contact parking brake (S200) senses the pressure in the parking brake circuit. When the pressure is so high that the parking brake is released, the sensor opens an electric circuit. This is used to indicate that the parking brake is released.

The parking brake NC switch (S200) is supplied voltage by, and sends a voltage signal to, Control unit, frame front (D797-F). When the pressure increases above the cut-off pressure, the voltage signal to Control unit, frame front (D797-F) is cut off.

The signal can be checked from the diagnostic menu, see section *8 Control system*, group *8.4.5.5 HYD, menu 5.*

NOTE

Gears cannot be engaged when the parking brake is applied.



000436

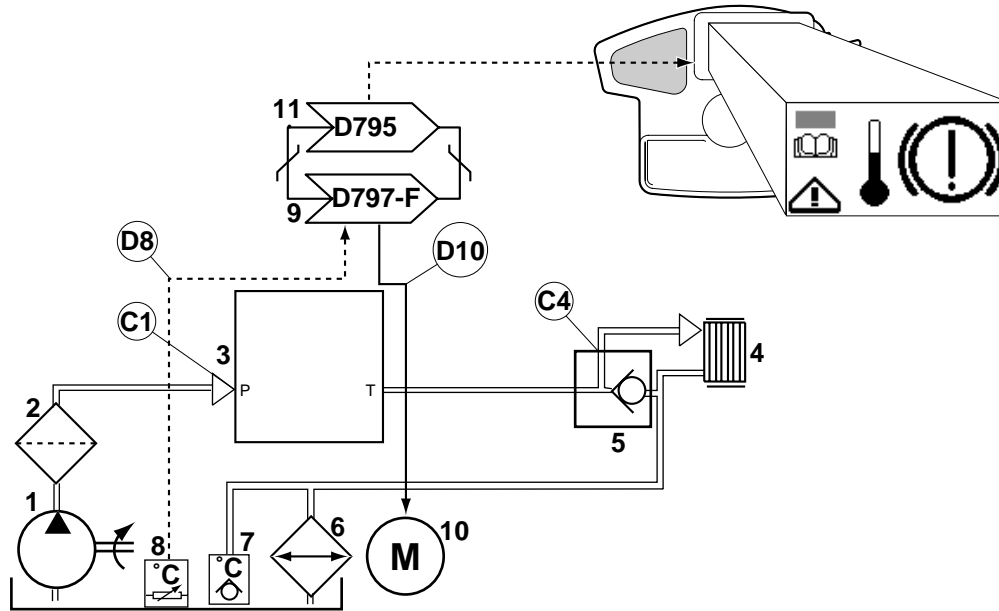
4.5.6 Pipes and hoses

Piped and hoses, description

See section *10 Common hydraulics*, group *10.5.1 Pipes and hoses.*

4.8 Temperature control, cleaning and brake oil

Temperature control, cleaning and brake oil, function description



006403

Pos	Explanation	Signal description	Reference
1	The brake fluid pump pumps fluid from the brake fluid tank.	$P = 19 \pm 0.5 \text{ MPa}$	<i>Brake fluid pump, description page 7</i> <i>Brake fluid tank, description page 39</i>
2	The brake oil filter cleans the oil.	-	<i>Brake fluid filter, description page 45</i>
3	The accumulator charging valve directs oil to charging of accumulators or through the brake system's cooling circuit.	Max. 0.1 MPa	<i>Accumulator charging valve, description page 13</i>
4	The oil cools the wheel brake.	-	<i>Wheel brake, description page 28</i>
5	The bypass valve in the distribution block leads oil past the drive axle if the back pressure through the wheel brake is too high.	-	<i>Drive axle block, description page 24</i>
6	The cooler cools the oil.	-	<i>Oil cooler, description page 41</i>
7	The thermo-bypass valve leads oil past the cooler if the temperature is low.	approx. 50 °C	<i>Thermal bypass valve, description page 42</i>
8	The temperature sensor (B762) detects and oil temperature and sends Control unit, frame front (D797-F) a voltage signal proportional to the oil temperature.	$R = 25 \text{ k}\Omega \text{ at } 20 \text{ }^\circ\text{C}$	<i>Brake fluid temperature sensor, description page 43</i> D8: Diagnostic menu, see section 8 Control system , group 8.4.5.2 HYD, menu 2

Pos	Explanation	Signal description	Reference
9	Control unit, frame front (D797-F) transmits the oil temperature information on the CAN bus.	Checked by control system, error shown with error code.	Section 11 <i>Common electrics</i> , group 11.5.3.2 <i>Control unit, frame front</i>
10	When the oil is hot, Control unit, frame front (D797-F) activates the cooling fan (M674) and increases airflow through the cooler.	U = 24 V with activated fan Activates at 65 °C Deactivates at 55 °C	<i>Cooling fan, description page 42</i> D10: Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.5.2 <i>HYD, menu 2</i>
11	If temperature is high, the KID control unit (D795) activates the high brake fluid temperature warning in the display.	Checked by control system, error shown with error code.	Section 11 <i>Common electrics</i> , group 11.5.3.12 <i>KID control unit</i>

Hydraulic diagram, basic machine

4.8.1 Brake fluid tank

Brake fluid tank, description

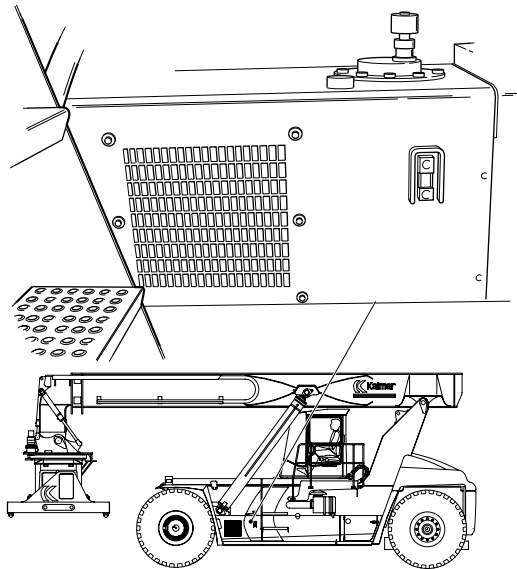
The brake fluid tank stores the brake system fluid and is located on the left side of the machine in front of the fuel tank.

The brake system is separate from other hydraulics and has its own tank and oil filter. This makes it possible to keep additives out of the brake system fluid.

Brake fluid is filled directly to the tank. A drain plug is located at the bottom of the tank. Hatches on top of the tank facilitate internal cleaning.

The tank is equipped with a filtered breather that allows volume changes in the tank, due to temperature variations and use. See *Breather filter, description page 44*.

The tank has a sight glass for checking oil level.



000012

4.8.2 Tank heater

Tank heater, safety



CAUTION

High voltage.

The tank heater is connected to high voltage (110 - 400 V).

Installation and reconnection of the tank heater may only be performed by personnel authorised for work with high voltage.

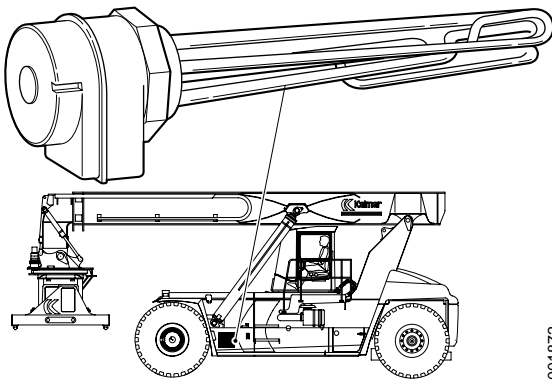
Tank heater, description



The brake fluid tank can be equipped with a tank heater, which heats the brake fluid in the tank and sits in a flange on the front short side of the tank. The tank heater is designed for cold-climate usage.

The tank heater is operated with high voltage. Heater output is adapted through different connections and adaptation to different operating voltage - 110, 230 or 400 V AC. Higher voltage generates higher heater output.

The tank heater can be equipped with an adjustable thermostat which maintains a constant temperature level. The thermostat is mounted directly on the heating coil and can be adjusted using the control on the terminal box. The recommended temperature setting is 20 –30 °C.



4.8.3 Brake fluid pump

Brake fluid pump, general

See group 4.3.1 *Brake fluid pump*.

4.8.4 Accumulator charging valve

Accumulator charging valve, general

See 4.3.3 *Accumulator charging valve*.

4.8.5 Drive axle block

Drive axle block, description

See *Drive axle block, description page 24*.

4.8.6 Wheel brake

Wheel brake, general

See 4.3.9 *Wheel brake* and *drive axle supplier documentation*.

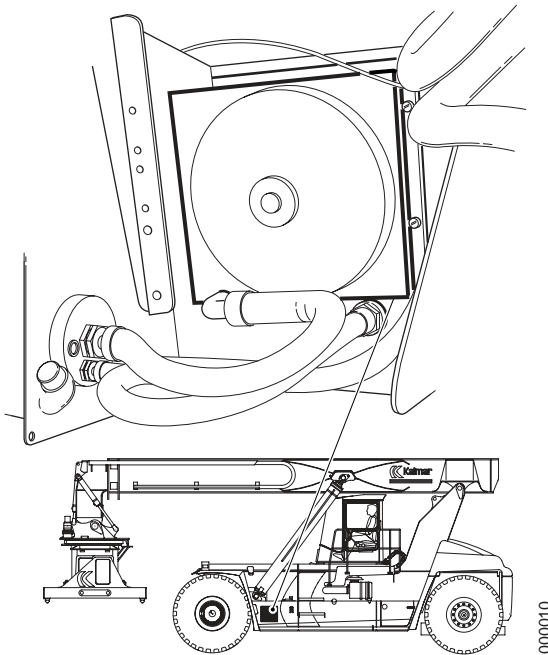
4.8.7 Oil cooler

Oil cooler, description

The oil cooler cools the brake system fluid in order to maintain brake performance. The oil cooler is found inside the side panel on the left side behind the front wing.

The brake system uses a flow-through cooler with electric cooling fan. The brake system fluid is cooled when it passes the cooler. Openings in the frame panel allow air to pass through the cooler.

The cooling fan is screwed onto the cooler. See *Cooling fan, description page 42*.



Brake system oil cooler, replacement

NOTE

Read the safety instructions for oil before working, see section B Safety.

- 1 Machine in service position, see section B Safety.
- 2 Drain the brake fluid tank; see *Brake system fluid, changing page 46*.
- 3 Mark up and disconnect hydraulic hoses from the cooler. Let the oil in the cooler drain into the collection container.

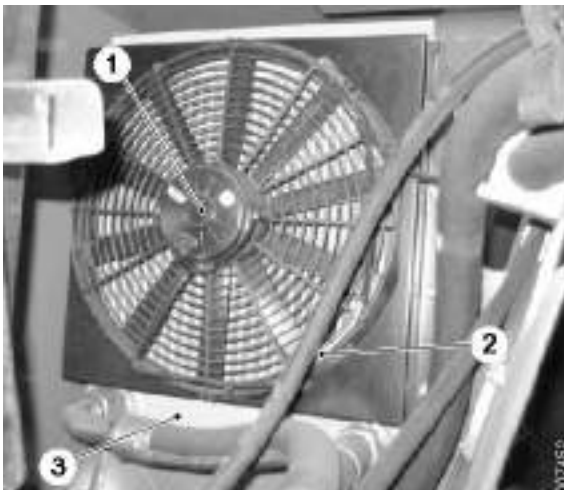
NOTE

Plug all unions at once to protect the hydraulic system from contamination.

- 4 Disconnect the cabling from the cooling fan.
- 5 Remove the attaching bolts and lift away the cooler.
- 6 Transfer the cooling fan to the new cooler.
- 7 Install the cooler.
- 8 Connect the cabling to the cooling fan.
- 9 Connect the hydraulic hoses to the cooler.

NOTE

Check that the O-rings are intact and fitted correctly.



1. Cooling fan
2. Connector
3. Radiator



- 10 Fill the brake fluid tank; see *Brake system fluid, changing* page 46. The fluid level should be visible in the sight glass.

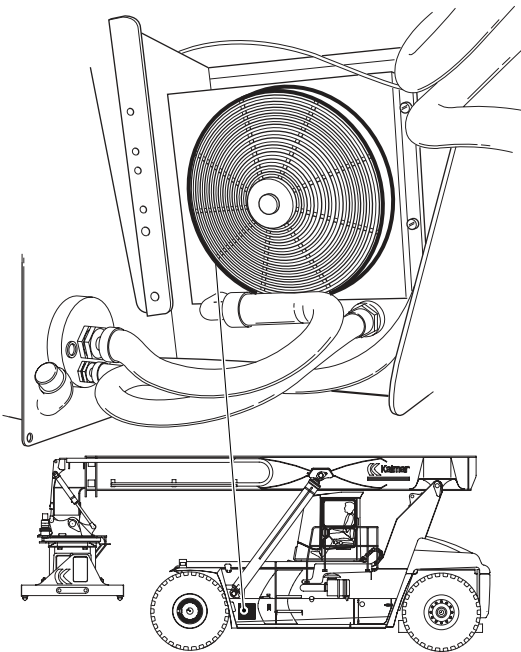
4.8.8 Cooling fan

Cooling fan, description

The cooling fan (M674) is a suctioning electronic fan. The fan suctions air from the outside of the machine through the cooler and increases airflow through the oil cooler as needed. The cooling fan is mounted inside the cooler inside the side panel behind the left drive wheel.

The cooling fan (M674) is supplied voltage by Control unit, frame front (D797-F). The cooling fan is activated when oil temperature is 65 °C in the brake oil tank and the fan is deactivated when oil temperature is 55 °C.

The signal can be checked from the diagnostic menu, see section *8 Control system*, group *8.4.5.2 HYD, menu 2*.



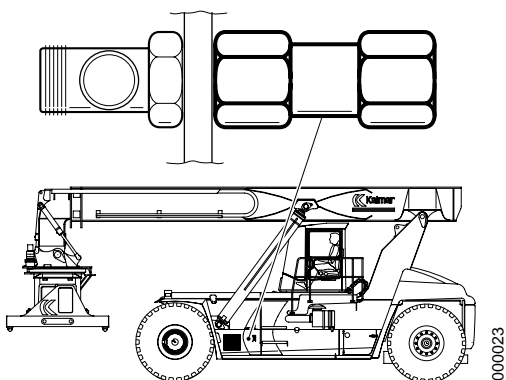
000009

4.8.9 Thermal bypass valve

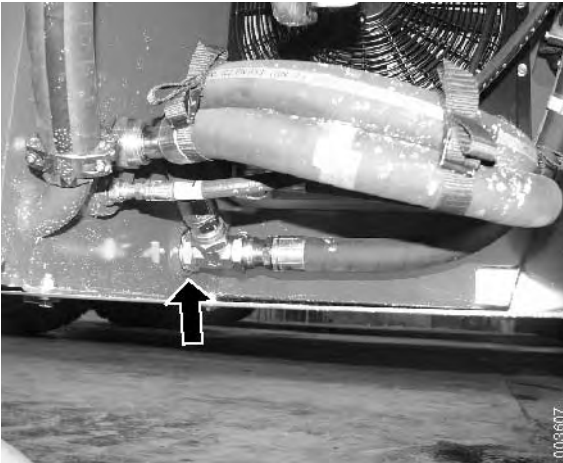
Thermal bypass valve, description

When the oil is cold, the thermo-bypass valve guides the oil past the cooler directly to the tank. The thermo-bypass valve is found inside the brake fluid tank at the hose connections to and from the cooler.

The thermo-bypass valve is a temperature-regulated bimetal valve that is open at low temperatures and completely closed at 50 °C.



000023



Thermo-bypass valve, replacement

NOTE

Read the safety instructions for oil before working, see section *B Safety*.

- 1 Machine in service position, see section *B Safety*.
- 2 Depressurise the brake and hydraulic systems, see section *B Safety*.
- 3 Drain the brake fluid tank; see *Brake system fluid, changing page 46*.
- 4 Remove the thermo-bypass valve located inside the hydraulic oil tank.

NOTE

Note how the valve is fitted.

- 5 Fit in reverse order.

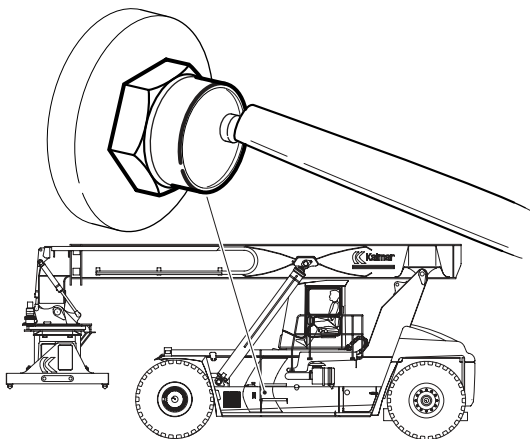
4.8.10 Sensor brake oil temperature

Brake fluid temperature sensor, description

The brake fluid temperature sensor (B762) detects the temperature of the brake system fluid. The sensor is mounted on the rear short side of the brake fluid tank and therefore takes the accumulated heat in the brake system fluid into account.

The brake fluid temperature sensor (B762) is supplied voltage by Control unit, frame front (D797-F) and sends the control unit a voltage signal proportional to temperature.

The signal can be checked from the diagnostic menu, see section *8 Control system*, group *8.4.5.2 HYD, menu 2*.



Brake fluid temperature sensor, replacement

NOTE

Read the safety instructions for oil before working, see section *B Safety*.

- 1 Machine in service position, see section *B Safety*.
- 2 Drain the brake fluid tank; see *Brake system fluid, changing page 46*.
- 3 Disconnect the wiring from the fluid temperature sensor.
- 4 Remove the fluid temperature sensor.

NOTE

Check that the O-rings are intact and fitted correctly.

- 5 Connect the cabling to the sensor.



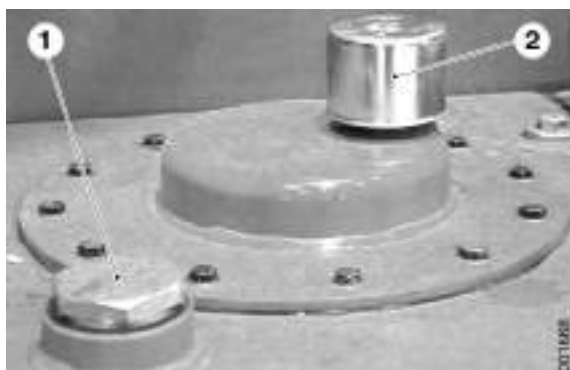
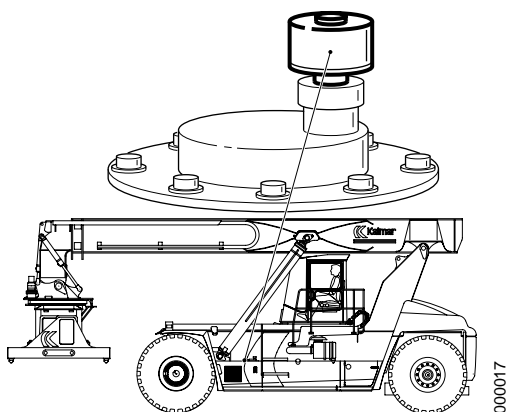
- 6 Fill the brake fluid tank; see *Brake system fluid, changing page 46*. The fluid level should be visible in the sight glass.

4.8.11 Breather filter

Breather filter, description

The breather filter cleans the air that passes the tank's breather upon volume changes arising due to temperature variations and use. The breather filter is located in a holder on the top of the brake fluid tank.

The breather filter is a paper insert filter. The filter removes moisture and dust from the air passing through the tank's breather.



1. Brake system fluid filler orifice
2. Breather filter, brake fluid tank

Breather filter, replacement

- 1 Clean the area around the break tank breather filter.
- 2 Remove the cover from the filter holder.
Remove the centre screw and lift away the cover.
- 3 Remove the old filter insert.
- 4 Clean the filter holder.

NOTE

Take care so as not to contaminate the tank.

- 5 Fit a new filter insert.
- 6 Refit the cover on the filter holder.

4.8.12 Brake fluid filter

Brake fluid filter, description

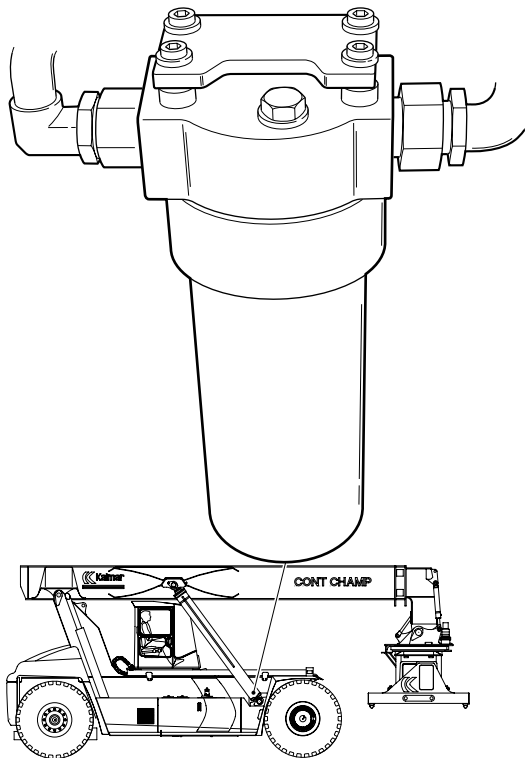
The brake fluid filter eliminates contaminants from the fluid in the brake system. The filter is secured on a mounting in front of the gearbox under the lifting beam.

The brake system fluid filter is a high-pressure filter with removable filter insert. It is located between the pump and accumulator charging valve. The fluid is cleaned when it is forced through the (glass-fibre) material of the filter insert before reaching the accumulator charging valve.

A bypass valve located between the intake and outlet protects the insert. If resistance through the filter surface becomes too great, the bypass valve opens a passage past the insert. The bypass function opens if the oil is viscous (cold or too low/high viscosity) or if the filter insert is clogged with dirt.

NOTE

When the filter is clogged, the oil is directed past the filter without cleaning. Therefore, it is very important to replace the filter at the prescribed interval.



000018

Brake fluid filter, replacement

NOTE

Read the safety instructions for oil before working, see section B Safety.

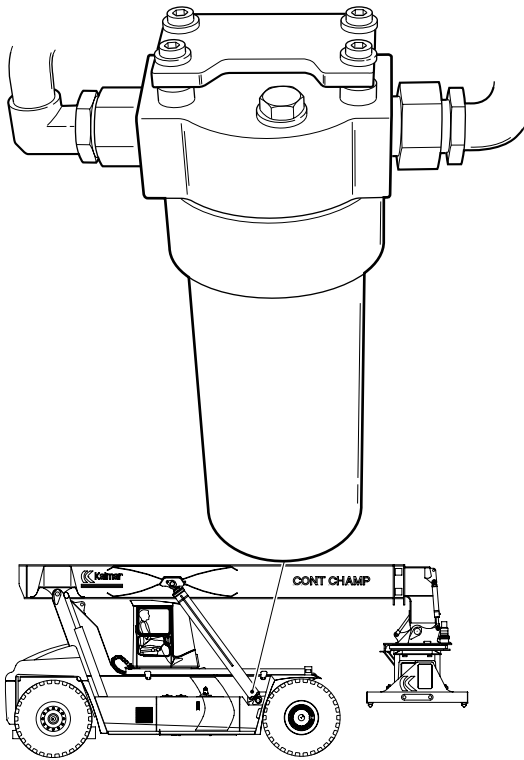
IMPORTANT

The filter protects the brake system against contaminants. It is vital that new contaminants do not enter the brake system during filter replacement.

- 1 Machine in service position, see section *B Safety*.
- 2 Depressurise the hydraulic and brake systems; see section *B Safety*.

NOTE

Leave the valves open during replacement.



- 3 Remove the drain plug on the underside of the filter.
Let the oil run out. Wait a moment since it runs out slowly.
- 4 Remove the filter holder.

NOTE

The filter holder is heavy. Detach it carefully.

- 5 Remove the filter insert.

NOTE

Note the location of the O-rings.

- 6 Clean the filter holder.
- 7 Fit the O-rings on the filter insert and filter holder. Lubricate the O-rings with brake fluid.
- 8 Fit the new filter insert on the filter mounting.
- 9 Fit the filter holder and drain plug.
- 10 Close the valves opened for draining the pressure in the hydraulic system.
- 11 Start the engine and check the filter holder for leaks.

4.8.13 Pipes and hoses

Piped and hoses, description

See section *10 Common hydraulics*, group *10.5.1 Pipes and hoses*.

4.8.14 Brake system fluid

Brake system fluid, general

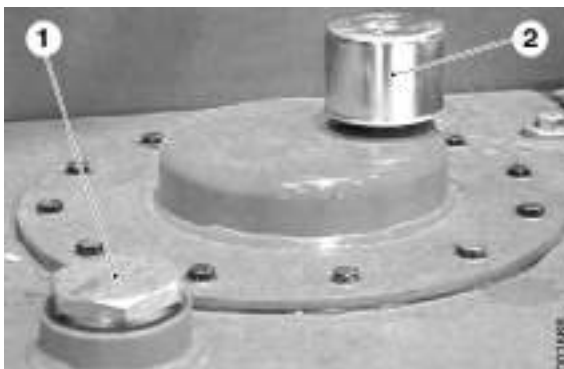
See section *F Technical data*.

Brake system fluid, changing

NOTE

Read the safety instructions for oil before working, see section B Safety.

- 1 Machine in service position, see section *B Safety*.
- 2 Depressurise the hydraulic and brake systems; see section *B Safety*.
- 3 Remove the filler cap and drain the brake fluid tank.
- 4 Remove the drain plug and allow the last of the fluid drain into a receptacle.
- 5 Fit the drain plug, using a new gland washer.
- 6 Fill brake fluid until the fluid level is in the middle of the sight glass. For volume and grade, see section *F Technical data*.
- 7 Fit the filler cap.



1. Brake system fluid filler orifice
2. Breather filter, brake fluid tank

Table of Contents 5 Steering

5	Steering	3
5.1	Controls and instruments	3
5.1.2	Mini-wheel	3
5.1.3	Joystick	4
5.2	Power assisted system	6
5.2.1	Hydraulic oil pump	13
5.2.2	Priority valve	14
5.2.3	Steering valve	20
5.2.4	Steering cylinder	23
5.2.5	Steering axle cradle	26
5.2.6	Link arm	27
5.2.7	Wheel spindle	27
5.2.8	Wheel hub	27
5.2.9	Shuttle valve	27
5.2.10	Control valve mini-wheel/joystick control	28
5.2.11	Shuttle valve, mini-wheel/lever steering	31
5.2.12	Steering angle sensor	32
5.2.13	Pipes and hoses	32

5 Steering

5.1 Controls and instruments

5.1.2 Mini-wheel

Mini-wheel, description



On machines with mini-wheel, the machine is steered with an electric control. A directional valve pressurises the steering cylinder.

The mini-wheel controls are integrated in the left armrest. The controls consist of two rotary potentiometers and three switches to activate the mini-wheel, select direction of travel and activate the horn.

NOTE

The mini-wheel is deactivated if the standard steering wheel is used.

Mini-wheel or lever steering can only be activated at speeds below 3 km/h.

Mini-wheel

Rotary potentiometers transmit a 0-5 V signal for one revolution. The potentiometers have phase displacement to determine the direction of turning. The rotary potentiometers are supplied voltage by the cab control unit (D790-1) and send it a voltage signal proportional to the turn to indicate steering deflection.

The relationship between the deflection of the mini-wheel and that of the wheels can be set to 31 different settings - from linear to extremely progressive. It is also possible to set how steering deflection is to be adapted based on machine speed. This is done via the diagnostic menus; see section 8 Control system, group 8.5.1 Initiation.

The signals can be read from the diagnostic menu, see section 8 Control system, group 8.4.11.4 EL-STEERING, menu 1.

Switch, mini-wheel activation

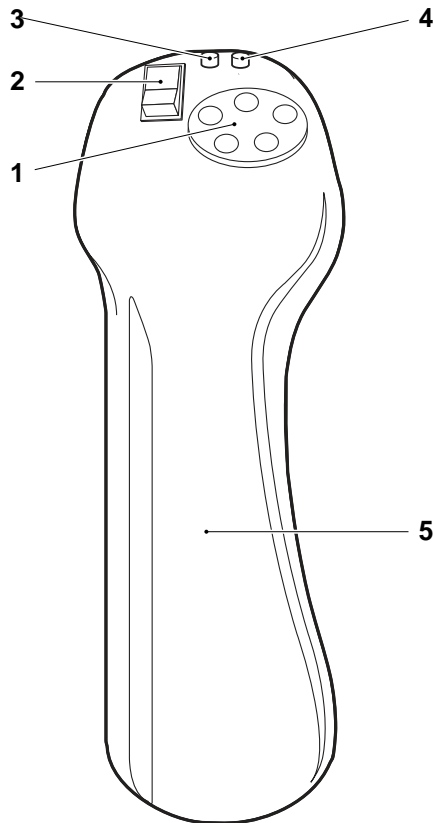
The mini-wheel switch (position 3) activates steering with the mini-wheel. The switch is supplied voltage by and sends a voltage signal to the cab control unit (D790-1).

The signals can be read from the diagnostic menu, see section 8 Control system, group 8.4.11.4 EL-STEERING, menu 2.

Travel direction selector

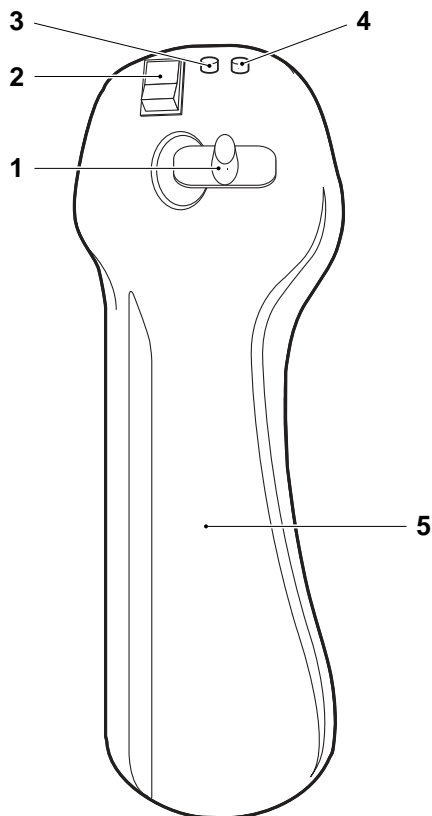
The travel direction selector is used to choose direction of travel (forward or reverse) when the mini-wheel is activated. The switch is supplied voltage by and sends a voltage signal to the cab control unit (D790-1).

The signals can be read from the diagnostic menu, see section 8 Control system, group 8.4.11.4 EL-STEERING, menu 2.



1. Mini-wheel
2. Travel direction selector (F / N / R)
3. Switch, mini-wheel activation
4. Acoustic signal
5. Armrest

000583



1. Joystick
2. Travel direction selector (F / N / R)
3. Switch, joystick activation
4. Acoustic signal
5. Armrest

Acoustic signal

The acoustic signal is used to activate the signal horn when the mini-wheel is activated. The switch is supplied voltage by and sends a voltage signal to the cab control unit (D790-1).

The signals can be read from the diagnostic menu, see section *8 Control system*, group *8.4.11.4 EL-STEERING*, menu 2.

5.1.3 Joystick

Joystick, description



On machines with joystick, the machine is steered with an electric control. A directional valve actuates the steering cylinder.

The joystick is integrated in the left armrest. The controls consist of a sliding potentiometer and three switches to activate lever steering, select direction of travel and activate the horn.

NOTE

Lever steering is deactivated if the standard steering wheel is used.

Mini-wheel or lever steering can only be activated at speeds below 3 km/h.

Joystick

The sliding potentiometer is supplied voltage by the cab control unit (D790-1) and sends it a voltage signal proportional to movement to indicate steering deflection.

The signals can be read from the diagnostic menu, see section *8 Control system*, group *8.4.11.4 EL-STEERING*, menu 1.

The relationship between the deflection of the joystick and that of the wheels can be set to 31 different settings - from linear to extremely progressive. It is also possible to set how steering deflection is to be adapted based on machine speed. This is done via the diagnostic menus; see section *8 Control system*, group *8.5.1 Initiation*.

Joystick position (left, centre, right) can be calibrated with the diagnostic menus; see section *8 Control system*, group *8.5.2.2 Calibrate steering*.

Switch, joystick activation

The joystick activation switch (position 3) activates steering with the joystick. The switch is supplied voltage by and sends a voltage signal to the cab control unit (D790-1).

The signals can be read from the diagnostic menu, see section *8 Control system*, group *8.4.11.4 EL-STEERING*, menu 2.

000900

Travel direction selector

The travel direction selector is used to choose direction of travel (forward or reverse) when lever steering is activated. The switch is supplied voltage by and sends a voltage signal to the cab control unit (D790-1).

The signals can be read from the diagnostic menu, see section *8 Control system*, group *8.4.11.4 EL-STEERING*, menu 2.

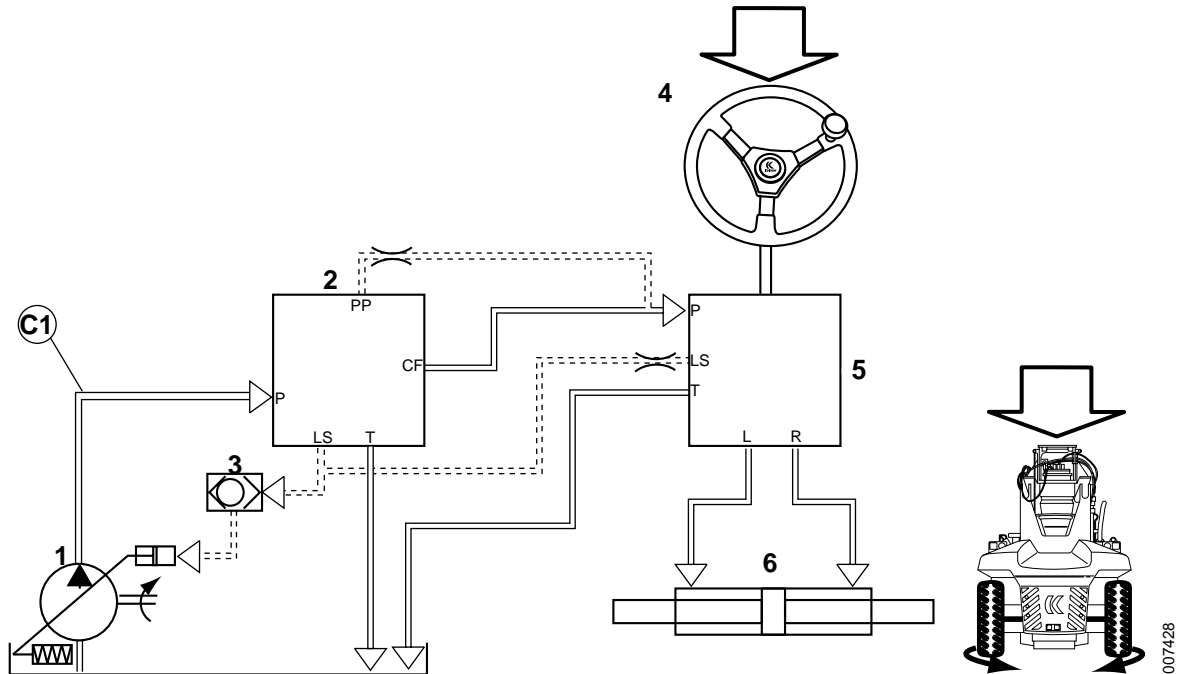
Acoustic signal

The acoustic signal is used to activate the horn when the lever steering is activated. The switch is supplied voltage by and sends a voltage signal to the cab control unit (D790-1).

The signals can be read from the diagnostic menu, see section *8 Control system*, group *8.4.11.4 EL-STEERING*, menu 2.

5.2 Power assisted system

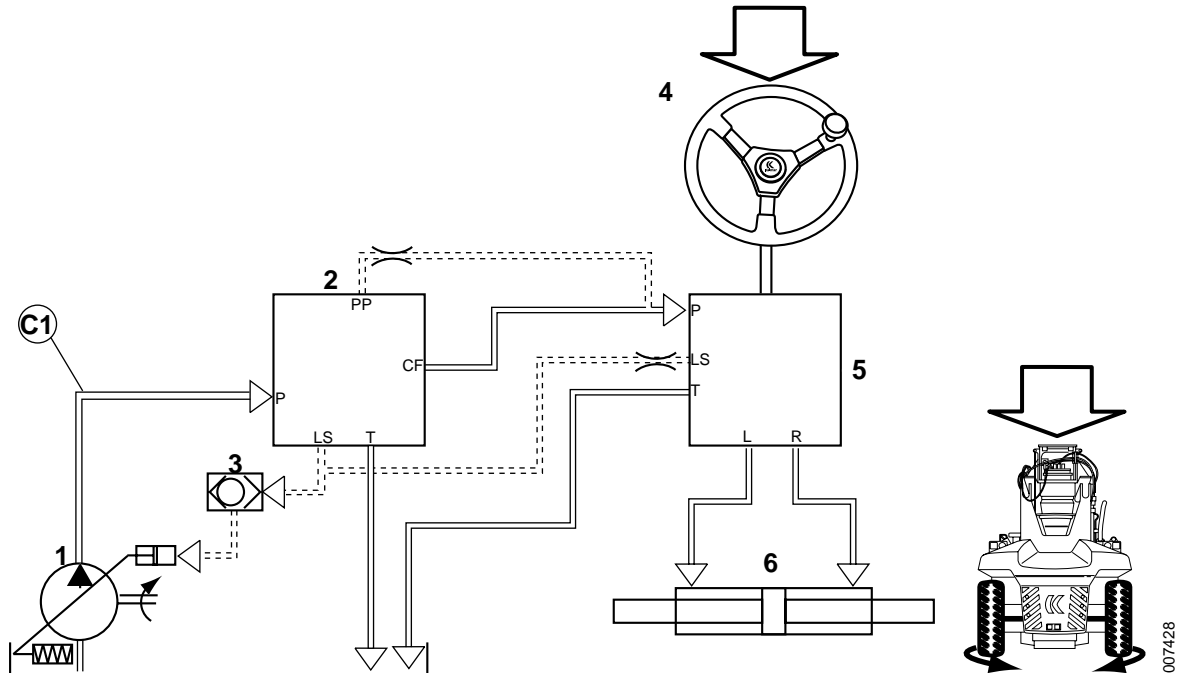
Power assisted system, function description (hydraulic oil pump alternative Rexroth)



Pos	Explanation	Signal description	Reference
1	The hydraulic oil pumps pump oil to the priority valve.	See pressure plate on left frame beam.	Section 10 Common hydraulics, group 10.4.2 Axial piston pump with variable displacement
2	The priority valve prioritises pressure supply to the steering valve over the working hydraulics. The priority valve also transmits a control signal to the hydraulic oil pump 3 and 4.	Checked by control system, error shown with error code.	Priority valve, description (hydraulic oil pump alternative Rexroth) page 14
3	The shuttle valve selects the strongest load signal to the main pump if hydraulic functions are activated at the same time as the steering wheel is turned.	Checked by control system, error shown with error code.	Section 10 Common hydraulics, group 10.5.3 Shuttle valve
4	The steering wheel is turned and acts on the steering valve's input shaft.	-	Section 9 Frame, body, cab and accessories, group 9.1 Controls and instruments
5	The steering valve pumps pressurised oil to the steering cylinder and transmits a load signal to the main pumps.	-	Steering valve, description page 20
6	The steering cylinder turns the wheels.	-	Steering cylinder, description page 23

Hydraulic diagram, basic machine

**Power assisted system, function description
(hydraulic oil pump alternative Sauer-Danfoss)**



Pos	Explanation	Signal description	Reference
1	The hydraulic oil pump 2 pumps oil to the priority valve.	See pressure plate on left frame beam.	Section 10 Common hydraulics, group 10.4.2 Axial piston pump with variable displacement
2	The priority valve prioritises pressure supply to the steering valve over the working hydraulics. The priority valve also transmits a control signal to the hydraulic oil pump 2.	Checked by control system, error shown with error code.	Priority valve, description (hydraulic oil pump alternative Rexroth) page 14
3	The shuttle valve selects the strongest load signal to the main pump if hydraulic functions are activated at the same time as the steering wheel is turned.	Checked by control system, error shown with error code.	Section 10 Common hydraulics, group 10.5.3 Shuttle valve
4	The steering wheel is turned and acts on the steering valve's input shaft.	-	Section 9 Frame, body, cab and accessories, group 9.1 Controls and instruments
5	The steering valve pumps pressurised oil to the steering cylinder and transmits a load signal to the main pumps.	-	Steering valve, description page 20
6	The steering cylinder turns the wheels.	-	Steering cylinder, description page 23

Hydraulic diagram, basic machine

Joystick control/mini-wheel, function description (hydraulic oil pump alternative Rexroth)



Mini-wheel or lever steering is a steering option that makes it possible to steer the machine with an electric control.

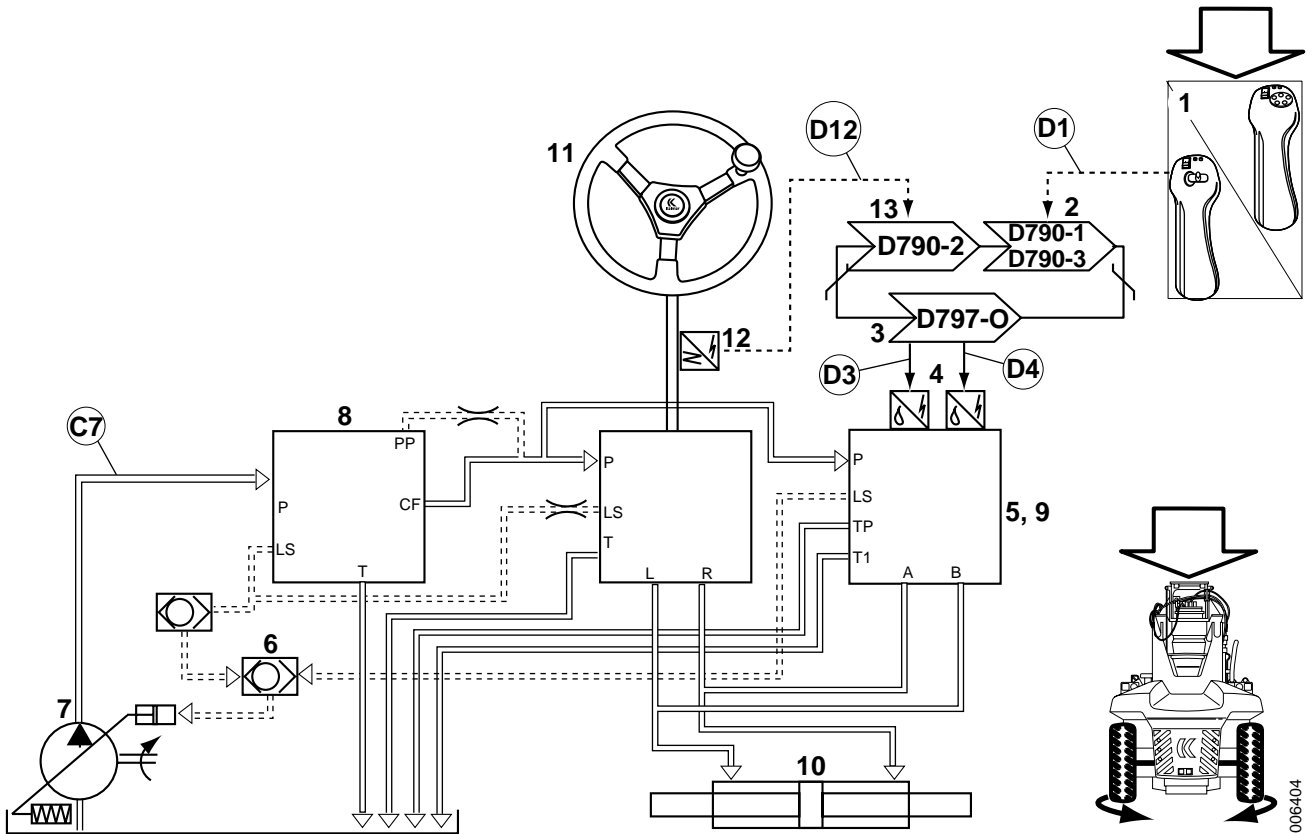
The relationship between the deflection of the control and that of the wheels can be set to 31 different settings - from linear to extremely progressive. It is also possible to set how steering deflection is to be adapted based on machine speed. This is done via the initiation menus; see section 8 *Control system*, group 8.5.1 *Initiation*.

NOTE

The mini-wheel/lever steering is deactivated if the standard steering wheel is used.

Mini-wheel or lever steering can only be activated at speeds below 3 km/h.

Condition	Reference value	Reference
Lever steering activated	Voltage signal from switch mini-wheel/joystick control.	<i>Mini-wheel, description page 3 or Joystick, description page 4</i> Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.11.4 <i>EL-STEERING</i> , menu 2
Steering wheel stationary	No signal from sensor steering wheel movement.	<i>Sensor, steering wheel movement, description page 32</i>
Speed	Below 3 km/h (at engagement)	-
Safety switch	Not activated	Section 11 <i>Common electrics</i> , group 11.2.3 <i>Safety switch</i>



006404

Pos	Explanation	Signal description	Reference
1	The joystick switch <i>or mini-wheel switch</i> sends a voltage signal to the cab control unit (D790-1). On machines with Combi attachment the signal is sent to the cab control unit option (D790-3).	Signal 1, U = 0.5 - 4.5 V Signal 2, U = 0.5 - 4.5 V (mini-wheel only)	<i>Mini-wheel, description page 3 or Joystick, description page 4</i> D1: Diagnostic menu, see section 8 Control system , group 8.4.11.4 EL-STEERING, menu 1
2	The cab control unit (D790-1) transmits the desired steering deflection on the CAN bus. On machines with Combi attachment the cab control unit option (D790-3) sends steering deflection on the CAN bus.	Checked by control system; error indicated with error code.	Section 11 Common electrics, group 11.5.3.1 Cab control unit
3	Control unit, frame option (D797-O) supplies voltage to the solenoid valve for steering right (Y636R) <i>or the solenoid valve for steering left (Y636L)</i> .	I = 350–550 mA	Section 11 Common electrics, group 11.5.3.4 Control unit, frame option D3: Diagnostic menu, see section 8 Control system , group 8.4.11.4 EL-STEERING, menu 4 and 5

Pos	Explanation	Signal description	Reference
4	The solenoid valve, steering right (Y636R) or solenoid valve, steering left (Y636l) pressurises the steering slide in the solenoid valve for lever steering or mini-wheel.	-	<i>Control valve for lever steering or mini-wheel, description page 28</i> D4: Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.11.4 <i>EL-STEERING</i> , menu 4 and 5
5	The solenoid valve for lever control or mini-wheel sends a load signal to shuttle valve, steering.	-	<i>Control valve for lever steering or mini-wheel, description page 28</i>
6	The shuttle valve selects the strongest load signal to hydraulic oil pump 3 and 4 if hydraulic functions are activated at the same time as the steering wheel is turned.	-	<i>Shuttle valve for mini-wheel or lever control, description page 31</i>
7	Hydraulic oil pumps 3 and 4 pump oil from the hydraulic oil tank.	See pressure plate on left frame beam.	Section 10 <i>Common hydraulics</i> , group 10.4.2 <i>Axial piston pump with variable displacement</i>
8	The priority valve prioritises pressure supply to the steering valve over the working hydraulics. The priority valve also transmits a control signal to the hydraulic oil pump 3 and 4.	See pressure plate on left frame beam.	<i>Priority valve page 14</i>
9	The slide changes position and pressurises the steering cylinder.	-	<i>Control valve for lever steering or mini-wheel, description page 28</i>
10	The steering cylinder turns the wheels.	-	<i>Steering cylinder, description page 23</i>
11	The steering wheel is turned and acts on the steering valve's input shaft.	-	Section 9 <i>Frame, body, cab and accessories</i> , group 9.1 <i>Controls and instruments</i>
12	Sensor steering axle sends a voltage signal to Control unit, cab (D790-1).	U = 24 V	<i>Sensor, steering wheel movement, description page 32</i> D12: Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.11.4 <i>EL-STEERING</i> , menu 3
13	The cab control unit (D790-1) transmits the stop steering on the CAN bus.	Checked by control system; error indicated with error code.	Section 11 <i>Common electrics</i> , group 11.5.3.1 <i>Cab control unit</i>

Hydraulic diagram, joystick control

Joystick control/mini-wheel, function description (hydraulic oil pump alternative Sauer-Danfoss)



Mini-wheel or lever steering is a steering option that makes it possible to steer the machine with an electric control.

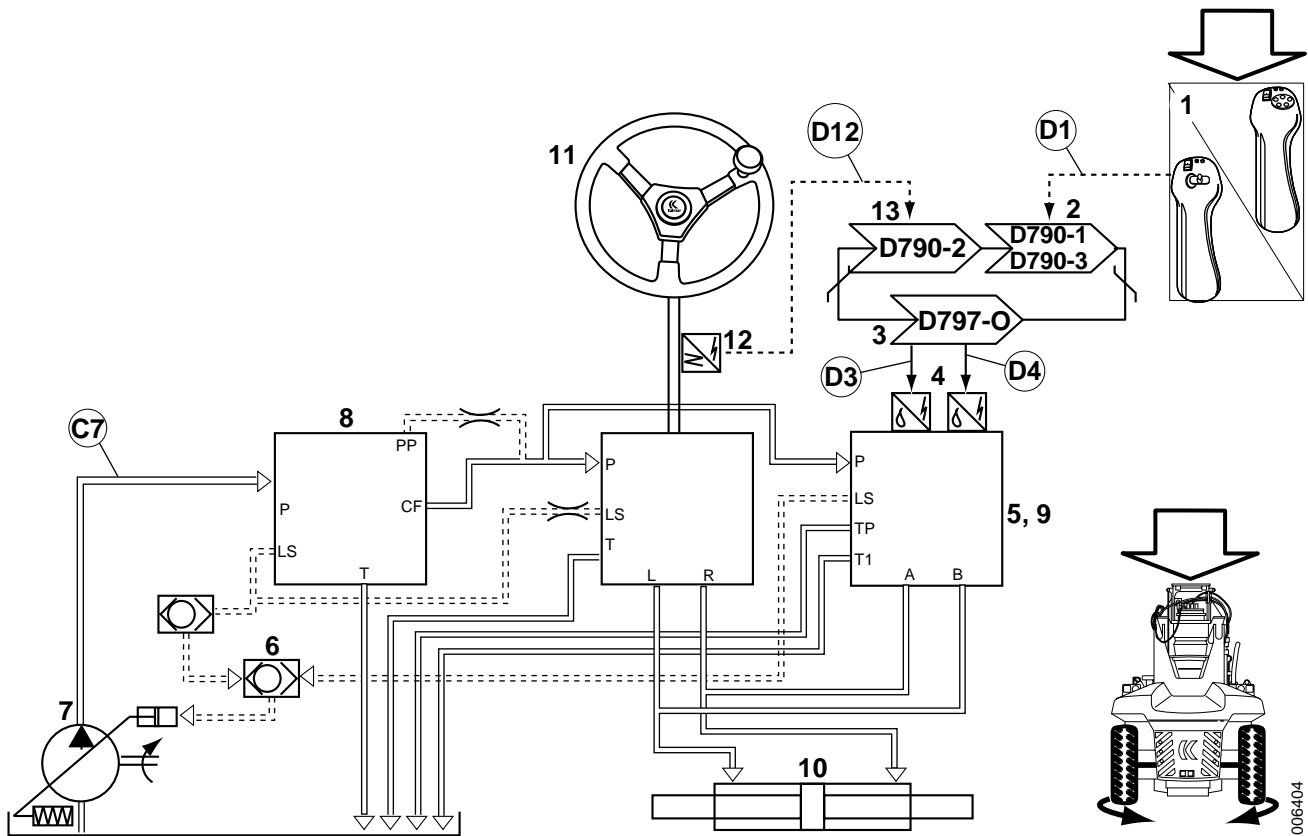
The relationship between the deflection of the control and that of the wheels can be set to 31 different settings - from linear to extremely progressive. It is also possible to set how steering deflection is to be adapted based on machine speed. This is done via the initiation menus; see section 8 *Control system*, group 8.5.1 *Initiation*.

NOTE

The mini-wheel/lever steering is deactivated if the standard steering wheel is used.

Mini-wheel or lever steering can only be activated at speeds below 3 km/h.

Condition	Reference value	Reference
Lever steering activated	Voltage signal from switch mini-wheel/joystick control.	<i>Mini-wheel, description page 3 or Joystick, description page 4</i> Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.11.4 <i>EL-STEERING, menu 2</i>
Steering wheel stationary	No signal from sensor steering wheel movement.	<i>Sensor, steering wheel movement, description page 32</i>
Speed	Below 3 km/h (at engagement)	-
Safety switch	Not activated	Section 11 <i>Common electrics</i> , group 11.2.3 <i>Safety switch</i>



Pos	Explanation	Signal description	Reference
1	The joystick switch <i>or</i> mini-wheel switch sends a voltage signal to the cab control unit (D790-1). On machines with Combi attachment the signal is sent to the cab control unit option (D790-3).	Signal 1, U = 0.5 - 4.5 V Signal 2, U = 0.5 - 4.5 V (mini-wheel only)	<i>Mini-wheel</i> , description page 3 <i>or</i> <i>Joystick</i> , description page 4 D1: Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.11.4 <i>EL-STEERING</i> , menu 1
2	The cab control unit (D790-1) transmits the desired steering deflection on the CAN bus. On machines with Combi attachment the cab control unit option (D790-3) sends steering deflection on the CAN bus.	Checked by control system; error indicated with error code.	Section 11 <i>Common electrics</i> , group 11.5.3.1 <i>Cab control unit</i>
3	Control unit, frame option (D797-O) supplies voltage to the solenoid valve for steering right (Y636R) <i>or</i> the solenoid valve for steering left (Y636L).	I = 350–550 mA	Section 11 <i>Common electrics</i> , group 11.5.3.4 <i>Control unit, frame option</i> D3: Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.11.4 <i>EL-STEERING</i> , menu 4 and 5

Pos	Explanation	Signal description	Reference
4	The solenoid valve, steering right (Y636R) or solenoid valve, steering left (Y636L) pressurises the steering slide in the solenoid valve for lever steering or mini-wheel.	-	<i>Control valve for lever steering or mini-wheel, description page 28</i> D4: Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.11.4 <i>EL-STEERING</i> , menu 4 and 5
5	The solenoid valve for lever control or mini-wheel sends a load signal to shuttle valve, steering.	-	<i>Control valve for lever steering or mini-wheel, description page 28</i>
6	The shuttle valve selects the strongest load signal to hydraulic oil pump 2 if hydraulic functions are activated at the same time as the steering wheel is turned.	-	<i>Shuttle valve for mini-wheel or lever control, description page 31</i>
7	Hydraulic oil pump 2 pumps oil from the hydraulic oil tank.	See pressure plate on left frame beam.	Section 10 <i>Common hydraulics</i> , group 10.4.2 <i>Axial piston pump with variable displacement</i>
8	The priority valve prioritises pressure supply to the steering valve over the working hydraulics. The priority valve also transmits a control signal to the hydraulic oil pump 2.	See pressure plate on left frame beam.	<i>Priority valve page 14</i>
9	The slide changes position and pressurises the steering cylinder.	-	<i>Control valve for lever steering or mini-wheel, description page 28</i>
10	The steering cylinder turns the wheels.	-	<i>Steering cylinder, description page 23</i>
11	The steering wheel is turned and acts on the steering valve's input shaft.	-	Section 9 <i>Frame, body, cab and accessories</i> , group 9.1 <i>Controls and instruments</i>
12	Sensor steering axle sends a voltage signal to Control unit, cab (D790-1).	U = 24 V	<i>Sensor, steering wheel movement, description page 32</i> D12: Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.11.4 <i>EL-STEERING</i> , menu 3
13	The cab control unit (D790-1) transmits the stop steering on the CAN bus.	Checked by control system; error indicated with error code.	Section 11 <i>Common electrics</i> , group 11.5.3.1 <i>Cab control unit</i>

Hydraulic diagram, joystick control

5.2.1 Hydraulic oil pump

Hydraulic oil pump, general (hydraulic oil pump alternative Rexroth)

Steering is supplied oil by the hydraulic oil pumps 3 and 4, see section 10 *Common hydraulics*, group 10.4 *Pumps*.

Hydraulic oil pump, general (hydraulic oil pump alternative Sauer-Danfoss)

Steering is supplied oil by the hydraulic oil pump 2, see section *10 Common hydraulics*, group *10.4 Pumps*.

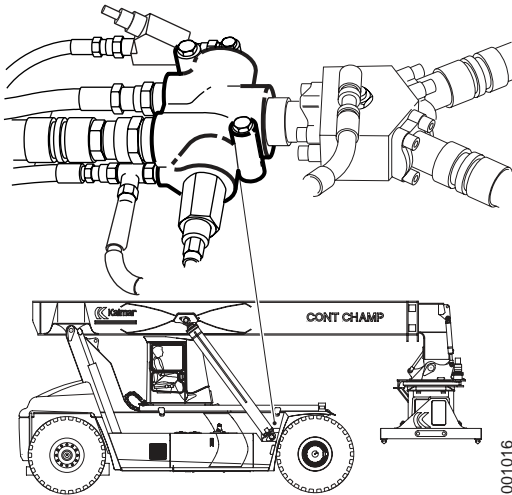
5.2.2 Priority valve

Priority valve, description (hydraulic oil pump alternative Rexroth)

The priority valve divides the oil flow from the main pump 3 and 4 so that there is always oil to the steering valve. The residual flow goes to working hydraulics.

The priority valve is load sensing and pilot pressure compensating. Load sensing means that the valve adapts the control signal to the steering valve's consumption. Pilot pressure compensating means that the priority valve compensates for the pressure drop between the priority valve and steering valve via a separate line.

The priority valve has a built-in pressure limiter on the load signal. The pressure limiter maximises the load signal's pressure.

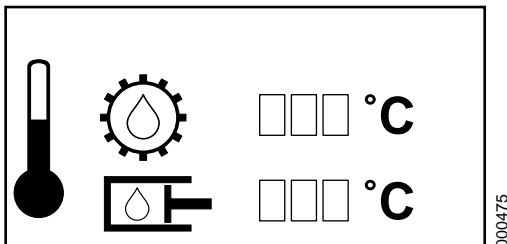


Steering pressure, checking (hydraulic oil pump alternative Rexroth)

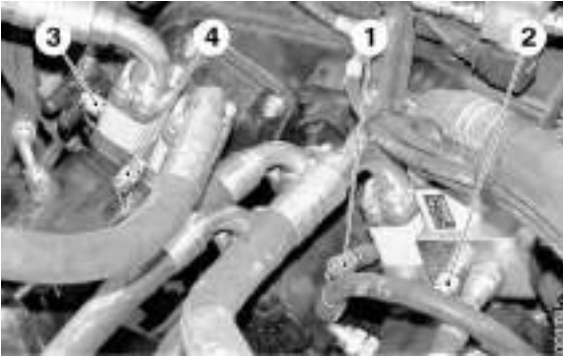
NOTE

Read the safety instructions for oil before working, see section B Safety.

- 1 Operate and warm up the machine so that the hydraulic oil reaches operating temperature, 50 °C.
- 2 Machine in service position, see section *B Safety*.
- 3 Depressurising removed.

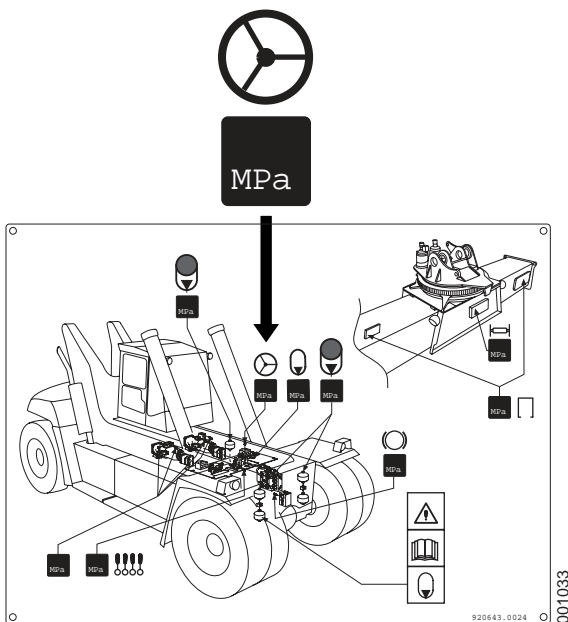


Operating menu, hydraulic oil temperature



Measuring outlet, hydraulic oil pumps

1. Hydraulic oil pump 1
2. Hydraulic oil pump 2
3. Hydraulic oil pump 2
4. Hydraulic oil pump 4



- 4 Connect the pressure gauge to the measuring outlet for hydraulic oil pump 3 or 4.
- 5 Start the engine and increase engine speed to approx. 1200 rpm.

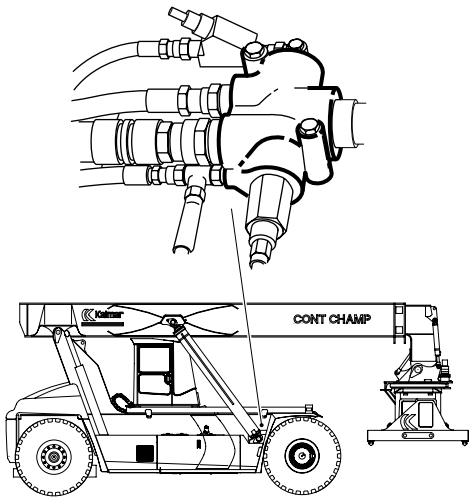
- 6 Turn the steering wheel fully and read pump pressure during steering wheel movement. Compare this to the steering pressure on the hydraulics plate. The max. pressure measured on the pump should be **1.5 MPa** more than the steering pressure on the hydraulics plate.
- 7 Stop the engine and turn the starter key to position I.
- 8 Depressurising removed.
- 9 Turn the start key to position 0 and turn off the main electric power.
- 10 Remove the pressure gauge and fit the protective cap on the measuring outlet.

Priority valve, description (hydraulic oil pump alternative Sauer-Danfoss)

The priority valve divides the oil flow from the main pump 2 so that there is always oil to the steering valve. The residual flow goes to working hydraulics.

The priority valve is load sensing and pilot pressure compensating. Load sensing means that the valve adapts the control signal to the steering valve's consumption. Pilot pressure compensating means that the priority valve compensates for the pressure drop between the priority valve and steering valve via a separate line.

The priority valve has a built-in pressure limiter on the load signal. The pressure limiter maximises the load signal's pressure.



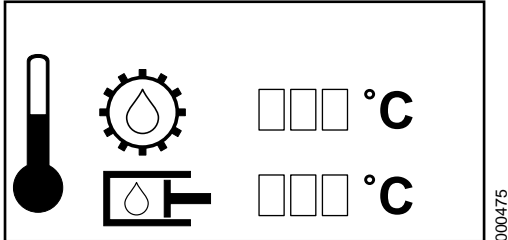
011345

Steering pressure, checking (hydraulic oil pump alternative Sauer-Danfoss)

NOTE

Read the safety instructions for oil before working, see section B Safety.

- 1 Operate and warm up the machine so that the hydraulic oil reaches operating temperature, 50 °C.
- 2 Machine in service position, see section B Safety.
- 3 Depressurising removed.



000475

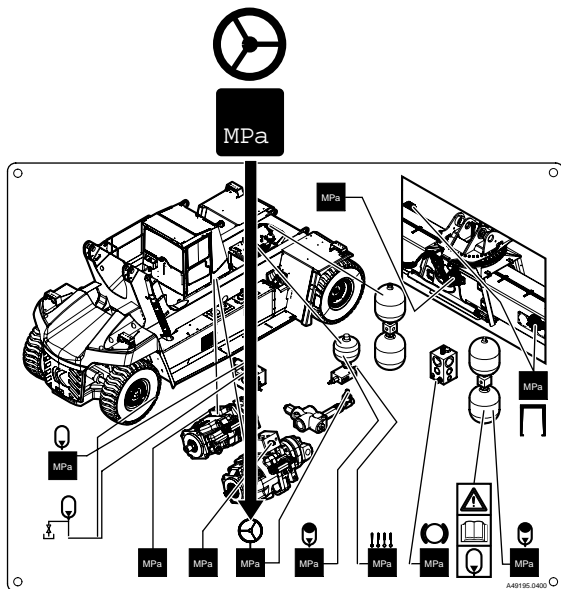
Operating menu, hydraulic oil temperature



Measuring outlet, hydraulic oil pumps

1. Hydraulic oil pump 1
2. Hydraulic oil pump 2

- 4 Connect the pressure gauge to the measuring outlet for hydraulic oil pump 2.
- 5 Start the engine and increase engine speed to approx. 1200 rpm.



- 6 Turn the steering wheel fully and read pump pressure during steering wheel movement. Compare this to the steering pressure on the hydraulics plate. The max. pressure measured on the pump should be **1.5 MPa** more than the steering pressure on the hydraulics plate.
- 7 Stop the engine and turn the starter key to position I.
- 8 Depressurising removed.
- 9 Turn the start key to position 0 and turn off the main electric power.
- 10 Remove the pressure gauge and fit the protective cap on the measuring outlet.

Priority valve, replacement

NOTE

Read the safety instructions for oil before working, see section B Safety.

- 1 Machine in service position, see section B Safety.
- 2 Depressurise the brake and hydraulic systems, see section B Safety.
- 3 Turn the start key to position 0 and turn off the main electric power.
- 4 Mark up and detach the hydraulic hoses from the priority valve.



NOTE

Plug all connections immediately to protect the brake system from impurities.

- 5 Remove the priority valve attaching bolts.
- 6 Release the priority valve from the collection block.
- 7 Remove the priority valve.
- 8 Transfer the connection adapters to the new priority valve.

NOTE

Transfer one connection at a time so that the marking is not mixed up.

- 9 Connect the new priority valve to the collection block.



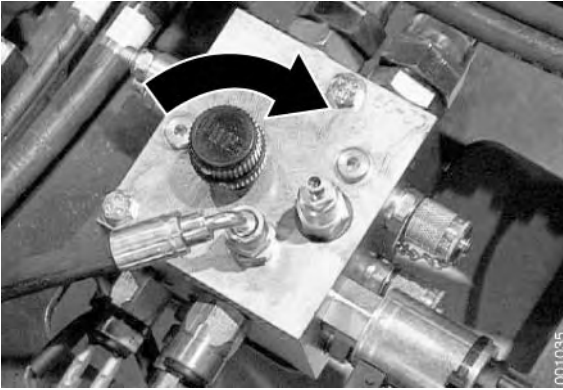
CAUTION

Do not tighten the hydraulic connection between priority valve and collection block before all other connections and attaching bolts are fitted.

Stresses in the priority valve may result in incorrect function.



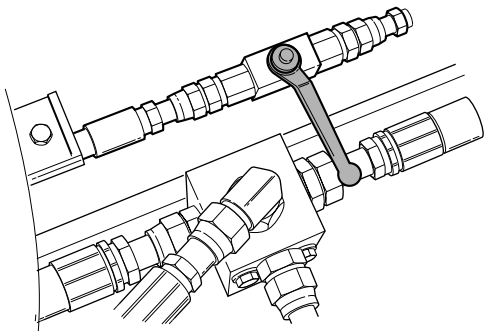
- 10 Fit the priority valve attaching bolts.
- 11 Connect the hydraulic hoses to the priority valve.
- 12 Check that the collection block is not pressing against the priority valve.
- 13 Tighten the hydraulic connection between priority valve and collection block.



- 14 Close the drain valve on the accumulator charging valve.

NOTE

Check that the accumulator drain valve is fully closed and tighten the lock ring.



010475

Relief valve for top lift, the figure shows a closed valve.

- 15 Close the relief valve for top lift.

CAUTION

Hydraulic oil may be directed the wrong way.

Risk of damage to the fine filter for hydraulic oil.

Check that the relief valve for top lift is closed before starting the engine.

- 16 Start the engine and check that the hydraulic connections at the priority valve are sealed.
- 17 Check the oil level in the hydraulic oil tank with the lift cylinders fully down and the extension cylinder fully in. The oil level should be in the centre of the level glass. Top up if necessary, for grade see section *F Technical data*.



CAUTION

Overfilling of oil, leakage, and environmental damage.

The hydraulic oil level is checked with the boom completely lowered and retracted.

- 18 Check steering pressure, see *Steering pressure, checking (hydraulic oil pump alternative Rexroth) page 14*.

5.2.3 Steering valve

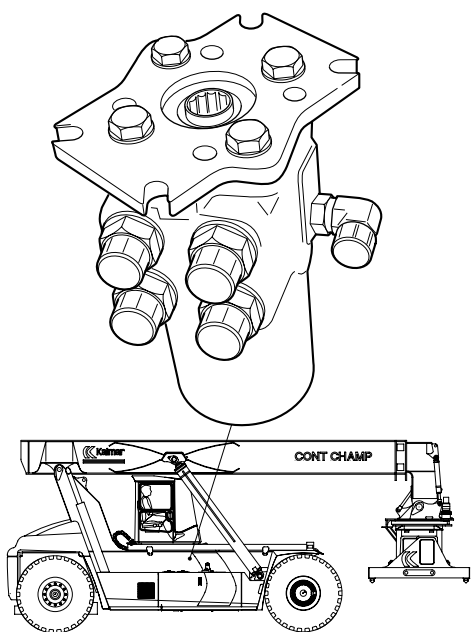
Steering valve, description

The steering valve is a "progressive, closed centre, non-reaction valve" with load signal connection to the priority valve.

The load signal generates load-dependent control of oil flow from the priority valve to the steering valve. Closed centre means that the steering valve is closed in its neutral position. This is necessary so that signal pressure can be connected to the steering valve.

The steering valve consists of a gear pump and a distribution valve. When the steering wheel is turned, oil flows from the main pump over the gear pump to the distribution valve, which guides oil to the steering cylinder. The gear pump ensures that the oil flow fed to the cylinder is proportional to the steering wheel angle.

There are double shock and anti-cavitation valves in the steering valve. The shock valves protect the hydraulics against pressure spikes which can arise from impacts on the steering wheels. The anti-cavitation valves (non-return valves) protect against vacuum on the piston's rear side, which can lead to cavitation.



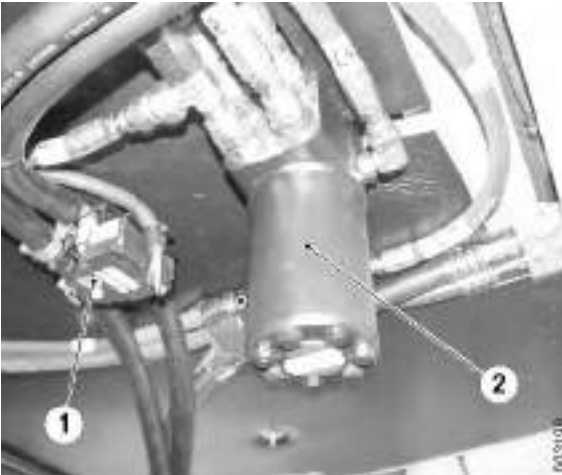
001082

Steering valve, replacement

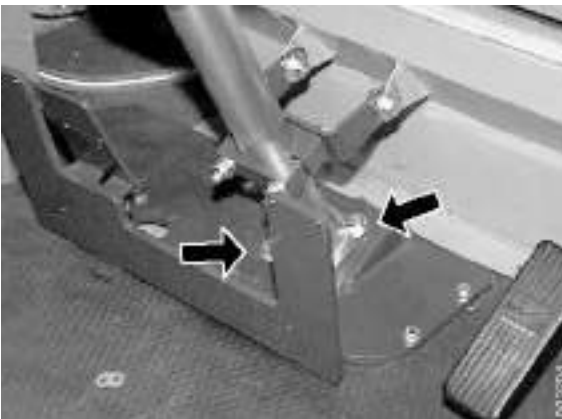
NOTE

Read the safety instructions for oil before working, see section B Safety.

- 1 Remove the cover plates over the engine compartment.
- 2 Slide the cab forward so that the control valve is accessible from below.
- 3 Stop the engine and turn the starter key to position I.
- 4 Depressurise the brake and hydraulic systems, see section B Safety.
- 5 Turn the start key to position 0 and turn off the main electric power.



1. Water valve
2. Steering valve



- 6 Detach the steering valve from the brake pedal.
Remove the steering valve attaching bolts and lower the steering valve.
- 7 Mark up and detach the hydraulic hoses from the steering valve.

NOTE

Plug all connections immediately to protect the brake system from impurities.

- 8 Remove the steering valve.
- 9 Transfer the connection adapters to the new steering valve.

NOTE

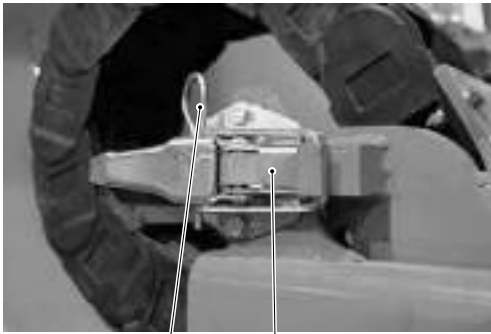
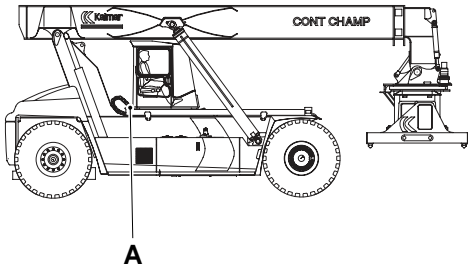
Transfer one at a time so that the marking is not mixed up.

- 10 Connect the hydraulic hoses to the steering valve in accordance with the marking.

NOTE

Check that the O-rings are intact and are fitted correctly.

- 11 Connect the new steering valve to the brake pedal.
Place the steering valve and check that the steering wheel shaft's splines enter straight in the steering valve's slot. Install the attaching bolts.

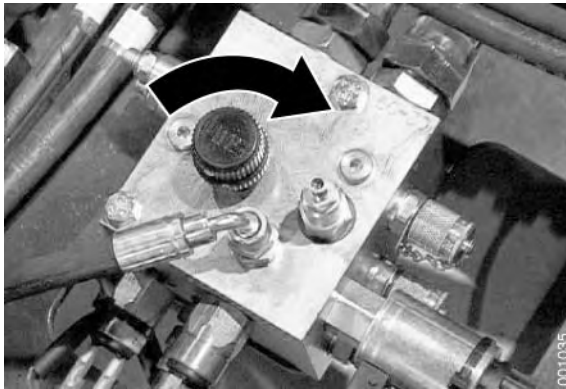


000270

- A. Location, lock handle
- B. Lock pin
- C. Lock handle for securing cab

12 On machines with manual sliding cab:

Lock the cab in its rearmost position with both locking catches.

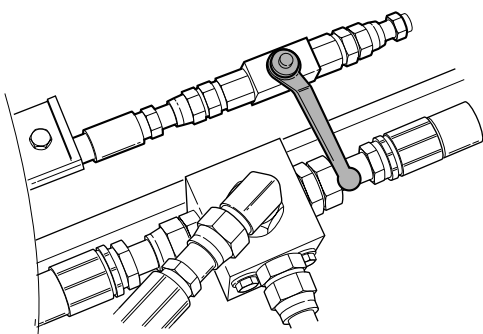


001035

13 Close the drain valve on the accumulator charging valve.

NOTE

Check that the accumulator drain valve is fully closed and tighten the lock ring.



010475

Relief valve for top lift, the figure shows a closed valve.

14 Close the relief valve for top lift.

⚠ CAUTION

Hydraulic oil may be directed the wrong way.

Risk of damage to the fine filter for hydraulic oil.

Check that the relief valve for top lift is closed before starting the engine.



- 15 Turn on the main electric power and start the engine.
- 16 Check that the connections on the steering valve are sealed.
- 17 Steer very carefully a few times right - left, to bleed the steering valve and steering cylinder.
- 18 Check the oil level in the hydraulic oil tank with the lift cylinders fully down and the extension cylinder fully in. The oil level should be in the centre of the level glass. Top up if necessary, for grade see section *F Technical data*.

CAUTION

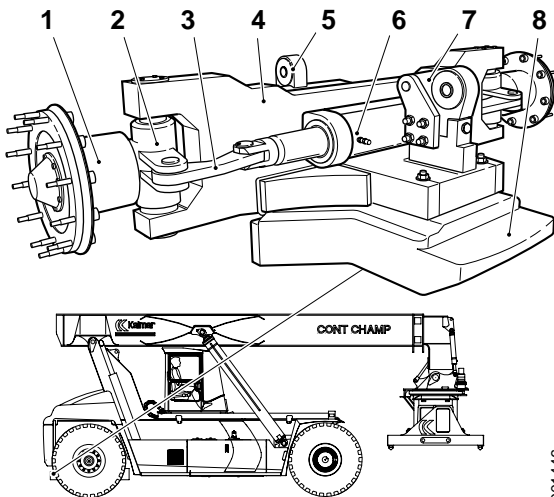
Overfilling of oil, leakage, and environmental damage.

The hydraulic oil level is checked with the boom completely lowered and retracted.

5.2.4 Steering cylinder

Steering cylinder, description

The steering cylinder acts on the wheels via the link arms. The steering cylinder is a double-acting hydraulic cylinder.



001446

1. Wheel hub
2. Wheel spindle
3. Link arm
4. Steering axle
5. Suspension
6. Steering cylinder
7. Rear mounting
8. Counterweight

Steering cylinder, replacement

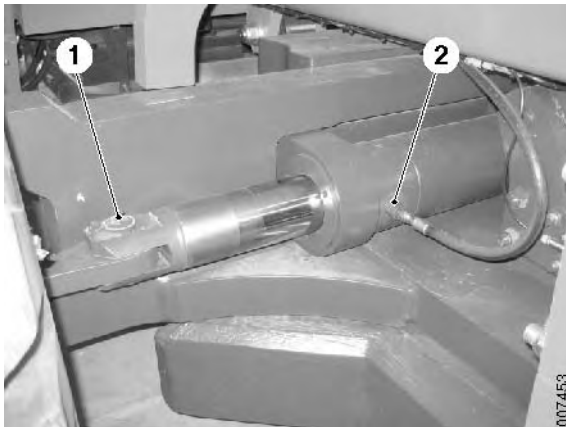
NOTE

Read the safety instructions for oil before working, see section B Safety.

- 1 Park the machine with the wheels fully turned so that the steering cylinder can be lifted out to one side.
- 2 Machine in service position, see section B Safety.
- 3 Depressurise the brake and hydraulic systems, see section B Safety.
- 4 Disconnect the link arms from the steering cylinder.
- 5 Mark up and disconnect the hydraulic hoses from the steering cylinder.

NOTE

Plug all connections immediately to protect the brake system from impurities.



1. Link arm mounting
2. Hydraulic connection



Attaching bolts steering cylinder.

- 6 Remove the steering cylinder's attaching bolts.
- 7 Change the steering cylinder. Lift aside the steering cylinder.

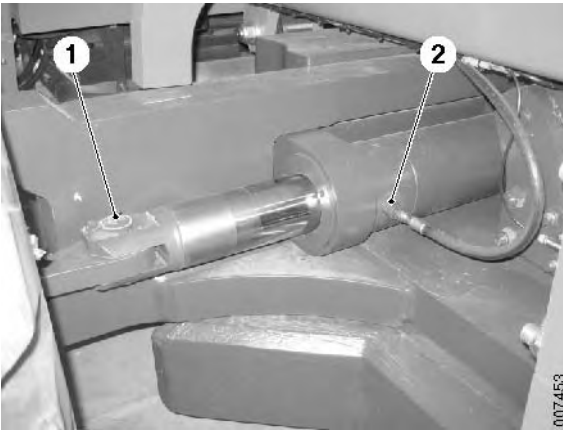
NOTE

The steering cylinder is heavy, use lifting equipment.

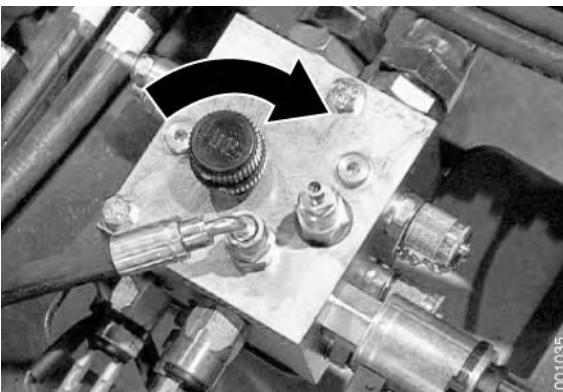
- 8 Support the new steering cylinder so that the holes in the attaching bolts are lined up directly opposite the holes in the steering axle.
- 9 Fit and lubricate the steering cylinder attaching bolts. Tighten them crosswise in steps until 680 Nm is achieved.
- 10 Transfer parts to the new steering cylinder.

NOTE

Check that the O-rings are intact and fitted correctly.



1. Link arm mounting
2. Hydraulic connection



- 11 Fit the link arms to the steering cylinder.
- 12 Connect the hydraulic hoses to the steering cylinder.

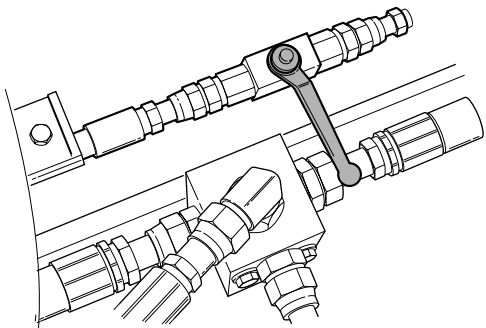
NOTE

Check that the O-rings are intact and fitted correctly.

- 13 Close the drain valve on the accumulator charging valve.

NOTE

Check that the accumulator drain valve is fully closed and tighten the lock ring.



Relief valve for top lift, the figure shows a closed valve.

- 14 Close the relief valve for top lift.



CAUTION

Hydraulic oil may be directed the wrong way.

Risk of damage to the fine filter for hydraulic oil.

Check that the relief valve for top lift is closed before starting the engine.

- 15 Start the engine and check for leaks.



- 16 Check the oil level in the hydraulic oil tank with the lift cylinders fully down and the extension cylinder fully in. The oil level should be in the centre of the level glass. Top up if necessary, for grade see section *F Technical data*.

! **CAUTION**

Overfilling of oil, leakage, and environmental damage.

The hydraulic oil level is checked with the boom completely lowered and retracted.

Hydraulic cylinders, repairs

See section *10 Common hydraulics*, group *10.7.1 Hydraulic cylinders*.

5.2.5 Steering axle cradle

Steering axle cradle, general

See section *6 Suspension*, group *6.2.1 Steering axle cradle*.

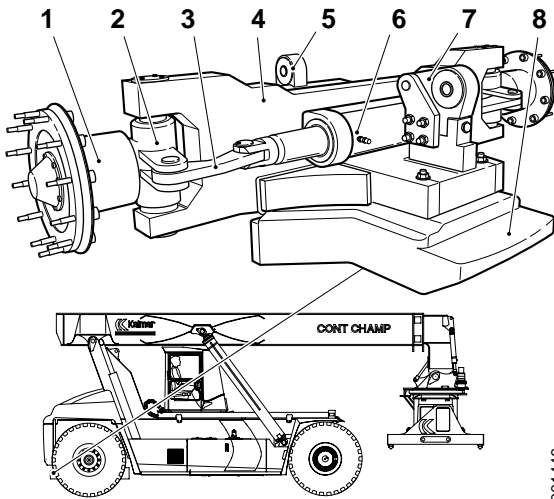
5.2.6 Link arm

Link arm, description

The link arm transfers the lateral movement of the steering cylinder to turning the wheel spindles.

The setting of the steering wheels cannot be adjusted. If the link arms are deformed in a way that changes the setting of the steering wheels, they must be replaced.

The link arms must be turned to the right direction, otherwise they can be damaged by the rims with large wheel angles.



1. Wheel hub
2. Wheel spindle
3. Link arm
4. Steering axle
5. Suspension
6. Steering cylinder
7. Rear mounting
8. Counterweight

5.2.7 Wheel spindle

Wheel spindle, general

See section 6 *Suspension* , group 6.2.2 *Wheel spindle*.

5.2.8 Wheel hub

Wheel hub, general

See section 6 *Suspension* , group 6.2.3 *Wheel hub*.

5.2.9 Shuttle valve

Shuttle valve, description

See section 10 *Common hydraulics* , group 10.5.3 *Shuttle valve*.

5.2.10 Control valve mini-wheel/joystick control

Control valve for lever steering or mini-wheel, description



On machines with joystick control or mini-wheel, steering cylinder displacement is regulated by the control valve for joystick control or mini-wheel. The control valve is located on the inside of the right frame member in front of the engine. The control valve is regulated by Control unit, frame option (D797-O).

The control valve is an electro-hydraulically controlled, proportional and pressure-compensated directional valve. Electrically controlled pressure reducing valves convert electrical current to servo pressure. The servo pressure controls the spring-centred valve slides, which control pressure and flow for the function in question. The valve slides have flow limits so that several functions can be activated simultaneously.

Valve slide, steering

The valve slide controls the direction and steering angle by controlling the hydraulic pressure to the steering cylinder.

The valve slide is controlled by servo valve right and servo valve left.

Servo valve right

Servo valve right controls servo pressure to valve slide, steering, so that it controls oil pressure for steering right.

Servo valve right regulates electrically with the solenoid valve steering right (Y636R), which is activated by Control unit, frame option (D797-O).

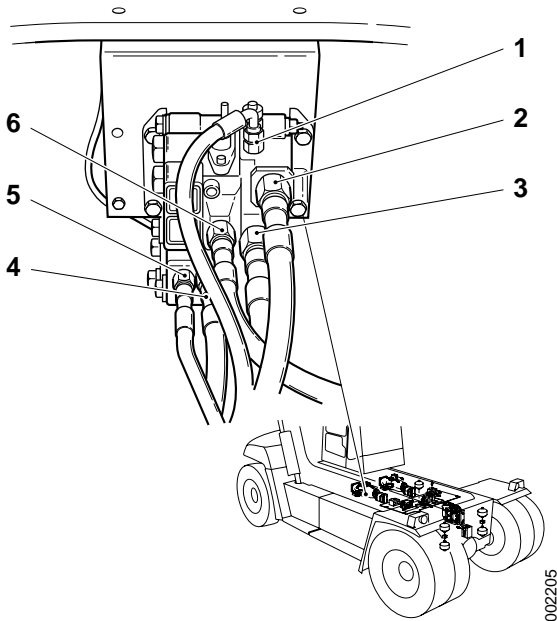
The signals can be read from the diagnostic menu, see section 8 *Control system*, group 8.4.11.4 *EL-STEERING*, menu 5.

Servo valve left

Servo valve left controls servo pressure to valve slide, steering, so that it controls oil pressure for steering left.

Servo valve left regulates electrically with the solenoid valve steering left (Y636L), which is activated by Control unit, frame option (D797-O).

The signals can be read from the diagnostic menu, see section 8 *Control system*, group 8.4.11.4 *EL-STEERING*, menu 4.



1. Load signal (LS)
2. Pressure supply (P)
3. Tank return (T)
4. Connection, steering cylinder (B)
5. Tank return (TP)
6. Connection, steering cylinder (A)

Control valve for joystick control or mini-wheel, replacement



NOTE

Read the safety instructions for oil before working, see section B Safety.

- 1 Machine in service position, see section B Safety.
- 2 Depressurise the brake and hydraulic systems, see section B Safety.
- 3 Mark up and detach the hydraulic hoses from the control valve.

NOTE

Plug all connections immediately to protect the hydraulic system from impurities.

- 4 Mark up and detach the wiring from the control valve.
- 5 Remove the control valve.
Remove the attaching bolts and lift away the valve. Place the valve on a clean and protected surface.
- 6 Transfer parts to the new control valve.

NOTE

Check that the O-rings on the hydraulic connections are intact and in place.

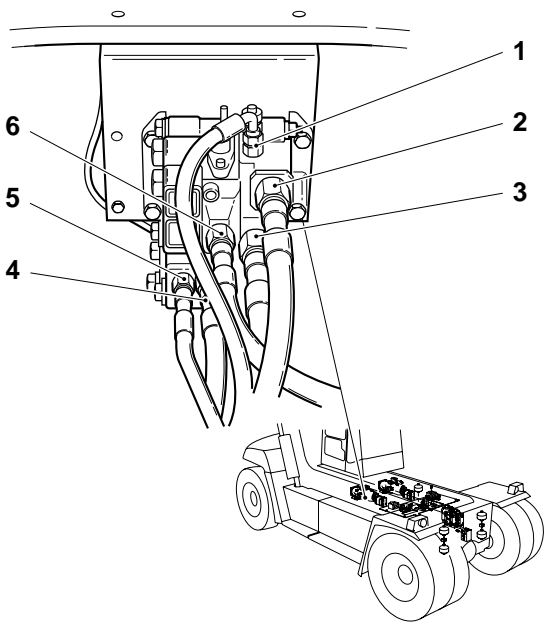
NOTE

Transfer one adapter component at a time so that the marking is not mixed up.

- 7 Mark up the servo valves on the new control valve.
- 8 Fit the valve.
- 9 Connect the wiring to the control valve in accordance with the marking.
- 10 Connect the hydraulic hoses to the control valve in accordance with the marking.

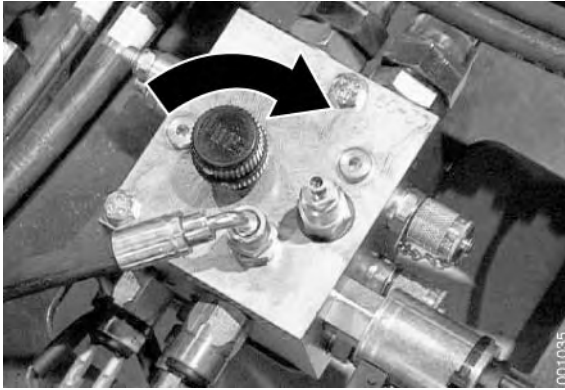
NOTE

Check that the O-rings are intact and fitted correctly.



002205

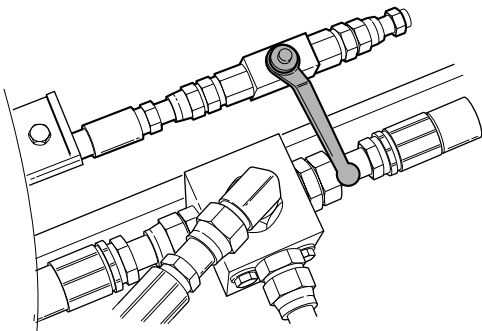
1. Load signal (LS)
2. Pressure supply (P)
3. Tank return (T)
4. Connection, steering cylinder (B)
5. Tank return (TP)
6. Connection, steering cylinder (A)



- 11 Close the drain valve on the accumulator charging valve.

NOTE

Check that the accumulator drain valve is fully closed and tighten the lock ring.



010475

Relief valve for top lift, the figure shows a closed valve.

- 12 Close the relief valve for top lift.

! CAUTION

Hydraulic oil may be directed the wrong way.

Risk of damage to the fine filter for hydraulic oil.

Check that the relief valve for top lift is closed before starting the engine.

- 13 Start the engine and check for leaks.

- 14 Check the function.

! CAUTION

Air in the hydraulic system may cavitate and result in product damage.

Activate the steering carefully and drive a couple of times with lowest possible speed to avoid cavitation.



- 15 Check the oil level in the hydraulic oil tank with the lift cylinders fully down and the extension cylinder fully in. The oil level should be in the centre of the level glass. Top up if necessary, for grade see section *F Technical data*.

! CAUTION

Overfilling of oil, leakage, and environmental damage.

The hydraulic oil level is checked with the boom completely lowered and retracted.

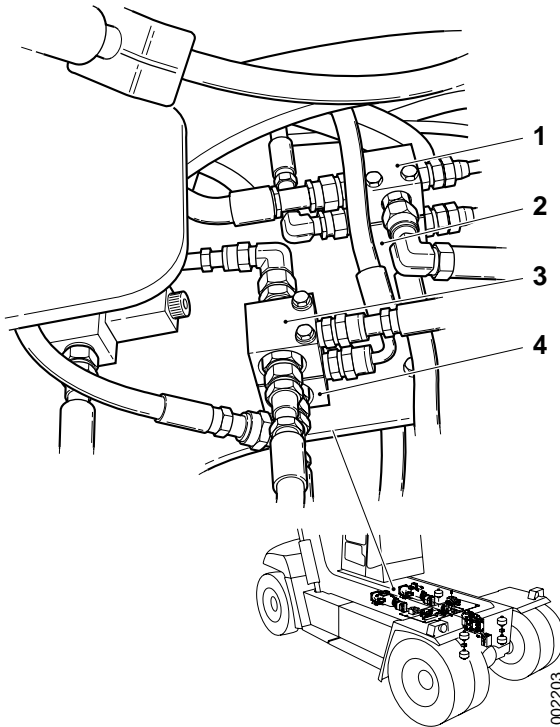
5.2.11 Shuttle valve, mini-wheel/lever steering

Shuttle valve for mini-wheel or lever control, description



Machines with lever steering or mini-wheel have an extra shuttle valve for the control signal cables of the hydraulic oil pumps. The shuttle valves are fitted on the bracket for oil filling and dipsticks between engine and transmission.

The shuttle valve forwards the control signal from the control valve to the main pumps.



Shuttle valves on attachment plate between engine and transmission

1. Shuttle valve, frame option
2. Shuttle valve lifting / steering
3. Shuttle valve joystick control/mini-wheel
4. Shuttle valve lifting / attachment

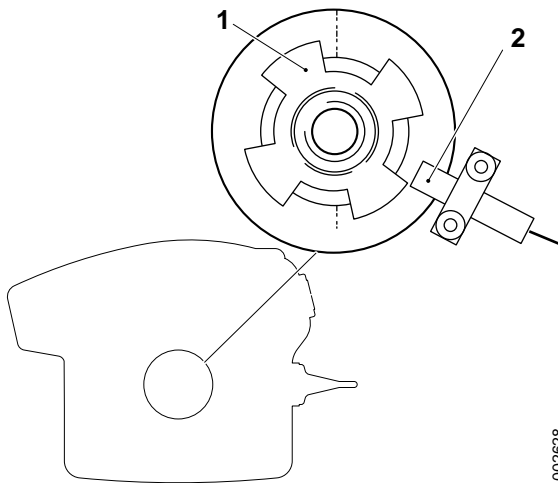
5.2.12 Steering angle sensor

Sensor, steering wheel movement, description



The steering angle sensor (B770) detects if the steering wheel is turned and sends a signal to the KIT control unit (D790-2). This is used to disengage joystick control or the mini-wheel. The sensor is located by the steering axle inside the panels. The sensor is tripped by an indicator ring on the steering axle with four lobes. The location of the sensor and lobes' spacing means that small steering wheel movements can be detected.

The signals can be read from the diagnostic menu, see section *8 Control system*, group *8.4.11.4 EL-STEERING*, menu 3.



002628

1. Indicator ring
2. Sensor steering wheel movement (B770)

Position sensor, checking and adjustment

See section *7 Load handling*.

5.2.13 Pipes and hoses

Piped and hoses, description

See section *10 Common hydraulics*, group *10.5.1 Pipes and hoses*.

Table of Contents 6 Suspension

6	Suspension	3
6.2	Suspension	3
6.2.1	Steering axle cradle	5
6.2.2	Wheel spindle	7
6.2.3	Wheel hub	11
6.3	Tyres and rims	16
6.3.1	Tyres	18
6.3.2	Rims	19
6.3.3	Nut, washer and clamp	20

6 Suspension

6.2 Suspension

Bushing steering axle mounting, changing

DANGER

Steering axle and machine are very heavy.

Risk of pinch injury!

It is not permissible to go under a machine which has been lifted by a jack or similar. For machine weights, please refer to section *F Technical data*.

- 1 Machine in service position, see section *B Safety*.
- 2 Turn the start key to position 0 and turn off the main electric power.
- 3 Remove the counterweights on the rear of the machine.

NOTE

Mark the locations of the counterweights so that they can be refitted at the same spot. This is important for the machine's stability.

- 4 Support under the steering axle so that it cannot fall over.
- 5 Connect lifting equipment to the rear of the machine and take up the slack so that the steering axle's mounts are relieved.

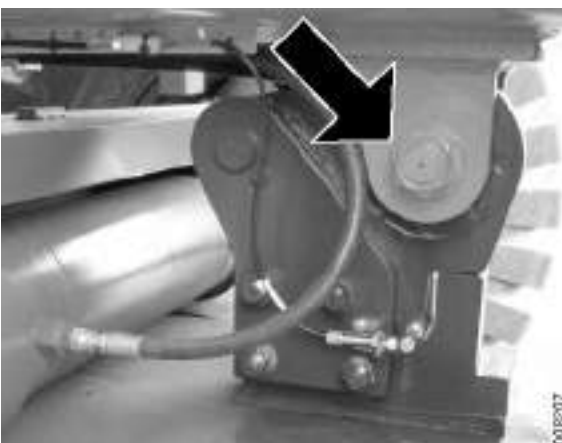
NOTE

Do not lift so much that the wheels are off the ground.

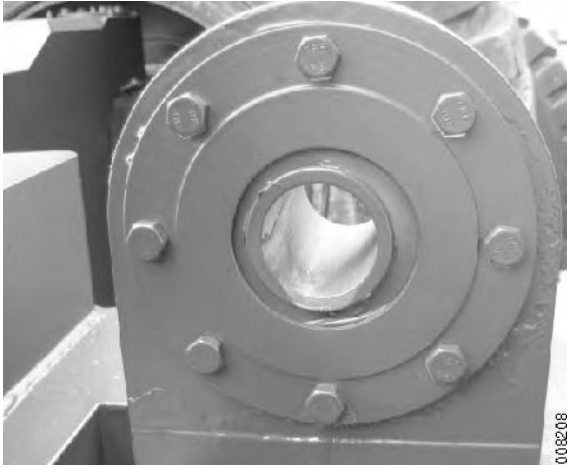
- 6 Remove the shafts holding the steering axle.
- 7 Lift the machine up so that the frame is lifted away from the axle.
- 8 Support the machine under the frame.
- 9 Move the steering axle so that the mountings can be accessed.

NOTE

If needed, disconnect the cabling for the sensors on the steering axle.



The illustration shows rear attachment.



The illustration shows front mounting.



Parts of bushing steering axle

1. Inner race
2. Bearing halves

- 10 Remove the washers that hold the bushing in place.
- 11 Press out the bushing.
- 12 Clean the bearing surfaces on the steering axle.

- 13 Assemble the parts of the bushing and press in the new bushing. Lubricate the bushing with grease in order to simplify installation.

CAUTION

The bearing halves must be mounted horizontally.

- 14 Fit the washers that hold the bushing in place. Use locking fluid and tighten the bolts to a torque of **45 Nm**.
- 15 Move the steering axle into place under the frame.
- 16 Grease and install the pins by the steering axle's mounts.
- 17 Remove the lifting equipment from the machine.
- 18 Fit the counterweights.

NOTE

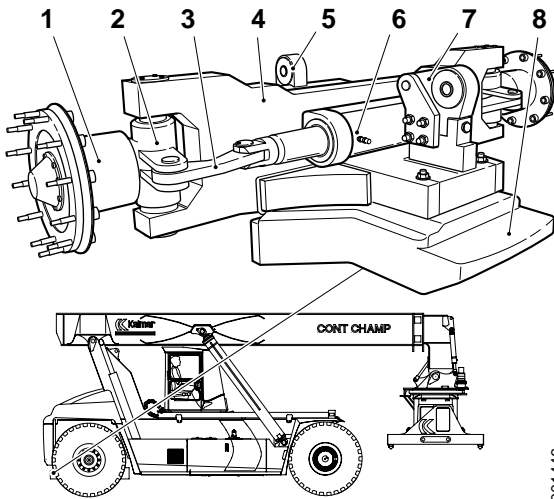
Make sure that all counterweights are refitted and that they are fitted in the exact same location as before. The stability of the machine is affected if the counterweights are changed.

6.2.1 Steering axle cradle

Steering axle cradle, description

The steering axle is pendulum suspended with a double-acting steering cylinder. The construction comprises a minimum of moving parts to minimise service points and simplify maintenance.

The frame suspension comprises maintenance-free parts. The rear suspension is designed with a leading knee which is used to indicate too low load on the steering axle, a so-called mechanical overload system, see section 8 *Control system*, group 8.2.1 *Overload System*.



1. Wheel hub
2. Wheel spindle
3. Link arm
4. Steering axle
5. Front mounting
6. Steering cylinder
7. Rear mounting
8. Counterweight

Steering axle cradle, replacement



DANGER

Steering axle and machine are very heavy.

Risk of pinch injury!

It is not permissible to go under a machine which has been lifted by a jack or similar. For machine weights, please refer to section F *Technical data*.

- 1 Clean the steering axle and its surrounding area.
- 2 Stop the engine and turn the starter key to position I.
- 3 Depressurise the brake and hydraulic systems, see section B *Safety*.
- 4 Turn the start key to position 0 and turn off the main electric power.

- 5 Remove the counterweights on the rear of the machine.

NOTE

Mark the locations of the counterweights so that they can be refitted at the same spot. This is important for the machine's stability.

- 6 Connect the lifting equipment to the rear section of the machine.
- 7 Tension the lifting equipment, do not lift so high that the wheels start to hang.
- 8 Support the machine's rear section.
- 9 Detach the wiring from the overload sensor (applies only to machines with mechanical overload system).
- 10 Detach the hydraulic hoses from the steering cylinder.

NOTE

Plug all unions at once to protect the hydraulic system from contamination.

- 11 Remove the shafts holding the steering axle.
- 12 Lift the machine up so that the frame is lifted away from the axle.
- 13 Lift out the steering axle.



CAUTION

The steering axle may start to roll.

Crushing injury!

Make sure that the steering axle does not start uncontrolled movement.

- 14 Adjust the support so that the machine is secured in the new position.
- 15 Lift the steering axle into place underneath the frame.
- 16 Remove the support under the frame.
- 17 Lower the rear of the machine.
- 18 Fit the shafts at the steering axle mountings.
- 19 Connect the hydraulic hoses to the steering cylinder.

NOTE

Check that the O-rings are intact and that they are fitted correctly.

- 20 Attach the wiring to the overload sensor (applies only to machines with mechanical overload system).

- 21 Remove the lifting equipment from the machine.
- 22 Fit the counterweights.

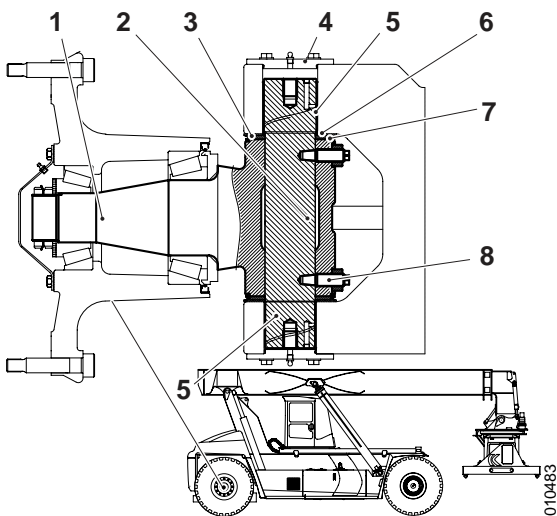
NOTE

Make sure that all counterweights are refitted and that they are fitted in the exact same location as before. The stability of the machine is affected if the counterweights are changed.

6.2.2 Wheel spindle

Wheel spindle, description

The wheel spindle is the link between steering axle and wheel hubs which means that the wheels can be turned.

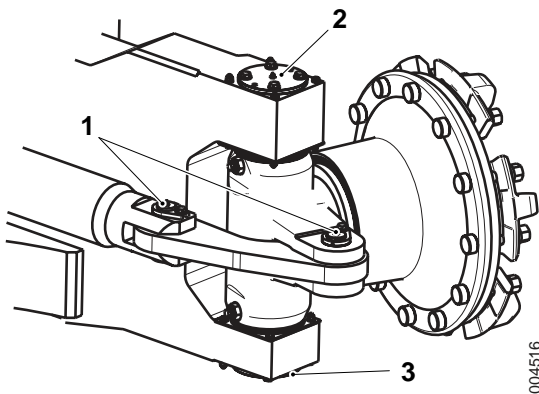


1. Wheel spindle
2. Spindle bolt
3. Seal
4. Slide bearing washer
5. Cover
6. Spindle bolt bearing
7. Thrust bearing
8. Lock screw

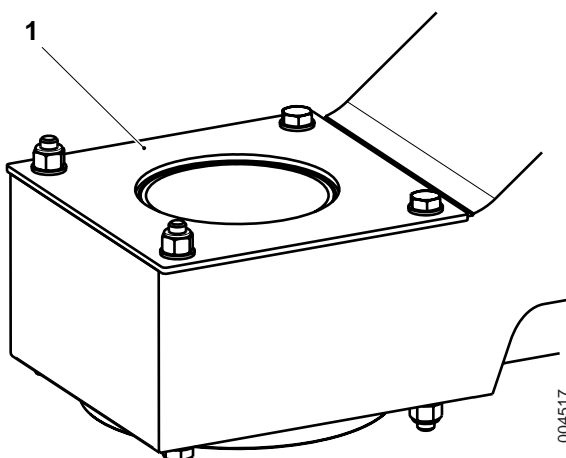
Spindle bolt bearing, replacement

- 1 Clean the wheel spindle and its surrounding area.
- 2 Lift the machine under the steering axle at the wheel in question. Support the steering axle in a suitable way.
- 3 Remove the steering wheel in question.





1. Shaft, link arm
2. Cover (upper)
3. Cover (lower)



1. Wear washer, thrust bearing

- 4 Detach the link arm from the wheel spindle.
Remove the lock screw and then remove the axle. Move the link arm aside.
- 5 Position a lifting strap inside the hub to secure the spindle.
- 6 Remove the covers at the spindle bolt's upper and lower bearing.
- 7 Remove the grease between the cover and spindle bolt.

- 8 Remove the spindle bolt's upper and lower lock screw.
Remove the nut and the lock screw.

- 9 Adjust the lifting equipment to relieve the load on the wheel spindle.

- 10 Remove the spindle bolt.

Pull the spindle bolt up, using a sliding hammer or the like connected to the threaded hole in the centre of the spindle bolt.

- 11 Remove the wheel spindle.

Place the wheel spindle on a soft surface.

- 12 Remove the thrust bearings from the steering axle.

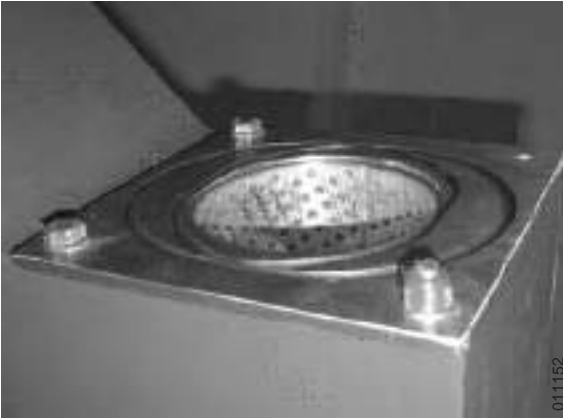
- 13 Press out the old bearing bushings. Note how the old bearing bushings are fitted so that the new ones can be positioned the same way with the space in the same place.

- 14 Clean the surfaces inside the steering axle.

- 15 Press in the new bearing bushings. Make sure that the space ends up at the same spot as before.

NOTE

The upper bearing bushing must protrude (4.5-4.8 mm) so that it is level with the thrust bearing's slotted washer.



- 16 Fit new thrust washers on the steering axle. Only fit three bolts in the manner illustrated. The fourth bolt cannot be fitted until the wheel spindle is in place. Only tighten the bolts slightly (**5-10 Nm**) so that the thrust bearings are secured in position.

Thoroughly coat the bearing bushings with grease. For grade, see section *F Technical data*.

NOTE

Be sure to position the nuts as illustrated.

- 17 Fit new O-rings on the wheel spindle.
Pull the O-ring toward the hub.
- 18 Lift the wheel spindle into place on the steering axle.
- 19 Coat the wear surface of the lower wear washer with lubricating grease and align the bearing between the wheel spindle and the lower thrust washer. Use a rubber mallet to get the bearing to the right position. Check that the bearing is centred in the wheel spindle by looking in the spindle from below.
- 20 Coat the wear surface of the upper wear washer with lubricating grease and align the bearing between the wheel spindle and the upper thrust washer. Use a rubber mallet to get the bearing to the right position. Check that the bearing is centred in the wheel spindle by looking in the spindle from above.



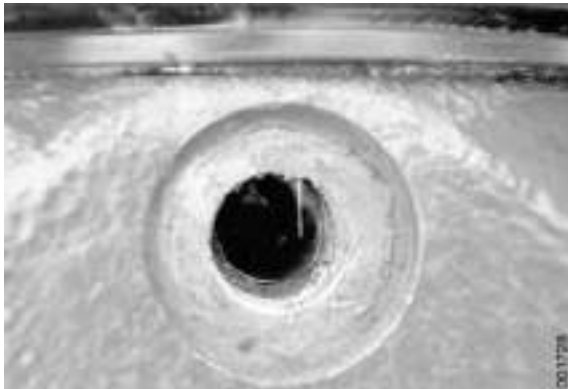
- 21 Fit the spindle bolt.

Coat the spindle bolt with lubricating grease and press it into place.

NOTE

Check that the spindle bolt is turned so that the holes for the guide screws align with the holes in the wheel spindle. It is important that the spindle bolt is perfectly seated before the lock screws are fitted. It is not possible to "tighten" the spindle bolt into place.

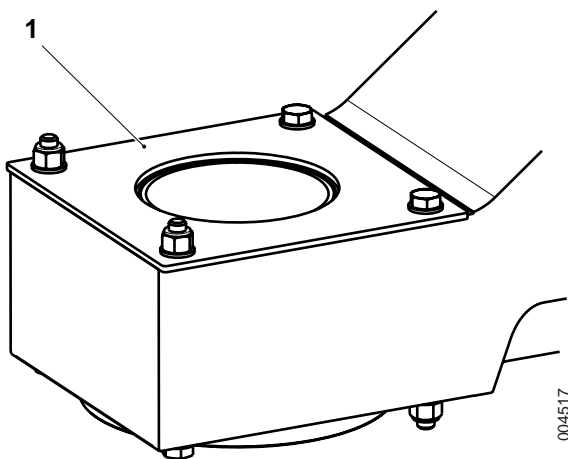




- 22 Fit the lock screws and tighten with the lock nuts. Tighten to **250 Nm (oiled screw)**.
- 23 Coat the space between the wheel spindle and steering axle with lubricating grease.

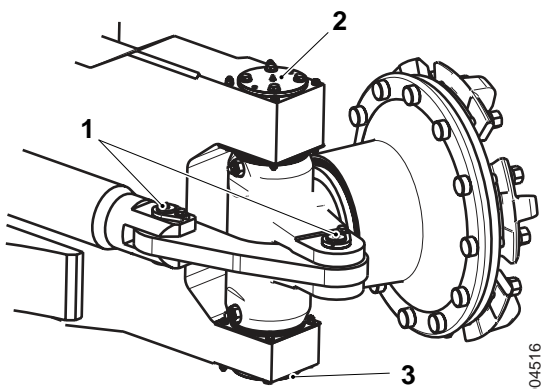


- 24 Position the O-rings.



1. Wear washer, thrust bearing

- 25 Fit the remaining bolts to the thrust bearings' wear washer as illustrated. Tighten to **25 Nm (oiled screw)**.



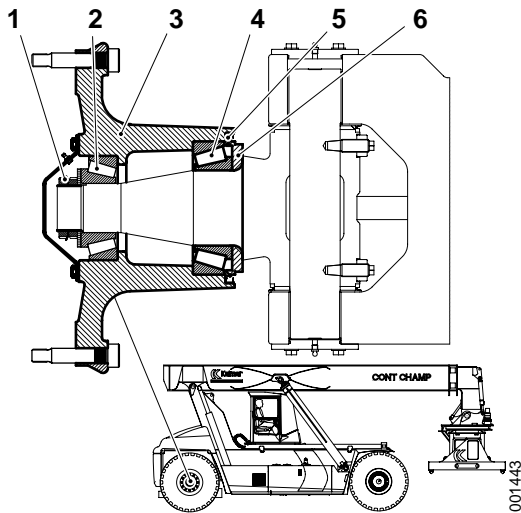
1. Cover (upper)
2. Shaft, link arm
3. Cover (lower)

- 26 Fit the upper cover and the lower cover.
- 27 Lubricate the upper and lower bearings of the spindle bolt with lubricating grease.
- 28 Rock the wheel spindle back and forth a few times to even out the grease. Check that resistance is uniform.
- 29 Connect the link arm to the wheel spindle. Lubricate the link arm bearings with grease.
- 30 Fit the wheel.
- 31 Remove the support and lower the steering wheel.
- 32 Test-run the machine and test the steering. Check also that the machine feels stable when driving straight ahead.

6.2.3 Wheel hub

Wheel hub, description

The wheel hub holds the wheel in place and allows the wheel to rotate.



1. Hub nut with locking washer
2. Outer wheel bearing
3. Hub
4. Inner wheel bearing
5. Seal
6. Support ring

Wheel bearing, replacement



- 1 Lift the machine under the steering axle by the wheel in question. Support securely under the steering axle.
- 2 Remove the steering wheel in question.



- 3 Clean the hub cover and its surrounding area.
- 4 Remove the hub cover.
- 5 Wipe away grease from hub cover and hub nuts. Handle it as environmentally hazardous waste.



- 6 Secure the hub with a lifting strap.

Route the lift sling over the hub and around a wheel bolt. Install a clamp and nut to secure the lift sling. Use manual forklift, pallet forks or similar to lift the hub.



- 7 Bend up the lock washer's tabs, remove the lock nut and the lock washer.
8 Tension the lifting equipment so that the hub is unloaded.
9 Remove the hub nut.



- 10 Lift out the hub from the spindle.

Remove the outer bearing inner race and pull the hub from the axle.



- 11 Remove the inner bearing from the wheel spindle.



- 12 Remove the seal from the hub.
- 13 Remove the bearings' outer races from the hub.
Use a drift and press out the bearing races.
- 14 Clean the hub and smear the inside with universal grease "EP2".
- 15 Fit new bearing races in the hub.
Use a drift and press in the bearing races. Never tap directly on the bearings.

NOTE

Fit the outer bearings with the larger diameter outward.



- 16 Fit a new seal on the inside with the seal lip turned out.
Press in a new seal in the hub. Use a suitable round plate, the seal does not tolerate impacts from a hammer.

NOTE

Turn the seal correctly.



- 17 Install the inner bearing's inner race and rollers on the wheel spindle. Pack the bearing with universal grease "EP2".



- 18 Fill the empty space in the hub with universal grease "EP2".



19 Fit the hub on the wheel spindle.



20 Install the outer bearing, protecting washer, and bearing nut.

Pack in the bearing with grease and fit the bearing.

Fit the washer and hub nut with the smooth surface in towards the hub.

21 Remove the lifting equipment.



22 Torque the bearing nut as follows.

A. Lubricate the thread and the side of the nut facing the bearing with oil (SAE 80W/140).

B. Tighten the nut to **250 Nm (oiled screw)**.

C. Rotate the hub 10 revolutions.

D. Angle tighten the nut 45°.

E. Rotate the hub 10 revolutions.

F. Angle tighten the nut 45°.

23 Grease the lock washer and fit it.

24 Fit the lock nut and tighten to at least **250 Nm (oiled screw)** or then more to engage the locking washer in the closest groove. Lock the bearing nut and lock nut with the locking washer.





- 25 Fit the bearing casing and fill it with grease.
- 26 Grease the wheel bearing with grease through the grease nipple.
Lift the seal ring's lip with a small screwdriver to facilitate the escape of air. Grease until grease comes out at the seal.
- 27 Fit the wheel.
- 28 Remove the support and lower the steering wheel.

6.3 Tyres and rims

Tyres and rims, safety



DANGER

Always block the wheels on the side of the axle that is not going to be worked on before positioning the jack. Always secure the jack to prevent it from sliding out of position.

Deflate the tyre before removal. Otherwise the conical ring and locking clips can loosen and shoot out when the pressure is changed. With double wheel fitting both tyres must be deflated!

Do not release air through the valve if the tyre or rim is damaged. Drill a hole in the tread to release the air. Damaged tyres may explode.

Never stand directly in front of the wheel when deflating or inflating. The conical ring and locking clips can loosen and shoot out when the pressure is changed.

Never install damaged tyres or rims.

It's prohibited to repair rims with welding.

It's prohibited to operate the machine if one of the tyres is flat.

Wheels, tyres and rims are dimensioned and selected for each machine type so that maximal wheel loads and travel speeds are not exceeded. For this reason it is forbidden to change tyre dimension, tyre brand, tyre type, rim type or rim brand without approval from Cargotec.



CAUTION

When removing wheels, the wheel nuts should be left in place after loosening. If the wheel nuts are removed immediately, the wheel may release from the hub.

When removing drive wheels, make sure that the wheels are secured in position when the spacer rings are removed. If the wheels move they may displace the spacer rings, with crushing injuries as a result.

When installing drive wheels, ensure that the clamps clamp straight on the spacer ring.

Wheel nuts should be check-tightened after 4-5 operating hours.

Always follow the tyre manufacturer's or other approved instructions when changing tyres.

Never use a steel hammer to install or remove rim components. Instead, use a lead, brass or plastic mallet.

Keep the tyre pressure at the prescribed level. Insufficient tyre pressure impairs stability and reduces the machine's capacity.

Remove penetrating objects, such as crushed glass, pieces of wood and metal filings.

Check if tyre wear is abnormal. This could indicate a mechanical fault. Rectify faults immediately and change damaged tyres.

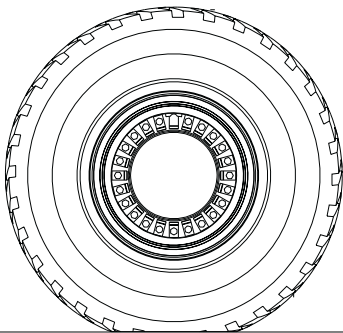
6.3.1 Tyres

Tyres, description

The tyres are the point of contact between the machine and the ground. These absorb unevenness and provide suspension.

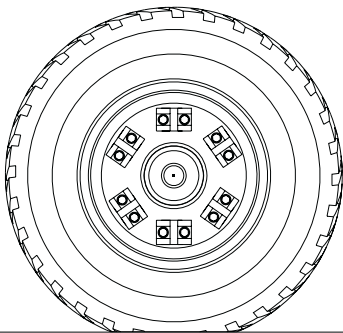
The drive axle is subject to major forces during operation. If each tyre's rolling circumference differs, the stresses on the drive axle increase. For this reason it is important that the tyres on the drive axle have equal wear and correct air pressure.

Spare and replacement tyres must be from a manufacturer approved by Cargotec.



002027

Front wheels



002026

Rear wheels

Tyre replacement

**DANGER**

Changing tyres is complicated and dangerous work.

FATAL DANGER!

Leave tyre work to authorised personnel/ tyre company.

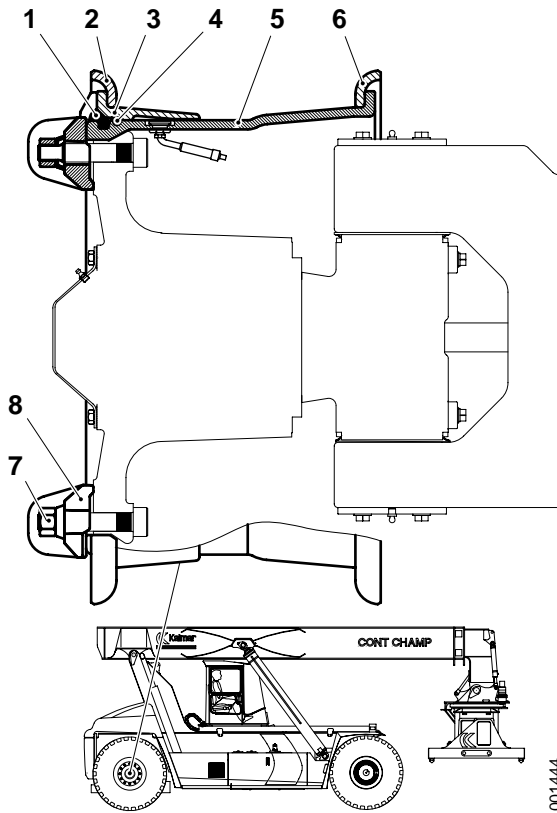
The wheel rims must be checked when tyres are changed. See *Maintenance manual DRF 400–450* section 6 *Suspension*.

6.3.2 Rims

Rim, description

The rim is split to make it possible to fit a tyre, the rim consists of the following parts.

- Rims
- Rim bead seat
- Rim flange
- Lock ring
- Lock lugs
- Hub plate



001444

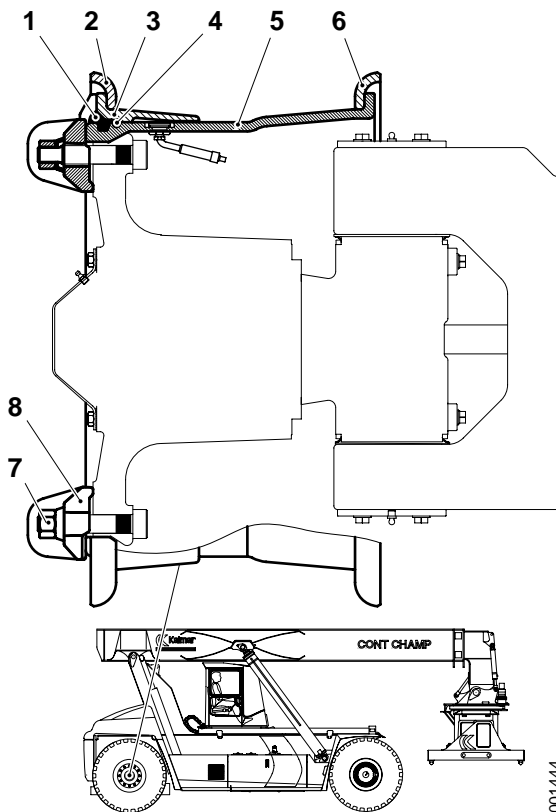
1. Lock ring
2. Rim flange
3. Tapered rim bead seat
4. O-ring
5. Rims
6. Rim flange
7. Wheel nut
8. Wheel clamp

6.3.3 Nut, washer and clamp

Nut, washer and clamp, description

The rim is attached to the wheel hub with nuts and clamps.

The number of nuts and clamps varies depending on the type of drive axle and steering axle used.



1. Lock ring
2. Rim flange
3. Tapered rim bead seat
4. O-ring
5. Rims
6. Rim flange
7. Wheel nut
8. Wheel clamp

Wheel bolt, replacing

- 1 Machine in service position, see section *B Safety*.
- 2 Raise the machine with a jack positioned under the steering axle.
- 3 Remove the steering wheel, see *Maintenance Manual DRF 400-450* section *6 Suspension*.



- 4 Knock out the bolt with a sledge hammer.
- 5 Replace the bolt.



Table of Contents 7 Load handling

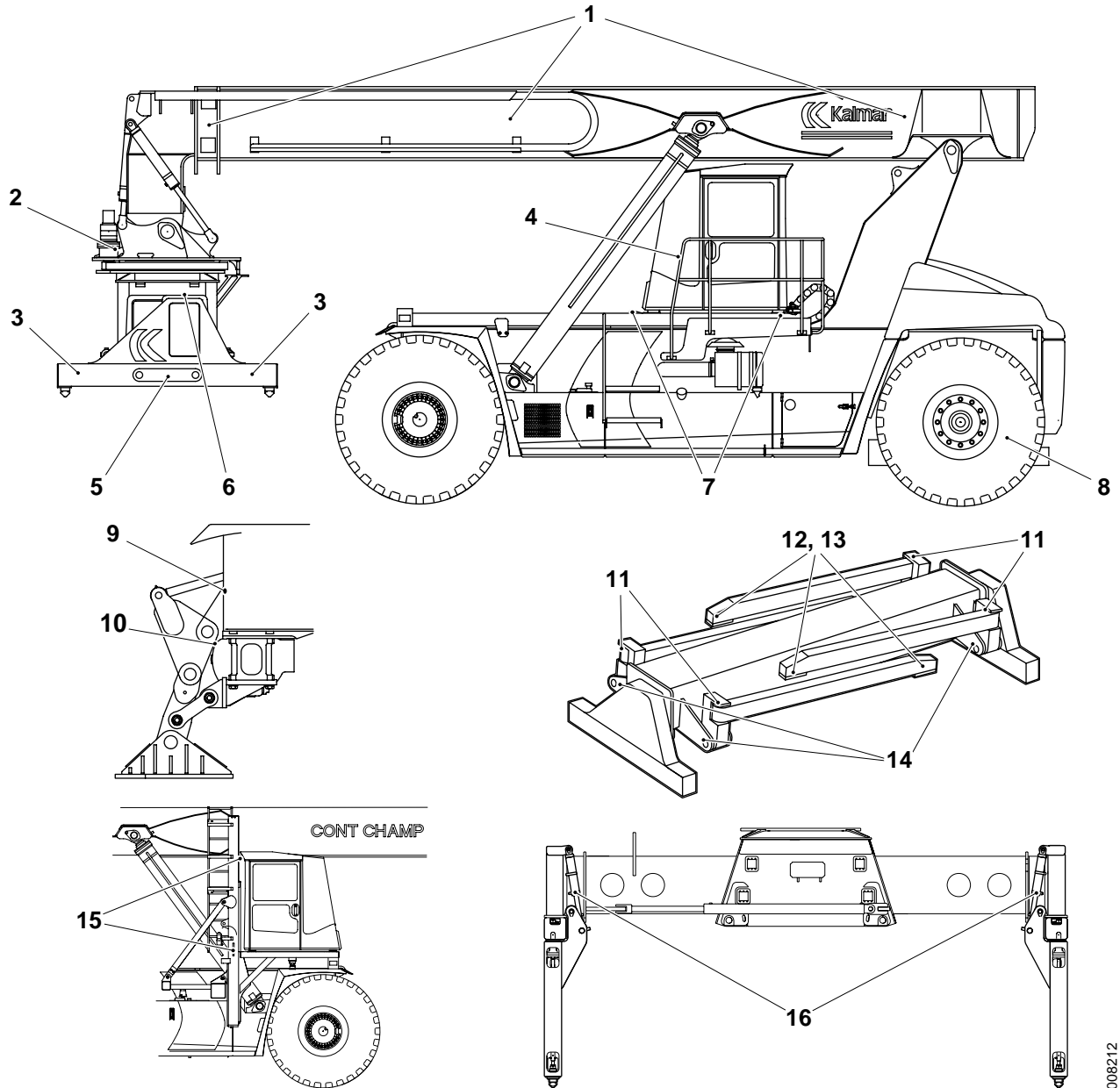
7	Load handling.....	5
7.1	Controls and instruments	7
7.1.1	Control lever	7
7.1.2	Switch, lock twistlocks	9
7.1.3	Switch, automatic spreading	10
7.1.5	Switch, stop at 30' or 35'	10
7.2	Lifting/lowering	11
7.2.1	Hydraulic oil pump	15
7.2.2	Servo filter	16
7.2.3	Pressure reducer	16
7.2.4	Accumulator servo circuit	18
7.2.5	Control valve lift, lower and extension	20
7.2.6	Shuttle valve	22
7.2.7	Valve block lift cylinder	23
7.2.8	Lift cylinder	27
7.2.9	Sensor hydraulic pressure lift cylinder	32
7.2.10	Lift boom	35
7.2.11	Sensor, boom angle	35
7.2.12	Pipes and hoses	35
7.2.16	Sensor, attachment damping	36
7.3	Extension	37
7.3.1	Hydraulic oil pump	44
7.3.2	Servo filter	44
7.3.3	Pressure reducer	44
7.3.4	Accumulator servo circuit	45
7.3.5	Control valve lift, lower, extension	45
7.3.6	Shuttle valve	46
7.3.7	Valve block, extension cylinder	47
7.3.8	Extension cylinder	47
7.3.9	Valve block, pump relief	51
7.3.10	Lift boom	53
7.3.11	Sensor, boom length	55
7.3.12	Pipes and hoses	55
7.4	Side shift	56
7.4.1	Hydraulic oil pump	57
7.4.2	Valve block, top lift hydraulics	58
7.4.3	Control valve attachment	59
7.4.4	Shuttle valve	63
7.4.5	Side shift cylinder	64
7.4.6	Side shift frame	65
7.4.7	Main beam, attachment	69
7.4.8	Relief valve, attachment	69
7.4.9	Pipes and hoses	70
7.5	Spreading	71

7.5.1	Hydraulic oil pump	78
7.5.2	Valve block, top lift hydraulics	78
7.5.3	Control valve attachment	78
7.5.4	Shuttle valve	78
7.5.5	Valve block, spreading motor	79
7.5.6	Spreading motor	79
7.5.7	Spreader chains	83
7.5.8	Spreader beam	91
7.5.9	Main beam, attachment	93
7.5.10	Position sensor, spreading	93
7.5.11	Relief valve, attachment	93
7.5.12	Pipes and hoses	93
7.5.13	Buzzer, automatic spreading 20'-40'	94
7.6	Rotation	95
7.6.1	Hydraulic oil pump	99
7.6.2	Valve block, top lift hydraulics	99
7.6.3	Control valve attachment	100
7.6.4	Shuttle valve	100
7.6.5	Valve block, rotation motor	101
7.6.6	Rotation motor unit	102
7.6.7	Rotation yoke	105
7.6.8	Ring gear	108
7.6.9	Side shift frame	109
7.6.10	Sensor, rotation stop	110
7.6.11	Relief valve, attachment	110
7.6.12	Pipes and hoses	110
7.7	Tilt	111
7.7.1	Hydraulic oil pump	116
7.7.2	Valve block, top lift hydraulics	116
7.7.3	Damping block, tilt	117
7.7.4	Lock valve, tilt	119
7.7.5	Control valve attachment	120
7.7.6	Shuttle valve	120
7.7.7	Tilt cylinder	121
7.7.8	Lift boom	121
7.7.9	Rotation yoke	121
7.7.10	Relief valve, attachment	121
7.7.11	Pipes and hoses	121
7.8	Levelling	122
7.8.1	Hydraulic oil pump	126
7.8.2	Valve block, top lift hydraulics	126
7.8.3	Control valve attachment	127
7.8.4	Shuttle valve	128
7.8.5	Overcentre valve, levelling	128
7.8.6	Valve block, levelling cylinders	128
7.8.7	Levelling cylinders	129
7.8.8	Side shift frame	129

7.8.9	Relief valve, attachment	129
7.8.10	Pipes and hoses	129
7.9	Load carrier	130
7.9.1	Twistlocks	130
7.9.2	Lifting jacks	144
7.10	Other functions	172
7.10.1	Support jacks	172
7.10.2	Weight indicator	181
7.10.3	Container counter	187
7.10.4	Synchronised lift	192

7 Load handling

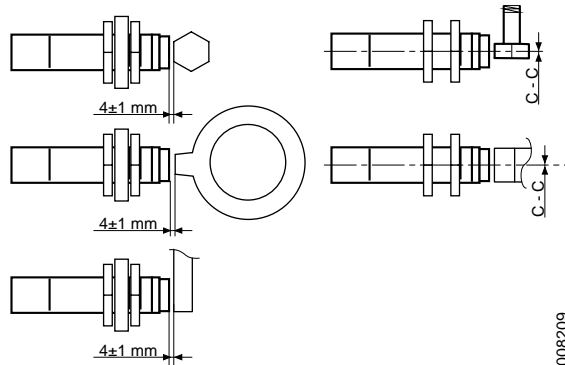
Position sensor, checking and adjustment



008212

1. Sensor, boom length 5. Sensor, twistlocks
 2. Sensor, rotation stop 6. Spreading sensor
 3. Sensor, contact 7. Sensor, end position damping
 4. Sensor, steering wheel 8. Sensor, steering axle movement

9. Sensor, support jacks up **+** 13. Sensor, clamping position
 10. Sensor, support jacks down 14. Sensor, knee
 11. Sensor, lifting jacks 15. Sensor, lowered cab **+**
 12. Sensor, contact 16. Sensor, overheight-jacks up **+**



Adjusting position sensor - indicator

008209

- 1 Machine in service position, see section *B Safety*.
- 2 Check that the sensor in question is free of damage and dirt.
- 3 Check that the distance between the position sensor and indicator is 4 ± 1 mm. Adjust if necessary.

IMPORTANT

It is very important that the bolt head on the steering axle sensor is in right front of the centre of the sensor and that the bolt head is turned so that the edge is parallel with the top of the sensor.

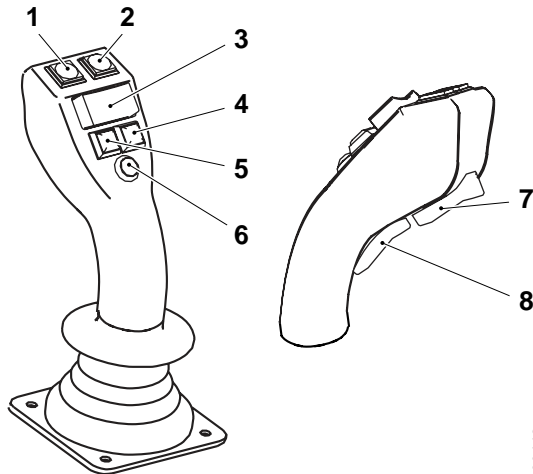
7.1 Controls and instruments

7.1.1 Control lever

Control lever, description

The control lever (S815) is used to control the boom and attachment. The lever sends a voltage signals to the cab control unit (D790-1).

The control lever has three or four potentiometer-controlled functions and six on/off functions.



1. Tilt lock (S815-T3.1)
2. Levelling lock (S815-T3.2)
3. Rotation (S815-P3)
4. Side shift right (S815-T1.2)
5. Side shift left (S815-T1.1)
6. Opening of twistlocks (S815-T2) upon full contact
7. Tilt (S815-P4)
8. Pistol trigger (S815-T4): Activates weighing , changes function of side shift to spreading out (S815-T1.2) and spreading in (S815-T1.1) as well as lift to synchronised lift

Lifting/lowering

Lifting/lowering is controlled by moving the control lever forward (lower boom) or rearward (lift boom). See *Lifting/lowering, function description page 11*.

The signal can be checked from the diagnostic menu, see section 8 *Control system*, group 8.4.8.1 *BOOM, menu 1*.

Extension

Extension is controlled by moving the control lever right (boom out) or left (boom in). See *Extension, function description (hydraulic oil pump alternative Rexroth) page 37*.

The signal can be checked from the diagnostic menu, see section 8 *Control system*, group 8.4.8.1 *BOOM, menu 1*.

Sideshift or spreading

When switch (position 4) is pressed down sideshift right is activated, and when switch (position 5) is pressed down sideshift left is activated. See *Side shift, function description page 56*.

If the pistol trigger (position 8) is pressed in at the same time as side shift right (position 4), spreading out is activated. If the pistol trigger (position 8) is pressed in at the same time as side shift left (position 5), spreading in is activated. See *Spreading, function description page 71*.

The signal can be checked from the diagnostic menu, see section 8 *Control system*, group 8.4.9.2 *ATTACH, menu 2*.

Rotation

When the potentiometer (position 3) is pressed down on the left side rotation clockwise is activated, and when right side is pressed in rotation anticlockwise is activated. See *Rotation, function description page 95*.


The signal can be checked from the diagnostic menu, see section 8 *Control system*, group 8.4.9.1 *ATTACH, menu 1*.

000442

Opening of twistlocks

When the switch (position 6) is activated, the twistlocks are opened if the conditions for such are fulfilled. See *Twistlocks, function description page 130*.

The signal can be checked from the diagnostic menu, see section 8 *Control system*, group 8.4.9.3 *ATTACH, menu 3*.

 As an option the machine can be equipped with sensors on the attachment that activate damping when the attachment is approaching a container.

Tilt



When the top edge of the potentiometer (position 7) is pressed down, tilt out is activated. When the bottom edge is pressed down, tilt in is activated. See *Tilt control, function description page 114*.

The signal can be checked from the diagnostic menu, see section 8 *Control system*, group 8.4.9.1 *ATTACH, menu 1*.

Tilt lock



When the switch (position 1) is pressed down, the tilt lock is activated. The light in the switch remains lit while the lock is active. See *Tilt locking, function description page 112*.

The signal can be checked from the diagnostic menu; see section 8 *Control system*, group 8.4.9.4 *ATTACH, menu 4*.

Levelling



When the rotation potentiometer (position 3) is pressed down on the left side at the same time as the pistol trigger (position 8) is pressed in then levelling right is activated. When the right side is pressed down at the same time as the pistol trigger is pressed in, levelling left is activated. See *Hydraulic levelling, function description page 122*.

The signal can be checked from the diagnostic menu, see section 8 *Control system*, group 8.4.9.1 *ATTACH, menu 1*.

Levelling lock



When the switch (position 2) is pressed down, the levelling lock is activated. The indicator light in the switch remains lit while the lock is active. See *Levelling lock, function description page 125*.

The signal can be checked from the diagnostic menu; see section 8 *Control system*, group 8.4.9.4 *ATTACH, menu 4*.

Pistol trigger

+ The pistol trigger (position 8) activates weighing if the machine is equipped with a weight indicator. See *Weight indicator, description page 181*.

The pistol trigger also changes the function of other buttons of the control lever.

If side shift is activated at the same time as the pistol trigger is pressed in, spreading is activated. See *Spreading, function description page 71*.

+ If lift is activated at the same time as the pistol trigger is pressed in, synchronised lift is activated if the machine is equipped with this option. See *Synchronised lift, function description page 192*.

The signal can be checked from the diagnostic menu, see section 8 *Control system*, group 8.4.9.2 *ATTACH, menu 2*.

7.1.2 Switch, lock twistlocks

Switch, lock twistlocks, description

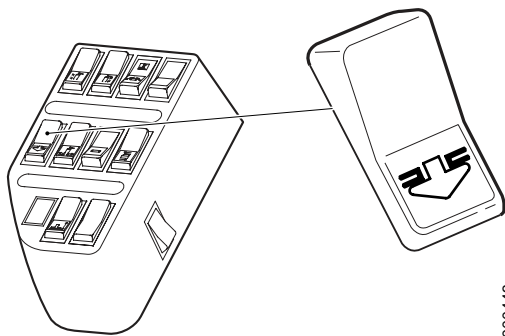
The switch for lock twistlocks (S1001) controls locking of twistlocks. The switch has three positions: two fixed and one rocker with the following functions.

1. Automatic locking of the twistlocks at full contact and released parking brake.
2. Twistlocks open (off).
3. Manual locking of the twistlocks at full alignment and released parking brake (rocker switch).

Twistlocks are opened with the switch on the control lever, see *Control lever, description page 7*.

The switch is supplied voltage by and sends a voltage signal to the KIT control unit (D790-1).

The signal can be checked from the diagnostic menu, see section 8 *Control system*, group 8.4.9.3 *ATTACH, menu 3*.



000443

7.1.3 Switch, automatic spreading

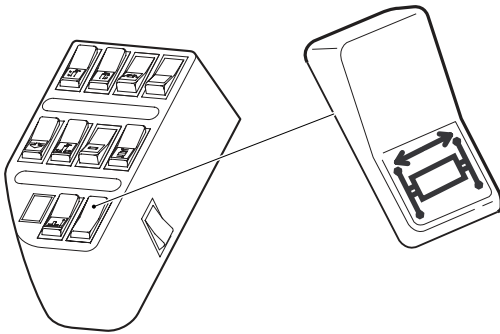
Switch automatic spreading, description



Switch, automatic spreading (S1012) activates automatic spreading. When the switch is depressed, spreading automatically goes to the next position (20, 30 or 40 feet) if spreading is activated with the control lever.

The switch is supplied with voltage from and sends a voltage signal to the cab control unit (D790-1) when the switch is activated.

The signal can be checked from the diagnostic menu; see section 8 *Control system*, group 8.4.9.4 *ATTACH*, menu 4.



000444



WARNING

Risk of crushing and product damage!

Automatic spreading is stopped by activating spreading in the opposite direction or deactivating the function with the switch.

7.1.5 Switch, stop at 30' or 35'

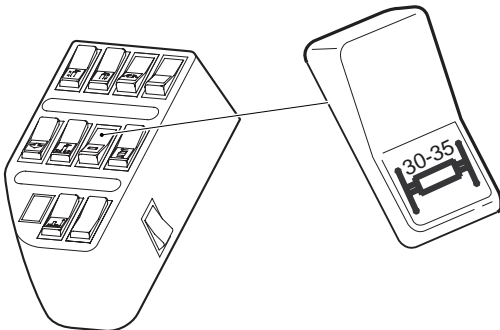
Switch, stop at 30' or 35', description



Switch, stop at 30' or 35' (S1004) activates 30 and 35 foot stop. When the switch is depressed the function for spreading is changed from 20'–40' to stop at 30'.

The switch is supplied voltage by and sends a voltage signal to the KIT control unit (D790-1).


The signal can be checked from the diagnostic menu, see section 8 *Control system*, group 8.4.9.2 *ATTACH*, menu 2.

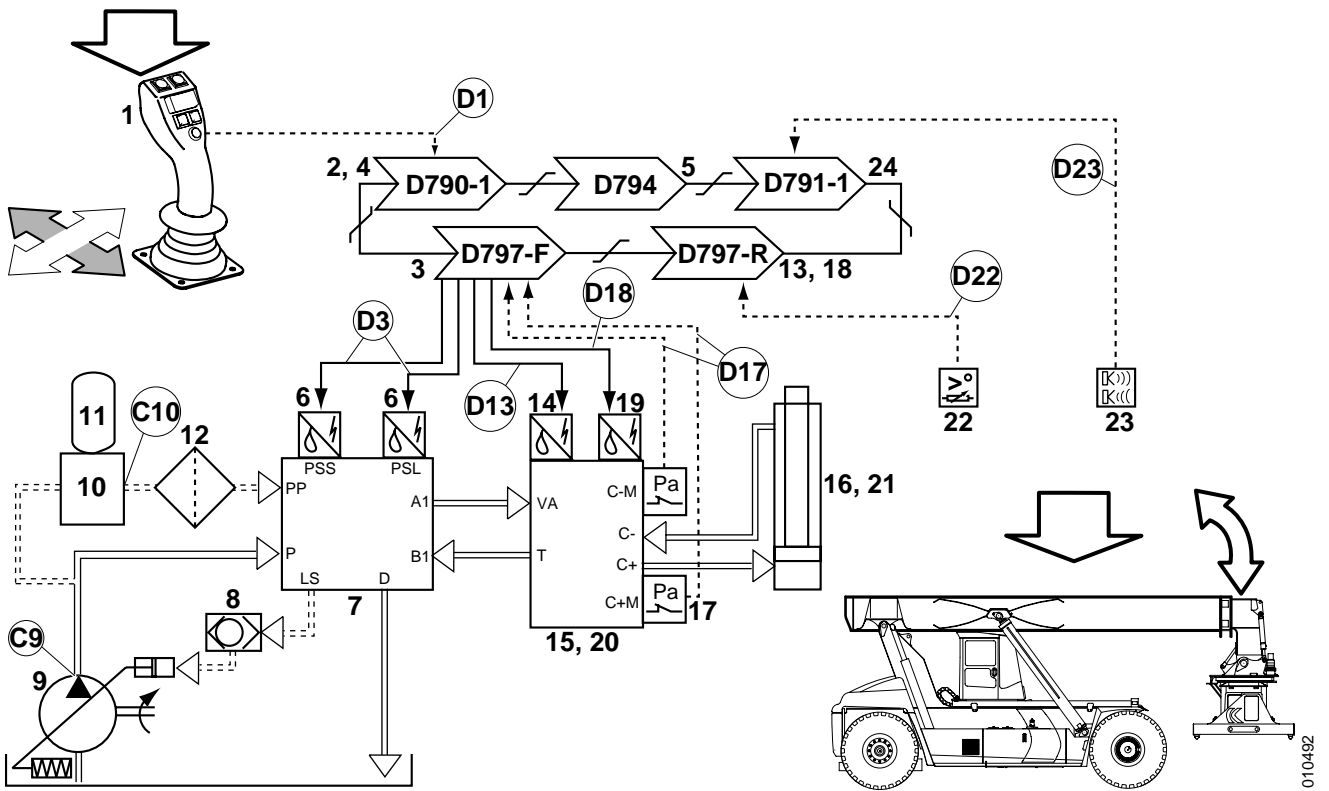


000447

7.2 Lifting/lowering

Lifting/lowering, function description



Condition	Reference value	Reference
Safety switch	Disengaged	Section 11 Common electrics, group 11.5.1.4 Emergency stop switch voltage
Twistlocks	Locked or unlocked, not intermediate position	Twistlocks, description page 137
Overload system	Boom up: passive Boom down: passive or bypass activated	Section 8 Control system , group 8.2.1 Overload system
Contact	Boom down: no alignment	Twistlocks, function description page 130
 Height limitation	Bypassed or boom height lower than height limitation	Section 8 Control system, group 8.2.4 Height limitation



010492

Pos	Explanation	Signal description	Reference
1	Control lever (S815-P1) sends the cab control unit (D790-1) a voltage signal proportional to lever movement.	Lower: $U_{S815/P1} = 0.5\text{--}2.0\text{ V}$ Zero position: $U_{S815/P1} = 2.0\text{--}3.0\text{ V}$ Lift: $U_{S815/P1} = 3.0\text{--}4.5\text{ V}$ 0.5 V is the fastest lowering speed and 4.5 V is the fastest lift speed. Lower voltages than 0.5 V and higher voltages than 4.5 V are used to detect malfunctions in cabling and controls.	<i>Control lever, description page 7</i> D1: Diagnostic menu, see section 8 Control system group 8.4.8.1 BOOM, menu 1
2	Control unit, cab (D790-1) transmits the request for Boom up or Boom down with the speed information on the CAN bus.	Checked by control system, error shown with error code.	Section 11 Common electrics, group 11.5.3.1 Cab control unit
3	Control unit, frame front (D797-F) activates Servo valve, lift (Y6005) or Servo valve, lower (Y6004).	$I = 380\text{--}650\text{ mA}$	Section 11 Common electrics, group 11.5.3.2 Control unit, frame front D3: Diagnostic menu, see section 8 Control system group 8.4.8.4 BOOM, menu 4 and 8.4.8.5 BOOM, menu 5
4	The cab control unit (D790-1) transmits the request for increased engine speed on the CAN bus.	Checked by control system, error shown with error code.	Section 11 Common electrics, group 11.5.3.1 Cab control unit
5	The engine control unit (D794) increases engine speed.	Checked by control system, error shown with error code.	Section 11 Common electrics, group 11.5.3.10 Engine control unit
6	Servo valve, lift (Y6005) or Servo valve, lower (Y6004) pressurises the control valve's lift slide with servo pressure.	-	<i>Control valve lift, lower and extension page 20</i> D3: Diagnostic menu, see section 8 Control system group 8.4.8.4 BOOM, menu 4 and 8.4.8.5 BOOM, menu 5
7	The control valve's lift slide changes position and pressurises valve block, lift cylinder and sends a load signal to the hydraulic oil pumps.	-	<i>Control valve lift, lower and extension page 20</i>
8	The shuttle valve forwards the strongest load signal if several functions are activated simultaneously.	-	Section 10 Common hydraulics, group 10.5.3 Shuttle valve
9	The hydraulic oil pumps pump oil from the hydraulic oil tank.	See pressure plate on left frame beam.	Section 10 Common hydraulics, group 10.4.2 Axial piston pump with variable displacement
10	The pressure reducer reduces the oil pressure from the hydraulic pumps to servo pressure for the control valve.	See pressure plate on left frame beam.	<i>Pressure reducer, description page 16</i>

Pos	Explanation	Signal description	Reference
11	The accumulator stores servo pressure. The non-return valve in the pressure reducer makes it possible to store the pressure when the engine is shut off.	See pressure plate on left frame beam.	<i>Accumulator servo circuit, description page 18</i>
12	The servo filter cleans the servo oil before the control valve.	-	<i>Servo filter, description page 16</i>
13	With boom down Control unit, frame front (D797-F) activates Servo valve, blocking right (Y6001) and Servo valves, blocking left (Y6002).	U = 24 V	Section 11 <i>Common electrics</i> , group 11.5.3.2 <i>Control unit, frame front</i> D13: Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.8.2 <i>BOOM</i> , menu 2
14	With boom down Servo valve, blocking right (Y6001) and Servo valve, blocking left (Y6002) act on the blocking valves in the valve blocks for left and right lift cylinder respectively.	-	<i>Lift cylinder valve block, description page 23</i> D13: Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.8.2 <i>BOOM</i> , menu 2
15	With boom up the blocking valves in the valve blocks are opened for left and right lift cylinder respectively by the hydraulic pressure from the control valve. With boom down the blocking valve opens so that the pressure from the lift cylinder can be released.	-	<i>Lift cylinder valve block, description page 23</i>
16	The lift cylinders' piston side is pressurised and the boom is lifted.	-	<i>Lift cylinder, description page 27</i>
17	Regeneration The lift cylinder hydraulic pressure sensor, piston side left (B768-L1) sends Control unit, frame front (D797-F) a voltage signal proportional to oil pressure. NOTE <i>Regeneration is not possible in the proximity of end position or in the event of overload.</i>	$U_{B768-L1/1} = 5 \text{ V}$ $U_{B768-L1/2} = 0 \text{ V}$ $U_{B768-L1/5} = 0.5\text{-}4.5 \text{ V}$ Regeneration is activated when the pressure in the lift cylinders is 8.5 MPa. Regeneration is stopped if the pressure reaches 18.5 MPa.	<i>Lift cylinder hydraulic pressure sensor, description page 32</i> D17: Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.10.3 <i>OP</i> , menu 3
18	Control unit, frame front (D797-F) activates solenoid valve, regeneration right (Y6051) and solenoid valve, regeneration left (Y6052) if the pressure is sufficiently low for regeneration.	U = 24 V	Section 11 <i>Common electrics</i> , group 11.5.3.2 <i>Control unit, frame front</i> D18: Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.8.3 <i>BOOM</i> , menu 3
19	The regeneration servo valve pressurised the regeneration valve.	-	<i>Lift cylinder valve block, description page 23</i>

Pos	Explanation	Signal description	Reference
20	The regeneration valve changes position and directs oil from the rod side of the lift cylinder to the piston side.	-	<i>Lift cylinder valve block, description page 23</i>
21	Lift speed increases.	-	-
22	Damping When the beam is approx. 4° from an end position then damping is activated. Sensor, boom angle (B771) sends a voltage signal proportional to the boom angle to Control unit, frame rear (D797-R) requesting damping on the CAN bus.	Checked by control system, error shown with error code.	Section 8 <i>Control system</i> , group 8.2.1.5 <i>Sensor, boom angle</i> Section 11 <i>Common electrics</i> , group 11.5.3.3 <i>Control unit, frame rear</i> D22: Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.8.8 <i>BOOM, menu 8</i>
23	 Container damping Sensor, attachment damping (B796) sends a voltage signal proportional to the container distance to Control unit, attachment (D791-1).	U = 0-10 V	<i>Sensor, attachment damping, description page 36</i> D23: Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.9.22 <i>ATTACH, menu 22</i>
24	 Container damping When the voltage signal from Sensor, attachment damping (B796) is equivalent to the set limit for damping then Control unit, attachment (D791-1) requests damping on the CAN bus.	Checked by control system, error shown with error code.	Section 11 <i>Common electrics</i> , group 11.5.3.5 <i>Control unit, attachment</i> D23: Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.9.22 <i>ATTACH, menu 22</i>

Hydraulic diagram, basic machine

Lowering speed, checking



DANGER

The lowering speed must correspond. If speed lowering is too high there is a risk of rollover.

The machine must absolutely not be operated before lowering speed is verified.

- 1 Operate the machine and hydraulics until the hydraulic oil reaches the operating temperature of **50 °C**.
- 2 Lift a container weighing 35-45 tonnes.
- 3 Move the machine away to a level and a safe place.

NOTE

It is important that the ground is level and without gradient.

- 4 Retract the boom fully and lift to maximum.
- 5 Note the time for how long it takes to lower from the top position until the container is about 20 cm from the ground.
Lowering should take **18-21 seconds**.
- 6 If the time does not correspond then contact Cargotec for further instructions.

7.2.1 Hydraulic oil pump

Hydraulic oil pump, general

See section *10 Common hydraulics*, group *10.4.2 Axial piston pump with variable displacement*.

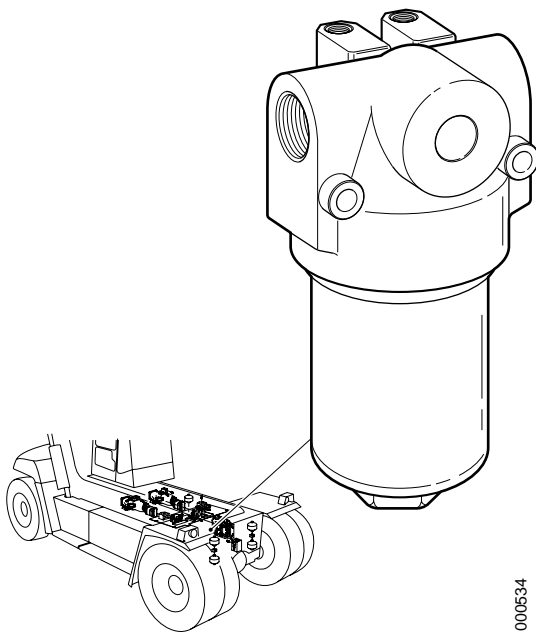
7.2.2 Servo filter

Servo filter, description

The servo filter protects the control valve's servo circuits against contaminants. The servo filter is located in the front edge of the lifting beam on the right of the engine compartment, between the pressure reducer and the control valve for lift, lower and extension.

The servo filter is a low-pressure filter with detachable filter insert. The oil is cleaned when it passes through the filter insert's filter material.

The filter insert is pressed against the upper section of the filter housing by a spring. Rubber gaskets seal between the insert and filter housing. If the back pressure through the filter is too great the insert is pressed down so that the oil passes by the insert. This occurs if the oil is viscous (cold or incorrect viscosity) or if the filter insert is clogged.



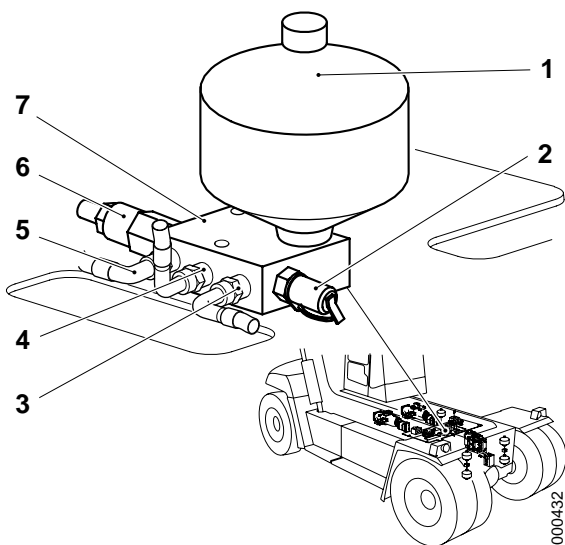
000534

7.2.3 Pressure reducer

Pressure reducer, description

The pressure reducer reduces the pressure from hydraulic oil pumps to servo pressure for the control valve. The pressure reducer is located to the right on the lifting beam in the engine compartment fitted together with the accumulator for servo pressure.

Servo pressure is stored in an accumulator. A built-in non-return valve prevents pressure leakage from the accumulator when the machine is not in use.



000432

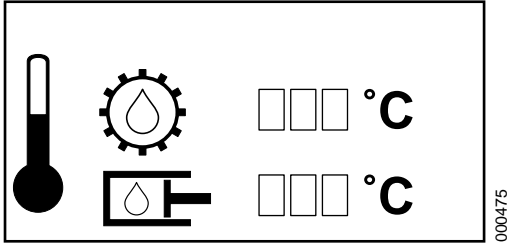
1. Servo pressure accumulator
2. Servo pressure test outlet
3. Pressure feed from servo filter
4. Return to tank
5. Servo pressure to control valve
6. Servo pressure adjusting screw.
7. Pressure reducer

Servo pressure, checking and adjustment

NOTE

Read the instructions for oil before working; see section B Safety.

- 1 Operate and warm up the machine so that the hydraulic oil is at operating temperature, at least 50 °C. As an alternative, operate until the cooling fan is activated.
- 2 Machine in service position, see section B Safety.



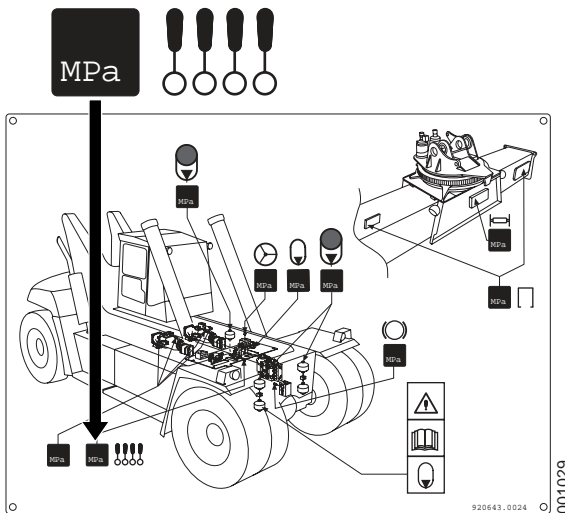
Operating menu, hydraulic oil temperature



- 3 Connect a pressure gauge (0–25 MPa) to the measuring outlet on the pressure reducing valve.

- 4 Start the engine and check the servo pressure. Compare with the pressure plate.

Turn the steering wheel or activate a load handling function to activate the hydraulic oil pumps. The servo pressure is higher than the standby pressure of the hydraulic oil pumps.



The appearance of the pressure plate may vary, but the symbols are the same.



- 5 If necessary, adjust the pressure with the adjusting screw. Loosen the lock nut and turn the adjusting screw.

NOTE

If the servo pressure is too high, a load handling function must be activated so that servo pressure is used from the accumulator for a reduction on the adjusting screw to be seen on the pressure gauge. Sometimes the engine has to be shut off between the checks.

Clockwise: reduce pressure.

Counter-clockwise: increase pressure.

- 6 Remove the pressure gauge and fit the protective cap on the measuring outlet.

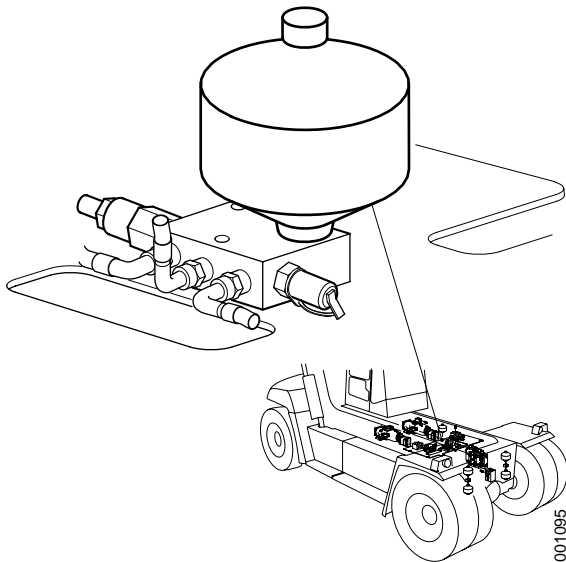
7.2.4 Accumulator servo circuit

Accumulator servo circuit, description

The accumulator stores pressurised oil and ensures that there is servo pressure for activating control valve functions. The accumulator is located to the right on the lifting beam in the engine compartment.

The accumulator is a diaphragm type and is divided into two spaces by a diaphragm. One side of the diaphragm is pressurised with nitrogen gas. The other side is pressurised by hydraulic oil which compacts the nitrogen gas.

Furthest up on the accumulator is a test outlet for checking gas pressure and filling gas.

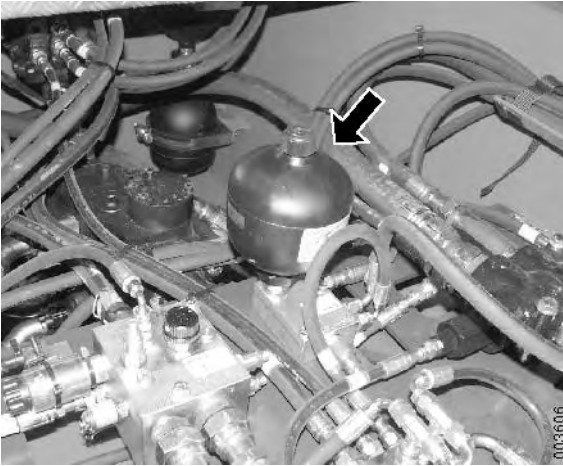


Accumulator servo circuit, replacement

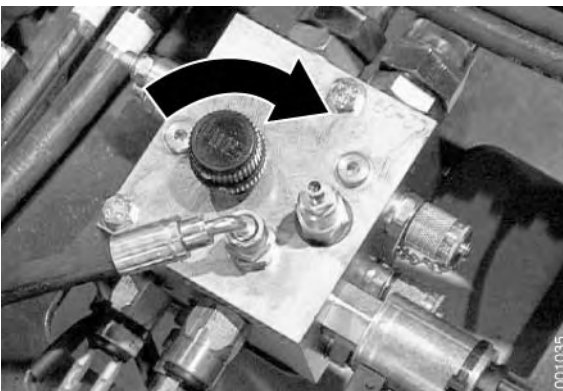
NOTE

Read the safety instructions for oil before working, see section B Safety.

- 1 Depressurise the brake and hydraulic systems, see section B Safety.
- 2 Machine in service position, see section B Safety.



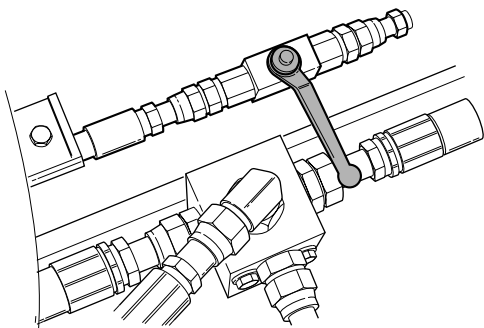
- 3 Detach the accumulator from its mounting.
- 4 Replace the accumulator.
- 5 Fit in the reverse order.



- 6 Close the drain valve on the accumulator charging valve.

NOTE

Check that the accumulator drain valve is fully closed and tighten the lock ring.



010475

Relief valve for top lift, the figure shows a closed valve.

- 7 Close the relief valve for top lift.

CAUTION

Hydraulic oil may be directed the wrong way.

Risk of damage to the fine filter for hydraulic oil.

Check that the relief valve for top lift is closed before starting the engine.



- 8 Check the oil level in the hydraulic oil tank with the lift cylinders fully down and the extension cylinder fully in. The oil level should be in the centre of the level glass. Top up if necessary, for grade see section *F Technical data*.

CAUTION

Overfilling of oil, leakage, and environmental damage.

The hydraulic oil level is checked with the boom completely lowered and retracted.

7.2.5 Control valve lift, lower and extension

Control valve lift, lower and extension, description (model year -2008)

The control valve controls the speed and direction of lift and extension. The control valve is located on a bracket in the space between the lifting beam and front axle.

The valve has two sections - one for the lift function and one for boom extension. The sections have many similarities, but are described separately under the respective function. For extension, see *Control valve lift, lower, extension page 45*. Electric servo valves control the flow from the valve.

The control valve is a proportional valve that is controlled by servo valves. This means that both volume and direction of the flow from the valve can be adjusted and that the valve can also send a control signal to the variable pumps.

Electrically controlled pressure reducing valves (servo valves) convert electrical current into a low hydraulic pressure that is proportional to the current, known as the servo pressure. The servo pressure acts on the spring-centred control slide in the control valve for the function in question and thereby controls the main flow.

The speed of the function is controlled by means of the flow being regulated in proportion to the lever movement.

Lift slide

The lift slide controls direction and flow of oil to the lift cylinder.

Servo valve, lift

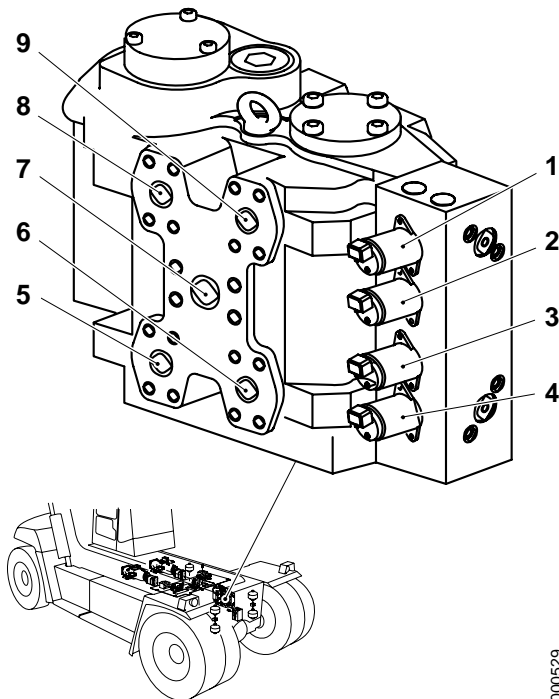
The lift servo valve controls servo pressure to the lift slide so that it controls oil pressure for lifting. The valve is controlled electrically with the lift solenoid valve (Y6005), which is activated by Control unit, frame front (D797-F).

The signals can be checked from the diagnostic menu, see section *8 Control system*, group *8.4.8.4 BOOM, menu 4*.

Servo valve, lower

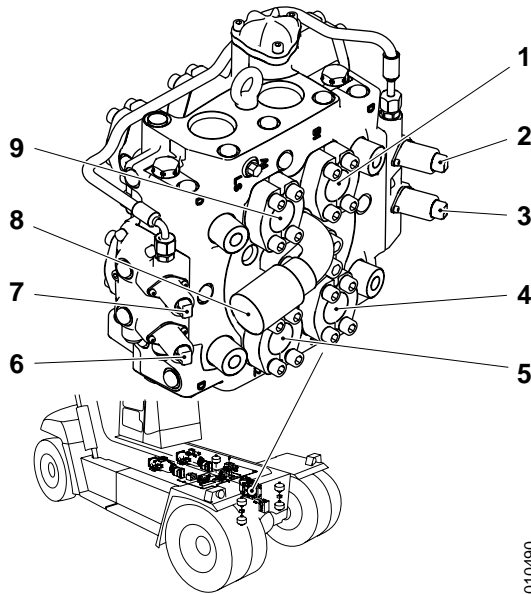
The lower servo valve controls servo pressure to the lift slide so that it controls oil pressure for lowering. The valve is controlled electrically with the lower solenoid valve (Y6004), which is activated by Control unit, frame front (D797-F).

The signals can be checked from the diagnostic menu, see section *8 Control system*, group *8.4.8.5 BOOM, menu 5*.



1. Servo valve, boom out (Y6006)
2. Servo valve, boom in (Y6007)
3. Servo valve, lower (Y6004)
4. Servo valve, lift (Y6005)
5. Connection, rod side, right lift cylinder (B2)
6. Connection, piston side, right lift cylinder (A1)
7. Connection, feed from hydraulic oil pumps (P)
8. Connection, rod side, extension cylinder (B1)
9. Connection, piston side, extension cylinder (A1)

000529



010490

1. Connection, rod side, extension cylinder (B1)
2. Servo valve, boom out (Y6006)
3. Servo valve, lift (Y6005)
4. Connection, rod side, right lift cylinder (B2)
5. Connection, piston side, right lift cylinder (A2)
6. Servo valve, lower (Y6004)
7. Servo valve, boom in (Y6007)
8. Connection, feed from hydraulic oil pumps (P)
9. Connection, piston side, extension cylinder (A1)

Control valve lift, lower and extension, description (model year 2009-)

The control valve controls the speed and direction of lift and extension. The control valve is located on a bracket in the space between the lifting beam and front axle.

The valve has two sections - one for the lift function and one for boom extension. The sections have many similarities, but are described separately under the respective function. For extension, see *Control valve lift, lower, extension page 45*. Electric servo valves control the flow from the valve.

The control valve is a proportional valve controlled by servo valves. This means that both volume and direction of the flow from the valve can be adjusted and that the valve can also send a control signal to the variable pumps.

Electrically controlled pressure reducing valves (servo valves) convert electrical current into a low hydraulic pressure that is proportional to the current, known as the servo pressure. The servo pressure acts on the spring-centred control slide in the control valve for the function in question and thereby controls the main flow.

The speed of the function is controlled by means of the flow being regulated in proportion to the lever movement.

Lift slide

The lift slide controls direction and flow of oil to the lift cylinder.

Servo valve, lift

The lift servo valve controls servo pressure to the lift slide so that it controls oil pressure for lifting. The valve is controlled electrically with the lift solenoid valve (Y6005), which is activated by Control unit, frame front (D797-F).

The signals can be checked from the diagnostic menu, see section *8 Control system*, group *8.4.8.4 BOOM, menu 4*.

Servo valve, lower

The lower servo valve controls servo pressure to the lift slide so that it controls oil pressure for lowering. The valve is controlled electrically with the lower solenoid valve (Y6004), which is activated by Control unit, frame front (D797-F).

The signals can be checked from the diagnostic menu, see section *8 Control system*, group *8.4.8.5 BOOM, menu 5*.

Control valve lift, lower and extension, replacement



DANGER

The lowering speed must correspond. If speed lowering is too high there is a risk of rollover.

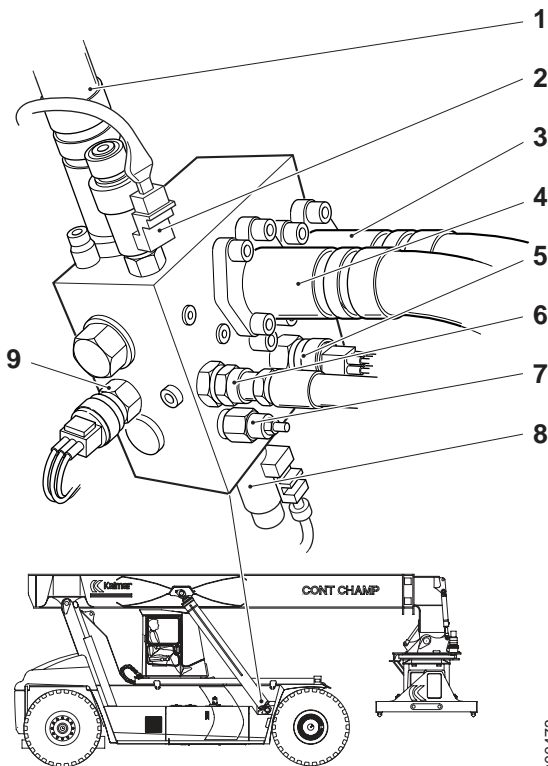
The machine must absolutely not be operated before lowering speed is verified.

After replacing control valve lift, lower and extension or parts of the valve, lowering speed must be checked. See *Lowering speed, checking page 15*.

7.2.6 Shuttle valve

Shuttle valve, description

See section *10 Common hydraulics*, group *10.5.3 Shuttle valve*.



1. Connection, rod side, lift cylinder (C-)
2. Solenoid valve regeneration (Y6051 or Y6052)
3. Pressure feed connection (VA)
4. Connection tank (T)
5. Pressure sensor, piston side (C+M)
6. Draining servo valves (D)
7. Shock valve
8. Solenoid valve blocking (Y6001 or Y6002)
9. Pressure sensor, rod side (C-M)

7.2.7 Valve block lift cylinder

Lift cylinder valve block, description

The lift cylinder valve block directs oil to the lift cylinder and is mounted directly on the lower part of the lift cylinder. The valve block comprises the blocking valve, regeneration valve, non-return valve and shock valve.

Blocking valve

The blocking valve prevents unwanted lowering and angling of the lift cylinders. The blocking valve holds the load by ensuring that the connection to the lift cylinder's piston side is closed. (The pressure passes through a restriction as blocking pressure and holds the valve slide closed.)

Servo valve blocking actuates the blocking valve. The servo valve is controlled electrically with Solenoid valve, blocking left (Y6002) and Solenoid valve, blocking right (Y6001), which are activated by Control unit, frame front (D797-F).

The signal can be checked from the diagnostic menu, see section 8 *Control system*, group 8.4.8.2 *BOOM, menu 2*.

Regeneration valve

The regeneration valve directs oil from the rod side of the cylinder back to the piston side. This allows the oil to be re-used during lifting. For more information on regeneration see *Lifting/lowering, function description page 11*. The regeneration valve is regulated by the regeneration servo valve.

The regeneration servo valve actuates the regeneration valve. The servo valve is regulated electrically with solenoid valve, regeneration right (Y6051) or solenoid valve, regeneration left (Y6052), which are activated by Control unit, frame front (D797-F).

The signal can be checked from the diagnostic menu, see section 8 *Control system*, group 8.4.8.3 *BOOM, menu 3*.

Shock valve

The shock valve protects the hydraulic system against pressure surges which can occur when operating with a load. The shock valve opens a connection between the lift cylinder piston side and tank if the pressure becomes too high.

Non-return valve

The non-return valve prevents oil from going the wrong way during regeneration.

000473

Lift cylinder valve block, replacing

NOTE

Read the safety instructions for oil before working, see section B Safety.

- 1 Machine in service position, see section B Safety.
- 2 Depressurise the brake and hydraulic systems, see section B Safety.
- 3 Turn the start key to position 0 and turn off the main electric power.
- 4 Mark up and detach the wiring from the valve block.
- 5 Remove the wiring's clamping at the valve block.



- 6 Mark up and detach the hydraulic hoses from the valve block.

NOTE

Plug all connections immediately to protect the hydraulic system from impurities.





- 7 Remove the valve block from the lift cylinder.
Remove the attaching bolts and lift away the valve block.
- 8 Transfer the connection adapters, sensors and servo valves to the new valve block.

NOTE

Check that the O-rings are intact and fitted correctly.

NOTE

Transfer one part at a time so that the marking is not mixed up.



- 9 Fit the new valve on the lift cylinder.

NOTE

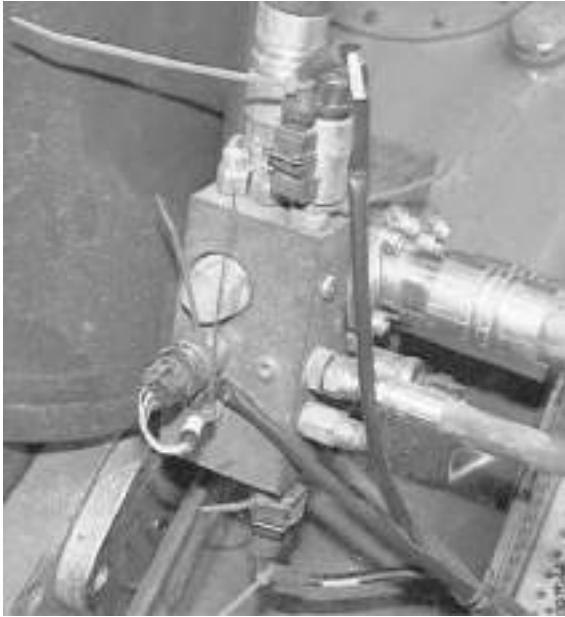
Check that the O-rings are intact and fitted correctly.



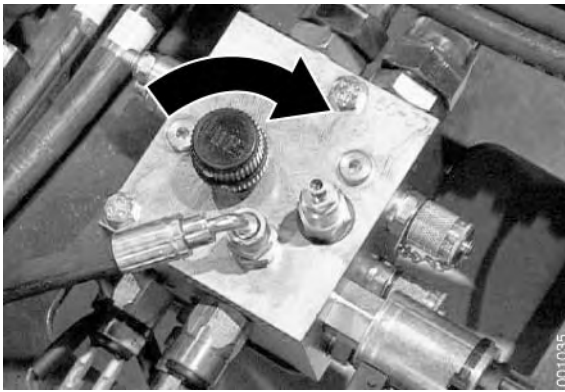
- 10 Connect the hydraulic hoses to the valve block in accordance with the marking.

NOTE

Check that the O-rings are intact and fitted correctly.



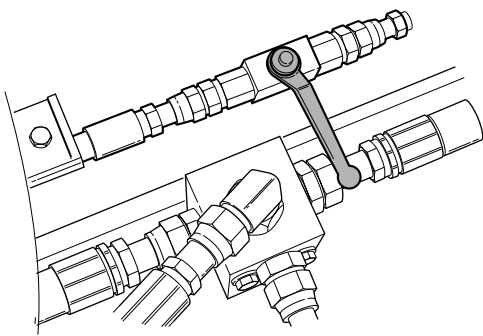
- 11 Connect the cable harness to the valve block in accordance with the marking.
- 12 Clamp the cable harness as before.



- 13 Close the drain valve on the accumulator charging valve.

NOTE

Check that the accumulator drain valve is fully closed and tighten the lock ring.



Relief valve for top lift, the figure shows a closed valve.

010475

- 14 Close the relief valve for top lift.

CAUTION

Hydraulic oil may be directed the wrong way.

Risk of damage to the fine filter for hydraulic oil.

Check that the relief valve for top lift is closed before starting the engine.

- 15 Turn on the main electric power and start the engine.

- 16 Activate the lift carefully.

CAUTION

Air in the hydraulic system may cavitate and result in product damage.

Activate the functions carefully and operate at the lowest possible speed a couple of times to avoid cavitation.

- 17 Check for leaks.

- 18 Check the oil level in the hydraulic oil tank with the lift cylinders fully down and the extension cylinder fully in. The oil level should be in the centre of the level glass. Top up if necessary, for grade see section *F Technical data*.



CAUTION

Overfilling of oil, leakage, and environmental damage.

The hydraulic oil level is checked with the boom completely lowered and retracted.

- 19 Check the lowering speed, see *Lowering speed, checking page 15*.

7.2.8 Lift cylinder

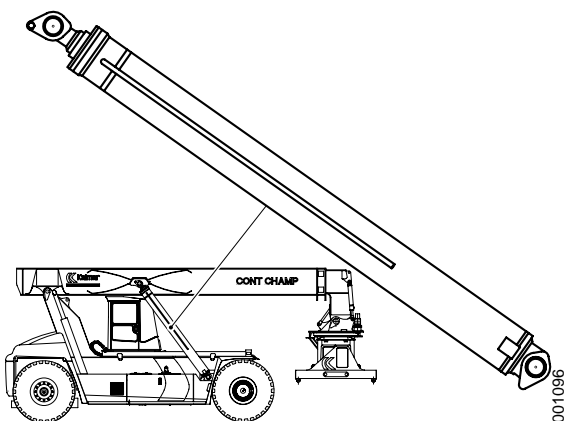
Lift cylinder, description

The lift cylinders lift and lower (angle) the lift boom. The lift cylinders are located between boom and frame in the front edge of the machine, one on the right and one on the left-hand side.

Each lift cylinder houses a valve block that controls pressurization and regeneration of the lift cylinder.

The lift cylinder is equipped with guide bearings both in the cylinder end and the piston rod mounting. The piston rod mounting is threaded in the piston rod and locked with a lock nut.

The lift cylinders are connected in parallel and are supplied from the lift, lower and extension control valve, see *Control valve lift, lower and extension page 20*.



Lift cylinder, replacement



DANGER

Fatal danger, risk of crushing!

Be certain to compensate for the lift cylinder's support of the boom by lifting the boom's leading edge with the lifting equipment.

A lift cylinder weighs approx. 2 tonnes. Use wooden blocks as protection between cab and lift cylinder when the lift cylinder is lowered or lifted.

The boom may move when the shafts are removed. Make sure that the shafts are unloaded. Stand to the side of the boom mounting so that the mounting protects in the event of movement.

- 1 Move the cab into the front position.
- 2 Machine in service position, see section *B Safety*.
- 3 Depressurise the hydraulic and brake systems, section *B Safety*.
- 4 Turn the start key to position 0 and turn off the main electric power.
- 5 Connect the lifting equipment at the front edge of the boom.
- 6 Lift the boom at the front edge so that the bearings on the lift cylinders are unloaded.





7 Mark up and detach the hydraulic hoses from the lift cylinder.



8 Attach lifting equipment to the lift cylinder.

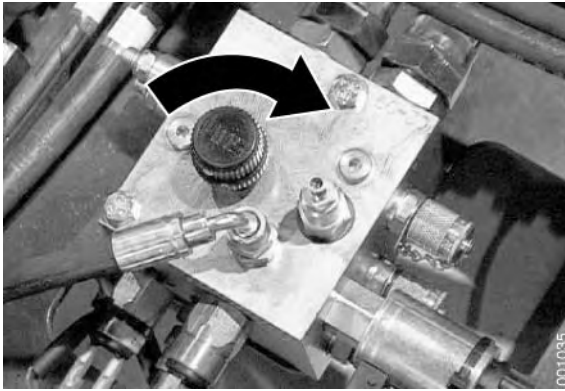


- 9 Remove the upper shaft for the lift cylinder.
- 10 Unload the lower bearing of the lift cylinder.
- 11 Remove the lower shaft for the lift cylinder.
- 12 Lift away the lift cylinder.
- 13 Fit new bearing races in the lift cylinder.
- 14 Lubricate the lift cylinder's bearing races and the holes for the shafts in the frame and the boom with plenty of aluminium paste.

NOTE

The bearings are only lubricated during replacement.

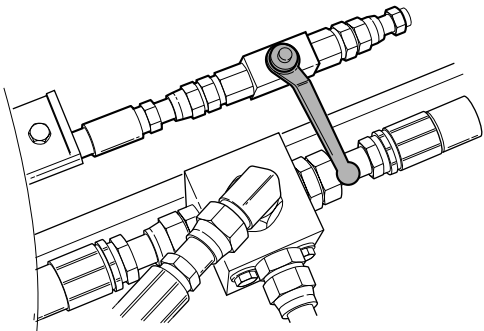
- 15 Lift the new lift cylinder into place.
- 16 Fit the shafts for the lift cylinder.



- 17 Connect the hydraulic hoses to the lift cylinder.
- 18 Close the drain valve on the accumulator charging valve.

NOTE

Check that the accumulator drain valve is fully closed and tighten the lock ring.



Relief valve for top lift, the figure shows a closed valve.

010475

- 19 Close the relief valve for top lift.

CAUTION

Hydraulic oil may be directed the wrong way.

Risk of damage to the fine filter for hydraulic oil.

Check that the relief valve for top lift is closed before starting the engine.

- 20 Turn on the main electric power and start the engine.
- 21 Carefully activate the lift function.

CAUTION

Air in the hydraulic system may cavitate and result in product damage.

Activate the functions carefully and operate at the lowest possible speed a couple of times to avoid cavitation.

- 22 Check for leaks.



- 23 Check the oil level in the hydraulic oil tank with the lift cylinders fully down and the extension cylinder fully in. The oil level should be in the centre of the level glass. Top up if necessary, for grade see section *F Technical data*.



CAUTION

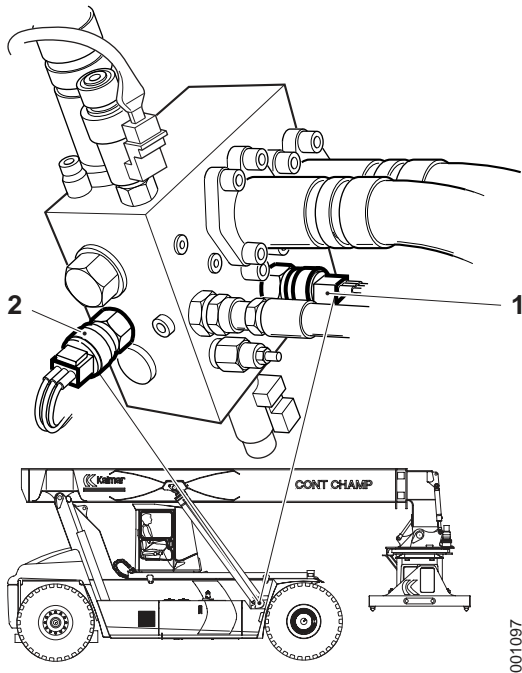
Overfilling of oil, leakage, and environmental damage.

The hydraulic oil level is checked with the boom completely lowered and retracted.

- 24 Check the lowering speed, see *Lowering speed, checking page 15*.

Hydraulic cylinders, repairs

See section *10 Common hydraulics, group 10.7.1 Hydraulic cylinders*.



1. Sensor, hydraulic pressure lift cylinder, piston side, left (B768-L1)

⊕ Sensor, hydraulic pressure lift cylinder, piston side, right (B768-R1)

2. ⊕ Sensor, hydraulic pressure lift cylinder, rod side, left (B768-L2)

⊕ Sensor, hydraulic pressure lift cylinder, rod side, right (B768-R2)

7.2.9 Sensor hydraulic pressure lift cylinder

Lift cylinder hydraulic pressure sensor, description

The lift cylinder hydraulic pressure sensor measures the pressure in the lift cylinders and is located on the lift cylinder valve block.

Pressure is measured to determine if regeneration can be activated. A sensor measures the pressure on the piston side of the left lift cylinder.



If the machine is equipped with the fixed scale option then an extra pressure sensor is used, on the piston side for the right lift cylinder.



If the machine is equipped with the electrical dynamic scale option then two pressure sensors are used, one for the rod side and one for the piston side on right and left-hand lift cylinders respectively (a total of four pressure sensors).

The sensors are supplied with power by, and send a voltage signal proportional to the hydraulic oil pressure, to Control unit, frame front (D797-F).

The signals can be checked from the diagnostic menu, see section 8 Control system, group 8.4.10.3 OP, menu 3.

Lift cylinder hydraulic pressure sensor, replace

NOTE

Read the safety instructions for oil before working, see section B Safety.

- 1 Machine in service position, see section B Safety.
- 2 Depressurise the brake and hydraulic systems, see section B Safety.
- 3 Detach the cable harness from the lift cylinder hydraulic pressure sensor.
- 4 Remove the lift cylinder hydraulic pressure sensor.

NOTE

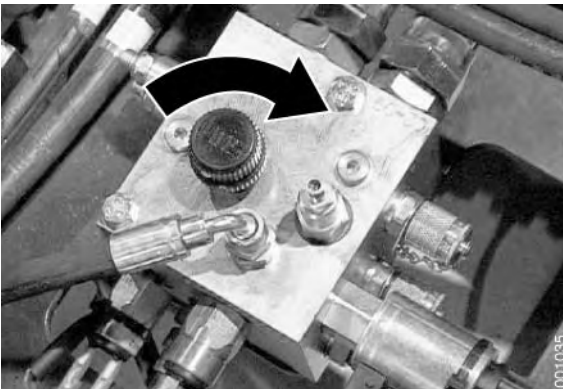
Plug all connections immediately to protect the hydraulic system from impurities.

- 5 Fit the new sensor.

NOTE

Check that the O-rings are intact and fitted correctly.

- 6 Connect the cable harness to the hydraulic pressure sensor.
- 7 Clamp the cable harness as before.

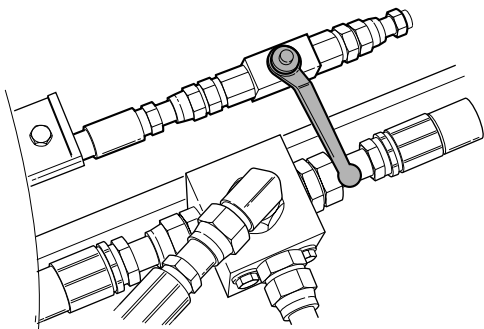


- 8 Close the drain valve on the accumulator charging valve.

NOTE

Check that the accumulator drain valve is fully closed and tighten the lock ring.

- 9 Close the relief valve for top lift.



Relief valve for top lift, the figure shows a closed valve.

CAUTION

Hydraulic oil may be directed the wrong way.

Risk of damage to the fine filter for hydraulic oil.

Check that the relief valve for top lift is closed before starting the engine.

- 10 Turn on the main electric power and start the engine.

- 11 Activate the lift carefully.

CAUTION

Air in the hydraulic system may cavitate and result in product damage.

Activate the functions carefully and operate at the lowest possible speed a couple of times to avoid cavitation.

- 12 Check that the hydraulic connections of the valve block do not leak and the lifting/lowering works correctly.
- 13 Check the oil level in the hydraulic oil tank with the lift cylinders fully down and the extension cylinder fully in. The oil level should be in the centre of the level glass. Top up if necessary, for grade see section *F Technical data*.

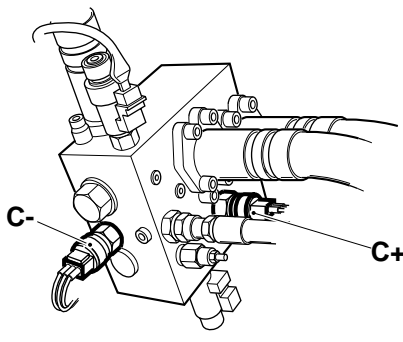
CAUTION

Overfilling of oil, leakage, and environmental damage.

The hydraulic oil level is checked with the boom completely lowered and retracted.



DIAG OP	3 (x)	
PRESENT INPUT SIGNAL		
LIFT CYL LE	RI	
C-	X.XXV	X.XXV
C+	X.XXV	X.XXV



008213

- 14 Check the function of the sensor from the diagnostic menu. See section *8 Control system*, group *8.4.10.3 OP, menu 3*.

Raise the boom and check that the sensor is sending values. The value should be approximately the same as from the sensor on the second lift cylinder (RI/LE).

7.2.10 Lift boom

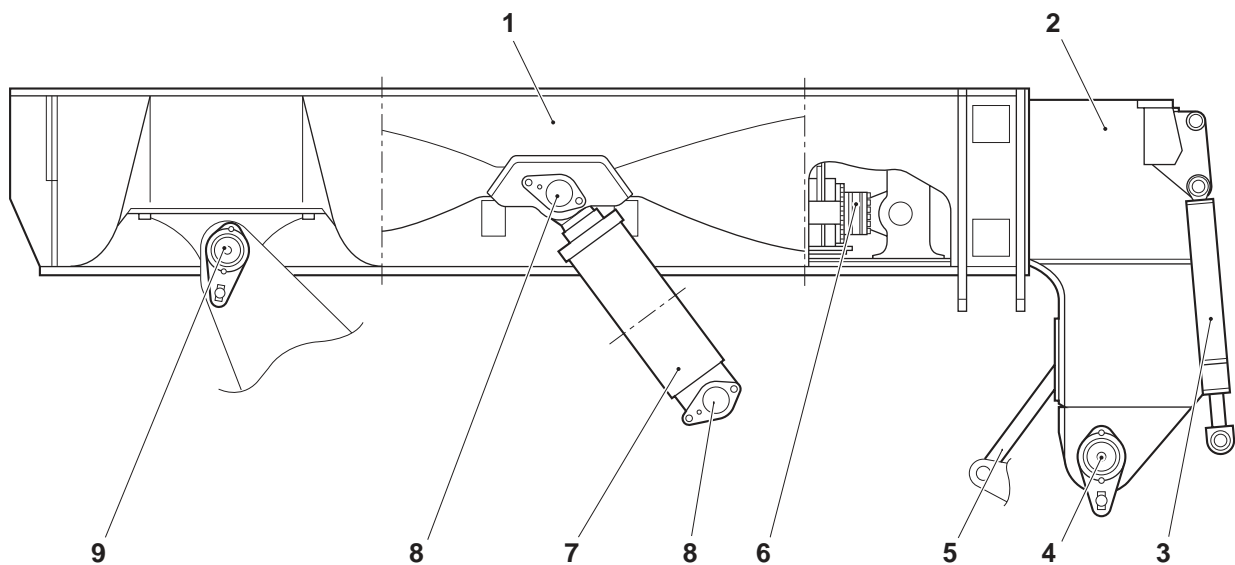
Lift boom, description

The lift boom lifts the load. The rear section of the boom is secured into the frame with two bearing-mounted shafts. In the front edge is the lift attachment and in the centre on each side of the boom are lift cylinders which are secured with bearing-mounted shafts. The lift cylinders angle the boom and raise the front section of the boom in this way. The lift boom is available in several versions depending on reach and load capacity.

The boom consists of outer boom and inner boom manufactured in high-strength steel with a minimum number of welds to provide maximum strength.

The inner boom runs in the outer boom and can be extended longitudinally with the extension cylinder. There are slide plates between inner boom and outer boom which reduce the friction between them. The slide plates are located in the front edge of the outer boom and the rear edge of the inner boom.

Running along the left-hand side is a cable chain for hydraulic hoses and cables between outer and inner boom.



- 1. Outer boom
- 2. Inner boom
- 3. Tilt cylinder right side

- 4. Mounting, attachment
- 5. Tilt cylinder left side
- 6. Extension cylinder

- 7. Lift cylinder
- 8. Mounting, lift cylinder
- 9. Rear boom mounting

001239

7.2.11 Sensor, boom angle

Sensor, boom angle, general

See section 8 Control system, group 8.2.1.5 Sensor, boom angle.

7.2.12 Pipes and hoses

Piped and hoses, description

See section 10 Common hydraulics, group 10.5.1 Pipes and hoses.

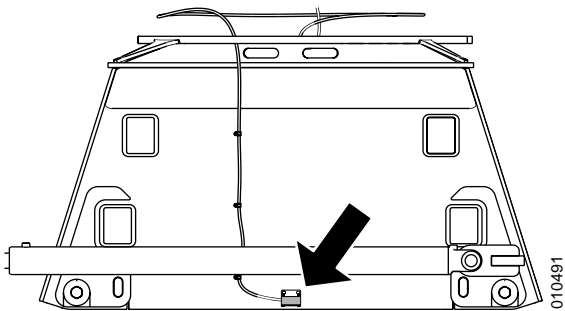
7.2.16 Sensor, attachment damping

Sensor, attachment damping, description





Sensor, attachment damping (B769) is an ultrasonic sensor that detects whether there is anything under the attachment. The sensor is fitted in the lower edge in the centre of the attachment's side shift frame.

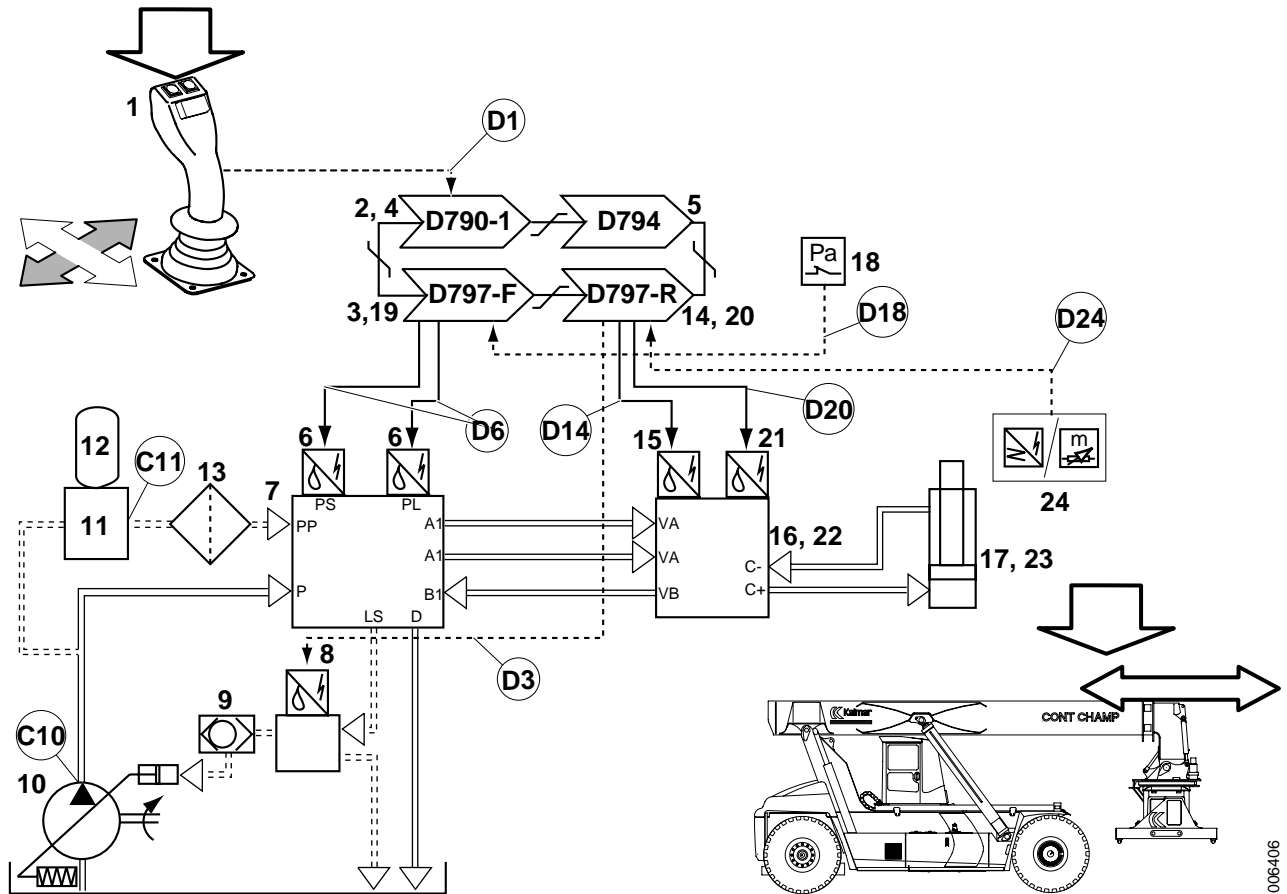
The sensors are supplied with power by, and send a voltage signal proportional to the distance to the object under the attachment to Control unit, attachment (D791-1).



7.3 Extension

Extension, function description (hydraulic oil pump alternative Rexroth)



Condition	Reference value	Reference
Safety switch	Disengaged	Section 11 Common electrics, group 11.5.1.4 Emergency stop switch voltage
Overload system	Boom out: passive	Section 8 Control system , group 8.2.1 Overload system
 Load centre limitation	Bypassed or the attachment is within the limit for the load centre limitation.	Section 8 Control system, group 8.2.3 Load centre limitation
 Height limitation	Bypassed or boom height lower than height limitation	Section 8 Control system, group 8.2.4 Height limitation



006406



Pos	Explanation	Signal description	Reference
1	Control lever (S815-P2) sends the cab control unit (D790-1) a voltage signal proportional to lever movement.	<p>Boom in: $U_{S815/P2} = 0.5-2.0 \text{ V}$</p> <p>Zero position: $U_{S815/P2} = 2.0-3.0 \text{ V}$</p> <p>Boom out: $U_{S815/P2} = 3.0-4.5 \text{ V}$</p> <p>0.5 V is the fastest retraction speed and 4.5 V is the fastest extension speed. Lower voltages than 0.5 V and higher voltages than 4.5 V are used to detect malfunctions in wiring and controls.</p>	<p><i>Control lever, description page 7</i></p> <p>D1: Diagnostic menu, see section 8 <i>Control system group 8.4.8.1 BOOM, menu 1</i></p>
2	Control unit, cab (D790-1) transmits the request for boom out <i>or boom in</i> with the speed information on the CAN bus.	Checked by control system, error shown with error code.	Section 11 <i>Common electrics</i> , group 11.5.3.1 <i>Cab control unit</i>
3	Control unit, frame front (D797-F) activates Servo valve, boom out (Y6006) <i>or Servo valve, boom in (Y6007)</i> . During retraction of the boom Control unit, frame rear (D797-R) activates Solenoid valve pump relief (Y6062).	$I = 380-650 \text{ mA}$	<p><i>Control valve lift, lower and extension page 20</i></p> <p>D3: Diagnostic menu, see section 8 <i>Control system group 8.4.8.6 BOOM, menu 6 and 8.4.8.7 BOOM, menu 7 and 8.4.8.2 BOOM, menu 2</i></p>
4	The cab control unit (D790-1) transmits the request for increased engine speed on the CAN bus.	Checked by control system, error shown with error code.	Section 11 <i>Common electrics</i> , group 11.5.3.1 <i>Cab control unit</i>
5	The engine control unit (D794) increases engine speed.	Checked by control system, error shown with error code.	Section 11 <i>Common electrics</i> , group 11.5.3.10 <i>Engine control unit</i>
6	Servo valve, boom out (Y6006) <i>or Servo valve, boom in (Y6007)</i> pressurises the control valve's extension slide with servo pressure.	-	<p><i>Control valve lift, lower and extension page 20</i></p> <p>D6: Diagnostic menu, see section 8 <i>Control system group 8.4.8.6 BOOM, menu 6 and 8.4.8.7 BOOM, menu 7</i></p>
7	The control valve's extension slide changes position and pressurises valve block, extension cylinder and sends a load signal to the hydraulic oil pumps.	-	<i>Control valve lift, lower and extension page 20</i>
8	When the boom is retracted the valve block, pump relief load signal, drains to two of the hydraulic oil pumps to the tank so that only two pumps generate pressure.	-	<i>Valve block, pump relief, description (hydraulic oil pump alternative Rexroth) page 51</i>
9	The shuttle valve forwards the strongest load signal if several functions are activated simultaneously.	-	Section 10 <i>Common hydraulics</i> , group 10.5.3 <i>Shuttle valve</i>

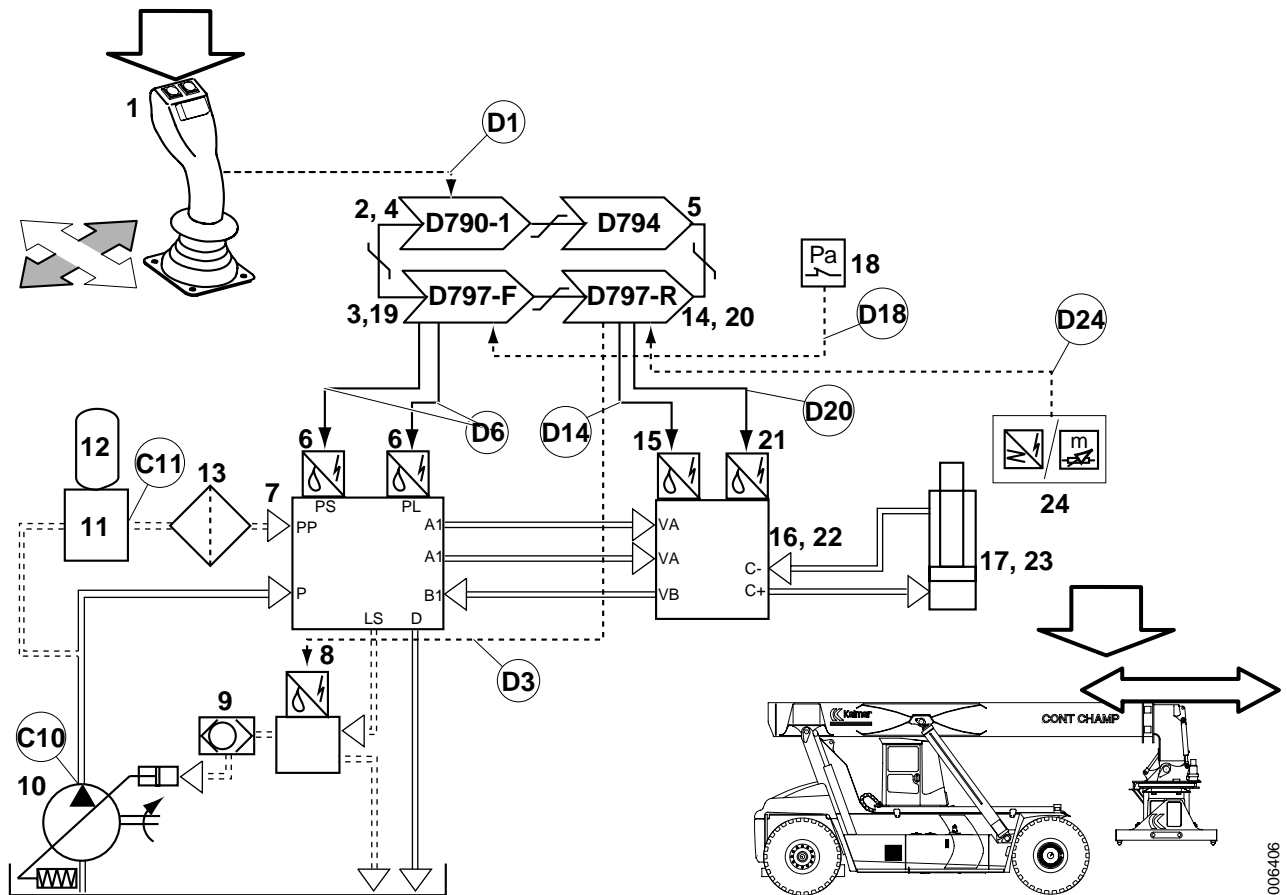
Pos	Explanation	Signal description	Reference
10	The hydraulic oil pumps pump oil from the hydraulic oil tank.	See pressure plate on left frame beam.	Section 10 <i>Common hydraulics</i> , group 10.4.2 <i>Axial piston pump with variable displacement</i>
11	The pressure reducer reduces pressure from the hydraulic oil pumps to servo pressure.	See pressure plate on left frame beam.	<i>Pressure reducer, description page 16</i>
12	Servo pressure is stored in the accumulator. The non-return valve in the pressure reducer makes it possible to store the pressure when the engine is shut off.	See pressure plate on left frame beam.	<i>Accumulator servo circuit, description page 18</i>
13	The servo filter filters the oil before the control valve.	-	<i>Servo filter, description page 16</i>
14	For boom in Control unit, frame rear (D797-R) activates Servo valve, blocking extension (Y6050).	U = 24 V	<i>Valve block extension cylinder, description page 47</i> D14: Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.8.2 <i>BOOM</i> , menu 2
15	For boom in Servo valve, blocking extension (Y6050) actuates the blocking slide in valve block, extension cylinder.	-	<i>Valve block extension cylinder, description page 47</i>
16	For boom out the blocking slide is opened in valve block, extension cylinder by the hydraulic pressure from the control valve. For boom in the blocking valve opens and releases pressure from the extension cylinder.	-	<i>Valve block extension cylinder, description page 47</i>
17	Extension cylinder extends or retracts the boom.	-	<i>Extension cylinder, description page 47</i>
18	Regeneration The lift cylinder hydraulic pressure sensor, piston side left (B768-L1) sends Control unit, frame front (D797-F) a voltage signal proportional to the cylinder pressure in the lift cylinders.	$U_{B768-L1/1} = 5 \text{ V}$ $U_{B768-L1/2} = 0 \text{ V}$ $U_{B768-L1/3} = 0.5\text{--}4.5 \text{ V}$	<i>Lift cylinder hydraulic pressure sensor, description page 32</i> D18: Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.10.3 <i>OP</i> , menu 3
19	Control unit, frame front (D797-F) sends information about the pressure in the lift cylinders.	Checked by control system, error shown with error code.	Section 11 <i>Common electrics</i> , group 11.5.3.2 <i>Control unit, frame front</i>
20	Control unit, frame rear (D797-R) activates Servo valve, regeneration (Y6046), if the pressure is low enough for regeneration.	U = 24 V	<i>Valve block extension cylinder, description page 47</i> D20: Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.8.3 <i>BOOM</i> , menu 3

Pos	Explanation	Signal description	Reference
21	Servo valve, regeneration (Y6046) pressurises the regeneration valve.	-	<i>Valve block extension cylinder, description page 47</i>
22	The regeneration valve changes position and directs oil from the rod side of the lift cylinder to the piston side.	-	<i>Valve block extension cylinder, description page 47</i>
23	Extension speed increases.	-	<i>Valve block extension cylinder, description page 47</i>
24	<p>Damping</p> <p>When the extension is about 0.4 m from the end position damping is activated.</p> <p>Mechanical overload system:</p> <p>Sensor, boom length (B769-3 or B769-4) sends a voltage signal to Control unit, frame rear (D797-R) which sends damping on the CAN bus.</p> <p></p> <p>Mechanical overload system with analogue position sensors or Electronic overload system:</p> <p>Sensor, boom length (B777) sends a voltage signal proportional to the boom extension to Control unit, frame rear (D797-R) that sends damping on the CAN bus.</p>	-	<p>Section 8 Control system, group 8.2.1.6 Sensor, boom length</p> <p>Mechanical overload system:</p> <p>D24: Diagnostic menu, see section 8 Control system, group 8.4.10.1 OP, menu 1,</p> <p></p> <p>Mechanical overload system with analogue position sensors or Electronic overload system:</p> <p>D24: Diagnostic menu, see section 8 Control system, group 8.4.10.4 OP, menu 4 and 8.4.10.6 OP, menu 6</p>

Hydraulic diagram, basic machine

Extension, function description (hydraulic oil pump alternative Sauer-Danfoss)



Condition	Reference value	Reference
Safety switch	Disengaged	Section 11 <i>Common electrics</i> , group 11.5.1.4 <i>Emergency stop switch voltage</i>
Overload system	Boom out: passive	Section 8 <i>Control system</i> , group 8.2.1 <i>Overload system</i>
 Load centre limitation	Bypassed or the attachment is within the limit for the load centre limitation.	Section 8 <i>Control system</i> , group 8.2.3 <i>Load centre limitation</i>
 Height limitation	Bypassed or boom height lower than height limitation	Section 8 <i>Control system</i> , group 8.2.4 <i>Height limitation</i>



006406

Pos	Explanation	Signal description	Reference
1	Control lever (S815-P2) sends the cab control unit (D790-1) a voltage signal proportional to lever movement.	Boom in: $U_{S815/P2} = 0.5-2.0 \text{ V}$ Zero position: $U_{S815/P2} = 2.0-3.0 \text{ V}$ Boom out: $U_{S815/P2} = 3.0-4.5 \text{ V}$ 0.5 V is the fastest retraction speed and 4.5 V is the fastest extension speed. Lower voltages than 0.5 V and higher voltages than 4.5 V are used to detect malfunctions in wiring and controls.	<i>Control lever, description page 7</i> D1: Diagnostic menu, see section 8 <i>Control system</i> group 8.4.8.1 <i>BOOM</i> , menu 1
2	Control unit, cab (D790-1) transmits the request for boom out <i>or boom in</i> with the speed information on the CAN bus.	Checked by control system, error shown with error code.	Section 11 <i>Common electrics</i> , group 11.5.3.1 <i>Cab control unit</i>
3	Control unit, frame front (D797-F) activates Servo valve, boom out (Y6006) <i>or Servo valve, boom in</i> (Y6007). During retraction of the boom Control unit, frame rear (D797-R) activates Solenoid valve pump relief (Y6062).	$I = 380-650 \text{ mA}$	<i>Control valve lift, lower and extension page 20</i> D3: Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.8.6 <i>BOOM</i> , menu 6, 8.4.8.7 <i>BOOM</i> , menu 7 and 8.4.8.2 <i>BOOM</i> , menu 2
4	The cab control unit (D790-1) transmits a request for increased engine speed on the CAN bus.	Checked by control system, error shown with error code.	Section 11 <i>Common electrics</i> , group 11.5.3.1 <i>Cab control unit</i>
5	The engine control unit (D794) increases engine speed.	Checked by control system, error shown with error code.	Section 11 <i>Common electrics</i> , group 11.5.3.10 <i>Engine control unit</i>
6	Servo valve, boom out (Y6006) <i>or Servo valve, boom in</i> (Y6007) pressurises the control valve's extension slide with servo pressure.	-	<i>Control valve lift, lower and extension page 20</i> D6: Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.8.6 <i>BOOM</i> , menu 6 and 8.4.8.7 <i>BOOM</i> , menu 7
7	The control valve's extension slide changes position and pressurises valve block, extension cylinder and sends a load signal to the hydraulic oil pumps.	-	<i>Control valve lift, lower and extension page 20</i>
8	When the boom is retracted the valve block, pump relief load signal, drains to one of the hydraulic oil pumps to the tank so that only one pump generates pressure.	-	<i>Valve block, pump relief, description (hydraulic oil pump alternative Sauer-Danfoss) page 52</i>

Pos	Explanation	Signal description	Reference
9	The shuttle valve forwards the strongest load signal if several functions are activated simultaneously.	-	Section 10 <i>Common hydraulics</i> , group 10.5.3 <i>Shuttle valve</i>
10	The hydraulic oil pumps pump oil from the hydraulic oil tank.	See pressure plate on left frame beam.	Section 10 <i>Common hydraulics</i> , group 10.4.2 <i>Axial piston pump with variable displacement</i>
11	The pressure reducer reduces pressure from the hydraulic oil pumps to servo pressure.	See pressure plate on left frame beam.	<i>Pressure reducer, description page 16</i>
12	Servo pressure is stored in the accumulator. The non-return valve in the pressure reducer makes it possible to store the pressure when the engine is shut off.	See pressure plate on left frame beam.	<i>Accumulator servo circuit, description page 18</i>
13	The servo filter filters the oil before the control valve.	-	<i>Servo filter, description page 16</i>
14	For boom in Control unit, frame rear (D797-R) activates Servo valve, blocking extension (Y6050).	U = 24 V	<i>Valve block extension cylinder, description page 47</i> D14: Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.8.2 <i>BOOM</i> , menu 2
15	For boom in Servo valve, blocking extension (Y6050) actuates the blocking slide in valve block, extension cylinder.	-	<i>Valve block extension cylinder, description page 47</i>
16	For boom out the blocking slide is opened in valve block, extension cylinder by the hydraulic pressure from the control valve. For boom in the blocking valve opens and releases pressure from the extension cylinder.	-	<i>Valve block extension cylinder, description page 47</i>
17	Extension cylinder extends or retracts the boom.	-	<i>Extension cylinder, description page 47</i>
18	Regeneration The lift cylinder hydraulic pressure sensor, piston side left (B768-L1) sends Control unit, frame front (D797-F) a voltage signal proportional to the cylinder pressure in the lift cylinders.	$U_{B768-L1/1} = 5 \text{ V}$ $U_{B768-L1/2} = 0 \text{ V}$ $U_{B768-L1/3} = 0.5\text{--}4.5 \text{ V}$	<i>Lift cylinder hydraulic pressure sensor, description page 32</i> D18: Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.10.3 <i>OP</i> , menu 3
19	Control unit, frame front (D797-F) sends information about the pressure in the lift cylinders.	Checked by control system, error shown with error code.	Section 11 <i>Common electrics</i> , group 11.5.3.2 <i>Control unit, frame front</i>

Pos	Explanation	Signal description	Reference
20	Control unit, frame rear (D797-R) activates Servo valve, regeneration (Y6046), if the pressure is low enough for regeneration.	U = 24 V	<i>Valve block extension cylinder, description page 47</i> D20: Diagnostic menu, see section 8 Control system, group 8.4.8.3 BOOM, menu 3
21	Servo valve, regeneration (Y6046) pressurises the regeneration valve.	-	<i>Valve block extension cylinder, description page 47</i>
22	The regeneration valve changes position and directs oil from the rod side of the lift cylinder to the piston side.	-	<i>Valve block extension cylinder, description page 47</i>
23	Extension speed increases.	-	<i>Extension cylinder, description page 47</i>
24	<p>Damping</p> <p>When the extension is about 0.4 m from the end position damping is activated.</p> <p>Mechanical overload system:</p> <p>Sensor, boom length (B769-3 or B769-4) sends a voltage signal to Control unit, frame rear (D797-R) which sends damping on the CAN bus.</p> <p></p> <p>Mechanical overload system with analogue position sensors or Electronic overload system:</p> <p>Sensor, boom length (B777) sends a voltage signal proportional to the boom extension to Control unit, frame rear (D797-R) that sends damping on the CAN bus.</p>	-	<p>Section 8 Control system, group 8.2.1.6 Sensor, boom length</p> <p>Mechanical overload system:</p> <p>D24: Diagnostic menu, see Workshop Manual section 8 Control system, group 8.4.10.1 OP, menu 1</p> <p></p> <p>Mechanical overload system with analogue position sensors or Electronic overload system:</p> <p>D24: Diagnostic menu, see section 8 Control system, group 8.4.10.4 OP, menu 4 and 8.4.10.6 OP, menu 6</p>

Hydraulic diagram, basic machine

7.3.1 Hydraulic oil pump

Hydraulic oil pump, general

See section 10 Common hydraulics , group 10.4.2 Axial piston pump with variable displacement.

7.3.2 Servo filter

Servo filter, description

See Servo filter, description page 16.

7.3.3 Pressure reducer

Pressure reducer, description

See Pressure reducer, description page 16.

7.3.4 Accumulator servo circuit

Accumulator servo circuit, description

See *Accumulator servo circuit, description page 18*.

7.3.5 Control valve lift, lower, extension

Control valve lift, lower and extension, description (model year -2008)

The control valve has two sections: one for the lift function and one for boom extension. The sections have many similarities but are described separately for each function.

For general information on the control valve, refer to *Control valve lift, lower and extension page 20*.

Extension slide

The extension slide controls direction (in or out) and oil flow to valve block extension cylinder.

Servo valve, boom out

Servo valve boom out, controls servo pressure to the extension slide so that it controls oil pressure for extension.

Servo valve boom out is controlled electrically with Solenoid valve boom out (Y6006) which is activated by Control unit, frame front (D797-F).

The signal can be checked from the diagnostic menu, see section *8 Control system*, group *8.4.8.7 BOOM*, menu *7*.

Servo valve, boom in

Servo valve boom in, controls servo pressure to the extension slide so that it controls oil pressure for boom retraction.

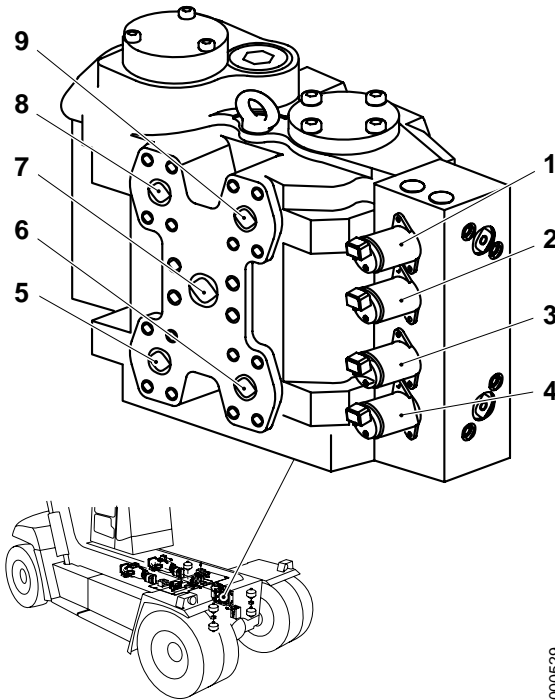
Servo valve boom in is controlled electrically with Solenoid valve boom in (Y6007) which is activated by Control unit, frame front (D797-F).

The signal can be checked from the diagnostic menu, see section *8 Control system*, group *8.4.8.6 BOOM*, menu *6*.

Shock valve, extension

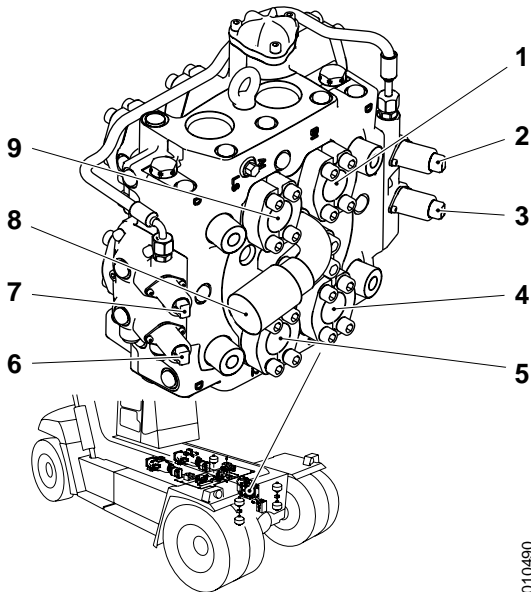
Two shock valves protect the hydraulic system against surges which can occur when operating on uneven ground or when stopping.

The shock valve opens a connection between the extension cylinder piston side and tank if the pressure becomes too high.



1. Servo valve, boom out (Y6006)
2. Servo valve, boom in (Y6007)
3. Servo valve, lower (Y6004)
4. Servo valve, lift (Y6005)
5. Connection, rod side, right lift cylinder (B2)
6. Connection, piston side, right lift cylinder (A1)
7. Connection, feed from hydraulic oil pumps (P)
8. Connection, rod side, extension cylinder (B1)
9. Connection, piston side, extension cylinder (A1)

000529



1. Connection, rod side, extension cylinder (B1)
2. Servo valve, boom out (Y6006)
3. Servo valve, lift (Y6005)
4. Connection, rod side, right lift cylinder (B2)
5. Connection, piston side, right lift cylinder (A2)
6. Servo valve, lower (Y6004)
7. Servo valve, boom in (Y6007)
8. Connection, feed from hydraulic oil pumps (P)
9. Connection, piston side, extension cylinder (A1)

010490

Control valve lift, lower and extension, description (model year 2009-)

The control valve has two sections: one for the lift function and one for boom extension. The sections have many similarities but are described separately for each function.

For general information on the control valve, refer to *Control valve lift, lower and extension page 20*.

Extension slide

The extension slide controls direction (in or out) and oil flow to valve block extension cylinder.

Servo valve, boom out

Servo valve boom out, controls servo pressure to the extension slide so that it controls oil pressure for extension.

Servo valve boom out is controlled electrically with Solenoid valve boom out (Y6006) which is activated by Control unit, frame front (D797-F).

The signal can be checked from the diagnostic menu, see section *8 Control system*, group *8.4.8.7 BOOM, menu 7*.

Servo valve, boom in

Servo valve boom in, controls servo pressure to the extension slide so that it controls oil pressure for boom retraction.

Servo valve boom in is controlled electrically with Solenoid valve boom in (Y6007) which is activated by Control unit, frame front (D797-F).

The signal can be checked from the diagnostic menu, see section *8 Control system*, group *8.4.8.6 BOOM, menu 6*.

Shock valve, extension

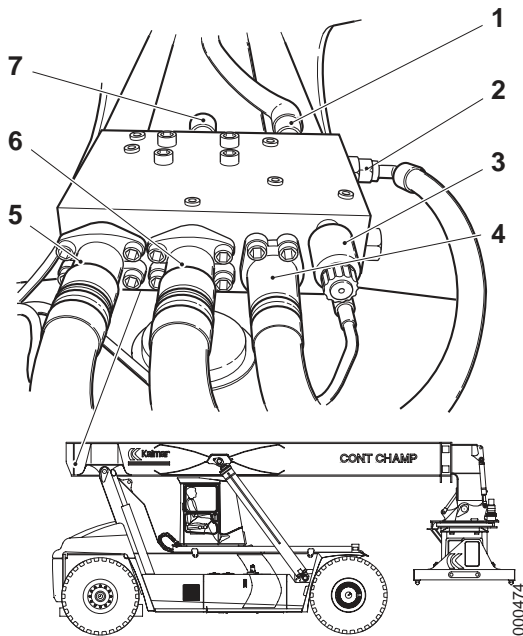
Two shock valves protect the hydraulic system against surges which can occur when operating on uneven ground or when stopping.

The shock valve opens a connection between the extension cylinder piston side and tank if the pressure becomes too high.

7.3.6 Shuttle valve

Shuttle valve, description

See section *10 Common hydraulics*, group *10.5.3 Shuttle valve*.



1. Connection, rod side, (C-)
2. Draining (D)
3. Solenoid valve regeneration (Y6046)
4. Connection control valve (VB)
5. Connection control valve (VA)
6. Connection control valve (VA)
7. Solenoid valve blocking (Y6050)

7.3.7 Valve block, extension cylinder

Valve block extension cylinder, description

Valve block extension cylinder directs pressure to the extension cylinder. The valve block is located at the rear edge of the extension cylinder in the lift boom and contains a blocking valve, regeneration valve, and non-return valve.

Blocking valve

The blocking valve prevents unwanted lowering. The valve holds the load by keeping the connection to the extension cylinder's piston side closed. The pressure passes through a restriction providing a blocking pressure and holds the valve slide closed.

Solenoid valve blocking (Y6050) actuates the blocking valve. Solenoid valve, blocking extension (Y6050) which is activated by Control unit, frame rear (D797-R).

The signal can be checked from the diagnostic menu, see section 8 *Control system*, group 8.4.8.2 *BOOM*, menu 2.

Regeneration valve

The regeneration valve directs oil from the rod side back to the piston side. This allows the oil to be re-used during extension. For more information on regeneration see *Extension, function description (hydraulic oil pump alternative Rexroth)* page 37 or *Extension, function description (hydraulic oil pump alternative Sauer-Danfoss)* page 41.

The regeneration valve is regulated by the regeneration servo valve.

Solenoid valve, extension (Y6046) pressurises the regeneration valve. Solenoid valve, extension (Y6046) is activated by Control unit, frame rear (D797-R).

The signal can be checked from the diagnostic menu, see section 8 *Control system*, group 8.4.8.3 *BOOM*, menu 3.

7.3.8 Extension cylinder

Extension cylinder, description

The extension cylinder forces out and pulls in the inner boom. The extension cylinder is located in the lift boom. The rear section is secured in the outer boom, the front section is secured in the inner boom. On the extension cylinder is a valve block which controls pressurising of the cylinder and regeneration for boom out.

The extension cylinder piston rod end is designed as a lug with a flange which is secured on the piston rod with hexagonal bolts.

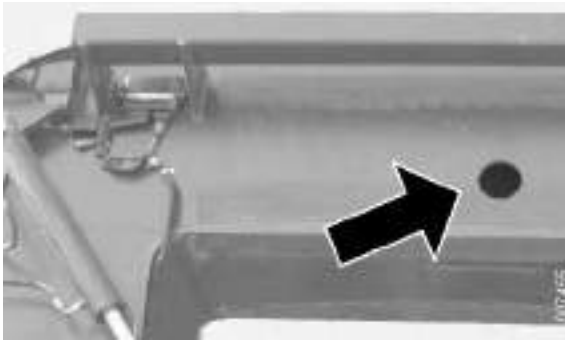
Extension cylinder, replacement


NOTE

Read the safety instructions for oil before working, see section B Safety.

Removal

- 1 Machine in service position, see section B Safety.
- 2 Operate the boom out until the inspection holes in the side of the inner boom become accessible.
- 3 Depressurise the brake and hydraulic systems, see section B Safety.



- 4 Remove the lock rings and press out the shaft for the front cylinder mounting in the inner boom.
- 5  Machine with analogue sensor boom length. Remove the sensor for boom length from the boom, see section 8 Control systems, group 8.2.1.6 Sensor boom length.
- 6 Mark up and detach the hydraulic hoses from the extension cylinder.

NOTE

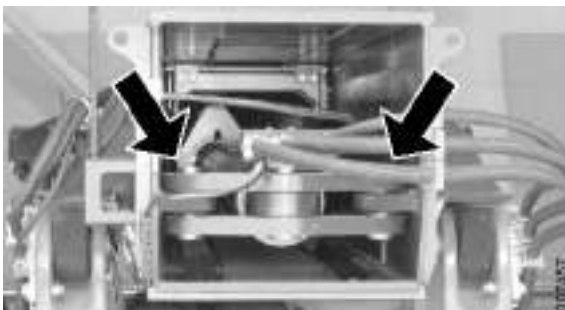
Plug all hydraulic connections immediately.

- 7 Mark up and detach the wiring from the valve block on the extension cylinder.
- 8 Remove the valve block from the extension cylinder.

NOTE

Plug all hydraulic connections immediately.

- 9 Remove the lock rings and press out the outer shafts for the rear cylinder mountings in the outer boom.
- 10 Connect lifting equipment to the rear extension cylinder mounting.
- 11 Tighten the extension cylinder carefully. When the cylinder has come out slightly connect a second lifting device that is moved forward on the lift cylinder during the entire disassembly in order to stabilise the lifting.
- 12 Place the cylinder on wooden blocks.
- 13 Transfer parts to the new extension cylinder.



Outer shafts extension cylinder

Installation

- 14 Clean and lubricate all bearing surfaces with lubricating grease.
- 15 Measure how far the old extension cylinder is extended and extend the new cylinder to the same length.

NOTE

If this is not carried out then the front cylinder mounting will not reach far enough forward.

- 16 Lift the extension cylinder into place.



CAUTION

Use the dual lifting devices to achieve balance during the lifting. The front should be positioned behind the support at the front edge of the cylinder so that it can be slid into the boom.



- 17 Fit the shaft at the front cylinder mounting in the inner boom.

NOTE

Lubricate the shaft with lubricating grease before installation.

- 18 Fit the lock rings on the shaft.



- 19 Fit the shafts at the rear cylinder mountings.

NOTE


Lubricate the shaft with lubricating grease before installation.

- 20 Fit the lock rings on the shafts.
- 21 Fit the valve block on the extension cylinder.

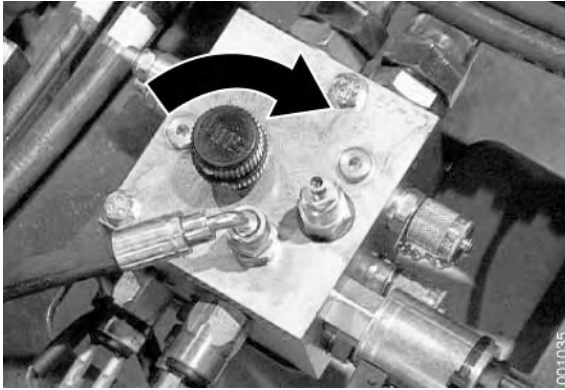
NOTE

Check that the O-rings are intact and fitted correctly.

- 22 Connect the hydraulic hoses and the wiring to the extension cylinder.

- 23  Machine with analogue sensor boom length.

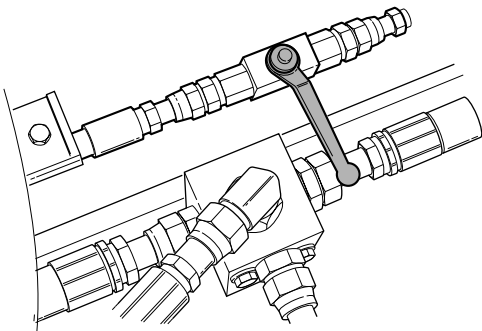
Fit the sensor for boom length, see section 8 Control system, group 8.2.1.6 Sensor boom length.



- 24 Close the drain valve on the accumulator charging valve.

NOTE

Check that the accumulator drain valve is fully closed and tighten the lock ring.



Relief valve for top lift, the figure shows a closed valve.

- 25 Close the relief valve for top lift.

CAUTION

Hydraulic oil may be directed the wrong way.

Risk of damage to the fine filter for hydraulic oil.

Check that the relief valve for top lift is closed before starting the engine.

- 26 Start the engine and check for leaks.

- 27 Check the oil level in the hydraulic oil tank with the lift cylinders fully down and the extension cylinder fully in. The oil level should be in the centre of the level glass. Top up if necessary, for grade see section *F Technical data*.



CAUTION

Overfilling of oil, leakage, and environmental damage.

The hydraulic oil level is checked with the boom completely lowered and retracted.

- 28 Calibrate the sensor for boom length, see section *8 Control system*, group *8.5.2.1 Calibrate SCALE* steps 9 - 12.

Hydraulic cylinders, repairs

See section *10 Common hydraulics*, group *10.7.1 Hydraulic cylinders*.

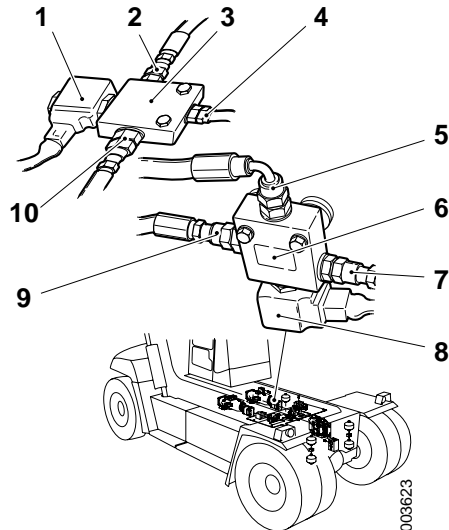
7.3.9 Valve block, pump relief

Valve block, pump relief, description (hydraulic oil pump alternative Rexroth)

For boom in, only a small oil flow is required. Solenoid valve pump relief (Y6062) drains the control signal for hydraulic oil pump 2, to the tank. This results in only one pump unit building up pressure, which reduces the use of engine power and thus fuel consumption. If other functions are activated at the same time, the pressure signal will pass through the shuttle valve, see section *10 Common hydraulics*, group *10.5.3 Shuttle valve*. The load signal goes to the pumps that are needed. The valve block is located standing on the bracket for the oil filling point between the engine and transmission.

Solenoid valve, pump relief (Y6062) is supplied with voltage by Control unit, frame rear (D797-R) on activation.

The signal can be checked from the diagnostic menu, see section *8 Control system*, group *8.4.8.2 BOOM, menu 2*.



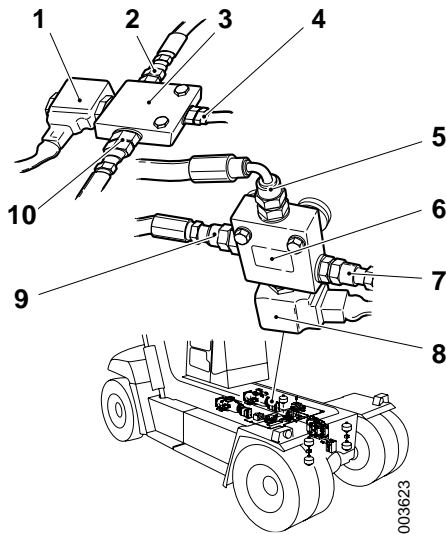
1. Solenoid valve, engagement of hydraulic pressure (Y6003)
2. Pressure signal to hydraulic oil pump 2
3. Valve block, top lift hydraulics
4. Tank drain
5. Pressure signal in, from shuttle valve
6. Valve block, pump relief
7. Pressure signal to hydraulic oil pump 2
8. Solenoid valve, pump relief (Y6062)
9. Tank drain
10. Pressure signal in, from shuttle valve 1

Valve block, pump relief, description (hydraulic oil pump alternative Sauer-Danfoss)

For boom in, only a small oil flow is required. Solenoid valve pump relief (Y6062) drains the control signal for hydraulic oil pump 2, to the tank. This results in only one pump unit building up pressure, which reduces the use of engine power and thus fuel consumption. If other functions are activated at the same time, the pressure signal will pass through the shuttle valve, see the Workshop Manual, section *10 Common hydraulics*, group *10.5.3 Shuttle valve*. The load signal goes to the pumps that are needed. The valve block is located standing on the bracket for the oil filling point between the engine and transmission.

Solenoid valve, pump relief (Y6062) is supplied with voltage by Control unit, frame rear (D797-R) on activation.

The signal can be checked from the diagnostic menu, see section *8 Control system*, group *8.4.8.2 BOOM*, menu 2.



1. Solenoid valve, engagement of hydraulic pressure (Y6003)
2. Pressure signal to hydraulic oil pump 1
3. Valve block, top lift hydraulics
4. Tank drain
5. Pressure signal in, from shuttle valve
6. Valve block, pump relief
7. Pressure signal to hydraulic oil pump 1
8. Solenoid valve, pump relief (Y6062)
9. Tank drain
10. Pressure signal in, from shuttle valve 1

7.3.10 Lift boom

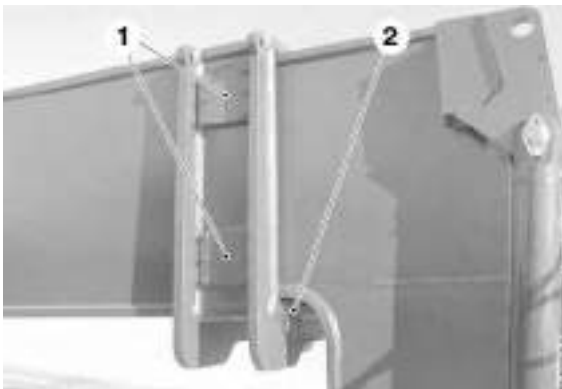
Lift boom, general

See *Lift boom, description page 35*.

Slide plates, lift boom, replacement

NOTE

When adjusting the side-mounted slide plates, it is important to check the clearance for the whole travel of the boom and that the inner boom is centred in the outer boom.



1. Side-mounted slide plates
2. Lower slide plates

Front slide plates

- 1 Move the boom to the lowest position with the inner boom extended approx. 50 cm.
- 2 Remove the cover plate for the side-mounted slide plates and remove the spacer plates and slid plate.
- 3 Fit in the reverse order.
- 4 Check the clearance between the boom and slide plate, the clearance should be **1 mm**, adjust with spacer plates as required.

NOTE

Inner boom must be centred in the outer boom.

- 5 Remove the lock screws and the slide plates' brackets, and pull out the upper slide plates and the spacer plates.
- 6 Unload the lower slide plates, lift the inner boom at the front edge and use wooden shims.

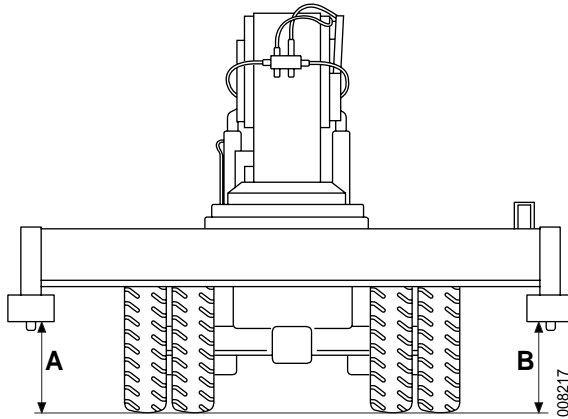


WARNING

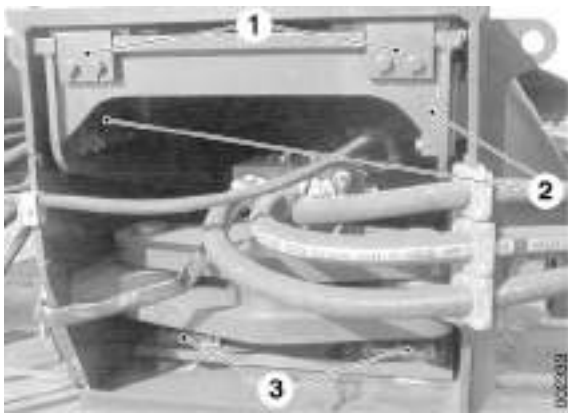
Risk of pinch injury!

Secure the inner boom relative to the outer boom with wooden blocks.

- 7 Remove the lock screws, slide plates' brackets and pull out the lower slide plates.
- 8 Transfer the nuts for the lock screws for the lower slide plates to the new slide plates.
- 9 Fit the new lower slide plates, lock screws and brackets.
- 10 Remove the wooden blocks and ease down the inner boom so that it rests on the lower slide plates.
- 11 Transfer the nuts for the lock screws for the upper slide plates to the new slide plates.
- 12 Fit the new slide plates, spacer plates, lock screws and brackets.



Measuring points, levelling, attachment



1. Upper slide plates
2. Side-mounted slide plates
3. Lower slide plates

- 13 Check the clearance between the boom and stop at the front edge/top edge of the boom, the clearance must be **max. 2 mm**, adjust the slide plates with spacer plates if necessary.

Check attachment levelling

- 14 Park the machine on level ground.
- 15 Lower the boom fully and centre the attachment.
- 16 Measure the distance between the extension beam and the ground on the right and left-hand sides of the attachment.
The difference between the dimensions for right (A) and left (B) sides must not be more than 50 mm at 20' position, or 100 mm for 40' position.
Check both the dimensions with the boom fully retracted and fully extended.
- 17 If necessary, adjust the lower slide plates so that the attachment is straight.

Rear slide plates

- 18 Start the engine and operate the boom inwards completely (fully retracted).
- 19 Remove the cover plate for the side-mounted slide plates and remove the spacer plates and slid plate.
- 20 Fit in the reverse order.
- 21 Check the clearance between the boom and slide plate, the clearance should be **1 mm**, adjust with spacer plates as required.
- 22 Unload the lower slide plates, use wooden shims.

WARNING

Risk of pinch injury!

Secure the inner boom relative to the outer boom with wooden blocks.

- 23 Remove the cover plates, spacer plates and the lower slide plates.
- 24 Fit new slide plates, spacer plates and cover plate.
- 25 Unload the upper slide plates, use wooden shims.

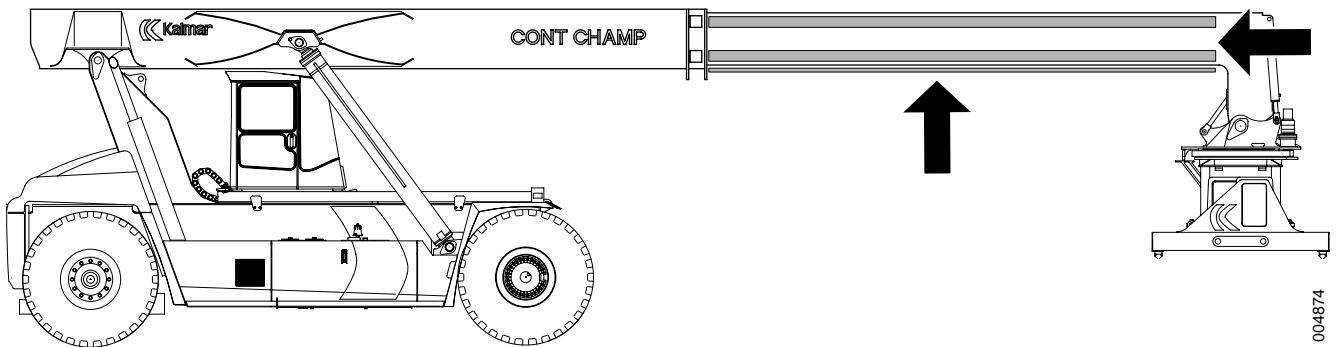
WARNING

Risk of pinch injury!

Secure the inner boom relative to the outer boom with wooden blocks.

- 26 Remove the lock screws, the slide plates' brackets and pull out the upper slide plates and the spacer plates.
- 27 Transfer the nuts for the lock screws for the upper slide plates to the new slide plates.
- 28 Fit the new slide plates, spacer plates, lock screws and brackets.
- 29 Check the clearance between the outer and inner boom, the clearance should be **max. 2 mm**, adjust the slide plates with spacer plates as required.

Lubrication



004874

Sliding surfaces, boom

- 30 Operate the inner boom outwards completely and lubricate the sliding surfaces inside the outer boom and on the inner boom with white lubricating paste.
- 31 Operate the boom in and out about 10 times and stop with the boom fully out.
- 32 Wipe away excess lubricating paste at the slide plates and on sliding surfaces.

7.3.11 Sensor, boom length

Sensor, boom length, general

See section 8 *Control system*, group 8.2.1.3 *Sensor, boom length*.

7.3.12 Pipes and hoses

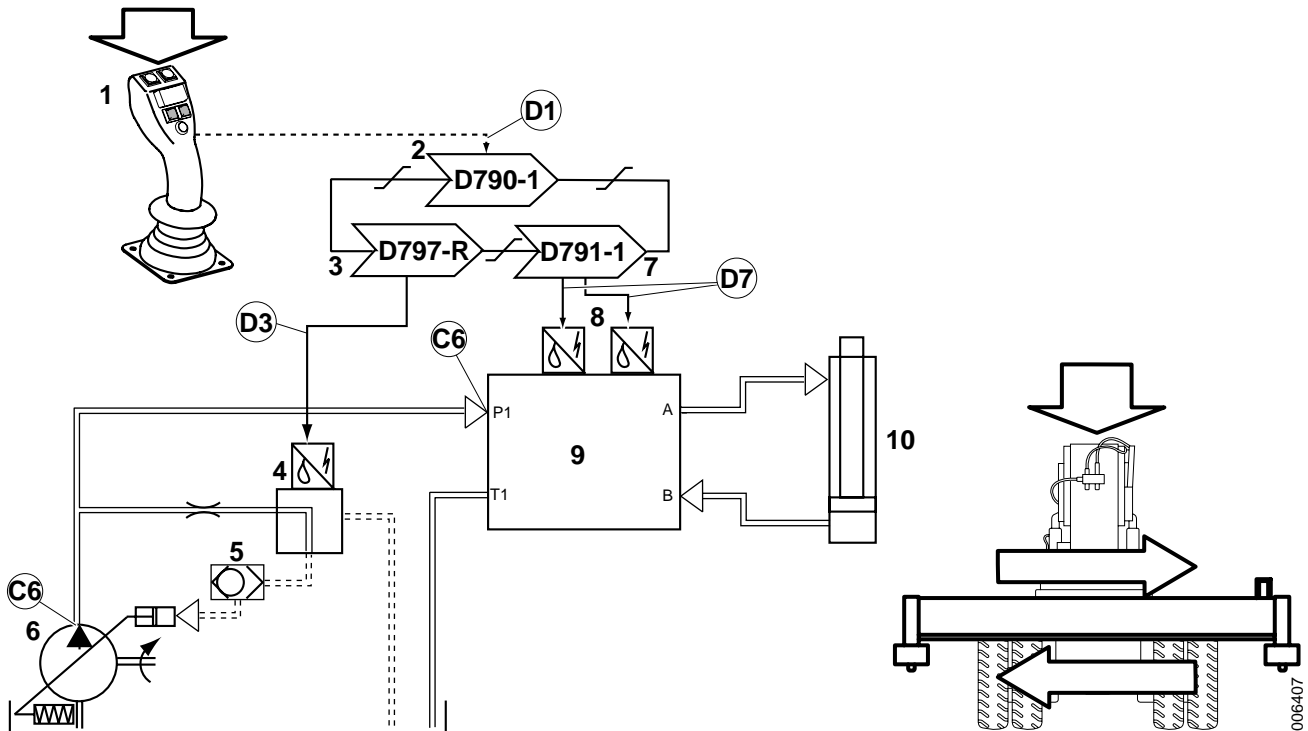
Piped and hoses, description

See section 10 *Common hydraulics*, group 10.5.1 *Pipes and hoses*.

7.4 Side shift

Side shift, function description

Condition	Reference value	Reference
Safety switch	Disengaged	Section 11 <i>Common electrics</i> , group 11.5.1.4 <i>Emergency stop switch voltage</i>



Pos	Explanation	Signal description	Reference
1	The control lever (S815-T1.1) sends a voltage signal to the cab control unit (D790-1).	Left: $U_{S815-T1.1} = 24\text{ V}$ Right: $U_{S815-T1.2} = 24\text{ V}$	<i>Control lever, description page 7</i> D1: Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.9.2 <i>ATTACH</i> , menu 2
2	The cab control unit (D790-1) transmits side shift left or right on the CAN bus.	Checked by control system, error shown with error code.	Section 11 <i>Common electrics</i> , group 11.5.3.1 <i>Cab control unit</i>
3	Control unit, frame rear (D797-R) activates the solenoid valve, engagement of hydraulics for top lift (Y6003).	$U = 24\text{ V}$	Section 11 <i>Common electrics</i> , group 11.5.3.3 <i>Control unit, frame rear</i> D3: Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.5.6 <i>HYD</i> , menu 6
4	Solenoid valve, engagement of hydraulics for top lift (Y6003) opens and pressurises valve block lift cylinder and sends a load signal to hydraulic oil pump 2.	-	<i>Valve block, top lift hydraulics, description page 58</i> D3: Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.5.6 <i>HYD</i> , menu 6

Pos	Explanation	Signal description	Reference
5	The shuttle valve forwards the strongest load signal to the hydraulic oil pumps if several functions are activated simultaneously.	-	Section 10 <i>Common hydraulics</i> , group 10.5.3 <i>Shuttle valve</i>
6	Hydraulic oil pump 2 pumps oil from the hydraulic oil tank.	See pressure plate on left frame beam.	Section 10 <i>Common hydraulics</i> , group 10.4.2 <i>Axial piston pump with variable displacement</i>
7	Control unit, attachment (D791-1) activates the servo valve for side shift left (Y6020) or servo valve for side shift right (Y6021).	U = 24 V	Section 11 <i>Common electrics</i> , group 11.5.3.5 <i>Control unit, attachment</i> D7: Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.9.8 <i>ATTACH</i> , menu 8
8	The servo valve for side shift left (Y6020) or servo valve for side shift right (Y6021) pressurizes the side shift slide in the attachment control valve.	-	<i>Attachment control valve, description page 59</i> D7: Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.9.8 <i>ATTACH</i> , menu 8
9	The control valve's side shift slide changes position and pressurizes the side shift cylinders.	-	<i>Attachment control valve, description page 59</i>
10	The side shift cylinders push the main beam in sideways in relation to the side shift frame.	-	<i>Side shift cylinder, description page 64</i>

Hydraulic diagram, top lift

Hydraulic diagram, top lift, tilt lock and controllable tilt

Hydraulic diagram, combi yoke

Hydraulic diagram, top lift, tilt lock and controllable tilt and hydraulic levelling

7.4.1 Hydraulic oil pump

Hydraulic oil pump, general

See section 10 *Common hydraulics*, group 10.4.2 *Axial piston pump with variable displacement*.

7.4.2 Valve block, top lift hydraulics

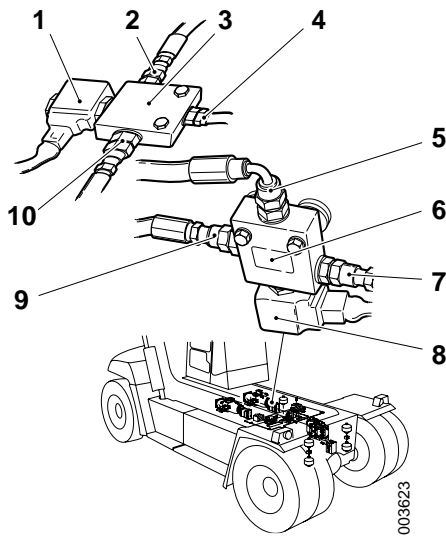
Valve block, top lift hydraulics, description

The valve block for top lift hydraulics is an electrically controlled valve. It leads an unloaded constant pressure as the load signal to the hydraulic oil pumps when attachment functions are activated. The valve block is positioned horizontally on the bracket for the oil filling point between the engine and transmission.

When the solenoid valve is activated, pressure is routed from the top hydraulics' supply through a shuttle valve to the hydraulic oil pumps for steering. A restriction before the valve block ensures that pressure for control of the hydraulic oil pumps does not become too high. When the solenoid valve is not activated, the load signal is drained to the tank and the inlet from the top hydraulics' supply is closed.

The valve is controlled electrically with Solenoid valve, engagement hydraulic pressure (Y6003) which is activated by Control unit, frame rear (D797-R).

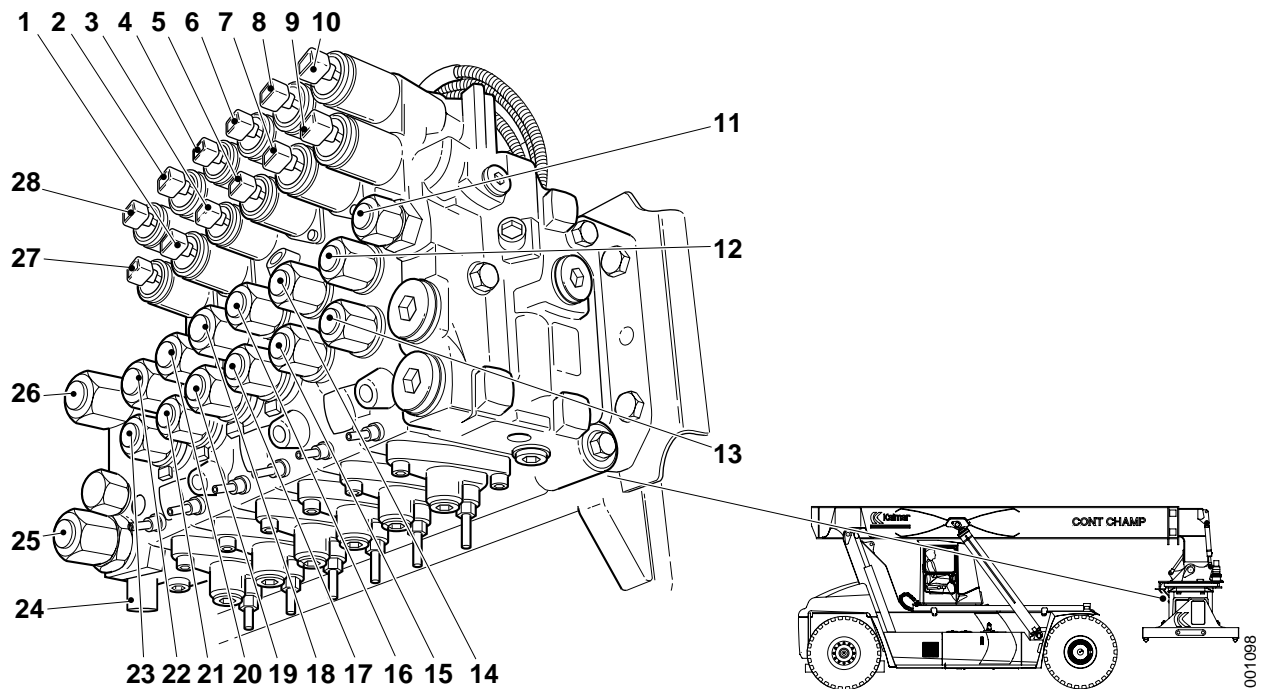
The signal can be checked from the diagnostic menu, see section 8 *Control system*, group 8.4.5.6 *HYD*, menu 6.



1. Solenoid valve, engagement of hydraulic pressure (Y6003)
2. Pressure signal to hydraulic oil pump 2
3. Valve block, top lift hydraulics
4. Tank drain
5. Pressure signal in, from shuttle valve
6. Valve block, pump relief
7. Pressure signal to hydraulic oil pump 2
8. Solenoid valve, pump relief (Y6062)
9. Tank drain
10. Pressure signal in, from shuttle valve 1

7.4.3 Control valve attachment

Attachment control valve, description



- | | |
|--|--|
| 1. Solenoid valve, tilt out (Y6010) + | 16. Connection to side shift cylinder |
| 2. Solenoid valve, tilt in (Y6011) + | 17. Connection to side shift cylinder |
| 3. Solenoid valve rotation clockwise (Y6008) | 18. Connection to rotation motor |
| 4. Solenoid valve rotation anticlockwise (Y6009) | 19. Connection to rotation motor |
| 5. Solenoid valve, side shift right (Y6021) | 20. Connection to tilt cylinder + |
| 6. Solenoid valve, side shift left (Y6020) | 21. Connection to tilt cylinder + |
| 7. Solenoid valve, spreading out (Y6018) | 22. Connection to levelling cylinder + |
| 8. Solenoid valve, spreading in (Y6019) | 23. Connection to levelling cylinder + |
| 9. "Lock twistlocks" solenoid valve (Y6040) | 24. Test outlet, feed pressure to control valve |
| 10. "Open twistlocks" solenoid valve (Y6039) | 25. Feed from hydraulic oil pump 2 |
| 11. Drain to tank | 26. Return to tank (through tank filter) |
| 12. Connection to lock cylinder | 27. Solenoid valve, levelling right (Y6035) + |
| 13. Connection to lock cylinder | 28. Solenoid valve, levelling left (Y6036) + |
| 14. Connection to spreader motor | |
| 15. Connection to spreader motor | |



Side shift is controlled by a separate section of the attachment control valve.

The attachment control valve controls hydraulic functions on the attachment. The control valve is located at the centre rear of the attachment. Electric servo valves control the flow from the valve.

The control valve is an electro-hydraulically controlled, proportional and pressure-compensated directional valve. Electrically controlled servo valves convert current to servo pressure. The servo pressure controls the spring-centred valve slides, which control pressure and flow for the function in question. The valve slides have a flow limit so that several functions can be used simultaneously. This enables them to control main flow.

The control valve has built-in supply of pilot pressure. This means that the valve has built-in pressure reduction which converts feed pressure to servo pressure for the various functions. Supply of pilot pressure is common for all functions. This reduces pressure variations due to long hoses and reduces the number of hoses to the valve.

The control valve has the following sections:

- Side shift
- Spreading
- Rotation
- Twistlocks
- Controllable tilt 
- Hydraulic levelling 

Side shift slide

The valve slide controls side shift direction and speed.

The valve slide is controlled by a servo valve for side shift right and a servo valve for side shift left.

Servo valve, side shift left

The servo valve for side shift left directs pressure to the side shift slide so that the side shift slide opens and pressurises the side shift cylinders.

The servo valve for side shift left is controlled electrically by the solenoid valve for side shift left (Y6020), which is activated by the attachment control unit (D791-1). The servo valve directs servo pressure to the side shift slide in proportion to the control current to the solenoid valve.

The signal can be checked from the diagnostic menu, see section 8 *Control system*, group 8.4.9.8 *ATTACH*, menu 8.

Servo valve, side shift right

The servo valve for side shift right directs pressure to the side shift slide so that the side shift slide opens and pressurises the side shift cylinders.

The servo valve for side shift is controlled electrically by the solenoid valve for side shift right (Y6021), which is activated by the attachment control unit (D791-1). The servo valve directs servo pressure to the side shift slide in proportion to the control current to the solenoid valve.

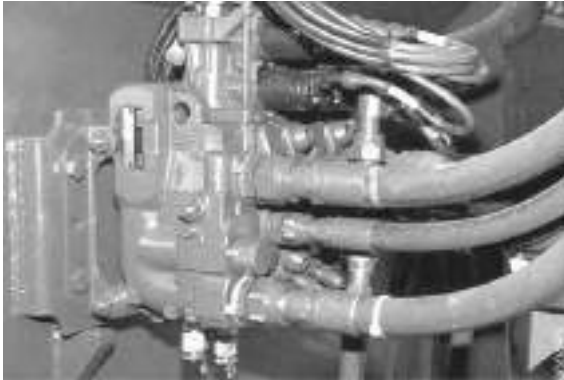
The signal can be checked from the diagnostic menu, see section 8 *Control system*, group 8.4.9.8 *ATTACH*, menu 8.

Attachment control valve, replacement

NOTE

Read the safety instructions for oil before working, see section B Safety.

- 1 Machine in service position, see section B Safety.
- 2 Depressurise the brake and hydraulic systems, see section B Safety.
- 3 Mark up and detach the hydraulic hoses from the control valve.



NOTE

Plug all connections immediately to protect the hydraulic system from impurities.

- 4 Mark up and detach the wiring from the control valve.
- 5 Remove the control valve.
Remove the attaching bolts and lift away the valve. Place the valve on a clean and protected surface.
- 6 Transfer the connection adapters to the new control valve.

NOTE

Check that the O-rings are intact and fitted correctly.

NOTE

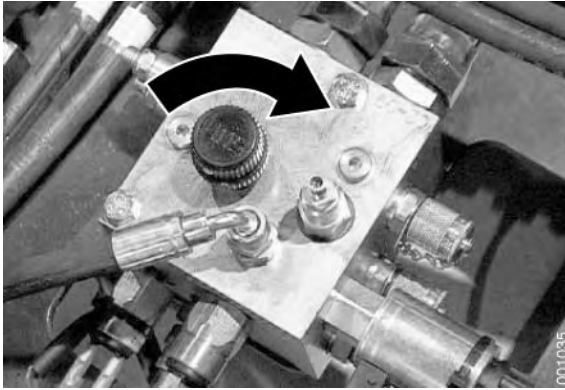
Transfer one adapter at a time so that the marking is not mixed up.

- 7 Mark up the servo valves on the new control valve.
- 8 Fit the valve.
Lift the valve into place and fit the attaching bolts.
- 9 Connect the wiring to the control valve in accordance with the marking.
- 10 Connect the hydraulic hoses to the control valve in accordance with the marking.



NOTE

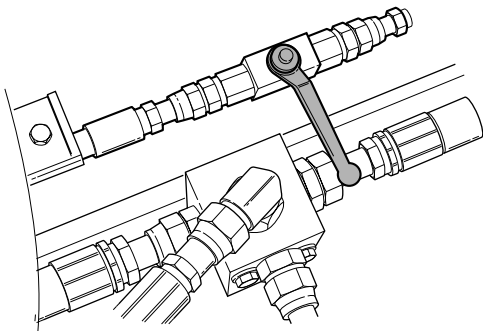
Check that the O-rings are intact and fitted correctly.



- 11 Close the drain valve on the accumulator charging valve.

NOTE

Check that the accumulator drain valve is fully closed and tighten the lock ring.



Relief valve for top lift, the figure shows a closed valve.

010475

- 12 Close the relief valve for top lift.

CAUTION

Hydraulic oil may be directed the wrong way.

Risk of damage to the fine filter for hydraulic oil.

Check that the relief valve for top lift is closed before starting the engine.

- 13 Turn on the main electric power and start the engine.
 14 Check that the valve's hydraulic connections are sealed.
 15 Check that the attachment is working.

CAUTION

Air in the hydraulic system may cavitate and result in product damage.

Activate the functions carefully and operate at the lowest possible speed a couple of times to avoid cavitation.

- 16 Check the oil level in the hydraulic oil tank with the lift cylinders fully down and the extension cylinder fully in. The oil level should be in the centre of the level glass. Top up if necessary, for grade see section *F Technical data*.



CAUTION

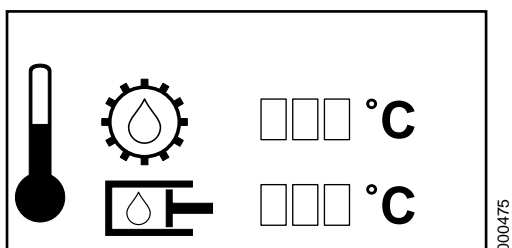
Overfilling of oil, leakage, and environmental damage.

The hydraulic oil level is checked with the boom completely lowered and retracted.

Attachment control valve, checking hydraulic pressure

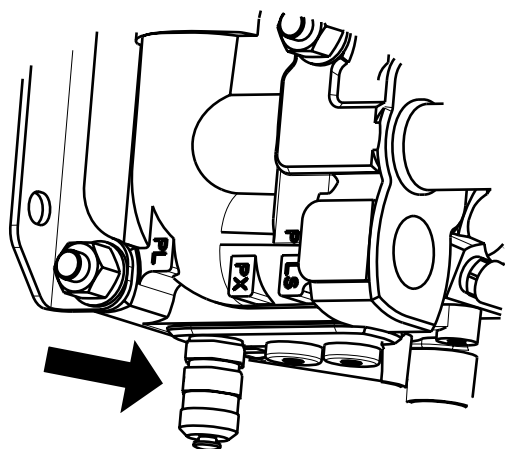
NOTE

Read the instructions for oil before working; see section B Safety.



000475

Operating menu, hydraulic oil temperature



008226

Measuring outlet, control valve, attachment

- 1 Operate and warm up the machine so that the hydraulic oil is at operating temperature, at least 50 °C. As an alternative, operate until the cooling fan is activated.
- 2 Machine in service position, see section B Safety.

- 3 Connect a pressure gauge to measuring outlet PL on the attachment control valve.
- 4 Start the engine and run it at idling speed. Check the pressures in the attachment's different functions by letting each function go to its end-position and then reading off the pressure gauge.

Function	Pressure
Side shift	16.0 MPa
Spreading	12.0 MPa
Rotation	15.0 MPa
Tilt control	15.0 MPa
Levelling	15.5 MPa
Twistlocks	Same as feed pressure.
Overheight jacks, lowering	10.0 MPa
Lifting jacks, knee in/out	10.0 MPa
Lifting jacks, jack up/down	13.0 MPa
Lifting jacks, clamping	13.0 MPa

- 5 Remove the pressure gauge and fit the protective cap on the measuring outlet.

7.4.4 Shuttle valve

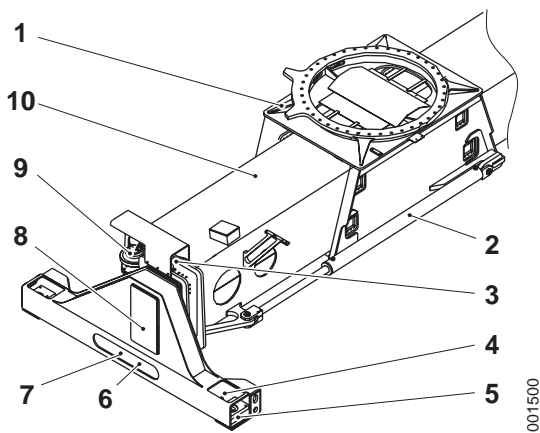
Shuttle valve, description

See section 10 Common hydraulics , group 10.5.3 Shuttle valve.

7.4.5 Side shift cylinder

Side shift cylinder, description

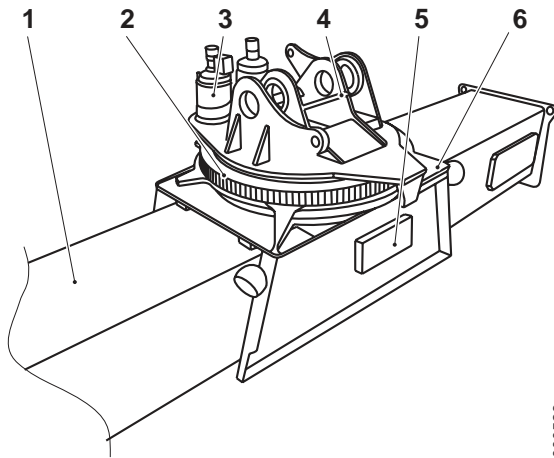
The side shift cylinders are two cross connected hydraulic cylinders which extend the attachment's main beam laterally in relation to the sideshift frame. The side shift cylinders are located along the front and rear of the attachment and are used to centre the load's centre of gravity.



1. Side shift frame
2. Side shift cylinder
3. Position sensor, spreading
4. Sensor alignment
5. Twistlock
6. Twistlock sensor
7. Lock cylinder, twistlocks
8. Spreading boom
9. Spreading motor
10. Main beam, attachment

Hydraulic cylinders, repairs

See section *10 Common hydraulics*, group *10.7.1 Hydraulic cylinders*.



1. Main beam
2. Ring gear
3. Rotation motor unit
4. Rotation yoke
5. Control valve attachment
6. Side shift frame

000526


7.4.6 Side shift frame

Side shift frame, description

The attachment is secured in the boom with the rotation yoke. The side shift frame is located under the rotation yoke. The attachment's main beam is located in the side shift frame. The main beam can be extended laterally in relation to the side shift frame with two hydraulic cylinders. Inside the main beam are two spreader beams which can be extended in and out with a hydraulic motor.

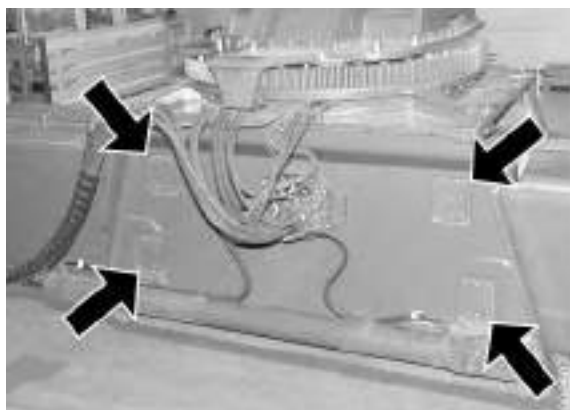
The position of the attachment can be adjusted laterally by moving the main beam in relation to the side shift frame. The main beam runs on slide plates in the sides and in the bottom. The side shift cylinders secure the lateral position.

The side shift frame is available in two versions:

- Standard top lift. The side shift frame allows the main beam to be levelled 5°. Side shift 800 mm.
- Pile-slope top lift 

The side shift frame is located in the rotation yoke with four hydraulic cylinders which mean that the levelling can be controlled for adaptation to angled containers. Side shift 800 mm. *Side shift frame, description page 129*

Slide plates, side shift frame, replacement



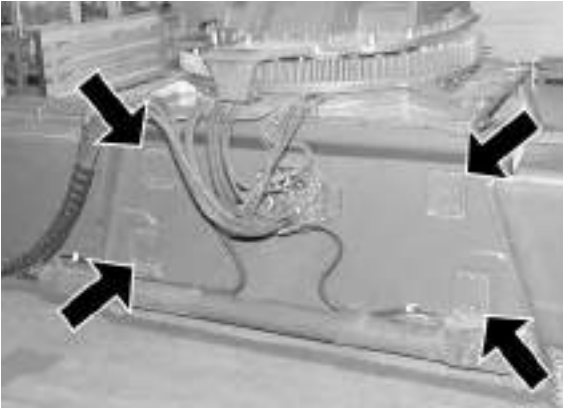
- 1 Undo the cover plate's attaching bolt and remove the cover plate.
- 2 Remove the spacer plates and slide plate.
- 3 Repeat steps 1 - 3 on the other slide plates.



- 4 Measure the distance between the edge of the cover plate and the attachment's main beam slide surface on all slide plates.
- 5 Centre the boom so that the distance between the attachment's main beam and edge is the same on all slide plates.



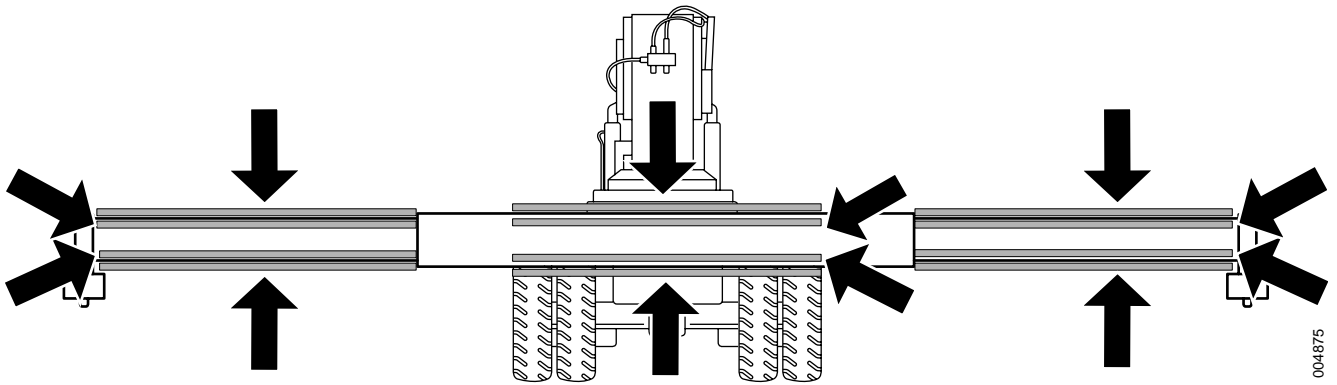
- 6 Fit the new slide plate.
- 7 Check the slide plate's clearance by measuring the distance between the slide plate and the edge of the cover plate. The clearance between the attachment's main beam and slide plates must be **1 mm**.
- 8 Fit the spacer plates until the distance is correct.



9 Fit the cover plate.

10 Repeat steps 7 - 10 on the other slide plates.

Lubrication

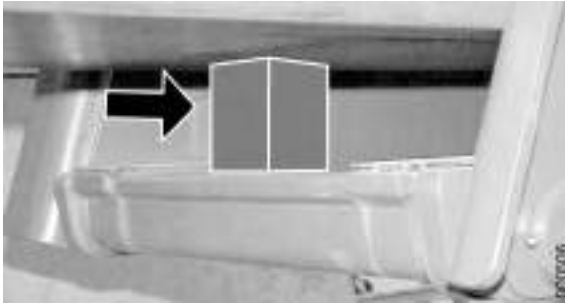


Sliding surfaces, attachment

- 11 Lubricate the sliding surfaces of the attachment with white lubricating paste.
- 12 Operate full side shift from right to left approx. 10 times.
- 13 Wipe away excess lubricating paste at the slide plates and on sliding surfaces.

Lower slide plates, side shift frame, replacement

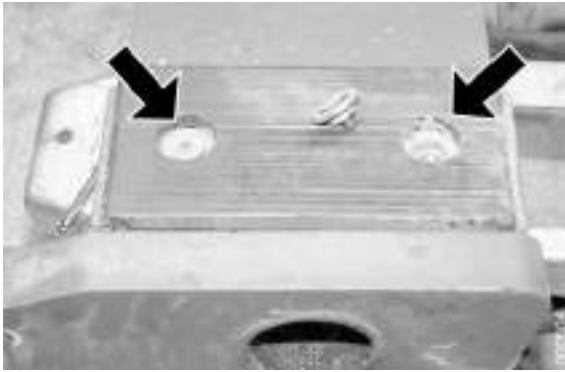
- 1 Position axle stands or similar under the attachment's spreader booms and lower the attachment on the stands so that the side shift frame's lower slide plates are released.
- 2 Turn off the engine and the main electrical power.



! DANGER

Risk of pinch injury!

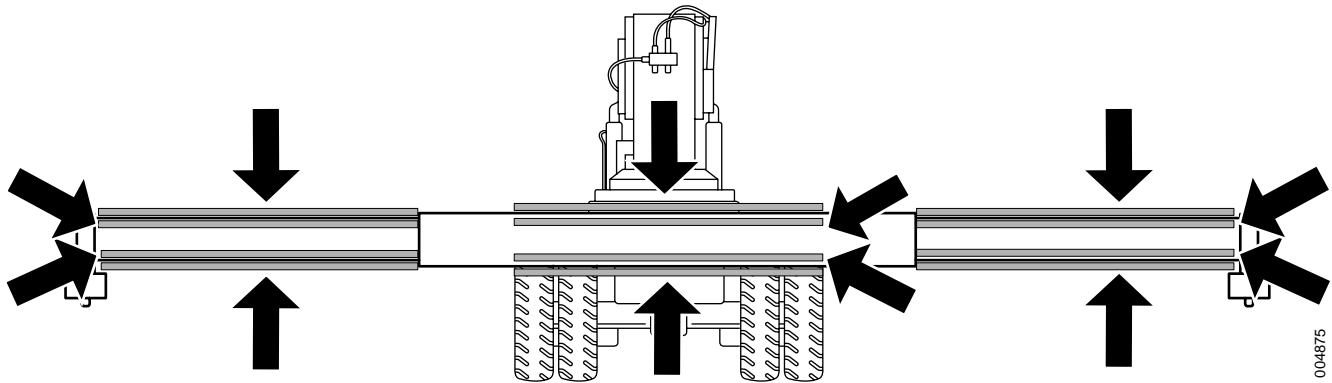
Place spacers between the crossmember and the attachment's main boom for both crossmembers.



- 3 Remove the attaching bolts and remove the slide plates.
- 4 Install new slide plates.
- 5 Remove the spacer.
- 6 Turn on the main electric power and start the engine.
- 7 Lift the attachment and remove the stands.

Lubrication

The illustration shows a crossmember



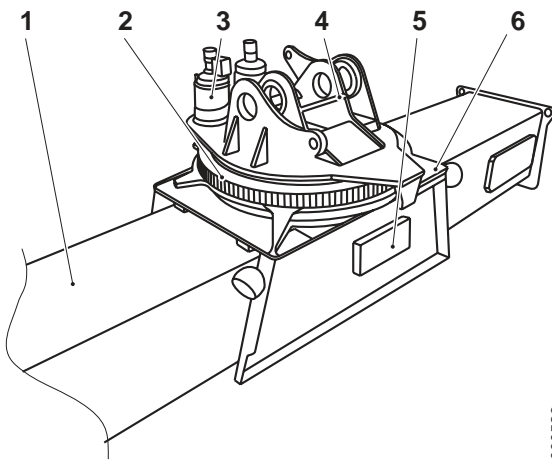
Slide plates, attachment

- 8 Lubricate the sliding surfaces of the attachment with white lubricating paste.
- 9 Operate full side shift from right to left approx. 10 times.
- 10 Wipe away excess lubricating paste at the slide plates and on sliding surfaces.

7.4.7 Main beam, attachment

Attachment main beam, description

The main beam attachment is located in the side shift frame. The main beam contains equipment for spreading (spreader beams, hydraulic motor, chains, slide plates and sensors). On the attachment's main beam are also the control valves for the attachment's hydraulic functions.



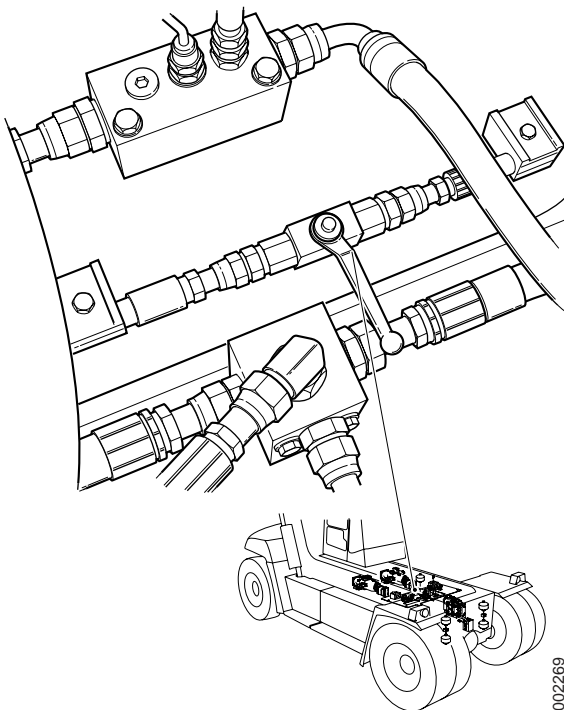
000526

1. Main beam
2. Ring gear
3. Rotation motor unit
4. Rotation yoke
5. Control valve attachment
6. Side shift frame

7.4.8 Relief valve, attachment

Attachment relief valve, description

The attachment relief valve opens the connection between the attachment's pressure supply and the tank. This is used to drain the pressure in the attachment hoses prior to work on the hydraulic system. The relief valve is located at the rear of the lifting beam in front of the transmission.



002269

7.4.9 Pipes and hoses

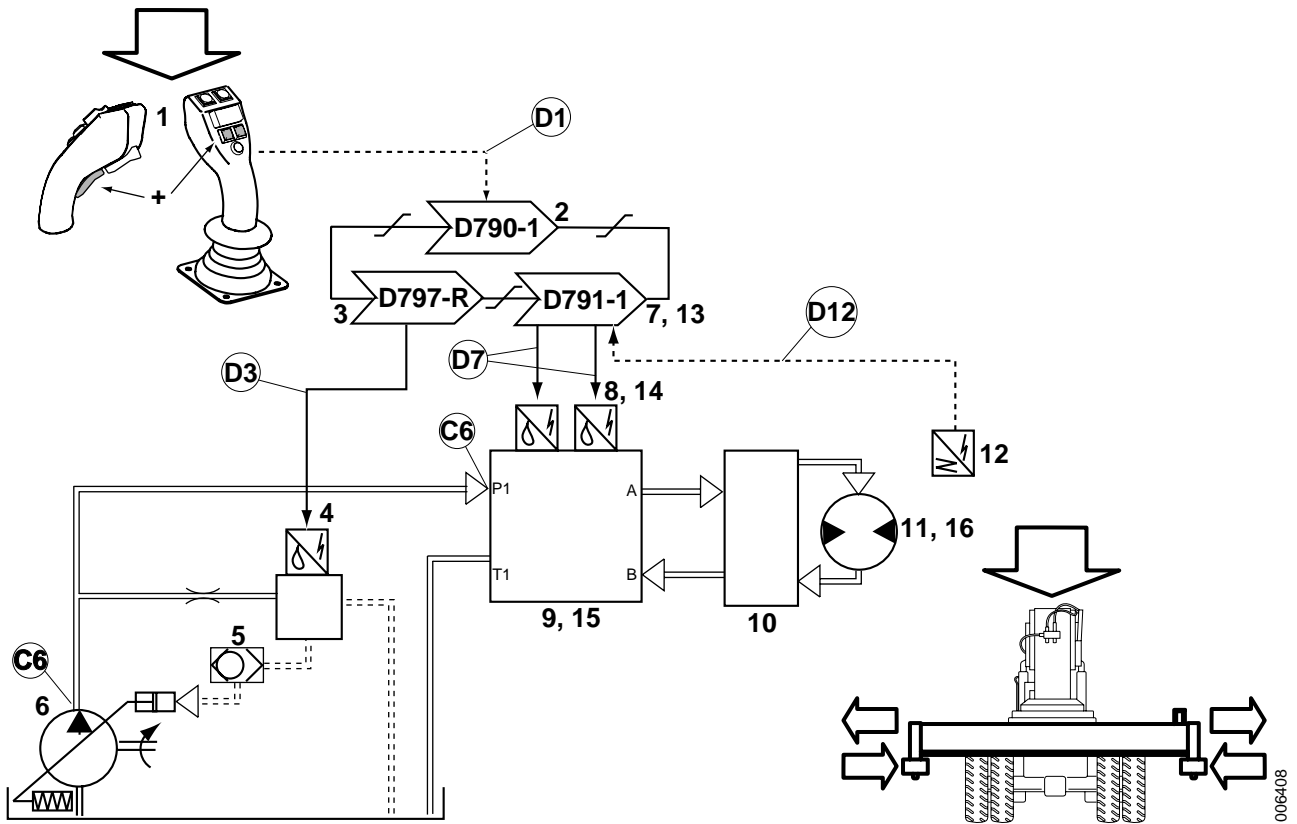
Pipes and hoses, description

See section *10 Common hydraulics*, group *10.5.1 Pipes and hoses*.

7.5 Spreading

Spreading, function description

Condition	Reference value	Reference
Safety switch	Disengaged	Section 11 <i>Common electrics</i> , group 11.5.1.4 <i>Emergency stop switch voltage</i>
Twistlocks	Unlocked or by-pass activated	<i>Twistlocks, description page 137</i> Section 8 <i>Control system</i> , group 8.2.2 <i>Bypassing</i>
Overload system	Passive	Section 8 <i>Control system</i> , group 8.2.1 <i>Overload system</i>



Pos	Explanation	Signal description	Reference
1	The control lever (S815-T1.x and S815-T4) sends a voltage signal to the cab control unit (D790-1).	Spreading: $U_{S815-T4} = 24\text{ V}$ Out: $U_{S815-T1.2} = 24\text{ V}$ In: $U_{S815-T1.1} = 24\text{ V}$	<i>Control lever, description page 7</i> D1: Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.9.2 <i>ATTACH, menu 2</i>
2	The cab control unit (D790-1) transmits a signal on the CAN bus.	Checked by control system, error shown with error code.	Section 11 <i>Common electrics</i> , group 11.5.3.1 <i>Cab control unit</i>

Pos	Explanation	Signal description	Reference
3	Control unit, frame rear (D797-R) activates the solenoid valve, engagement of hydraulics for top lift (Y6003).	U = 24 V	Section 11 <i>Common electrics</i> , group 11.5.3.3 <i>Control unit, frame rear</i> D3: Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.5.6 <i>HYD</i> , menu 6
4	Solenoid valve, engagement of hydraulics for top lift (Y6003) opens and sends a load signal to the hydraulic oil pumps.	-	<i>Valve block, top lift hydraulics, description page 58</i> D3: Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.5.6 <i>HYD</i> , menu 6
5	The shuttle valve forwards the strongest load signal to the hydraulic oil pumps if several functions are activated simultaneously.	-	Section 10 <i>Common hydraulics</i> , group 10.5.3 <i>Shuttle valve</i>
6	Hydraulic oil pump 2 pumps oil from the hydraulic oil tank.	See pressure plate on left frame beam.	Section 10 <i>Common hydraulics</i> , group 10.4.2 <i>Axial piston pump with variable displacement</i>
7	The attachment control unit (D791-1) activates the servo valve for spreading out (Y6018) or spreading in (Y6019).	I = 350–600 mA	Section 11 <i>Common electrics</i> , group 11.5.3.5 <i>Control unit, attachment</i> D7: Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.9.13 <i>ATTACH</i> , menu 13 and 8.4.9.14 <i>ATTACH</i> , menu 14
8	The servo valve for spreading out (Y6018) or spreading in (Y6019) pressurizes the spreader slide in the attachment's control valve.	-	<i>Attachment control valve, description page 59</i> D7: Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.9.13 <i>ATTACH</i> , menu 13 and 8.4.9.14 <i>ATTACH</i> , menu 14
9	The control valve's spreader slide changes position and directs pressure to the spreader motor.	-	<i>Attachment control valve, description page 59</i>
10	The motor valve block directs the pressure to the motor and prevents the motor from pumping (rotating faster than supplied pressure).	-	<i>Spreader motor valve block, description page 79</i>
11	The motor drives the chains that extend or retract the spreader beams.	-	<i>Spreader motor, description page 79</i>
12	The sensor for end position 20'-40' (B769) sends a voltage signal to the attachment control unit (D791-1).	Sensor directly opposite indicator plate: U > 24 V	<i>Position sensor spreading, description page 93</i> D12: Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.9.5 <i>ATTACH</i> , menu 5
13	The attachment control unit (D791-1) reduces control current to the servo valve for spreading out (Y6018) or spreading in (Y6019).	-	Section 11 <i>Common electrics</i> , group 11.5.3.5 <i>Control unit, attachment</i> D7: Diagnostic menu, see section 8 <i>Control system</i> , group 8.4.9.13 <i>ATTACH</i> , menu 13 and 8.4.9.14 <i>ATTACH</i> , menu 14